

ISSN 2669-0195 ONLINE

<http://doi.org/10.9770/IRD.2020.2.3>

# INSIGHTS INTO REGIONAL DEVELOPMENT

**Volume 2 Number 3  
September 2020**



ENTREPRENEURSHIP AND  
SUSTAINABILITY CENTER

**INSIGHTS INTO REGIONAL DEVELOPMENT**

ISSN 2669-0195 (online) <http://jssidoi.org/IRD/>

2020 Volume 2 Number 3 (September)

<http://doi.org/10.9770/IRD.2020.2.3>

The logo consists of a blue circle with a white rounded rectangle in the center. Inside the rectangle, the text "ENTREPRENEURSHIP AND SUSTAINABILITY CENTER" is written in blue, uppercase letters.

ENTREPRENEURSHIP AND  
SUSTAINABILITY CENTER

**Publisher**

<http://jssidoi.org/esc/home>

---

**Volume 2 Number 3 September 2020**

**INSIGHTS INTO REGIONAL DEVELOPMENT\***

---

*\* The journal was launched as a platform for dissemination of the project results, which has received funding from the European Union's Horizon 2020 research and innovation programme European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme Marie Skłodowska-Curie Research and Innovation Staff Exchanges ES H2020-MSCA-RISE-2014 CLUSDEVMED (2015-2019) Grant Agreement Number 645730730*



**European Research Council**  
Established by the European Commission

**INSIGHTS INTO REGIONAL DEVELOPMENT** ISSN 2669-0195 (online) is a peer-reviewed journal, which publishes original research papers and case studies. It is international journal published cooperating with universities, social companies, consultancies and associations. It is published quarterly.

Scope of research includes but is not limited to the following:

- Conceptual/Practical Approaches and Methodologies towards Sustainable Regional Development
- Globalization, Internationalization and Solutions for Low-Carbon Economies of Scope or Scale
- Innovations and Technology Transfer Pilot Results Advancing Regional Development
- Information Technologies (IT) and Information Communication Technologies (ICT) for Regional Development, and Socio-Economic Innovations
- Environmental Engineering for Sustainability and Regional Development
- Smart Electricity Grid Solutions for Sustainable Regional Development
- Entrepreneurship for Regional Development
- Safety and Regional Development
- Threats to Society, Entrepreneurship and Regional Development
- Security and Safety of Countries, Regions and Society as Precondition of Sustainable Regional Development
- Boarder Guard Issues and Regional Development
- Migration and Sustainable Regional Development
- Terrorism, International Crime and Secure Regional Development
- Security and Safety Models for Sustainable Regional Development
- Emerging Business Drivers, Opportunities, or Constraints in Future Sectors of Current Markets
- Retrofitting Techniques and Technologies Near-Zero Energy Demand Buildings and Regional Development
- Urban Planning and Advanced Construction Materials for Energy-Efficiency or Smart Cities
- Contemporary Regional Development in the Context of Security, Comfort, or Legislation
- PPPs for Developments in Sustainable Entrepreneurship, Finance, and Investments
- Accounting for Sustainable Regional Development
- Sustainable Regional Development in the Context of Management or Life-Long Learning
- Strategic Management Practices and Creative Marketing Techniques for Sustainable Regional Development
- Organizational Studies and Sustainable Regional Development
- Regional Development in the Context of Marketing, ICT, and Creative Industries
- Intercultural Communication for Sustainable Regional Development
- Institutions and Regional Development
- Case Studies on Entrepreneurship and Sustainable Regional Development
- Social Cohesion and Social Innovations for Regional Development
- Business Models and Strategic Management for Sustainable, Secure and Safe Futures
- Corporate Social Responsibility and Sustainable Regional Development
- Regional Development in the Context of Psychology, Education, or Women
- Intuitions about Emerging Phenomena in Regional Development
- Start-Ups, Spin-Offs, SMEs in the Context of Market Growth and Regional Development
- Global Value Chain Management for Sustainable Regional Development
- Knowledge Management for Sustainable and Safe Regional Development
- Legal Regulation Peculiarities Affecting Regional Development

### **Editorial correspondence including manuscripts and submissions:**

Prof. dr. Manuela Tvaronavičienė

Tel.: +37068783944

E-mail: [submissions@jssidoi.org](mailto:submissions@jssidoi.org) or [manuela.tvaronaviciene@jssidoi.org](mailto:manuela.tvaronaviciene@jssidoi.org)

## Editor-in-Chief

[Prof. Salvatore Monni](#), Roma Tre University, Italy

 <http://orcid.org/0000-0002-6326-5714>

## Editors

[Prof. Manuela Tvaronavičienė](#), Vilnius Gediminas Technical University, Lithuania

 <http://orcid.org/0000-0002-9667-3730>

[Prof. Wadim Strielkowski](#), Prague Business School, Prague, Czech Republic

 <http://orcid.org/0000-0001-6113-3841>

[Prof. Gil Vieira](#), Instituto Nacional de Pesquisas da Amazônia, Brazil

Author ID: 7005863986

[Dr. Ketí Lelo](#), Università degli Studi Roma Tre, Rome, Italy

 <http://orcid.org/0000-0002-2009-3772>

[Prof. Sebastian Kot](#), Management Faculty, Czestochowa University of Technology, Poland

 <http://orcid.org/0000-0002-8272-6918>

[Ms. Elisa Natola](#) CONFAP, Brazilian National Council of State Funding Agencies, Brazil

[Dr. Throstur Olaf Sigurjonsson](#), School of Business, Reykjavik University, Iceland [throstur\(at\)hr.is](mailto:throstur(at)hr.is)

Author ID: 35520490200

[Prof. Abel Femi Adekola](#), Wilkes University, USA

Author ID: 16302866000

[Prof. Fan Lü](#), Tongji University, Shanghai, China

 <http://orcid.org/0000-0002-8496-3941>

[Prof. Gilberto de Miranda Rocha](#), Federal University of Pará, Belém, Brazil

Author ID: 55813405600

[Prof. Marina Sheresheva](#), Lomonosov Moscow State University, Russian Federation

Author ID: 44662077400

[Prof. Dr. Sibylle Heilbrunn](#), Kinneret Academic College on the Sea of Galilee, Israel

Author ID: 16642930200

[Dr. Amr Radwan](#), Academy of Scientific Research and Technology

 <http://orcid.org/0000-0002-5567-6708>

[Prof. Armenia Androniceanu](#), The Bucharest University of Economic Studies, Faculty of Administration and Public Management, Bucharest, Romania

Author ID: 35253283800

[Prof. Najiba El Amrani](#), University Sidi Mohamed bin Abdellah, Faculty of Science and Technology, Fes, Morocco

Author ID: 56122394900

[Prof. Bora Aktan](#), University of Bahrain, the Kingdom of Bahrain

 <http://orcid.org/0000-0002-1334-3542>

[Prof. Gunnar Praise](#), Tallinn University of Technology, Estonia

 <http://orcid.org/0000-0002-3293-1331>  
**Prof. Vera Komarova**, Daugavpils University, Latvia

 <http://0000-0002-9829-622X>

**Prof. Fernando García**, Department of Economics and Social Sciences, Faculty of Business 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  
Author ID: 36680528200

**Prof. Ronaldo Lopes Rodrigues Mendes**, Federal University of Pará, Belém, Brazil

 <https://orcid.org/0000-0002-5584-8688>

**Dr. Andrea Bernardi**, Oxford Brookes University, UK

**Prof. Francesco Vigliarolo**, Universidad Católica de La Plata, Argentina

**Dr. Laima Gerlitz**, Wismar University of Applied Sciences, Wismar, Germany\_Author ID: 57015379200

**Dr. Federico Tomassi**, Agenzia per la Coesione Territoriale, Italy

**Dr. Kiran Javaria**, University of Lahore, Lahore, Pakistan

 <https://orcid.org/0000-0002-6147-5283>

**Prof. Maria da Gloria Gonçalves de Melo**, Universidade do Estado do Amazonas, Brazil



**Publisher**

<http://jssidoi.org/esc/home>



**Volume 2 Number 3**

**September 2020**

## CONTENTS

<b>Dr. Edoardo BERETTA and Prof. em. Dr. Alvaro CENCINI.</b> <b>FOREWORD</b>	609
<b>Edoardo Beretta, Alvaro Cencini</b> <b>DOUBLE-ENTRY BOOKKEEPING AND BALANCE OF PAYMENTS:</b> <b>THE NEED FOR DEVELOPING A NEW APPROACH</b>	610
<b>János Besenyő, Marianna Kármán</b> <b>EFFECTS OF COVID-19 PANDEMY ON AFRICAN HEALTH,</b> <b>POLITICAL AND ECONOMIC STRATEGY</b>	630
<b>Edmunds Čižo, Olga Lavrinenko, Svetlana Ignatjeva</b> <b>ANALYSIS OF THE RELATIONSHIP BETWEEN FINANCIAL</b> <b>DEVELOPMENT AND ECONOMIC GROWTH IN THE EU COUNTRIES</b>	645
<b>Francesca Mazzoni</b> <b>CIRCULAR ECONOMY AND ECO-INNOVATION IN ITALIAN</b> <b>INDUSTRIAL CLUSTERS.</b> <b>BEST PRACTICES FROM PRATO TEXTILE CLUSTER</b>	661
<b>Adetayo Olaniyi Adeniran, Oluwabukunmi Eunice Obembe</b> <b>THE SIGNIFICANCE OF STRATEGIC MANAGEMENT ACCOUNTING</b> <b>ON THE PERFORMANCE OF TRANSPORT BUSINESSES IN NIGERIA</b>	677
<b>Marcel Lincenyi, Michal Fabus.</b> <b>DEVELOPMENT OF THE RADIO MARKET IN THE SLOVAK REPUBLIC</b> <b>IN THE YEARS 2016 TO 2019</b>	689
<b>Tomas Plěta, Manuela Tvaronavičienė, Silvia Della Casa,</b> <b>Konstantin Agafonov</b> <b>CYBER-ATTACKS TO CRITICAL ENERGY INFRASTRUCTURE</b> <b>AND MANAGEMENT ISSUES: OVERVIEW OF SELECTED CASES</b>	703





**FOREWORD to**  
**INSIGHTS INTO REGIONAL DEVELOPMENT**  
2020 Volume 2, Number 3 (September)

*Dear readers,*

*Regional development has become despite or, perhaps, because of globalization a fundamental aspect in 2020. Regionality has been progressively accepted as a sustainable way to strengthen the enduring macro-trends towards growing commercial and financial interconnectedness, while it is indisputable that globalization is made of several regional social, economic and cultural realities that must be taken into consideration.*

*A powerful instrument to measure economic relations between countries and regions of the world is, for example, the balance of payments which records all commercial and financial transactions of private/public residents with the rest of the world. As the first paper of this issue of "Insights into regional development" shows, this tool should be consistently adapted on the basis of its double-entry bookkeeping approach so that the residents' economic contribution to economic growth is finally better displayed. By making it a reliable (i.e. not by errors and omissions biased) account of all international transactions, the balance of payments would become the most significant instrument to trace regional economic development.*

*The presence of this paper, based on a new monetary approach to macroeconomics, is the mark of the open-minded orientation of the Editors of this scientific journal. Obviously enough, this is just one among several approaches analyzing regional development, yet it provides an insight that might prove useful to the development of new lines of research.*

*With our respectful greetings,*

**Dr. Edoardo BERETTA**

and

**Prof. em. Dr. Alvaro CENCINI**

*The Università della Svizzera Italiana*  
**Lugano Switzerland**



**Publisher**

<http://jssidoi.org/esc/home>



---

## DOUBLE-ENTRY BOOKKEEPING AND BALANCE OF PAYMENTS: THE NEED FOR DEVELOPING A NEW APPROACH\*

Edoardo Beretta <sup>1</sup>, Alvaro Cencini <sup>2</sup>

<sup>1,2</sup> *Università Della Svizzera Italiana (USI), Via Giuseppe Buffi 13, Lugano, Switzerland*

E-mails: <sup>1</sup> [edoardo.beretta@usi.ch](mailto:edoardo.beretta@usi.ch); <sup>2</sup> [alvaro.cencini@usi.ch](mailto:alvaro.cencini@usi.ch)

*Received 20 March 2020; accepted 25 April 2020; published 30 September 2020*

**Abstract.** On the basis of the identity between each country's global imports (commercial and financial) and exports (commercial and financial), which is one of the fundamental economic principles of the balance of payments, the paper highlights why and how the leading account of transactions from/to the rest of the world needs to be reformed. As a strategic goal, the balance of payments should finally move beyond its current purely statistical and simple-entry bookkeeping approach in order to improve its macroeconomic relevance. This would also imply a new way of carrying out cross-border payments, which could in turn pave the way for a new system of international payments. The development of an economic account of the nation as a whole and the introduction of a consistent way of recording transactions following a truly double-entry bookkeeping would also erase statistical discrepancies *ex ante* and reflect the necessary equality (identity) of credits and debits both for all transactions taken together and for each of them separately. The balance of payments is already a powerful economic tool, but only through a money-consistent reform would it display its full potential.

**Keywords:** balance of payments; double-entry bookkeeping; nation's economic account; reserve assets

**Reference** to this paper should be made as follows: Beretta, E., Cencini, A. 2020. Double-entry bookkeeping and balance of payments: the need for developing a new approach. *Insights into Regional Development*, 2(3), 610-629. [https://doi.org/10.9770/IRD.2020.2.3\(1\)](https://doi.org/10.9770/IRD.2020.2.3(1))

**JEL Classifications:** B27, F32, F33, P33

---

\* *This research was partly supported by the project, which has received funding from the European Union's Horizon 2020 research and innovation programme European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme Marie Skłodowska-Curie Research and Innovation Staff Exchanges ES H2020-MSCA-RISE-2014 CLUSDEV MED (2015-2019) Grant Agreement Number 645730730*



**European Research Council**  
Established by the European Commission



## 1. Introduction

We can preliminarily (and safely) state that the balance of payments, namely “a statistical statement that systematically summarizes, for a specific time period, the economic transactions of an economy with the rest of the world” (International Monetary Fund, 1997), is the most relevant external statistical document registering all international (traceable) commercial and financial transactions between countries. It is common knowledge that this statistical tool can be separated into a “current account” and a “capital and financial account”. “Reserve assets”, which are a subcategory of the capital and financial account, mainly keep track of variations in official reserves made up of foreign currencies, precious metals and SDRs. Equally, there cannot be any uncertainties with specific regard to the double-entry bookkeeping principles ruling the balance of payments, namely that “every recorded transaction is represented by two entries with equal values. One entry of these pairs is designated a credit with a positive arithmetic sign, the other is designated a debit with a negative sign” (International Monetary Fund, 1997). So far, nothing new or original. And this is precisely the risk with today’s view of the balance of payments, that it may be interpreted (wrongly) as a mere tautological statement. Far more interesting, however, because they are largely neglected:

1. the double-entry bookkeeping logic behind the balance of payments *as conceived today* (positive analysis);
2. the double-entry bookkeeping logic behind the balance of payments *as it should be conceived in future* (normative analysis) to formulate a statistically-relevant statement coherent with the essence of modern money and a true system of international payments.

We begin by analyzing point 1., which refers to the current notion of balance of payments: its *equilibrium* results from “real” flows (cf. current account) matching “financial” flows (cf. capital and financial account). Under these conditions “[t]he balance of payments must accordingly be looked at as a whole rather than in terms of its individual parts” (Stern, 1973). However, a similar approach appears to be somewhat reductive since a situation of equilibrium between two distinct transactions reflects a simple-entry rather than double-entry bookkeeping logic. In fact, it would be simplistic – therefore, wrong – to claim that our purchase is our foreign correspondent’s sale (which is a truism), when the logic of double-entry bookkeeping requires both his and our purchases to be matched by simultaneous and equivalent sales. Hence, a second approach (cf. point 2.) should be explored, namely one reflecting a *truly* double-entry bookkeeping approach. More precisely, the paper will:

- show that every net buyer (seller) on the commercial market (cf. goods/services) *must be* a net seller (buyer) on the financial market (cf. securities);
- re-imagine the role of the “reserve assets” item and, more generally, of international reserves in the balance of payments itself.

The article will, first, deal with the identity between each country’s global imports, commercial and financial, (IM) and its global exports, commercial and financial, (EX), which are explained in Part 1. In Part 2, we will highlight the way in which the current account and capital and financial account are involved in the external transactions of a country. Part 3 will clarify why the reserve account (including the so-called “reserve assets”) is the account of a country taken as a whole, while Part 4 will explain why today’s system of international payments fails to recognize the existence of countries as sets of their residents. The methodological approach adopted will be mainly logical-analytical, supported by insights from statistical and numerical evidence.

## 2. The identity between each country's global imports (IM) and its global exports (EX)

The starting point of the entire discussion is that “countries’ international transactions have to comply with the balance of payments identity  $IM \equiv EX$ , where IM stands for the totality of a country’s imports, financial and commercial, and EX represents the totality of its exports, both commercial and financial, and [...] this is so even when their overall imports exceed their overall exports [or vice versa]” (Cencini, 2017). In other words, even where a current account surplus (deficit) clearly represents a positive (negative) disequilibrium of the transactions recorded therein over those registered in the capital and financial account, the balance of payments itself is perfectly balanced. This means that all the operations in all the accounts taken together are necessarily equal to zero. “As with any other account, the total receipts of a country are bound to be equal to the total payments of that country, if one includes all the receipts and all the payments of the country in the account” (Meade, 1970).

Bearing in mind that “gold” is no longer used to settle international transactions and that the “purchasing power” used to cover a commercial imports surplus derives from corresponding excess financial exports (current account deficits are financed by an equivalent sale of financial claims as registered in the capital and financial account), total receipts (+) are necessarily equal to total payments (-). Or, as formulated by Krugman and Obstfeld (1997), “this principle of payments accounting holds true because every transaction has two sides: if you buy something from a foreigner you must pay him in some way, and the foreigner must then somehow spend or store your payment”. This axiom could be translated as follows: if subject A in country A buys (sells) – either goods and services (cf. current account) or financial claims (cf. capital and financial account) – from (to) subject B in country B, he will necessarily have to sell (buy) goods, services or financial claims to finance his purchases. In other words, “[l]ooked at more closely [...] Krugman and Obstfeld’s quote discloses the presence of a fundamental law guaranteeing the necessary duality between each resident’s sales and purchases. In fact, if the foreigner from whom a resident buys must spend his payments – if he stores it, he spends it for the purchase of claims on bank deposits –, this means that the purchase of a resident is necessarily matched by an equivalent sale and that, reciprocally, the sale of the foreign correspondent is balanced by a purchase of the same amount” (Citraro, 2004).

Both individuals are, inevitably, commercial and/or financial buyers and purchasers at the same time and within every transaction. As we shall see, because of the flow nature of money, the law of the necessary equality of sales and purchases applies also when transactions concern countries considered as sets of their residents. Although bank money continues to be misinterpreted as an asset or a commodity, it is a fact that (“[money is] a circular flow that does not survive the payment occurring during a transaction between two economic agents in a capitalist economy [...]. [T]he instantaneous reflux of money to its point of origin cannot be identified with an equilibrium condition that might be satisfied (or not). It is, in fact, a fundamental law of bank money that will always be logically true, regardless of the behavior of economic agents” (Pilkington, 2007)). But let us for a moment suppose that money is in fact an asset: if so, (inter)national exchanges would split up into two non-simultaneous transactions. Goods/services/financial claims of resident A in country A against a sum of money of resident B in country B would mean a sale for the former and a purchase for the latter. At the same time, as described by Cencini (2005), “[m]oney being also considered as a simple veil, the seller will later become a purchaser, yet sale and purchase will be equivalent only at equilibrium (which is but one possible outcome of economic agents’ behaviour), and they will remain two chronologically distinct events”. In reality, issued by banks as a spontaneous acknowledgement of debt of zero intrinsic value, money is a vehicular means by which payments are carried out and not the object of these payments. By its own nature, money is a flow and not a stock. So, payments that are *conveyed* by money must have a real stock of produced goods and services as their *real content*. As monetary payments obey the principle of double-entry bookkeeping; each agent entering an exchange is simultaneously credited and debited by the same amount of money, whose circular flow is instantaneous. Money is present in each payment and flows immediately back to its point of injection as soon as the payment is completed. Finally, the terms of any exchange are real goods, present and future, conveyed through the circular flow of money. Being

at the same time credited (debited) and debited (credited) for the same amount of money, economic agents are therefore, simultaneously, sellers (buyers) and buyers (sellers) of real goods (either in the form of produced goods and services or in that of financial claims).

The formulations above describe the so-called “law of the identity between each agent’s sales and purchases” formulated by Bernard Schmitt (1975). In fact, based on the circular essence of bank money, every net buyer (seller) on the commercial market (cf. goods/services) must be a net seller (buyer) on the financial market (cf. securities). Put another way, an economic subject has to finance his purchases by a concurrent sale and - each time he sells - he must concurrently purchase. If this holds true for the individual agent, it is equally possible to treat the country itself (the set of its residents) as “a single macroeconomic agent acting on the commodity and financial markets. Hence, in the same way as any single resident can finance his purchases only through equivalent sales, a country can finance its commercial and financial imports only through equivalent sales of goods, services, and financial assets” (Cencini, 2005). This is confirmed by the IMF *Balance of payments manual*, which states that “[m]ost entries in the balance of payments refer to transactions in which economic values are provided or received in exchange for other economic values. These values consist of real resources (goods, services, and income) and financial items. Therefore, the offsetting credit and debit entries called for by the recording system are often the result of equal amounts having been entered for the two items exchanged” (International Monetary Fund, 1993). The terms “goods, services, and income” refer to the current account, while “financial items” refer to the capital and financial account.

Let us take the example of the payment of a reserve currency country’s net imports (the case of the United States of America). The American nation would pay for its net purchases of goods and services by transferring a certain amount of its domestic currency (\$100) to its foreign creditors in the rest of the world. Apparently, U.S. net commercial purchases are not matched by any sale. However, this conclusion cannot be right since it openly contravenes the fundamental reciprocity implied by double-entry bookkeeping. At the same time, since money is a circular flow, there cannot be any net transfer of US Dollars to the rest of the world. This means that the payment by the American banking system does not prevent - why should or how could it? - the immediate reflux of US Dollars to their point of departure. But, once again, is this not another way of saying that US net commercial purchases remain unmatched by equivalent sales? It is not. In fact, if on the one hand money units (\$100) are immediately recovered by the American banking system, on the other hand the rest of the world obtains, through the circular flow of US Dollars, a financial asset (a claim on US bank deposits) while the American nation obtains an equivalent amount of domestic output of the rest of the world. This example may be expressed in numerical terms (Table 1). On the one hand, US importers pay for their outstanding commercial transactions (\$100). On the other hand, exporters from the rest of the world (RW) receive the countervalue in domestic money (x units of MRW) on their bank accounts. This is precisely the way any transaction is settled from an individual perspective. Thus, the debtor pays and gets rid of his liability by means of his domestic currency (\$100) - regardless of whether the country is a reserve currency or a non-reserve currency one - while the creditor is paid in his own domestic currency (x units of MRW).

The U.S. Central Bank takes over the payment of its local importers and transfers it to the banking system of the rest of the world. The Central Bank’s monetary intermediation makes it possible for US importers to pay in their local currency (\$100) - of course, in the American case this is also helped by the privileged status of the US Dollar (“the United States has the privilege of being able to pay its debts in an international means of payment which it can print itself, and which is accepted by the international banking system” (Teunissen, 1987)), yet the payment process would work in the same way for any other payer in the rest of the world - while the payee gets the countervalue in his local currency. What happens in between is the “monetization of an external gain” by the banking system (represented by its central bank) of the rest of the world, RW, which stores the US Dollar amount in its foreign currency reserves while it creates the countervalue in local money units to the benefit of RW’s exporters.

**Table 1.** Payment of a reserve-currency country's net imports

US banking system (with net commercial deficit)			
<i>Liabilities</i>		<i>Assets</i>	
Banking system of RW	\$100	US importers	\$100

Banking system of RW (with net commercial surplus)			
<i>Liabilities</i>		<i>Assets</i>	
Exporters of RW	$x \text{ units of MRW}$	US banking system	\$100

Source: own representation based on Cencini (2005)

Therefore, US importers pay \$100 while exporters from the rest of the world (RW) receive  $x$  units of MRW. The transaction is settled from a microeconomic perspective. Let us now look at what happens on a macroeconomic level, namely between countries as sets of residents. The US banking system enters the payment in the banking system of the rest of the world (RW) under its liabilities (\$100) whereas the banking system of the rest of the world (RW) enters the payment received under its assets (\$100). Even though the US can pay for its net imports in US Dollars, their payment obeys the same rule applying to any other country. Indeed, the flow nature of money and the compliance with double-entry bookkeeping are such that the Dollars paid to RW flow immediately back to the US banking system. Net purchases of commercial goods from R, the USA is therefore, at the same time and for the same value, a net seller of financial claims on US bank deposits. Hence, each country's purchases, commercial and financial, are funded by equivalent and simultaneous sales.

- US economy:
  - o net purchase of goods/services from RW (-\$100);
  - o net sale of a claim on domestic income, namely national bank deposits (+\$100);
- Rest of the world's (RW's) economy:
  - o net purchase of a claim on US income, namely national US bank deposits (-\$100);
  - o net external sale of goods/services (+\$100).

If mainstream economics remarks that “[a]lthough the balance of payments accounts are, in principle, balanced, imbalances result in practice from imperfections in source data and compilation” (International Monetary Fund, 2009) and the aggregate sum of debts and credits has to be specifically offset by an item called “net errors and omissions”, it is because it is *de facto* neglecting that the balance of payments is not based on an equilibrium, but on an “identity” (International Monetary Fund, 2009). In other words,  $CAB + CFAB \equiv 0$  where CAB corresponds to the current account and CFAB to the capital and financial account balance “Alternatively, it could be said that the current account balance is equal to the sum of balances on the capital and financial accounts (with signs reversed, if necessary, depending on the presentation used) including reserve assets” (International Monetary Fund, 2009). Yet, accepting that today's balance-of-payments entries are often derived independently from different sources (with consequent risk of time lags) confirms once again the implicitly underlying single-entry bookkeeping conception and reduces the balance of payments itself to a mere collection of statistical data instead of being a clear-cut T-account of all external transactions.

### 3. The involvement of current account and capital and financial account in countries' external transactions

Current account and capital and financial account play a role not only in the transactions carried out by countries' residents, but also in the impact of these transactions on the international investment position of countries considered as sets of their residents. The aim of this section is to verify to what extent this involvement is influenced by whether the present system of international payments complies with the principle of double-entry bookkeeping. Carried out by countries' residents, cross-border payments concern the systems of national and of international payments. Both are founded on the use of bank money, hence on the necessary equality, the identity, of credit and debit. Economists all over the world accept this identity, which is nothing other than the principle of double-entry bookkeeping. Within nations, national banking systems function consistently with this principle, while at the international level balances of payments are, at least in theory, assumed to adopt it as a necessary reference. Is this enough? Can double-entry be considered as a guiding principle, as a reference, or as a point of equilibrium that can only be approximated but hardly ever or very seldom reached? We shall argue that the answer to both questions is no. In no way can logical identity be avoided; but neither can it ever become a condition of equilibrium. If, nonetheless, it is not complied with, a disorder ensues, which weighs heavily on countries and their residents. It is an indisputable fact that cross-border transactions take place between the residents of any given country and those of the rest-of-the-world. This is true even in the case of public transactions, for the simple and obvious reason that public institutions as well as the State itself are residents of their own country. Whether public or private, international payments are carried out by banks in compliance with the double-entry bookkeeping rule establishing the necessary correspondence of credits and debits. If a resident  $a$  of country A purchases commercial goods or financial assets of a value equal to  $x$  units of money A, MA, from a resident  $b$  of country B, it is tautological to say that  $a$ 's purchases are  $b$ 's sales. It is also a truism to claim that the payment of  $a$ 's purchases defines the debit of  $a$ 's bank account and the equivalent credit of  $b$ 's bank account. If nothing more could be said about this payment, we would have to conclude that double-entry is nothing more than the matching of two separate entries in two distinct accounts, each entry being in all respects *simple*. Reality is far richer: double-entry entails both the debit *and* the credit of *each* agent involved in any transaction, national or international. In our example, agent  $a$  can pay for its international purchases only if it holds the amount of income required to finance them. Only two possibilities are relevant: either  $a$  is the holder of a previously earned income deposited in its bank account, or it obtains it through a sale of claims on the financial market (we leave aside gifts and inheritance, because irrelevant here). In the first case, when  $a$ 's bank pays  $b$  on behalf of its client, it credits  $a$  with  $x$  MA, because  $a$  gives up  $x$  MA of its bank deposits, and immediately debits it with  $x$  MA, because of  $a$ 's payment in favour of  $b$ . A bank deposit is a claim on the bank in which it is formed. When  $a$  gives up its claim or part of it, the bank cancels a debit and credits  $a$  with the amount of money previously deposited. In the second case, assuming that  $a$  sells a sum of financial assets equal to  $x$  MA and immediately spends the  $x$  MA it obtains in order to pay  $b$ , it is clear that  $a$  is at once credited and debited by its bank for an amount of  $x$  MA. The logical identity of  $a$ 's debit and credit appears in all its clarity if we drop the restrictive assumption introduced in the second case. Indeed, the introduction of a time interval separating  $a$ 's sales of financial assets from its commercial purchases from  $b$  allows us to dispel the impression that, at least in the second case, the couple credit-debit can be obtained through two distinct, but simultaneous, operations on two different markets. Indeed, if  $a$  sells financial claims worth  $x$  MA at time  $t_0$  and purchases  $b$ 's goods at time  $t_1$ , the credit-debit identity is verified both at  $t_0$  and at  $t_1$ . To verify this, one only needs to observe that at the very instant  $a$  is credited with  $x$  MA because of its financial sale, it is also debited with the same amount following the immediate deposit of  $x$  MA in its bank account. As a result of its sale of financial assets,  $a$  owns a right on a bank deposit and not a sum of money, of which it has been debited. At the later instant  $t_1$ , when  $a$  purchases from  $b$ , it is likewise credited, because of the cancellation of its bank deposit, and debited, because of the payment of  $b$ .

The analysis of what happens to  $b$  is straightforward, since it is simply the mirror image of what applies to  $a$ . Credited in money B, MB, for its commercial sales to  $a$ ,  $b$  is at the same time debited by its bank, where the  $y$  MB (if  $x$  MA =  $y$  MB) are instantly deposited. Identity credit-debit applies to each single economic agent and to each



single transaction. A mere transposition of the principle of double-entry bookkeeping, this identity can also be expressed, as Schmitt did (1975), as the law of the necessary equality between each single agent's sales and purchases. This means that every single transaction on any market is necessarily balanced by an immediate reverse transaction on another market. Let us refer once more to our simplified example. When agent *a* is a purchaser on the trade market of *b*'s goods, Schmitt's law states that *a* is also, at the same time, a seller on the financial market. Bank deposits are financial claims, so that when *a* gives back to its bank the rights on its bank deposits it is indeed selling an amount of financial assets. Finally, *a*'s net commercial purchases of *b*'s real goods are financed by equivalent and simultaneous sales of financial claims. Agent *b*, on the other hand, balances its commercial sales to *a* with an equivalent purchase of financial assets, claims on the bank where the proceeds of its sales are deposited.

It is thus confirmed that payments between residents, whether of the same country or of different countries, comply with the identity of their debits and credits, each purchase being financed by an equivalent and simultaneous sale. In other words, this means that money intervenes to convey reciprocal exchanges the objects of which are commercial and financial assets. Perfectly in line with Adam Smith's definition of money as the 'great wheel of circulation' (Smith, [1776] 1978), this notion of money as a 'vehicle' is the only one compatible with double-entry bookkeeping. In our example, MA and MB convey the payments between *a* and *b*; yet, neither MA, nor MB are an object of exchange. What agent *a* gives in exchange for a sum of goods sold by *b* is not a sum of MA, nor is it a sum of MB in which MA is transformed. Both MA and MB are vehicular means of payment; through their circular flow *a* and *b* exchange commercial goods against financial assets. Does the circular flow of money occur also when countries take over the foreign payments of their residents? This question calls for an analysis of the involvement of countries in the cross-border payments of their residents, State included.

The need to transfer abroad the cross-border payments initially made in national currency by their residents, leads to the direct involvement of their countries. If residents of country A are net importers of commercial goods from the rest-of-the-world, R, it is country A that is a net commercial importer, even though A's imports may not be traced back to any specific importer or exporter. The role of countries, or of their central banks, is to convert the payment in national money of their residents into a payment in foreign currency. In other words, they must convey through the 'international space' the external payments initially carried out in domestic currency. As officially recognized by international institutions such as the IMF and the WB, international transactions carried out by countries must comply with the balance of payments identity between entries in CA and entries in the CFA, the CA being the mirror image of the CFA. The necessary equilibrium between the transactions entered in the CA and those entered in the CFA means that a country's net commercial imports (resp., exports) must be balanced by equivalent net financial exports (resp., imports). Hence, A's net trade surplus is immediately matched by an equivalent deficit of its CFA. This is so because the payment of A's net imports gives rise to an inflow of foreign currencies into country RW, which are immediately invested in A. It is thanks to this investment, corresponding to the purchase by RW of an equal amount of A's financial assets, that A can finance its net commercial purchases from R.

Expressed as the identity between each country's global imports, IM, and its global exports, EX, the balance of payments identity is a logical principle accepted worldwide. If it were duly complied with, it would guarantee the vehicular use of any currency used to carry out international payments. The  $IM \equiv EX$  identity establishes on logical grounds the fact that the terms of any international exchange are always and necessarily real goods, either in the form of commercial goods or of financial assets. If the trade balance is in equilibrium, both terms of the exchange are actual goods. If it is not, the difference is an exchange between present goods and future goods, the latter being the object of the financial claims the export of which matches the net import of commercial goods. Being carried out in bank money, international payments taken over by countries are made through debits-credits and credits-debits, which implies that money is never the object of any payment. As in the case of payments analysed from the viewpoint of residents and non-residents, each country entering international exchange is



debited-credited or credited-debited anytime it carries out, or is the beneficiary of, a foreign payment. Let us consider the case where country A is paid by R, in MRW, for its sales of part of its domestic output. As soon as A is credited by RW of a sum of MRW it is debited by the same amount: issued by the banks of R, MRW flows immediately back to its point of departure (double-entry bookkeeping requires it), and in exchange for its commercial exports, A is credited with an equivalent claim on RW's banks, that is, with a claim on a bank deposit in R.

As countries carry out the cross-border payments of their residents, it is not surprising that they are subject to the same rules as their residents. They are involved by implication and their payments are the mere transposition at the international level of those carried out by national importers. The use of banknotes is no exception to the law. It is indisputable, in fact, that banknotes are posit certificates of their issuing bank, which clearly shows that even paid in banknotes, commercial exports (imports) are immediately matched by equivalent imports (exports) of financial claims. It is thus confirmed that, between countries, 'each commercial payment is a financial payment of inverse algebraic sign, [and] each financial payment is a zero-sum transaction unless it is founded on a commercial payment of opposite sign' (Schmitt, 2008 [our translation]). As a consequence of the identity  $IM \equiv EX$ , money is nothing more than an intermediary, a circular means of payment that never replaces the real terms, commercial and financial, of any international transaction.

Actually, the preceding conclusion must be somewhat qualified, because it describes the logical nature of international payments and not the way the present system works. IMF and WB experts say that '[i]n principle, the current and capital accounts should be mirror images' (International Monetary Fund, 1987). What is emphasized here is the existence of a discrepancy between theory and practice, between the way the system of international payments *should* work and the way it *actually* works. In its present form, the balance of payments is a mere collection of statistical data and not a true bookkeeping representation of countries' foreign transactions and payments. We are thus confronted with a number of inconsistencies, such as those denounced by the IMF Working Party in 1987 and concerning the non-zero amount of the world's CA, which indicates the presence of a disorder the consequences of which, countries' over-indebtedness, are disastrous for countries and their residents.

The relevance of the principle of double-entry bookkeeping for the correct analysis of monetary payments, national and international, as well as for the implementation of an improved methodology of the balance of payments is indisputable. Unfortunately, so far economists have failed to apply this principle in its most elaborate form. By erroneously identifying double-entry with *simple* double-entry (a mere tautology) rather than with *double* double-entry, each entry being simultaneously a debit-credit or a credit-debit, they have failed to fully recognize the flow nature of money. The balance of payments in its present form is a direct implication of this truncated conception of double-entry, an analytical instrument not entirely fit for purpose and that must be re-elaborated according to the true principle of debits-credits and to Schmitt's law of sales-purchases.

#### **4. The reserve account (including so-called "reserve assets") is the account of a country taken as a whole**

There is no doubt that "country boundaries recognized for political purposes may not always be appropriate for economic purposes" (International Monetary Fund, 1993). More generally, we have already mentioned that the economic (monetary) definition of "country" or "nation" relies on the money unit involved (US Dollar, Euro, Swiss franc, etc.) and the corresponding banking system (the American, European, Swiss, etc.). By way of example, "the United States of America are a single country from an economic point of view, since a common money unit has legal validity within this geographical region. [...] In each country, banks are organized according to a pyramidal scheme while the central bank tops this banking structure" (Schmitt, 1990 [our translation]). Hence, the monetary unit of physical production, which is used in the payment of wages (monetizing new goods/services and determining national income), has a crucial role in defining each country's monetary space.

According to the International Monetary Fund (2009), “[i]nternational accounts can be compiled in the domestic currency as well as in another currency. Data in domestic currency are needed because several other macroeconomic and micro data are compiled in domestic currency, except when a foreign currency is used as a legal tender”. Therefore, economic data also contained in international accounts like the balance of payments are compiled in a so-called “reference unit of account”, which mostly corresponds to the national currency. The sixth edition of the *Balance of payments and international investment position manual* rightly reminds us of the distinction between “currency of denomination” (corresponding to the national one in which data are expressed) and “currency of settlement” (corresponding to the national and/or foreign currencies used in the payment itself).

Foreign currencies (for instance, used by foreign trading partners and accepted by national ones) play a major role in external trade. Not surprisingly, the balance of payments also records a statistical item called “reserve assets”, which “are readily available to and controlled by monetary authorities for meeting balance of payments financing needs, for intervention in exchange markets to affect the currency exchange rate, and for other related purposes (such as maintaining confidence in the currency and the economy, and serving as a basis for foreign borrowing)” (International Monetary Fund, 2009). At the same time, “foreign currency liquidity” represents a broader concept than “reserve assets” or “international reserves”, because it “concerns foreign currency resources and drains on such resources of the monetary authorities and the central government [...], relates to the authorities’ foreign currency claims on and obligations to residents and nonresidents and [...] encompasses inflows and outflows of foreign currency that result from both on and off -balance-sheet activities of the authorities” (International Monetary Fund, 2013). Regardless of whether “reserve assets” or “foreign currency liquidity” are specifically involved, it remains true that the flows of net foreign currencies modify the International Investment Position (IIP) of countries defined as “sets of their residents”.

Let us separate this assertion into two logically distinct parts, of which the first is the more intuitive. In fact, since “the difference between the assets and liabilities is the net position in the IIP and represents either a net claim or a net liability to the rest of the world” (International Monetary Fund 2019, Internet), it goes without saying that net foreign currency outflows (resp., inflows) reduce (resp., increase) the net claims of a country as whole. The second part of the previous statement is equally true, but needs a more articulated explanation. In fact, we have to demonstrate why countries have to be conceived as “whole sets of their residents” instead of the more intuitive formulation of “aggregate or sum of their residents”. More precisely, countries or nations are monetarily speaking the “set of their private/public economic subjects (including the State)”. Why the term “State” is not synonymous with “nation” or “country” is plain to see, since the public sector is nothing more than a part, a component, of the economy as a whole (which includes also private, financial and non-financial subjects). But, why would it be wrong to claim that countries do not correspond to the simple aggregate of all (private and public) economic subjects? While the concept of “sum” quite simply implies that all economic actors ( $S_1, \dots, S_n$ ) of the nation are to be taken together:

$$\text{country} = \Sigma(S_1, \dots, S_n),$$

a “set” is not limited to their aggregation. If we graphically represent the macroeconomic concept of “country” by means of an ellipse or a circle containing several elements (national private-public residents), the “set” would correspond to the ellipse/circle as a whole (all its components, including its perimeter):

$$\text{country} = \Sigma\{S_1, \dots, S_n\}.$$

In Aristotle’s [5<sup>th</sup> century BC] (2016) *Metaphysics*, we find a sentence that has often been quoted, and which quite aptly encapsulates or supports our own thought: “ἀλλ’ ἔστι τι τὸ ὅλον παρὰ τὰ μέρη”, namely “many things have a plurality of parts and are not merely a complete aggregate but instead some kind of a whole beyond its parts”.

Evidently, the concept of “sum of residents” is more immediate, but also relies on purely micro-founded assumptions implying that macroeconomic analysis can be simply derived by considering a sufficiently high number of microeconomic situations, agents etc. As reminded by Cencini (1997), “[i]n the same way as the set is richer than its constitutive elements, the nation is a whole which acquires an existence which is partially autonomous from that of its residents. [...] However, if it is correct to claim that a set cannot be reduced to the sum of its elements, this does not mean that the situation of the set has to be cumulated with that of its elements”. For instance, a major logical-analytical proof that the country as a whole is – economically speaking – distinct from the sum of its elements is provided by the essence of international reserves themselves, which are, indeed, owned by countries.

Obviously, trade with the rest of the world is the first source of accumulation of foreign exchange reserves. For example, suppose that country A records a commercial export surplus (+100 MA) with country B, a net commercial importer (-100 MB) and that the exchange rate is of 1 MA to 1 MB. What happens as soon as the residents of country B settle their excess purchases of goods and services from A? The payment of B’s importers (100 MB, namely the equivalent of 100 MA) is made possible by the existence of bank deposits owned by the commercial importers in country B. Then, the payment is taken over by the central bank and the corresponding banking system. If MB is a key currency, the latter send this amount (100 MB) to the central bank of country A, which in turn is responsible for crediting the banking deposits of the commercial exporters in country A. The central bank of nation A - after recording the 100 MB received from B in its international reserves, which confirms that net commercial exports contribute to the accumulation of foreign exchange reserves - has in the meantime issued 100 MA to the benefit of its commercial banks. In fact, there is no doubt that bank customers always make and receive payments in the currency denomination of their bank deposit. This occurs simply because of the banking intermediation of the central bank at the top of each national monetary space. In other words, the central bank of country A monetizes the external profit deriving from A’s trade surplus (100 MB) by issuing the countervalue in local currency (100 MA) accruing to commercial exporters.

Hence, international reserves are managed by the central bank on behalf of the country as a whole. More precisely, commercial exporters in country A having been credited with the due amount of 100 MA no longer have any outstanding claims. The fact that “underlying the BPM5 concept of reserves are the notions of “effective control” by the monetary authorities of the assets and the “usability” of the assets by the monetary authorities” (Kester, 2001) does not contradict the logical-analytical conclusion that international reserves do not (monetarily speaking) pertain to any specific resident. Neither do they belong to the State, which might have contributed to their accumulation just by transacting with the rest of the world and which administers them through the central bank. The balance of payments should, therefore, distinguish more unequivocally between the “origin” (residents of the country), “administration” (the central bank) and “economic ownership” (the country as a whole, namely as “set of its residents”) of foreign exchange reserves. A similar distinction is precisely necessary, because countries are not just identifiable with the aggregate of all physical/legal persons, defined as their residents.

Issued by a domestic banking system, a country’s national currency is an acknowledgment of debt of the whole system. Outside its country of origin, a national currency defines the debt of the country as a whole, independently of the situation of its residents. Consider, for example, the case of a single import of resident *a* of country A. In order to get rid of its debt, due to its imports, *a* must credit its bank with an amount of MA sufficient to pay its foreign creditors. Once it has paid for its foreign purchases, *a* is no longer indebted to anyone. Yet, its country is far from being quits. If A is a key-currency country, the payment of *x* units of money A, *x* MA, to RW ends up with the transfer to RW of an amount, equal to *x* MA, of claims on bank deposits formed in A’s banking system. The transfer of financial claims from A to B defines a foreign debt of country A that does not correspond to a debt of any of its importers. This conclusion holds true even if MA, a key-currency, is wrongly considered as a net asset by RW and entered by RW’s banking system as the final payment of RW’s net exports. Being issued as a spontaneous acknowledgement of debt by A’s banking system, the MA entered on the assets

side of RW's banks defines the acknowledgement of debt of country A itself, which does not match any debt of its resident *a*.

*Ad absurdum*, if a country were solely represented by the sum of its residents, having settled the above-mentioned commercial transaction the nation as a whole would not record any net commercial surplus (deficit) in the balance of payments. In reality, the external profit of country A deriving from excess trade with the rest of the world represents a claim against country B and, therefore, a (spontaneous recognition of) debt of the corresponding banking system. The fact that country B still enters a net commercial deficit (-100 MB) even though commercial exporters in nation A have been finally paid constitutes the stringent proof that "a nation can be creditor[/debtor] independently of the creditor[/debtor] position of its residents. [...] once they have been paid by their banks, A's exporters no longer own any credit on their foreign correspondents and yet country A is a net creditor" (Cencini, 2005). Even legally there is no doubt that international reserves do not belong to a central bank or any other specific resident, as art. 3 of the Bundesbank Act reminds us ("[the Deutsche Bundesbank] hold[s] and manage[s] the foreign reserves of the Federal Republic of Germany" (Deutsche Bundesbank 2013, Internet) or art. 127 para. 2 of the Consolidated version of the Treaty on the functioning of the European Union ("the ESCB [...] hold[s] and manage[s] the official foreign reserves of the Member States" (European Union 2012, Internet)). Even when international reserves are owned by the central bank ("The Bank of Italy owns and manages the country's official reserves in foreign currency and gold" (Banca d'Italia 2019, Internet)), the central bank is acting on behalf of the undifferentiated set of the country's residents. This does not alter the initial claims according to which net foreign currencies' flows modify the IIP and this affects the country as a whole (not any specific private or public individual).

The fact that public (the State) and private institutions as well as individuals are elements of a whole defined as their country is implicitly confirmed by the IMF ("The sectors of an economy are composed of [...] (i) households and individuals who make up a household and (ii) legal and social entities, such as corporations and quasi-corporations (e.g., branches of foreign direct investors), nonprofit institutions, and the government of that economy" (International Monetary Fund, 1993)). The existence of countries as sets of their residents should lead to a new conception of the official reserves account. Re-imagining the role of "reserve assets" would be a necessary step. Today, in fact, as already mentioned, reserve assets appear to be involved merely in a limited number of transactions, mostly carried out by monetary authorities. Besides, - at least, in key-currency countries, whose means of payments are internationally accepted - they appear to have compensatory features rather than being a systematic account recording all transactions modifying the external position of the economy altogether. More precisely, since commercial and financial transactions recorded in the balance of payments pertain to private and public agents (residents) but contribute to modifying the nation's position as a whole, a country's economic account should also be created. This account would represent the flow-version of the already existing International Investment Position (IIP) and, by means of a double-entry bookkeeping approach, would highlight the involvement of the economy as a whole. The official reserves account would mainly deal with foreign reserves (as it already does) and it would represent the account of the country taken as a whole. Closely related to the inflows and outflows of foreign currencies, the reserve account would be directly involved in every current, capital and financial account transaction. Hence, for example, a commercial export would entail an increase in the country's official reserves caused by the positive inflow of a sum of foreign currency. Substantially, the reserve account would mirror the evolution of an important part of the country's IIP and represent the country's external financial position as defined by its net stock of financial assets and liabilities.

The implementation of such reform step would imply a new way of recording cross-border payments, paving the way for the creation of a new international payments system. The balance of payments is, even today, a powerful tool, but in order to display its "true" macroeconomic significance adjustments must be made by reformulating the official reserves account in a money-consistent way. As explained in Part 5, a profound reform is needed so that the balance of payments can be finally transformed into a bookkeeping instrument belonging both to the country

as a whole (macroeconomic dimension) and its residents (microeconomic dimension). This would also prevent the persistence of imbalances in the current account (Table 2).

**Table 2.** Current account imbalances at the world level (US Dollars, billions)

	Current account balance
2010	+287.08
2011	+351.56
2012	+406.28
2013	+384.30
2014	+402.63
2015	+242.18
2016	+293.37
2017	+423.72

*Source:* own representation on the basis of International Monetary Fund (2020b)

Undoubtedly, the commercial exports of any country are necessarily, and tautologically, the commercial imports of other countries. Yet, this is not so. Global current accounts show the presence of persistent discrepancies between deficits and surpluses (“What can explain these discrepancies? Was the Earth a net importer of goods and services from other planets before 2005 and a net exporter afterwards? [...] The IMF’s projection for the next five years is that these discrepancies will decrease (as they have been since 2012) and that the world current account will be negative. Accounting for the magnitude of these errors is difficult and still important to understand the existence of global imbalances around the world” (Federal Reserve Bank of St. Louis, 2016). What makes things worse is that the cumulated capital and financial account should also be equal to zero for the world taken as a whole, but it is not. This is shown (though subject to statistical discrepancies) in Table 3. Although these data are biased by insufficient transparency (at least, for some countries) and by the presence of the “net errors and omissions” item (see **Table 4**), not a negligible component, the picture is pretty clear: statistical discrepancies are very evident, enduring and - more relevantly - symptomatic of the fragmentary approach to the recording of transactions, whereas they should be registered in a simultaneous and identical-in-value way.

**Table 3.** Capital and financial account imbalances at the world level (US Dollars, billions)

	Capital account balance	Financial account balance	Capital and financial account balance
2010	+74.32	+31.82	+106.14
2011	+65.19	+57.31	+122.50
2012	+56.83	+58.18	+115.01
2013	+69.17	+277.32	+346.49
2014	+9.39	+379.50	+399.89
2015	+20.40	+60.65	+81.05
2016	+19.81	+47.52	+67.33
2017	+18.99	+214.84	+233.83

*Source:* own representation on the basis of International Monetary Fund (2020b)

Undeniably, it is the central bank of each country that ensures payments compensation between private banks giving them a homogenous “form” by means of the currency of the national banking system. By doing so, it also allows for the national monetary process coming full circle and the instantaneous “closure” of the national monetary circuit, which would instead remain “open” if no common monetary denominator were provided to currencies issued by different commercial banks (“Dans un système bancaire, toute monnaie émise par une banque est éligible à la compensation, mécanisme par lequel la monnaie de toute banque peut être librement convertie ou transformée objectivement - dans une opération de change absolu - en monnaie d’une autre banque”



(Schmitt, 1990)). A similar mechanism is needed for the settlement of cross-border transactions. Since the monetary concept of “nation” corresponds to the set of its private/public economic subjects (including the State itself), it is crucial that the workings of the balance of payments itself should duly reflect it. As briefly presented in the last part of this paper, this mechanism is based on the implementation of double double-entry bookkeeping by central banks, which will act on behalf of countries and of their residents.

##### **5. Today’s system of international payments does not recognize the existence of countries as sets of their residents. A new, conceptually reformed approach has to be developed**

In this last section we consider the main shortcomings of the present conception of international payments and we outline the principles of a reform of the balance of payments complying with the rule of double-entry bookkeeping. We start from the factual observation that nations or countries exist as monetary entities, note that money is still wrongly identified with a positive asset, analyse the implications of this erroneous notion of money, and end by advocating the institution of a National Bureau responsible for carrying out the external payments of the country’s residents according to the law of debit-credit and credit-debit.

The totality of any country’s external transactions is carried out by its residents, State included. The country itself, as the set of its residents, is no autonomous economic agent. It neither imports or exports either commercial goods or financial assets. We would therefore infer, too hastily, that a country is nothing more than the mirror image of its residents. While it is true that countries are involved by implication, since the cross-border transactions of their residents require their monetary intermediation, it is also true that the end result of these transactions concerns the country as a whole as well as its individual residents. Hence, although net exports cannot be attributed to any particular exporter or to any particular importer, they define a net gain for the country itself. Transferred to the country’s official reserves, this gain is that of the undifferentiated set of residents, of the country as a whole. Ultimately, it is monetary sovereignty that determines the economic existence of countries as such. Insofar as countries maintain their national currencies, they exist as distinct economic entities. At the same time, countries act as monetary intermediaries in the foreign payments of their residents. For these two reasons, they should be endowed with a mechanism accounting for their commercial and financial situation (the balance of payments) and allowing for their payments to be carried out in compliance with double-entry bookkeeping.

The net asset definition of money is unfortunately still widespread and a major obstacle to the understanding of its vehicular use, the only one compatible with double-entry. If money were not substantially distinct from real goods, economics would not even exist for lack of a numerical standard. Even issued by banks, money would be unable to relate to physical goods and could therefore not make them commensurable. The determination of numerical prices would remain mysterious, elusive, and the explanation of the purchasing power of money metaphysical, surreal. To claim that banks can issue money already endowed with a positive purchasing power is pure nonsense. Fortunately, double-entry comes to our rescue and guides us toward a modern conception of money. The necessary equality of debits and credits is the guiding principle, our lodestar. Money is spontaneously issued by banks, lent to the economy, and recovered in payments entered by banks in conformity with that equality. Far from being the result of a miraculous creation of a positive asset out of nothing, money is created-destroyed on both purchaser and seller and flows immediately back to its point of origin. Instead of financing monetary payments, it conveys them through its circular flow. As a *means* of payment (as distinct from the real objects involved in the payment), money is a numerical flow allowing for the exchange of real goods and financial assets.

Nationally, money is associated to production via the payment of productive services and plays the double role of unit of account and of numerical means of payment. Internationally, the intervention of money is limited to its vehicular role. As our main concern here is the balance of payments, let us consider the monetary aspect of international transactions. The question to be answered is whether or not payments between countries



acknowledge the flow nature of money. If they do, the present system of international payments is already an orderly one; if they do not, it must be reformed. The answer is not an easy one, because the credit-debit (resp. debit-credit) pair is in fact a logical identity, and identities will prevail whether they are complied with or not. Suppose, as is the case today, that the structure of the system of payments is inadequate: money will necessarily still obey the logic of those accounting identities. It is therefore already the case today that the monetary payment of a country's net commercial imports transfers to the exporting country an amount of financial claims (deposit certificates) and not a sum of money. If this fact were overtly recognized and if cross-border payments were entered accordingly in the respective balance sheets, everything would be perfect. However, this is not yet the case, which implies that, even though money paid by, say, country A flows back to A's banking system at once, it remains also recorded on the assets side of RW's banks. Submitted to what Jacques Rueff called a duplication, money A, its duplicate, remains available in R, where it defines a pathological capital of an inflationary nature (Schmitt, 1984).

A negative consequence of the lack of an orderly structure of international payments is the fact that, although money 'moves', of necessity in an instantaneous circular flow, countries have to purchase at a cost the vehicular money that is not explicitly provided by the system. Now, while it is true that when international payments are reciprocal these costs cancel each other out, there is an important case where this equalisation does not occur: the payment of interest on external debts. As clearly demonstrated by Schmitt (2004; 2012), interests are a spontaneous debt the payment of which, defined by the IMF and the World Bank as a unrequited transfer, is uncompensated. The country carrying it out transfers unilaterally part of its domestic resources without obtaining anything in exchange except the cancellation of its interest on debt. If the payment of interest were part of a reciprocal exchange between debtor and creditor countries, it would imply the circular use of a vehicular money and its cost for the debtor country would correspond to that of its internal resources only. The payment being unilateral, a monetary cost is added and the total cost for the debtor country doubles: on top of the loss of part of its national product, it has to pay for its 'monetary transfer' abroad. As absurd as it may seem, indebted countries pay twice their interests on debt<sup>†</sup>. One payment is microeconomic in nature and rests on the indebted country's residents. This payment is entirely justified. The second, pathological payment rests on the country taken as a whole, the set of its residents. This payment is macroeconomic and it is due to an anomaly of the present system of international payments, which does not provide countries with a mechanism guaranteeing the circular use of a vehicular money. Indebted countries have to purchase, at a cost, the vehicular money required to convey abroad the object (national resources) of their payment, which should be provided cost free by the system of international payments.

The system of international payments in its current form is flawed because it is at odds with the flow nature of money and with the double-entry principle. This is also true of the balance of payments. Being a mere collection of separate statistical data, the balance of payments hardly complies with the bookkeeping identity on which it should be founded. Billion-high net errors and omissions on the national as well as global level are an enduring consequence (Table 4)<sup>‡</sup>. The perfect correspondence between CA and CFA (with a reverse sign) cannot be the unstable and highly unlikely result of an equilibrium between separate transactions. It is only by entering each single transaction as a debit-credit or a credit-debit that the balance of payments can be considered as a bookkeeping representation of the foreign exchanges, both commercial and financial, of a country. The principle is simple. Like its residents, a country can finance its purchases only through equivalent and simultaneous sales, its imports through its exports. This does not at all mean that each country does or should necessarily balance its commercial imports with equivalent commercial exports. A country can perfectly well run a trade deficit on

<sup>†</sup> The same has been argued by Beretta (2012; 2017) with specific regard to historical cases of war reparation payments, which are typically unilateral and have to be provided in internationally accepted means of payments.

<sup>‡</sup> In the appendix the authors also provide a numerical insight into the balances of payments of countries belonging to the Group of Seven (G7) (Table 5).

condition that it bankrolls it through an equal financial surplus, that is, through a sale of financial claims. The reciprocity of exchanges subsumes both the commercial and the financial markets, any net commercial purchase being covered by a net sale of claims on part of the country's future output. It is not the trade balance of any single country that must be in equilibrium, but its monetary balance, its overall inflows and outflows of foreign currencies. The identity of IM and EX corresponds to the identity between each country's global sales and purchases. Its corollary is the necessary equilibrium of their monetary balances, the vehicular use of the currency used to convey their reciprocal payments.

**Table 4.** Net errors and omissions in the balance of payments of the world (US Dollars, billions)

	Net errors and omissions
2010	-329.58
2011	-359.44
2012	-404.93
2013	-176.15
2014	-32.53
2015	-201.92
2016	-265.66
2017	-227.86

*Source:* own representation on the basis of International Monetary Fund (2020b)

In practice, the reform needed to transform the balance of payments into a bookkeeping account of the external transactions of countries consists in creating, in each country, a national Bureau responsible for all the payments by and in favour of the country's residents. The Bureau must be conceived as a 'dual' institution, Janus-faced as it were: one face, its internal department, turned toward the country's domestic economy, and the other face, its external department, turned toward the rest-of-the-world. In this new scenario, each payment request made by a resident in favour of a non-resident is first submitted to the country's national Bureau, which represents the country as a whole. Using the country's domestic currency, each payment initiated by the country's residents is carried out as a double double-entry procedure. Thus, for example, importers are credited-debited by their banks: their purchases, which imply a debit, are matched by equivalent sales of financial claims (deposit certificates or securities), for the amount with which they will be credited. At the same time, the Bureau's internal department is credited by the sum of national currency spent by importers and debited for an equal amount to the benefit of its external department. Responsible for payments to the rest-of-the-world for their exports, the external department will first purchase financial claims from its domestic economy and then sell them abroad in order to finance its external payment on behalf of country's importers. Every inflow of national or foreign currencies to each department of the Bureau will thus be balanced by equivalent outflows. In the end, currencies will be used as a means to convey payments, and real goods, present and future, will be the only content or object of these payments.

The analytical description above encapsulates the gist of the reform advocated by Bernard Schmitt (2014). However simplified, it does show how any country on its own could reform its mechanism of external payments to avoid falling prey to the pathologies affecting the present non-system of international payments. The principles of the reform derive directly from double-entry bookkeeping and imply a radical change in the way balances of payments are constructed. This is not to say that balances of payments must be completely overhauled. On the contrary, all the rigorous work done by international experts to produce a detailed account of the various transactions involved can be preserved. What must be changed is the way entries are recorded. Every transaction must be entered twice, once as a credit (debit) and once as a debit (credit). This is the essence of the radical

change necessary to turn the balance of payments from a statistical collection of data into an instrument delivering a clear picture of a country's commercial and financial relationships with the rest-of-the-world.

## Conclusions

A country's balance of payments accounts for its international commercial and financial transactions with the rest of the world. Its significance is not only due to its far-reaching history, since data on goods, services, and financial claims have been published, quite systematically, from the 19<sup>th</sup> century onwards (see Thirlwall and Gibson, 1992), but also to the underlying double-entry bookkeeping mechanisms. Today, despite being still a powerful tool indicating the external (flow) position of a country towards the rest of the world, it lacks an approach structurally based on double-entry bookkeeping. Otherwise stated, the fact that commercial and financial registrations are recorded separately from each other exposes the balance of payments to billion-high inaccuracies. By doing so, the double-entry bookkeeping logic (which necessarily implies the identical balance between current account and capital and financial account) is openly neglected, turning the balance of payments into a mere statistical instrument.

The paper is a plea for a substantial, conceptual reform which would ultimately implement the double-entry bookkeeping already recognized to be a pillar of the balance of payments itself. This would also erase statistical discrepancies, which are still a serious bias in today's balances of payments. At the same time, the proposed reform would allow for:

- a renovated, reconditioned balance of payments, designed to account for any commercial and financial transactions between residents of the world and their impact on the residents' countries;
- a reformulated version of official reserves as the account of the country itself;
- a truly unbiased account of all international commercial and financial transactions.

The reform proposal outlined here would not be in any way "invasive". Despite introducing major changes in terms of systematicity, countries would be able to adopt and implement it relatively easily. They would benefit quite simply by the assurance that any commercial/financial transaction would not be compensated *ex post*, but take place bilaterally, as appropriate, and simultaneously. This would also drastically simplify the recording process, now complicated by valuation and time issues (leading in turn to massive, cumulative inaccuracies between the balances of payments of trading countries). A win-win solution, therefore, while times are ripe for embracing a conceptually macroeconomic approach truly in line with double-entry bookkeeping, that is, with the fundamental principles of the balance of payments.

## Numerical appendix

**Table 5.** The balances of payments of countries belonging to the Group of Seven (G7) (US Dollars, billions)

	Years	Current account balance	Capital account balance	Financial account balance	Net errors and omissions
Canada	2007	+11.05	-0.27	+13.37	+2.59
	2018	-45.32	-0.06	-36.63	+8.75
France	2007	-8.72	+3.39	+2.66	+7.99
	2018	-19.01	+2.44	-34.35	-17.76
Germany	2007	+235.78	-2.32	+253.35	+19.89
	2018	+289.90	+2.32	+270.80	-21.42
Italy	2007	-30.52	+2.55	-29.37	-1.39
	2018	+50.56	-0.74	+34.69	-15.13
Japan	2007	+211.74	-4.03	+233.81	+16.11
	2018	+174.72	-1.94	+181.85	+9.08
United Kingdom	2007	-103.09	-0.30	-127.58	-24.19
	2018	-123.11	-4.24	-101.36	+25.99
United States	2007	-711.03	+0.38	-632.85	+77.80
	2018	-490.99	+3.24	-445.46	+42.30

Source: own representation on the basis of International Monetary Fund (2020a)

## References

Aristotle 2006 [5<sup>th</sup> century BC]. *Metaphysics*. Lawrence: Published by Digireads.com.

*Balance of payments and international investment position manual - sixth edition (BPM6)*. 2009. Washington, D.C.: Published by International Monetary Fund.

*Balance of payments and International Investment Position statistics (BOP/IIP)*. 2019. Retrieved from <http://data.imf.org/?sk=7A51304B-6426-40C0-83DD-CA473CA1FD52>.

*Balance of payments manual - fifth edition*. 1993. Washington, D.C.: Published by International Monetary Fund.

Banca d'Italia 2019. *Foreign currency and gold reserves, investment portfolio and risk management*. Retrieved from <http://www.bancaditalia.it/compiti/riserve-portafoglio-rischi/index.html?com.dotmarketing.htmlpage.language=1>.

Beretta, E. 2012. The economics of external debt: a Damocles' Sword hanging over the Emergent and the Virtuous (Germany), *Banks and bank systems*, 7(2): 79-86.

Between nations, the interest multiplier is equal to 2, 2004. in: Research Laboratory in Monetary Economics (Ed.). *Quaderno di ricerca no. 12*, Lugano-Vezia: Research Laboratory in Monetary Economics, 1-54.

*Brésil en 2008. Les médias donnent une image fortement lénifiante de son passif financier envers le reste du monde*. Fribourg: Published by Université de Fribourg.

Cencini, A. 1997. *Monetary theory, national and international*. London and New York: Published by Routledge Frontiers of Political Economy.

Citraro, M. 2004. *World discrepancies in the balance of payments – PhD Dissertation*. Lugano: Published by Università della Svizzera italiana.

Deutsche Bundesbank 2013. *Bundesbank Act*. Retrieved from <http://www.bundesbank.de/resource/blob/618304/6d6986cbc43dff11cf78d56b2c29502b/mL/bundesbank-act-data.pdf>.

European Union 2012. *Consolidated version of the Treaty on the functioning of the European Union*. Retrieved from <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:12012E/TXT&from=IT>.

Federal Reserve Bank of St. Louis 2016. *Global current account surplus: is there trade with other planets?*. Retrieved from <http://www.stlouisfed.org/on-the-economy/2016/february/global-current-account-surplus-trade-other-planets>.

From reparations to (net) interest payments on external debt. 2017. Same script, different cast, in: Bailly, J.-L.; & Cencini, A.; & Rossi, S. (Eds.): *Quantum Macroeconomics. The legacy of Bernard Schmitt*, London and New York: Routledge, 105-121.

International Monetary Fund 1987. *Report on the world current account discrepancy*. Washington, D.C.: Published by International Monetary Fund.

*International reserves and foreign currency liquidity. Guidelines for a data template*. 2013. Washington, D.C.: Published by International Monetary Fund.

Kester, A. Y. 2001. *International reserves and foreign currency liquidity: guidelines for a data template*. Washington, D.C.: Published by International Monetary Fund.

Krugman, R. P.; & Obstfeld, M. 1997. *International economics: theory and policy – fourth edition*. Boston: Published by Addison-Wesley Longman, Inc.

*L'Écu et les souverainetés nationales en Europe*. Paris: Published by Dunod. 1990

*Les pays au régime de FMI*. Albeuve: Published by Castella. 1984.

*Macroeconomic foundations of macroeconomics*. 2005. London and New York: Published by Routledge Frontiers of Political Economy.

Meade, E. J. 1970. *The balance of payments*. London, New York and Toronto: Published by Oxford University Press.

Organisation for Economic Co-operation and Development 2010. *International reserve assets*. Retrieved from <http://stats.oecd.org/glossary/detail.asp?ID=2319>.

Pilkington, M. 2007. A macroeconomic analysis of the role of trans-national corporations in a monetary theory of production, in: Esen, O.; & Ogus Binatly, A. (Eds.). *Proceedings of the SUNY Cortland Conference on globalization and its discontents*, Izmir: Izmir University of Economics, 148-173.

Schmitt, B. 1975. *Théorie unitaire de la monnaie, nationale et internationale*. Albeuve: Published by Castella.

Smith, A. 1978 [1776]. *The wealth of nations*. Harmondsworth: Published by Pelican Classics.

Sovereign debt and interest payments, 2012. in: Gnos, C.; & Rossi, S. (Eds.). *Modern monetary macroeconomics*, Cheltenham: Edward Elgar Publishing, 239-260.

Stern, R. M. 1973. *The balance of payments. Theory and economic policy*. London and Basingstoke: Published by Macmillan.

Teunissen, J. J. 1987. The international monetary crunch: crisis or scandal?, *Alternatives – Social transformation and human governance*, 1 (3): 359-395.

*The balance of payments manual - fifth edition.* 1997. Washington, D.C.: Published by International Monetary Fund.

*The formation of sovereign debt. Diagnosis and remedy.* 2014. Retrieved from <http://ssrn.com/abstract=2513679>.

The sovereign debt crisis. 2017. in: Bailly, J.-L.; & Cencini, A.; & Rossi, S. (Eds.). *Quantum Macroeconomics. The legacy of Bernard Schmitt*, London and New York: Routledge, 144-157.

Thirlwall, A. P.; & Gibson, H. D. 1992. A history of the UK balance of payments, in Thirlwall, A.P.; & Gibson, H.D. (Eds.). *Balance-of-payments theory and the United Kingdom experience*, London: Palgrave Macmillan, 219-271.

*World and regional tables: balance of payments and International Investment Position by indicator (BPM6).* 2020a. Retrieved from <http://data.imf.org/regular.aspx?key=60961513>.

*World and regional tables: global discrepancies in balance of payments statistics.* 2020b. Retrieved from <http://data.imf.org/regular.aspx?key=60947556>.

## Acknowledgements

*This research was partly supported by the project, which has received funding from the European Union's Horizon 2020 research and innovation programme European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme Marie Skłodowska-Curie Research and Innovation Staff Exchanges ES H2020-MSCA-RISE-2014 CLUSDEV MED (2015-2019) Grant Agreement Number 645730730. The authors would also like to express their sincerest gratitude to Manuela Tvaronavičienė for the great opportunity and to Simona Cain for her wise and careful editing work. The paper has been also presented in the Joint Banco de Portugal, Irving Fisher Committee on Central Bank Statistics and European Central Bank Conference on “Bridging measurement challenges and analytical needs of external statistics: evolution or revolution?” (Banco de Portugal, February 17- 18, 2020). A shorter and, at some points, modified version of this paper with the title “Double-entry bookkeeping and the balance of payments: the need for a substantial, conceptual reform” will also appear in the IFC Bulletin published by the Irving Fisher Committee on Central Bank Statistics (IFC). The authors also thank the conference organizers for their interest in their research.*



**European Research Council**

Established by the European Commission



**Edoardo BERETTA** is the Director of examinations of the Faculty of Economics, a member of the Scientific Directorate and the Program Manager of the Swiss part of the Double Degree Master in Economics and International Policies (MEPIN) at the Università della Svizzera italiana (USI) in Lugano (Switzerland) where he also teaches international macroeconomics to Master's students. He has also been an Adjunct Professor at the Department of Economics and Finance of Franklin University Switzerland (FUS) in Lugano-Sorengo (Switzerland). Edoardo Beretta holds two PhD Degrees in Economics and his research focus lies on international monetary macroeconomics. In this specific regard, he has analyzed selected aspects like the German (external) war debt problem, the ongoing debate on the international monetary order as well as several reform proposals of the international payments system.

ORCHID ID: <https://orcid.org/0000-0002-2196-455X>

**Alvaro CENCINI** is Professor Emeritus of the Faculty of Economics at the Università della Svizzera italiana (USI) in Lugano (Switzerland) where he has also hold the Chair of Monetary Economics. He is also the Co-Director of the Research Laboratory in Monetary Economics (REMLab) at the Centre for Banking Studies in Lugano and an external member of the Centre d'études monétaires et financières of the University of Burgundy in Dijon (France). He has a D.phil degree of the University of Fribourg (Switzerland) and a Ph.D. degree of the London School of Economics in London (United Kingdom). Among his main publications are: *Time and the Macroeconomic Analysis of Income* (Pinter Publishers and St. Martin's Press; 1984, Bloomsbury, 2013), *Money, Income and Time* (Pinter Publishers, 1988; Bloomsbury 2013), *External Debt Servicing. A Vicious Circle* (Pinter Publishers, 1991, co-authored with Bernard Schmitt), *Monetary Theory, National and International* (Routledge, 1995, reprinted 1997), *Inflation and Unemployment* (Routledge 1996, co-edited with Mauro Baranzini), *Monetary Macroeconomics. A New Approach* (Routledge, 2001, reprinted 2014), *Macroeconomic Foundations of Macroeconomics* (Routledge 2005, reprinted 2007), *Economic and Financial Crisis* (Palgrave/Macmillan 2015, co-authored with Sergio Rossi). He is also the author of several contributions to books and peer-reviewed journals.

ORCHID ID: <https://orcid.org/0000-0002-5117-5703>

Register for an ORCID ID:

<https://orcid.org/register>

---

Copyright © 2020 by author(s) and VsI Entrepreneurship and Sustainability Center

This work is licensed under the Creative Commons Attribution International License (CC BY).

<http://creativecommons.org/licenses/by/4.0/>





**Publisher**

<http://jssidoi.org/esc/home>



---

## EFFECTS OF COVID-19 PANDEMY ON AFRICAN HEALTH, POLITICAL AND ECONOMIC STRATEGY\*

János Besenyő<sup>1</sup>, Marianna Kármán<sup>2</sup>

<sup>1,2</sup> Doctoral School of Safety and Security Studies, of Óbuda University, Hungary

E-mails: <sup>1</sup> [besenyo.janos@phd.uni-obuda.hu](mailto:besenyo.janos@phd.uni-obuda.hu); <sup>2</sup> [karman.marianna@phd.uni-obuda.hu](mailto:karman.marianna@phd.uni-obuda.hu)

Received 18 March 2020; accepted 10 July 2020; published 30 September 2020

**Abstract.** The appearance of COVID-19 is proving to be a difficult challenge not only for Africa but for the whole world. In order to prevent and curb, the leaders of the countries had to introduce health, economic and political changes and regulations, which were repeatedly sharply criticized. Although statistics show that the spread of the virus in Africa was far from the same as in China, Europe or the Americas, the world's strictest restrictions had to be put in place to stop the pandemic. At the same time, Africa has cut itself off from its main supporters, making its economic situation more difficult and risking the already weak stability of African societies.

**Keywords:** Africa; COVID-19; social effects of coronavirus; crisis

Reference to this paper should be made as follows: Besenyő, J., Kármán, M. 2020. Effects of COVID-19 pandemic on African health, political and economic strategy. *Insights into Regional Development*, 2(3), 630-644. [https://doi.org/10.9770/IRD.2020.2.3\(2\)](https://doi.org/10.9770/IRD.2020.2.3(2))

**JEL Classifications:** R59, I15, N17

### 1. Introduction

After appearance of COVID-19 and its spread outside China, the entire world watched in panic the reaction of the fragile health systems in Africa to the rapid spread of the virus. On the 30th of January, 2020, the WHO warned that the spread of the coronavirus in Africa poses a high risk, as people living in densely populated slums and refugee camps are particularly vulnerable to the spread of the virus. And Dr. Michel Yao, a WHO representative for Central Africa, also stressed in an interview that Africa is clearly not ready to stop an epidemic caused by a coronavirus (Jerving 2020).

Public spending on health in Africa is the lowest in the world. Due to low national budgets and inconsistent support from humanitarian aid countries, Africa is running a \$ 66 billion deficit in annual health spending. (O.

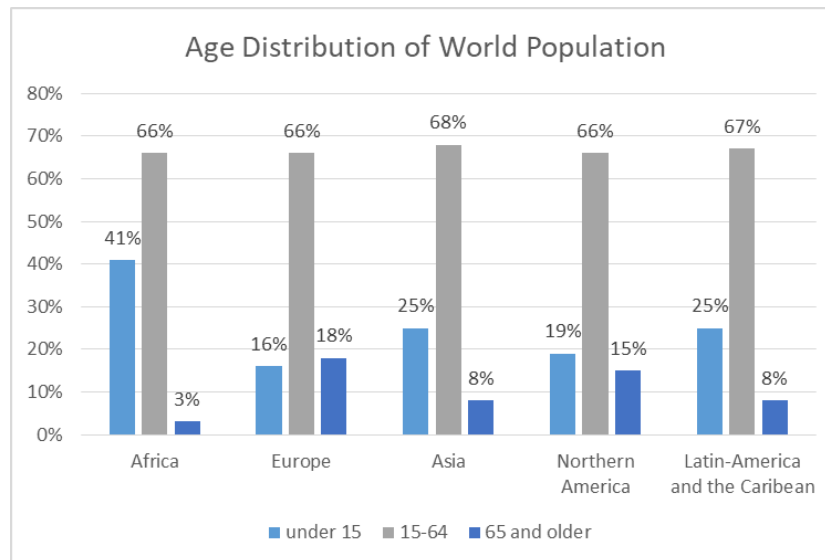
---

\* The research is supported by Doctoral School of Safety and Security Studies, Óbuda University, Hungary

Ogbuoji, I. Bharali, N. Emery and K. K. McDade, 2020) In Kenya, Nigeria and Zimbabwe, as well as in other parts of the region, health workers are almost routinely on strike due to low pay, arrears and a drastic shortage of resources in day-to-day care - these include simple devices such as bandages or rubber gloves. There is a significant shortage of health professionals in African healthcare systems: there is one doctor per 5,000 people (while in the United Kingdom 14 doctors/5,000). These conditions lead to a health situation in which the provision of regular health care is also a struggle for health systems.

In preparing for the coronavirus, countries “traditionally” supporting Africa have paid less attention to improving the health situation in Africa due to the global impact of the epidemic. In addition, the impossibility of economic relations with China, the fall in oil prices at the beginning of the year and the devastating locust infestation in East Africa put Africa in a particularly difficult economic situation, making it almost impossible to prepare for the health situation – let alone curb the epidemic, but also to prevent.

At present (05.25.2020) the available data (WHO) suggest that spread of COVID-19 in Africa is less prevalent than in other regions, some of which are thought to be due to the average age of people on the continent and others to climatic conditions – none of the assumptions are proven.

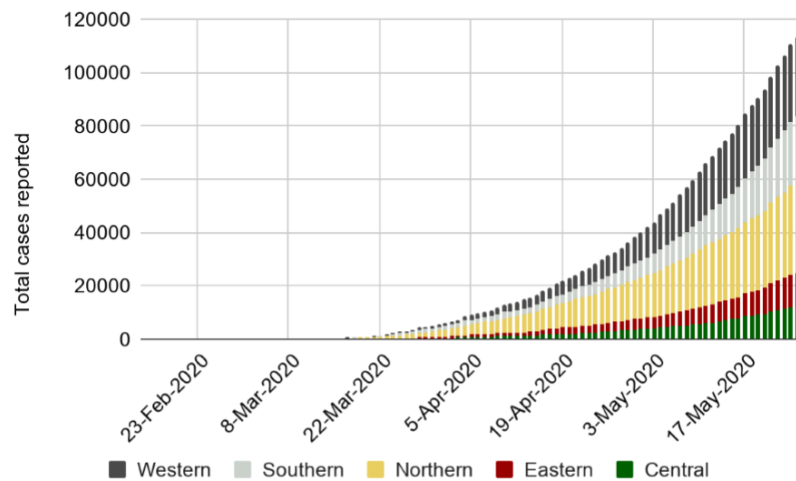


**Fig.1.** Age distribution of world population

Source: US Population Reference Bureau, Authors' edition

In Africa, the average age of the population is less than 20 years, with only 3% of the population over the age of 65, but 43% of the population living in large cities, which undoubtedly increases the risk of the virus spreading rapidly.

In Africa, a total of 118241 (WHO Situation Report 2020) people are currently registered with COVID-19, 3509 have died from the disease, and 327 are receiving intensive care. In Africa, a total of 11917 people have totally recovered from the virus infection.



**Fig.2.** Cumulative number of confirmed COVID-19 cases reported by region, 23 Feb - 26 May 2020

Source: Africa CDC

The most severely infected countries are South Africa (23615), Egypt (17967), Algeria (8503), Nigeria (8068), Morocco (7532), Ghana (6808), Cameroon (4890) and Sudan (3820). COVID-19 deaths were reported in 38 countries, most of them in Egypt (783) and in Algeria (609) and more than 100 in a total of five other countries (481 in South Africa, 233 in Nigeria, 200 in Morocco, 165 in Cameroon and the same in Sudan).

## 2. Health preparedness and the strategy of prevention

On the 3rd of February, the African Center for Epidemiological Control and Prevention (Africa CDC) set up a new African Coronavirus Task Force to work with the WHO on: surveillance, including screening of entry points, infection prevention and control in health facilities; clinical treatment of patients with severe coronavirus infection, laboratory diagnosis, and risk communication and community involvement. (Makoni, 2020)

The United Nations Health Organization has focused much of its efforts on the continent's 13 high-priority countries. The list of priority countries included mainly those that either run direct flights to China or attract large numbers of travellers from China. These include Algeria, Angola, Côte d'Ivoire, the Democratic Republic of the Congo, Ethiopia, Ghana, Kenya, Mauritius, Nigeria, South Africa, Tanzania, Uganda and Zambia. (Smith, S., 2020)

In addition to priority countries, even in countries where there is instability, such as South Sudan, coordination mechanisms have been developed to reach health workers and patients. Due to the Ebola epidemics, most African countries already had isolation infrastructure.

In the Democratic Republic of Congo, the Ebola outbreak – that started in October 2018 – was still going on earlier this year, by which time it was already abating – with a total of more than 3,000 registered cases and more than 2,000 dead. (MSF, 2020) This epidemic is by far the second largest Ebola crisis since the 2014 Ebola epidemic in West Africa, in which 28,616 people became ill and 11,310 died in Guinea, Liberia and Sierra Leone. During the epidemic, doctors brought isolated, rural areas to the fore, so by the time the disease reached the cities, it was able to wreak havoc on overcrowded areas. The situation was aggravated by the failure of nurses and health professionals to take appropriate preventive measures, resulting in an increasing infection rate. Lack of protective

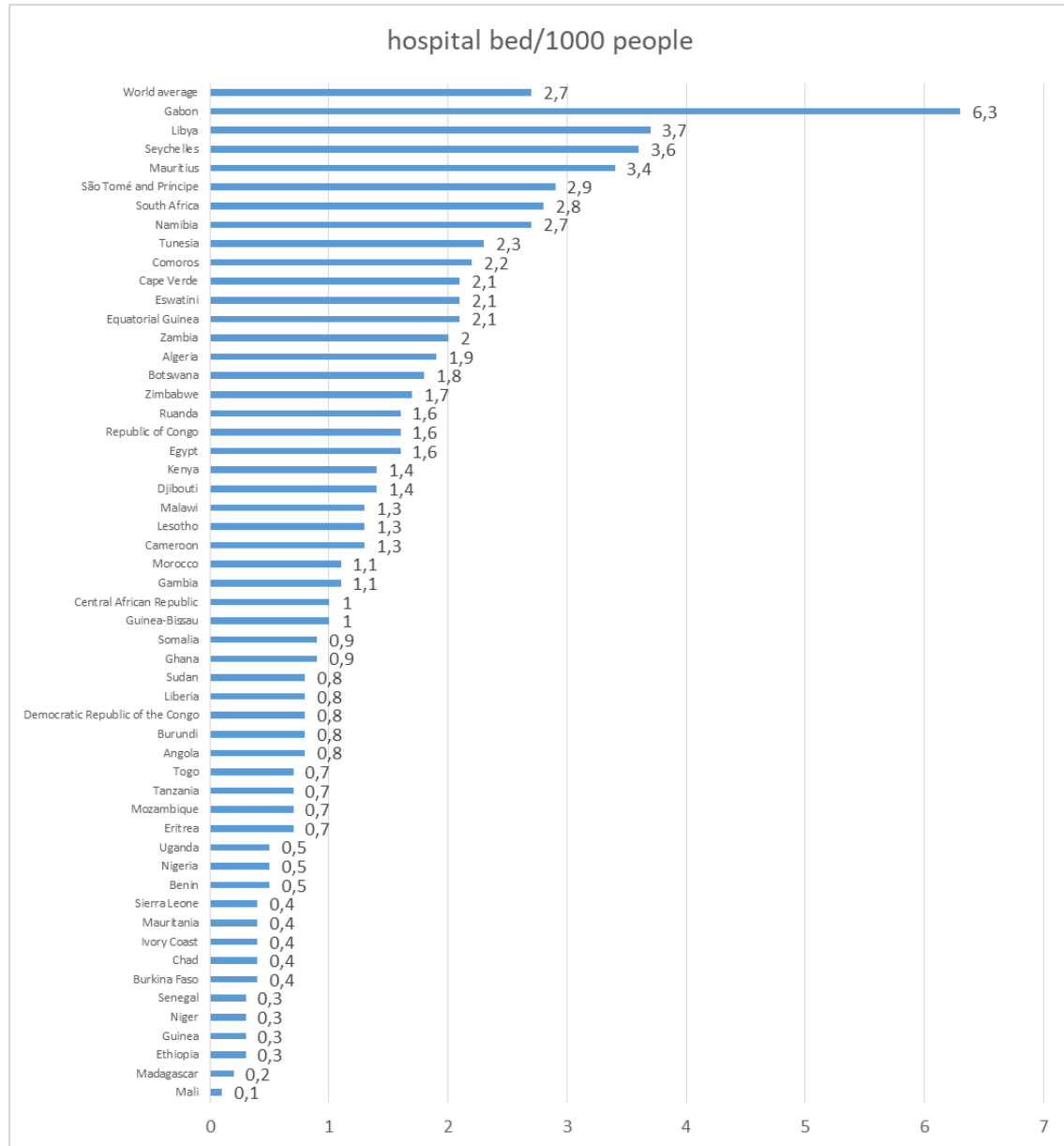
equipment and proper training also exacerbated the spread and the health care system began to collapse. Based on the dramatic image of the corpses lying on the streets, it seemed that the governments were not prepared for the outbreak of the epidemic, which caused even more confusion and fear among the public. Many believed that the Ebola epidemic was a lie invented by the leadership to get more international help, so the government's preventive and defensive regulations were ignored. (Moore and Nyenswah, 2020) The reduction in infections was ultimately caused by changes in the behaviour and attitudes of the population. This is definitely an example that Africa has had in mind since the release of COVID-19 outside China.

The massive emergence of the coronavirus in China has prompted African governments to take swift action and, above all, to focus on prevention, knowing that if COVID-19 enters the sub-Saharan region, the economic and health situation in African countries at the time will not stop the epidemics – especially if it also reaches densely populated areas. To prevent the virus from spreading to Africa, countries had to have mechanisms in place to identify, isolate, collect virus samples, send these samples to laboratories, and then provide treatment for confirmed cases. Healthcare workers and laboratory technicians also had to be trained to develop protocols for treating the virus and had protective equipment. (Kapata and others, 2020)

Poor laboratory capacity has been a problem in many countries on the continent, and until a test for diagnostic testing was commercially available, it was also provided by the WHO to African countries that were not equipped until the outbreak in Africa. The samples were sent to WHO laboratories, where the samples were tested and then returned, so in several countries it could take days to make a diagnosis. Despite having 28 laboratories set up at 28 locations in the World Organization, there were only two coronavirus tests: in South Africa and Senegal. (SOP South Africa 2020) By 4 February, additional countries - Ghana, Madagascar, Sierra Leone and Nigeria - were also able to test themselves, and after a week another 11 countries had testing facilities, making test results available more quickly. (Gilbert and others, 2020)

Towards prevention the WHO has asked African countries to draw up contingency plans that include statistics on possible cases and preparedness for care. The same had to be done for the countries neighbouring Congo at the time of the Ebola outbreak. (WHO, 2020)

By mid-March, the coronavirus was low in almost every country in Africa. However, health preparedness to prevent spread was still insufficient.



**Fig.3.** Number of hospital beds in Africa by countries

Source: WHO, Authors' edition

- South Africa has one of the best health systems in Africa, meaning it had less than 1000 intensive care beds for 56 million people, 160 of them in the private sector.
- In Malawi, there are about 25 ICU beds in public hospitals for 17 million people, while in Kenya there are 578 intensive beds for 50 million people - which is also an extremely low rate.
- There was no place in the hospital for major infectious diseases in the Zimbabwean capital, Harare, said the Zimbabwean Association of Human Rights Physicians.
- Nigeria, Africa's most populous country, has sought to establish isolation beds and provide specialized medical training and equipment in public hospitals, but only prevention and early detection could



continue to be adequately performed according to the Chief Executive Officer of Nigeria Centre for Disease Control (NCDC). (Mumin and Pensulo, 2020)

- Uganda declared a heightened emergency due to infection in the area but did not anticipate dealing with a large number of critical cases, like Nigeria, focused primarily on prevention through community awareness campaigns and public education. Ugandan Health Minister Jane Ruth Aceng said Uganda “has sufficient capacity to deal with a possible outbreak in terms of beds, ICU units”, but her statement has been questioned by many as the East African country of 44 million has only 1500 hospital beds at Mulago National Referral Hospital, with 60 ICU beds.
- In Somalia, Health Minister Dr. Fawziya Abikar said the government had set up a quarantine facility at Mogadishu Airport and set up a hospital to deal with Covid-19 cases. However, this means only 15 detached tents, and the hospital has a total of 100 beds.
- In South Sudan, which has been completely devastated by the five-year civil war, the government has only 24 separate beds.

Of further concern are widespread infectious diseases such as HIV or TB in the general population, which may exacerbate the severity of COVID-19-induced diseases. (Nordling, 2020)

The African Union has been preparing for the easing of closures and restrictions on the continent since mid-May, with these guidelines preparing for the resumption of transport, education and basic health services. During May, the African Union distributed 300 ventilators from the Jack Ma Foundation and a number of laboratory equipment and supplies from Jack Ma Foundation, Illumina and TIB Molbiol to its member states. Health training on COVID-19 has been held in May in Zimbabwe and Cameroon, and from June in South Sudan. The AU has enabled Member States to exchange experiences on coronavirus and ran campaigns to explain theoretical and practical hygiene standards and to dispel myths and false news about COVID-19.

On the recommendation of the AU and the WHO, enhanced surveillance of influenza-like illness is recommended for African countries – e. g. "adding questions about travel, contact history, and testing for coronaviruses to existing influenza surveillance systems; notifying healthcare facilities to immediately inform local public health officials about persons who meet the case definition for COVID-19, SARI and/or have recent travel to a country with local transmission or history of contact with a case." "Member States should continue to enhance surveillance at the borders to screen incoming travelers for severe respiratory illness and a history of recent travel to affected countries or territories reporting local or community transmission. Member States should perform contact tracing of confirmed cases based on transmission type and country capacity. Notify WHO and Africa CDC immediately if suspected or confirmed cases of infection with novel coronavirus are identified. Provide guidance to the general public about seeking immediate medical care and informing healthcare providers about recent travel or contact history in anyone who develops symptoms of severe respiratory illness." (AU 2020)

### **3. Government measures: closures, restrictions and curfews**

Until mid-February, travel restrictions were introduced in African countries (e.g. Gabon banned entry from China, no more visas were issued to Chinese citizens in Mozambique), economic and trade relations were suspended indefinitely with China (e.g. Cameroon banned food imports from China), citizens stranded in China - mainly students - were allowed to travel home under increased WHO control (e.g. 5000 Zambian students studied in China, 186 of them in Wuhan, and Zambia did not allow their evacuation for a long time despite parental claims) and without testing, arrivals from endangered areas were kept in quarantine (Sierra Leone). (Kamara, 2020)

The first African infected, Senou Pavel Daryl, a Cameroonian student, was registered on January 28, 2020 to Jingzhou Hospital in China. The African student may have been exposed to the virus during his trip to Wuhan. He was isolated in the hospital for 13 days and treated with antibiotics and drugs used to treat HIV patients. After two

weeks of medication, he was already showing signs of recovery, so he became not only the first African to be infected, but also the first African to be cured. (Vincent 2020) In China, thousands of African students were quarantined, many became ill, but did not return to their homeland at the time of the outbreak or its peak due to the quality of health care provided by China.

On February 14, the first case of coronavirus on the continent was reported: in Egypt. The infected was a Chinese citizen who was screened during inspections set up at Cairo International Airport, although he showed no symptoms of the disease at the scene.

The first case from the sub-Saharan region was reported on 25 February: the first illness was confirmed in Nigeria, the former capital, Lagos, by an Italian entrepreneur who came from Milan to a West African country. (Maclean and Dahir 2020) On the same day, the first case was found in Algeria, also involving an Italian man who was deported to Italy three days later.

The second sub-Saharan infection was registered on 2 March in Senegal, a French citizen living in a West African country who had previously skied in France. Even in Morocco that day, a Moroccan citizen living in Italy was diagnosed with a coronavirus infection and tested positive in an 89-year-old Moroccan woman also living in Italy. The first case was also registered in Tunisia on this day, with a 40-year-old Tunisian man returning from Italy.

On March 5, the first case was reported in South Africa, a South African citizen returning home from Italy became ill. After 100 registered cases, President Cyril Ramaphosa declared a disaster situation, restricting travel, ordering the closure of schools, a ban on rallies and restrictions on the operation of bars: closure or staff limitation of max. 50 people. In South Africa a person who violates coronavirus measures can face a fine or even imprisonment. The country has banned traffic in all its ports.

During March, African nations introduced sanctions similar to those of South Africa:

- Lagos State, Nigeria's economic centre banned gatherings of more than 50 people, schools closed; Africa's most populous country, where a total of twelve cases of coronavirus were found when sanctions were imposed, has banned landings from flights from countries where more than 1,000 infections have already been registered.
- Algeria, one of the worst affected African countries, closed its borders and stopped flights. The president also banned mass rallies, which also put an end to major anti-government protests.
- The Rwandan government banned passenger transport after 11 reports and distributed food donations at the end of the month due to the famine.
- In Kenya, perhaps one of the most religious countries on the continent, most temples and mosques have suspended worship. The government has also announced that it will produce a disinfectant at the state level, which will be distributed free of charge in order to remedy the shortfall.
- In Liberia, where the Ebola epidemic was in the spotlight a few years ago, after two registered Covid-19 cases passports were stopped in order to stop people's travel and entry from countries that were most affected by the pandemic.
- Zambia closed parliament, schools and universities after reporting two Covid-19 cases.
- Somalia closed its airspace after its first and only case.
- Uganda and Botswana, where there were no cases even then, closed schools.

At the end of March, the most populous cities and states in Nigeria and Ghana and the capital of the Democratic Republic of the Congo were closed down, and a partial ban on travel was imposed. In Botswana, a 28-day restriction was introduced after the first cases, as in Lesotho which has not got any case yet. (Smith, E., 2020) In

Senegal, as in many African countries, a night curfew has been introduced, and in Côte d'Ivoire the possibility of contact in society has been gradually limited. Among others in South Africa, Kenya, Nigeria and Uganda, compliance with the curfew is under military and police control. Most African countries have closed their borders and imposed some level of restriction and/or curfew.

By the end of March, much of the continent had isolated itself from the world: most African countries had suspended flights to and from Europe and Asia and other transport links, or were strictly controlling entry into its territory. Restrictions have also been placed on public gatherings, schools and religious services, and mass events have been lifted across the continent.

In April, these measures became increasingly stringent.

- On the 9th of April South Africa extended the night curfew until the end of April. He commanded 70,000 soldiers to comply with the restrictions. (Maseko 2020)
- In Kenya, restrictions were imposed by President Uhuru Kenyatta in the first week of April until the end of the month - before Easter. In the infected areas and in the capital, a travel and curfew ban was announced, while in other areas a night curfew was banned.
- On the 18th of April Sudan ordered the closure of the capital, Khartoum, for three weeks after the daily number of cases suddenly rose to 20-30. As 90% of those infected can be linked to Khartoum, the capital was closed with a partial curfew.
- Morocco has also extended the restrictions introduced on the 20th of March, which allow people to leave their homes only to buy food or medicine or to do essential work. Schools, mosques, shops and entertainment venues were closed. Morocco has made it mandatory to wear masks so much that those who fail will risk fines and imprisonment. In Moroccan cities, cars with loudspeakers alert people to stay at home. Public transport, streets and markets are constantly being disinfected.
- Restrictions imposed on the 21st of March continue in Zimbabwe. At some points, the government eased. However, the biggest problem is still working with doctors. Due to the lack of medical protective equipment, Zimbabwean doctors have filed a lawsuit against the government.
- In Libya, with the onset of Ramadan, the Government of National Consensus (GNA) is introducing a 24-hour curfew to try to ease pressure on the health system in areas under its control, including Tripoli. In a civil war-torn North African country, only the purchase of bread and food will be allowed, including only in the morning.

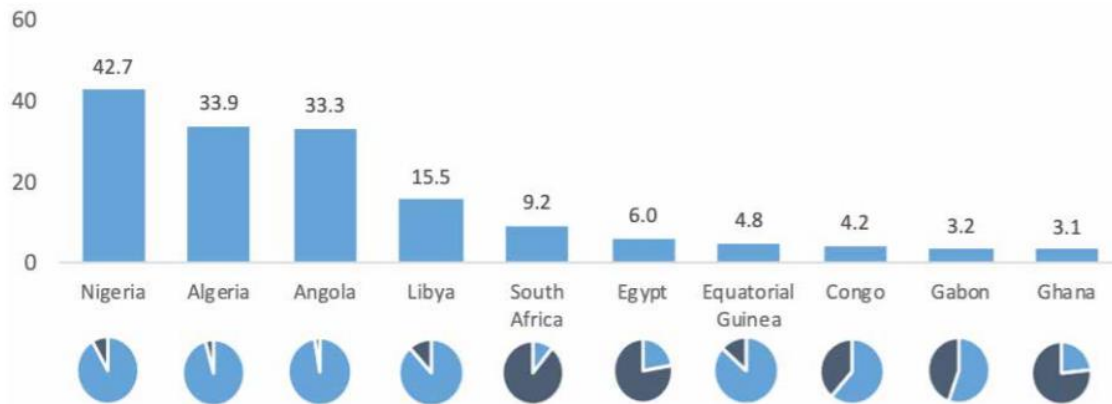
Restrictions introduced in recent months, as in other parts of the world, are having an impact on a country's economic, political and social situation in order to improve its health situation.

#### **4. Results of measures: economic and social crisis**

The emergence of the coronavirus in China has had a major impact on the Asian country's relations with Africa, both in terms of tourism and economics and diplomacy. African countries have steadily severed ties with China. Flights to China were cancelled, travel restrictions were imposed, and visas were denied to Chinese citizens until their borders were finally closed. However, this isolation was temporary. Since the number of coronavirus diseases in China has decreased significantly, it has again been actively involved in supporting the economic and health situation on the continent.

Africa's economic situation has not only been worsened by the temporary severance of relations with China. It was in the midst of the global fight against the coronavirus when the previously predicted energy crisis hit the world, pushing oil prices to their lowest level in 25 years. And the International Energy Agency (IEA) said even

if we assume that travel restrictions will ease in the second half of the year, we still expect global oil demand to fall by 9.3 million barrels a day in 2020 compared to 2019, which will destroy a decade of growth. (Ambrose, 2020)



**Fig.4.** Most significant exporters in Africa of petroleum fuels and share of country total exports, based on 2016–2018 averages (in billions of US dollars)

Source: UN ECA

The continent will also have to deal with losses in aviation following the spread of the coronavirus. African airlines lost up to \$ 4.4 billion in revenue after flights were cancelled due to COVID-19 and international airports closed.

The World Bank estimates that Covid-19 will cause the region an emissions loss of between \$ 37 billion and \$ 79 billion by 2020 due to the combined effects of the epidemic, including trade disruptions and declining remittances, tourism and foreign aid reduction.

While most countries in the region are experiencing declining growth, real GDP growth is projected to decline sharply, especially in the region's three largest economies - Nigeria, Angola and South Africa - due to persistently weak growth and declining investment according to the World Bank report. (Feleke 2020)

Since the emergence of the coronavirus, one of the greatest dangers as a result of interrupted agricultural production and food imports has been starvation. Africans spend most of their income on food (compared to Americans, who spend 9.7% of their total salary on food. More than 1 million people have lost their jobs in Ethiopia. Because of this year's extraordinary locust invasion, East Africa has already been threatened with famine in the past. In the shadow of the loss of work and the danger of starvation, the poorest sections of society can do not leave their homes, so compliance with curfew restrictions in some countries results in violent police action.

Recognizing more difficult than usual social conditions, several African countries are trying to alleviate the difficulties of the population in various ways. In the Republic of South Africa, the South African Statistical Office conducts surveys on the business situation and difficulties caused by the restrictions related to the coronavirus in a number of economic areas. To this end, the Agency recently launched an online qualitative survey to understand the impact of COVID-19 on businesses. (APO 2020) South Africa has promised to provide accommodation for all homeless people.

Uganda has promised food distribution to vulnerable populations, including breastfeeding women and day workers, and plans to support refugees living in camps. In April, Uganda finally closed its borders to asylum seekers. El-Khidir Daloum, the regional director of the United Nations World Food Program (UN WFP), said the local agency was struggling with \$ 137 million in funding (compared to the \$ 219 million need), raising the question of whether the 28 refugee settlements and how beneficiaries living outside them will receive benefits. With the vast majority of the 1.2 million refugees living in Uganda has travel-work and not receiving aid, they are primarily at risk of malnutrition. (Basiime, Warom, Iceta and Tumushabe, 2020) It was also observed that refugees who did not live near settlements returned to their homeland. Uganda is Africa's largest refugee country - mainly with asylum seekers from South Sudan and the Democratic Republic of the Congo.

Rwanda has promised to support 20,000 families in the form of door-to-door donations in the capital, but many other people living in poverty in both countries will not be reached by these initiatives. (Mutanganshuro 2020)

Due to the crisis situation, not only governments and local governments are trying to alleviate the situation of the population, but non-governmental organizations are also involved in providing not only humanitarian but also legal assistance. Human rights organizations are finding illegal actions by some African countries in many areas of protection against the coronavirus.

A group of this kind of acts are about making communication impossible, e.g. when Egypt, like China, expelled journalists from the country. Although it is undeniable that in Ethiopia, the general ban on telephone and internet services in the Western Oromo region, which had been going on for three months, has just been lifted because of the coron virus - but mainly due to protests from legal organizations.

Referring to overcrowding, advocacy groups demanded the release of political prisoners in Egypt, Libya and South Sudan. The status of refugee camps in Nigeria, Sudan and South Sudan has been highlighted as focal points for the spread of the virus.

Because the coronavirus came from outside the continent, the population did not feel in danger at first. As the virus spread in Europe, so did verbal atrocities, rarely abuse, against non-African people, in which citizens from abroad were "sent home" or the word coronavirus was shouted at them threateningly. Contrary to this attitude, however, people did not take the threat of the coronavirus seriously enough, despite the fact that African presidents introduced strict measures to prevent the spread of the virus. (Dahir, 2020)

In Morocco, at least a dozen people were arrested in mid-March for spreading false news about the coronavirus. On the same day, the government approved a bill regulating the use of social media to prevent false news and cybercrime that undermines public order and the economy. Legal organizations have also accused the government of curtailing press freedom, of which there have been many examples over the past year.

Among the virus-related pseudo-spreaders are those who deny the existence of the virus and therefore call for precautionary measures to be ignored and restrictions to be met. In contrast, there are also rumours that a city is closed and people are advised not to go there.

The emergence of the coronavirus is also a problem for religious organizations, so regardless of denomination, there are religious leaders across Africa who voice their outrage and ignore the restrictions. And in a fundamentally religious Africa, these leaders are unfavourably shaping public opinion in defence of COVID-19.

In Tanzania, President John Magufuli also tried to minimize the threat of the coronavirus, keeping in mind the will of religious leaders as well, so in early April, Magufuli continued to tell his citizens to attend religious services because divine help is the only thing that can overcome the disease. "Coronavirus cannot survive in the

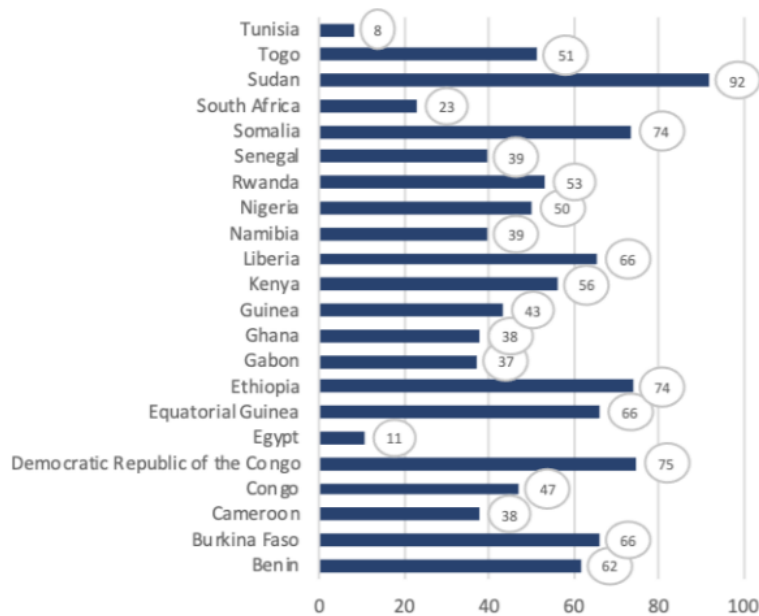


body of Jesus Christ, it will burn,” Magufuli said back in March. “That is exactly why I did not panic while taking the Holy Communion.” (Ward, 2020)

Although even the Mosque of Mecca closed its doors in an extraordinary way - even during the Ramadan period, imams of extremist denominations such as Rachid Eljay, the religious leader of Brest in Algeria, stated that prayer and supplications protect against the virus - meaning no need to the sciences. Ali Belhadj, leader of the Islamic Salvation Front, and Abdallah Djaballah, chairman of the Justice and Development Front, Islamist Party, issued statements on the closure of the mosques, demanding that the mosques not be closed because they are houses of God and protected by God.

On the 18th of April, in Kenya, elders of the Mijikenda religion, like the leaders of Njuri Njeke, performed ritual cleansing ceremonies in the forest to ward off the harmful spirits of the coronavirus and then asked the government to allow the treatment of coronavirus cases by traditional methods, as this was already the case in the 1950s. (KTN 2020)

The most important thing for us in understanding the current pandemic situation in Africa is that many millions live together in same part of the city, in very densely and in many cases superimposed dangerous conditions, “often in homely huts and with little or no access to basic needs such as clean drinking water and hygiene”. There is no piped water supply in the congested parts of the city, so the people living there usually (carry) the water from elsewhere or, for example, buy it at a very high price from the trader or from local gangs. In many cases, contaminated water that is hazardous to health is used for everyday purposes. (Tarrós 2020)



**Fig.5.** Proportion of urban population living in slums, percent

Source: UN ECA

Misconceptions about the coronavirus include the belief that COVID-19 does not infect Africans or that it is not able to survive in the African climate. In addition, superstitions have become widespread, saying that if someone is infected by COVID-19, it is enough to blow themselves with chlorine mixed with alcohol and recover, in

Kenya, drinking black tea in the morning is recommended to treat a coronavirus infection, neem wood preparations to protect against coronavirus.

As a result of drastic violations of restrictions and police brutality, more people have died so far in the Democratic Republic of Congo, Kenya (Ombour and Bearak 2020), South Africa and Nigeria than in coronavirus disease. In Nigeria, 18 people died in two weeks as a result of measures taken to enforce the restrictions, while at the same time, only 12 people died from COVID-19 at the time of the reported data. (Sargent 2020) In Kenya, even on the day the study was written, six people fell victim to police brutality enforcing curfew due to the coronavirus. The youngest victim of Kenyan police was a 13-year-old boy who was accidentally shot by police on his own balcony. In Uganda, women have been forced to undress during police violence, and police have targeted LGBTQ people with new powers. In South Africa, a number of videos are circulating on the internet about the abuses of national defence forces against civilians, most recently children were injured when a man was shot dead by police in front of their house. In all cases, the authorities promised to prosecute and punish the responsible officials.

## **5. Conclusions**

In 2020, Africa's poor health system, HIV, TB, malaria and other communicable diseases, the agricultural catastrophe caused by locust infestation, political instability in several countries and the economic situation which make Africa depending on external actors provide a breeding ground for COVID-19 or any infection. It has been brought to the attention of continent leaders by several world organizations.

Recognizing its own situation, Africa has thus focused primarily on prevention, because the task of virus emergence and screening still seemed feasible, while preventing the spread is, in all technical opinions, impossible. African governments, with the help of the WHO and then China, reacted quickly, and there were countries where this system already existed due to the Ebola epidemic, so some regions also had practical experience. Although the virus is already present in all countries, the timing of its releases is late compared to Europe, despite its direct contact with China.

Strict measures taken to prevent public exposure after the outbreak of the virus were introduced because of poor health care systems, but the restrictions result in economic hardship, social tensions, and political struggle. The existing difficulties: continent-wide hunger, economic crisis, police brutality raise the need and credibility of the public to fight the coronavirus, which is why misconceptions and false rumours about the virus are spreading rapidly on the continent. False news and misconceptions increase the extent of confrontation with governments and the risk of the virus spreading.

## References

- Ambrose, J. 2020, April 15. Oil prices slump as market faces lowest demand in 25 years. *The Guardian*, Retrieved from <https://www.theguardian.com/business/2020/apr/15/oil-prices-slump-as-market-faces-lowest-demand-in-25-years-covid-19>
- APO 2020, April 17. Coronavirus - South Africa: COVID-19 lockdown impacts publication of economic statistics. *Africanews/APO Group*, Retrieved from <https://www.africanews.com/2020/04/17/coronavirus-south-africa-covid-19-lockdown-impacts-publication-of-economic-statistics/>
- AU 2020, May 26. Outbreak Brief #19: Coronavirus Disease 2019 (COVID-19) Pandemic Date of Issue: 26 May 2020. *African Union/Africa CDC*, Retrieved from <https://au.int/sw/files>
- Basiime, F., Warom, F., Iceta, S. and Tumushabe, A. 2020, April 17. Refugee food cut exposes mothers, children to hunger. *Daily Monitor*, Retrieved from <https://www.monitor.co.ug/News/National/Refugee-food-cut-exposes-mothers-children-to-hunger/688334-5526338-nv58s0z/index.html>
- Dahir, A. L. 2020, March 17. Africa Braces for Coronavirus, but Slowly. *The New York Times*, Retrieved from <https://www.nytimes.com/2020/03/17/world/africa/coronavirus-africa-burkina-faso.html>
- Feleke, B. 2020, April 9. Sub-Saharan Africa to fall into its first recession in 25 years due to coronavirus, says World Bank. *CNN*, Retrieved from <https://edition.cnn.com/2020/04/09/africa/africa-recession-coronavirus/index.html>
- Gilbert, M., Pullano, G., Pinotti, F., Valdano, E., Poletto C., Boëlle, P-Y., D'Ortenzio, E., Yazdanpanah, Y., Eholie, S. P., Altmann, M., Gutierrez, B., Kraemer, M.U.G., Colizza, V. 2020, March 14. Preparedness and vulnerability of African countries against introductions of 2019-nCoV. *The Lancet*, Retrieved from [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(20\)30411-6/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30411-6/fulltext)
- Jerving, S. 2020, January 30. Africa needs early detection of coronavirus, WHO says. *Devex*, Retrieved from <https://www.devex.com/news/africa-needs-early-detection-of-coronavirus-who-says-96460>
- Kamara, M. M. 2020, February 8. Coronavirus: Sierra Leone introduces compulsory quarantine for travelers from China." *Politico SL*, Retrieved from <https://www.politicosl.com/articles/coronavirus-sierra-leone-introduces-compulsory-quarantine-travelers-china>
- Kapata, N., Ihekweazu, C., Ntoumi, F., Raji, T., Chanda-Kapata, P., Mwaba, P., Mukonka, V., Bates, M., Tembo, J., Corman, V., Mfinanga, S., Asogun, D., Elton, L., Arruda, L. B., Thomason, M. J., Mboera, L., Yavinsky, A., Haider, N., Simons, D., Hollmann, L., Lule, S. A., Veas, F., Abdel Hamid, M. M., Dar, O., Edwards, S., Vairo, F., McHugh, T. D., Drosten, C., Kock, R., Ippolito, G. and Zumla, A. 2020, February 8. Is Africa prepared for tackling the COVID-19 (SARS-CoV-2) epidemic? Lessons from past outbreaks, ongoing pan-African public health efforts, and implications for the future. *International Journal of Infectious Diseases*, Retrieved from [https://www.ijidonline.com/article/S1201-9712\(20\)30107-7/fulltext](https://www.ijidonline.com/article/S1201-9712(20)30107-7/fulltext)
- KTN 2020, April 18. We have COVID cure: Mijikenda elders claim they may have the cure to COVID-19. *KTN News*, Retrieved from <https://www.standardmedia.co.ke/ktnnews/video/2000188079/we-have-covid-cure-mijikenda-elders-claim-they-may-have-the-cure-to-covid19>
- Maclean, R. and Dahir, A. L. 2020, February 28. Nigeria Responds to First Coronavirus Case in Sub-Saharan Africa. *The New York Times*, Retrieved from <https://www.nytimes.com/2020/02/28/world/africa/nigeria-coronavirus.html>
- Makoni, M. 2020, February 15. Africa prepares for coronavirus." *The Lancet*, Retrieved from [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(20\)30355-X/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)30355-X/fulltext)
- Maseko, N. 2020, April 22. Coronavirus: South Africa deploys 70,000 troops to enforce lockdown. *BBC*, Retrieved from <https://www.bbc.com/news/world-africa-52387962>
- Moore, W. G. and Nyenswah, T. 2020, March 8. How can we prepare for Coronavirus? Learn from Liberia's experience with Ebola. *Mail&Guardian*, Retrieved from <https://mg.co.za/article/2020-03-08-how-can-we-prepare-for-coronavirus-learn-from-liberias-experience-with-ebola/>
- MSF 2020. Crisis Update. *Medecins Sans Frontieres*, Retrieved from <https://www.msf.org/drc-ebola-outbreak-crisis-update>

Mumin, A. A. and Pensulo, C. 2020, March 20. Africa's fragile health systems rush to contain coronavirus. *The Guardian*, Retrieved from <https://www.theguardian.com/world/2020/mar/20/africas-fragile-health-systems-rush-to-contain-coronavirus>

Mutanganshuro, L. 2020, March 28. Govt begins distribution of essential goods to citizens affected by COVID-19 lockdown. *The New York Times*, Retrieved from <https://www.newtimes.co.rw/news/govt-begins-distribution-essential-goods-citizens-affected-covid-19-lockdown>

Nordling, L. 2020, March 15. 'A ticking time bomb': Scientists worry about coronavirus spread in Africa. Retrieved from <https://www.sciencemag.org/news/2020/03/ticking-time-bomb-scientists-worry-about-coronavirus-spread-africa>

Ogbuonji, O., Bharali, I., Emery, N. and McDade, K. K. 2020, March 1. Closing Africa's health financing gap. *Future Development*, Retrieved from <https://www.brookings.edu/blog/future-development/2019/03/01/closing-africas-health-financing-gap/>

Ombuor, R. and Bearak, M. 2020, April 15. 'Killing in the name of corona': Death toll soars from Kenya's curfew crackdown. *The Washington Post*, Retrieved from [https://www.washingtonpost.com/world/africa/kenya-coronavirus-curfew-crackdown-death-toll/2020/04/15/740a8c4e-79be-11ea-a311-adb1344719a9\\_story.html](https://www.washingtonpost.com/world/africa/kenya-coronavirus-curfew-crackdown-death-toll/2020/04/15/740a8c4e-79be-11ea-a311-adb1344719a9_story.html)

Sargent, A. 2020, April 17. Curfew crackdowns in several African countries kill more people than Covid-19. *France24*, Retrieved from <https://www.france24.com/en/20200417-papers-curfew-crackdowns-in-several-african-countries-kill-more-people-than-covid-19>

Smith, E. 2020, April 2. Lockdowns, curfews and doorstep testing: Africa's crackdown on the coronavirus. *CNBC*, Retrieved from <https://www.cnb.com/2020/04/02/lockdowns-curfews-and-doorstep-testing-africas-crackdown-on-the-coronavirus.html>

Smith, S. 2020, February 4. What the Coronavirus Means for Africa. *Africa Center for Strategic Studies*, Retrieved from <https://africacenter.org/spotlight/what-the-coronavirus-means-for-africa/>

SOP 2020, January 30. Standard Operating Procedures for Preparedness, Detection and Response to A Coronavirus (2019-NCoV) Outbreak in South Africa. *National Department of Health Directorate: Communicable Diseases*, Retrieved from [https://www.hpcs.co.za/Uploads/Publications%202020/Resources/SOP\\_Coronavirus\\_29\\_Jan\\_2020.pdf](https://www.hpcs.co.za/Uploads/Publications%202020/Resources/SOP_Coronavirus_29_Jan_2020.pdf)

Tarrósy István 2020, May 8. Afrika a COVID-19 pandémia szorításában, *KKI elemzések*, Retrieved from <https://kki.hu/kki-elemzesek/>

UN ECA 2020, April 24. COVID-19 in Africa: Protecting Lives and Economies. *UN ECA*, Retrieved from <https://www.uneca.org/>

Vincent, D. 2020, February 17. Coronavirus: A Cameroon student on how he recovered. *BBC*, Retrieved from <https://www.bbc.com/news/world-africa-51502711>

Ward, A. 2020, April 21. Africa has so far been spared the worst of the coronavirus. That could soon change. *VOX*, Retrieved from <https://www.vox.com/2020/4/21/21225002/coronavirus-africa-cases-death-food-debt-economy>

WHO 2020, February 3. 2019 Novel Coronavirus (2019-nCoV): Strategic Preparedness and Response Plan. Retrieved from <https://www.who.int/docs/default-source/coronaviruse/srp-04022020.pdf>

WHO Situation Report 2020, May 26. Coronavirus Disease (COVID-19): Situation Report – 127. *WHO*, Retrieved from <https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200526-covid-19-sitrep-127.pdf>

### *Acknowledgements*

*The research is supported by Doctoral School of Safety and Security Studies, Óbuda University, Hungary*

**János BESENYŐ** holds PhD of Military Science and habilitated doctorate from History. He works full time as Associate professor for the Óbudai University, Doctoral School for Safety and Security Sciences, as the head of the Africa Research Center. Between 1987 and 2018 he was a professional soldier and served several times in Africa (Western Sahara, Darfur) and Afghanistan in various peacekeeping and military missions. His research interests include contemporary and recent history of Africa, migration and the Middle East, military conflicts, peacekeeping, military logistics, terrorism, and Christian-Muslim relationship on the continent. He is teaching not only at Óbudai University, Doctoral School for Safety and Security Sciences, but ELTE Doctoral School of History, EKE Doctoral School of History, and National University of Public Service, Doctoral School of Military Sciences. He wrote several books and articles. His most recent publication is „Hungary and the crisis in Western Sahara” (Monarchia Ltd, 2020).

**ORCID ID:** [orcid.org/0000-0001-7198-9328](http://orcid.org/0000-0001-7198-9328)

**Marianna KÁRMÁN**, PhD in African Literary and Cultural Studies, has been researching the oral and written traditions, cultural and religious system and practices of the region for about 20 years - primarily in Nigeria. Her specialization includes Islamic studies, intercultural discourse, African migration, the process and social context of African neology. Until 2012, she continued her scientific work as a doctoral student at the Doctoral School of Literary Studies at Pázmány Péter Catholic University, and currently as a researcher at the Doctoral School of Security Sciences at Óbuda University.

**ORCID ID:** [orcid.org/0000-0002-9907-5082](http://orcid.org/0000-0002-9907-5082)

---

Copyright © 2020 by author(s) and VSI Entrepreneurship and Sustainability Center

This work is licensed under the Creative Commons Attribution International License (CC BY).

<http://creativecommons.org/licenses/by/4.0/>



Open Access





**Publisher**

<http://jssidoi.org/esc/home>



---

## ANALYSIS OF THE RELATIONSHIP BETWEEN FINANCIAL DEVELOPMENT AND ECONOMIC GROWTH IN THE EU COUNTRIES

Edmunds Čižo <sup>1</sup>, Olga Lavrinenko <sup>2</sup>, Svetlana Ignatjeva <sup>3</sup>

<sup>1</sup>Department of Economic and Sociology, Daugavpils University\*, Parades Str. 1-421, Daugavpils, LV-5401, Latvia

<sup>2</sup>Institute of Humanities and Social Sciences, Daugavpils University, Parades Str. 1-421, Daugavpils, LV-5401, Latvia

<sup>3</sup>Computer Science Department, Daugavpils University, Parades Str. 1-413, Daugavpils, LV-5401, Latvia

E-mails: <sup>1</sup>[edmunds@chemi-pharm.com](mailto:edmunds@chemi-pharm.com), <sup>2</sup>[svetlana.ignatjeva@du.lv](mailto:svetlana.ignatjeva@du.lv), <sup>3</sup>[olga.lavrinenko@du.lv](mailto:olga.lavrinenko@du.lv)

Received 12 March; accepted 10 July; published 30 September 2020

**Abstract.** To what extent does financial development determine economic growth? Despite the obvious relationship between the level of financial development and economic growth rates, there is still no consensus on the significance and focus of this relation. Is there a directed impact of the level of financial development on economic growth, or does the development of a financial sector follow economic growth? Or is the relation between financial development and economic growth bidirectional? The aim of the research is to analyze the causal relationship between quantitative and dynamic differences in financial development and economic growth in the EU countries in the period 1995 - 2017. The period of the research from 1995 to 2017 is determined by the availability of financial development indicators for the EU countries. In order to prove the directed impact of the level of financial development on economic growth in the EU countries in the period 1995-2017, the average values of growth in the financial development index with the lag forwarding by one year, with the lag falling behind by one year, without the lag, and average values of the GDP growth per capita were analyzed.

**Keywords:** financial development; economic growth

**Reference** to this paper should be made as follows: Čižo, E., Lavrinenko, O., Ignatjeva, S. 2020. Analysis of the relationship between financial development and economic growth in the EU countries. *Insights into Regional Development*, 2(3), 645-660. [https://doi.org/10.9770/IRD.2020.2.3\(3\)](https://doi.org/10.9770/IRD.2020.2.3(3))

**JEL Classifications:** E44, G10, G19, O16

---

\* The research is supported by Daugavpils University, Latvia

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:

@IntoInsights

## 1. Introduction

The evolution of the concept of financial development began in the 6<sup>th</sup> century BC – 15<sup>th</sup> century AD and it still continues up to now, going through a number of stages and terminological corrections from elements of the financial market to modern interpretations of financial development according to functions and results. The issue of the impact of the financial market on economic growth was first raised almost 150 years ago within the classical school. In the early 20<sup>th</sup> century, J. Schumpeter examined the issue applying it to the theory of entrepreneurship. Later, due to objective factors – two world wars and the Great Depression – the issue of relation between the financial market and economic growth was out of the scope of the economic science. Since the early 1960s, there has been a steady increase in interest in this issue: first large-scale research of mainly historical and economic nature, were carried out. In the 1970s-1980s, there were works which rejected a verbal description of the influence of the financial market on economic growth in a particular country or countries in favor of building theoretical models, including those based on economic and mathematical methods, taking into account the determinants of financial development: openness, political power and political institutions, financial liberalization, legal traditions, economic institutions, macroeconomic determinants, as well as determinants that characterize culture and geography (Voghoei at al., 2011, La Porta, at al., 2002, Acemoglu, at al., 2001, Acemoglu at al., 2002, Acemoglu, at al., 2003, Acemoglu, at al., 2005, Acemoglu and Robinson 2006, Rodrik, 2005, Huybens and Smith 1999, Levine, 2005, Stulz and Williamson, 2003, Kitanović and Krstić, 2009). The increasing importance of the financial market for the global economy, processes of its liberalization, development of the finance theory, and emergence of new models of economic growth encouraged the active growth of scientific knowledge in this area (Đekić et al., 2019). Therefore, the concept “financial development” was not defined initially, but rather evolved from that of financial markets. A clear definition and structure of the concept of financial development has not yet been developed. The most detailed description of the definition and structure of financial development was provided in the World Bank documents in the late 1980s in order to reflect the relation between the saturation of the economy with monetary resources, complexity and branching of the financial and monetary system on the one hand, and economic growth rates on the other (Global Financial Development Report, 2013). Therefore, the judgements about financial development should be made according to the resultant structures of the development of financial markets and institutions: financial depth, availability of financial services (financial inclusion), financial efficiency, and financial stability (Čihák et al., 2012).

A. Gershenkron in his analysis of the problems of economic backwardness (Gershenkron, 1962), pointed to the role of the banking sector as one of the factors: the level of economic development before industrialization determines how important the role of the banking sector will be in this process. Thus, speaking about the direction of causal relationship, A. Gershenkron noted that economic development establishes the need for financial services, which increases the demand for external funds. If the difference in growth by sectors or industries is large, the demand for financing will belong to the leading sectors. In this case, mediation encourages economic growth by directing the savings of mostly small investors to large investors.

In 1966 H. Patrick (Patrick, 1966) identified direct and inverse relation between financial development and economic growth calling them “demand following” and “supply leading”. “Demand following” occurs when external sources of financing are needed to sustain the economic growth. “Supply leading” occurs when financial institutions accumulate savings and transform them into investments for the development of certain sectors of the economy. Patrick determined that “demand following” occurs at later stages of development, while “supply leading” is more typical of earlier stages. Thus, it is asserted that financial development affects economic growth, and this direction of the causal relationship is typical of developing countries. In the case of developed countries, its direction is opposite: economic growth itself generates the development of the financial system. A well-known

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:

@IntoInsights

expert in the field of economic history R. Cameron applied a similar approach for the research into relationship between the financial market and economic growth and described the relationship between the financial market and economic development in England, Scotland, France, Belgium, Germany, Japan, and Russia in the 19<sup>th</sup> century. Cameron also argues that financial systems may both encourage economic growth and be a consequence of it.

R. Goldsmith (Goldsmith, 1969) established that there is a linear relationship between finance and economic growth through efficiency gains and cumulative investment, and determined a linear positive relationship between the ratio of financial assets to GDP and GDP per capita for 35 countries in the period from 1860 to 1963. However, he could not prove his assumption about the impact of the financial depth structure on economic growth because of the lack of data on the securities market development for a large number of countries.

Over the past 30 years, research has focused mainly on the impact of financial development on economic growth. In most studies, the model structure is of the AK type (Accumulated Capital Model) (Romer, 1986; Lucas, 1988), in the sense that there is a constant return on a fairly broad concept of capital.

Researchers Aoife Hanley, Wan-Hsin Liu, Andrea Vaona (Hanley et al., 1973) determined that financial development of the region has a positive impact on the efficiency of regional innovation (patenting) in China and, consequently, on economic development. King, R. and Levine, R. (King and Levine, 1993) argue that a higher level of financial development significantly correlates with faster present and future rates of economic growth. Authors Altaf Hossain, Suman Biswas, Md. Nasif Hossain & Arnab Kumar Poddar (Hossain et al., 2017) obtained interesting research results when they used factor analysis for some selected indicators of the financial sector in Bangladesh in the period 1988-2013. The factor analysis shows that financial indicators of size, depth and stability, financial availability and efficiency cause economic growth insignificantly. Khan (Khan et al., 2005) evaluated the relationship between financial development and economic growth using regression analysis in Pakistan. A modern financial system facilitates investment in business, mobilizes savings, controls the manager's work, allows trading, hedging, diversifying risks, and providing services for the exchange of goods and services. He concludes that financial development has a positive impact on economic growth. Levine (Levine, 2002) also believes that the financial structure does not help explain differences between countries in their financial development, nor does it always explain economic growth. Beck and Levine (Beck and Levine, 2002) confirm that there is no single optimal institutional structure for providing financial functions in the economy. Merton and Bodie (Merton and Bodie 2004) also believe that the financial structure is not a particularly useful indicator of the extent to which the financial system contributes to economic growth.

Most of the studies confirmed the relationship between financial development and economic growth rates for different groups of countries and time periods. At the same time, a number of researchers show ambiguity of their conclusions about the direct relationship between the financial market development and economic growth, especially for low-income and middle-income countries. Using the example of loans to a private sector (Arcand et al., 2012) as well as highly liquid liabilities (Law and Singh, 2014), the authors of these studies show that the growth in the financial sector contributes to the development of the economy only up to a certain threshold; further financial development ceases to stimulate growth.

The final resolution on this issue has not yet been reached; it is necessary to clarify the nature of the relationship between financial development and economic growth in the EU countries.

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:

@IntoInsights

## 2. Methodology

The study will examine three main hypotheses that explain the relationship between financial development and economic growth:

**H1: there is a directed impact of the level of financial development on economic growth.**

**H2: development of financial sector follows the economic growth.**

**H3: there is a bidirectional causal relationship between financial development and economic growth.**

H1 is the “financial supply” hypothesis, which explains the impact of the financial sector on the development of the real economy by the fact that financial markets and institutions, by increasing the supply of financial services, create prerequisites for future economic growth. A lack of access to financial resources hinders the creation of new growth points and does not contribute to sustainable economic development (McKinnon, 1973). This hypothesis was confirmed in cross-country studies (King and Levine, 1993) and proved for a number of Asian (Kwan et al., 1998) and African countries (Ndebbio, 2004).

H2 is the “financial demand” hypothesis, according to which financial development depends on changes occurring in the real sector. Financial development follows economic growth as a result of the increased demand for financial services (Robinson, 1952).

H3 hypothesis states that there is a mutual influence of the level of financial development and economic growth, i.e. development of the financial system can contribute to economic growth, and economic development in turn contributes to the development of financial markets (Greenwood and Smith, 1996). The level of development of the financial system largely determines the economic development of countries. In the context of growing globalization and at the same time instability of the global economic system, a stable financial system becomes a “safety cushion” that can help in times of global economic turmoil and maintain a favorable climate in the national economy. There is a number of theoretically founded mechanisms through which financial development contributes to economic growth. Development of financial markets leads to the increase in transaction and information costs (Petrović and Krstić, 2011) and helps to reduce risks when making investment decisions. The financial system affects capital accumulation by mobilizing savings and distributing them among different capital investments. Financial markets also contribute to the growth in the real economy by facilitating the exchange of goods and services (Levine, 1997).

Thus, the purpose of the research is to determine the validity of one of the hypotheses for the EU countries in the period 1995-2017. In this study, the indicator of economic growth is the change in the values of GDP per capita, and the indicator of financial development is the change in the values of the financial development index (Global Financial Development Report).

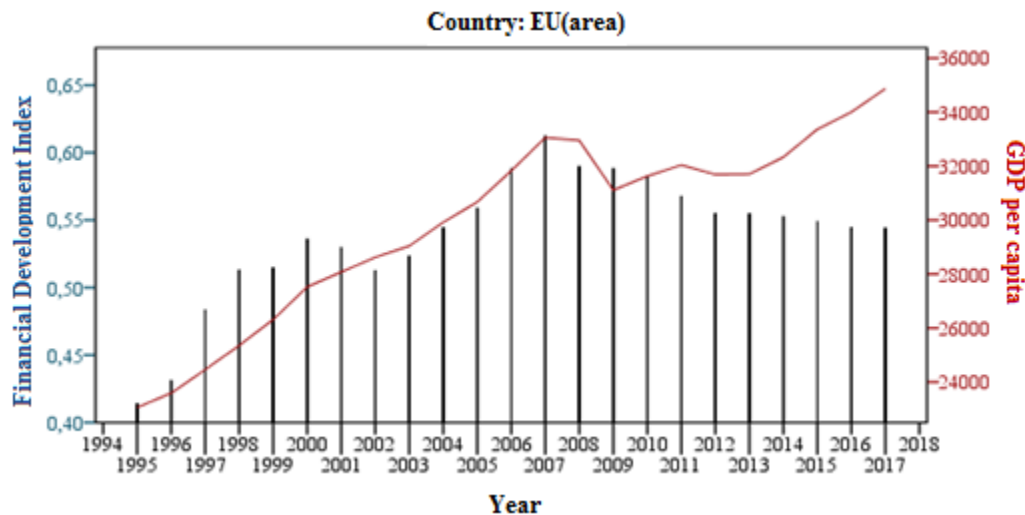
Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:  
@IntoInsights

### 3. Results

#### Analysis of the relationship between economic and financial development in the EU countries

Analyzing dynamics of the average value of the financial development indices and the average value of the GDP per capita in the 28 EU countries in the period 1995-2009 (irrespective of the year of accession), we can also make a conclusion about the relationship of these indicators.

However, since the 2009 crisis year, the significantly “failed” average values of the financial development index started to increase with decreasing average values of the GDP per capita (see Figure 1 below).



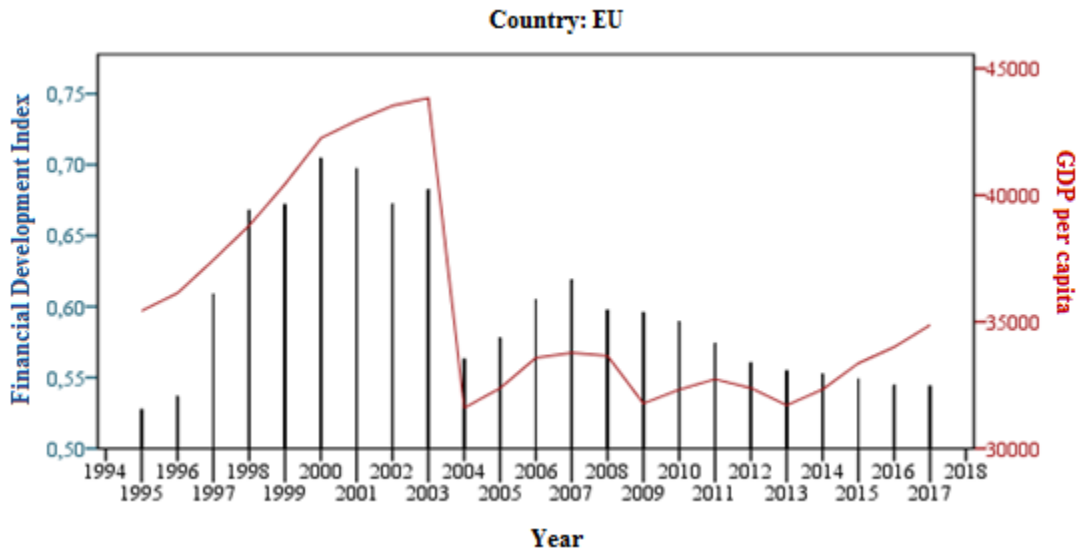
**Fig. 1.** Dynamics of the average value of the financial development index and the average value of the GDP per capita for all 28 EU countries in the period 1995-2017.

*Source:* developed by the authors in SPSS

However, if we consider trends in the changes in the values of GDP per capita and the values of the financial development index as far as countries join the EU, i.e. with a changing number of participating countries, since 2013, when Croatia joined the EU, the average values of GDP per capita decreased, while the average values of the financial development index increased in dynamics. It is obvious that the fifth EU enlargement in 2004 had the highest negative impact, much higher than the impact of the 2008-2009 crisis, on both the average values of the financial development index and GDP per capita (see Figure 2 below).

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:

@IntoInsights



**Fig. 2.** Dynamics of the average value of the financial development index and the average value of the GDP per capita in the EU\* countries in the period 1995-2017.

Source: developed by the authors in SPSS

*Note\*: the EU gradually expands by way of the accession of new member states:*

1957 — signing of the Treaty of Rome setting up the European Economic Community: Belgium, the Federal Republic of Germany, Italy, Luxembourg, the Netherlands, and France.

1973 — first EEU enlargement (Denmark, Ireland, and the United Kingdom joined).

1981 — second EEU enlargement (Greece joined).

1986 — third EEU enlargement (Spain and Portugal joined).

1995 — fourth enlargement (Austria, Finland, and Sweden joined).

1999 — introduction of single European currency — euro (in circulation since 2002).

2004 — fifth enlargement (the Czech Republic, Hungary, Poland, Slovakia, Slovenia, Estonia, Latvia, Lithuania, Cyprus, and Malta joined).

2007 — second wave of the fifth enlargement (Bulgaria and Romania joined).

2013 — sixth enlargement (Croatia joined).

Having carried out the correlation analysis between the indicators of average values of financial development and GDP per capita in groups of countries in the period 1995-2017, two periods, which characterize the linear correlation, were identified: a pre-crisis period (from 1995 to 2008) and a crisis and post-crisis period (from 2008 to 2017).

It is determined that there is a strong linear positive correlation between financial development and economic development for both the 28 EU countries and the EU with the increasing number of member countries in the period 1995-2008, while in the period 2008-2017 there is a rather strong negative linear correlation (see Table 1).



Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:  
@IntoInsights

**Table 1.** Pearson correlation coefficients (p-value from 0 to 0.05) characterizing a linear correlation between the average values of financial development and GDP per capita in the groups of countries in the period 1995-2008

Country	R (Pearson) 1995-2008	R (Pearson) 2008-2017
EU with the increasing number of member states	0.812	-0.622
EU (EU area)	0.943	-0.756

Source: developed by the authors in SPSS

Thus, it was determined that for the 28 EU countries in the pre-crisis period there is a strong linear positive correlation between financial development and economic development, and in the crisis and post-crisis period there is a strong linear negative correlation between financial development and economic development. The observed linear correlation between the values of the financial development index in the EU countries and GDP per capita in the EU countries for each year from 1995 to 2017 is positive and significant. The correlation appears in cross-sections by year throughout the period under study (1995–2017). Dynamics of the correlation coefficient in the spatial sample is presented in the table 2 below.

**Table 2.** Dynamics of the Pearson correlation coefficient (p-value from 0 to 0.05) characterizing a linear correlation between the values of financial development and GDP per capita in cross-sections by year in the period 1995–2017. (EU area)

Year	R (Pearson)	Year	R (Pearson)	Year	R (Pearson)	Year	R (Pearson)
1995	0.828	2001	0.765	2007	0.667	2013	0.700
1996	0.795	2002	0.751	2008	0.696	2014	0.662
1997	0.795	2003	0.747	2009	0.702	2015	0.674
1998	0.766	2004	0.746	2010	0.706	2016	0.680
1999	0.752	2005	0.737	2011	0.694	2017	0.690
2000	0.751	2006	0.714	2012	0.722		

Source: developed by the authors in SPSS

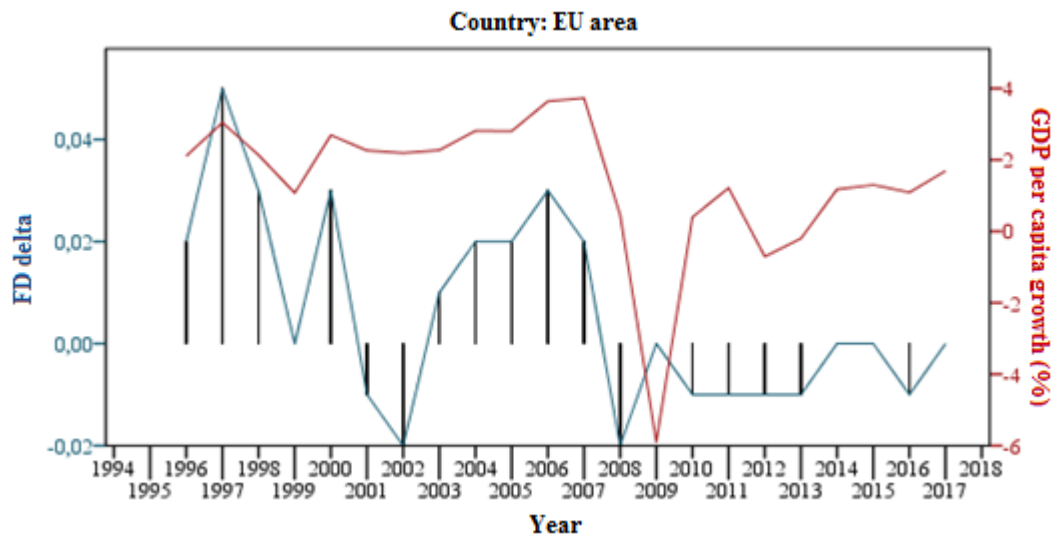
Thus, there is a close relationship between the level of financial development and the level of GDP per capita, appeared both in spatial samples of the EU countries throughout the period under study and in dynamic series.

#### Dynamic analysis of growth in the values of financial development index and the values of economic development.

The previous paragraph stated that there is a linear relationship between financial and economic development. Now, it is necessary to determine whether there is a relationship between the growth in financial development and economic growth, as well as to determine the direction of this relationship.

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:  
@IntoInsights

From the analysis of Figure 3, which characterizes the dynamics of growth in the average value of the financial development index and growth in the average value of GDP per capita in all EU countries in the period 1995-2017, we can clearly see a causal relationship: the decline in the growth of the financial development index is followed by the decline in the GDP growth, which supports the first hypothesis. The Pearson correlation coefficient which characterizes a linear correlation between the average values of financial development growth and the average values of growth in GDP per capita for the EU countries comprises 0.476 (p-value<0.05).



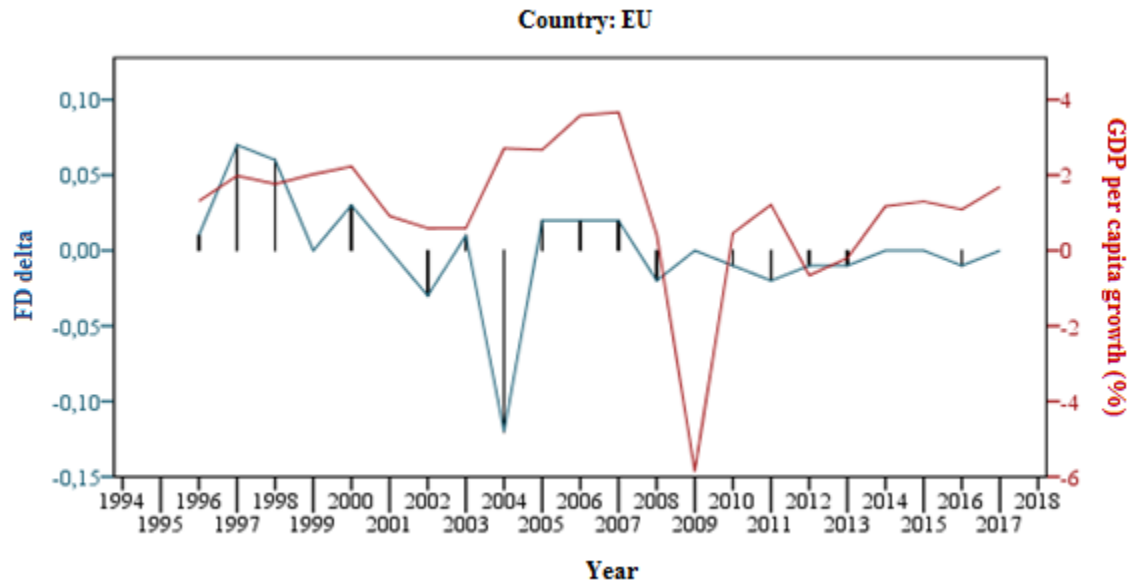
**Fig. 3.** Dynamics of the growth in the average value of financial development index and the growth in the average value of GDP per capita for all EU countries in the period 1995-2017.

*Source:* developed by the authors in SPSS

Figure 4 clearly shows the correlation between the growth in the values of financial development index and the growth in GDP per capita. The accession of new member countries to the EU in 2004 influenced significantly the growth in the values of financial development index. The crisis had a great impact on the GDP growth - in 2009 the growth “crashed”. A weak positive linear correlation between the growth indicators of the financial development index and the GDP per capita growth was determined: the Pearson correlation coefficient comprises 0.094 (p-value<0.05).

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:

@IntoInsights



**Fig. 4.** Dynamics of growth in the average value of financial development index and in the average value of GDP per capita in the EU\* countries in the period 1995-2017.

Source: developed by the authors in SPSS

*Note\*: the EU gradually expands by way of the accession of new member states:*

1957 — signing of the Treaty of Rome setting up the European Economic Community: Belgium, the Federal Republic of Germany, Italy, Luxembourg, the Netherlands, and France.

1973 — first EEU enlargement (Denmark, Ireland, and the United Kingdom joined).

1981 — second EEU enlargement (Greece joined).

1986 — third EEU enlargement (Spain and Portugal joined).

1995 — fourth enlargement (Austria, Finland, and Sweden joined).

1999 — introduction of single European currency — euro (in circulation since 2002).

2004 — fifth enlargement (the Czech Republic, Hungary, Poland, Slovakia, Slovenia, Estonia, Latvia, Lithuania, Cyprus, and Malta joined).

2007 — second wave of the fifth enlargement (Bulgaria and Romania joined).

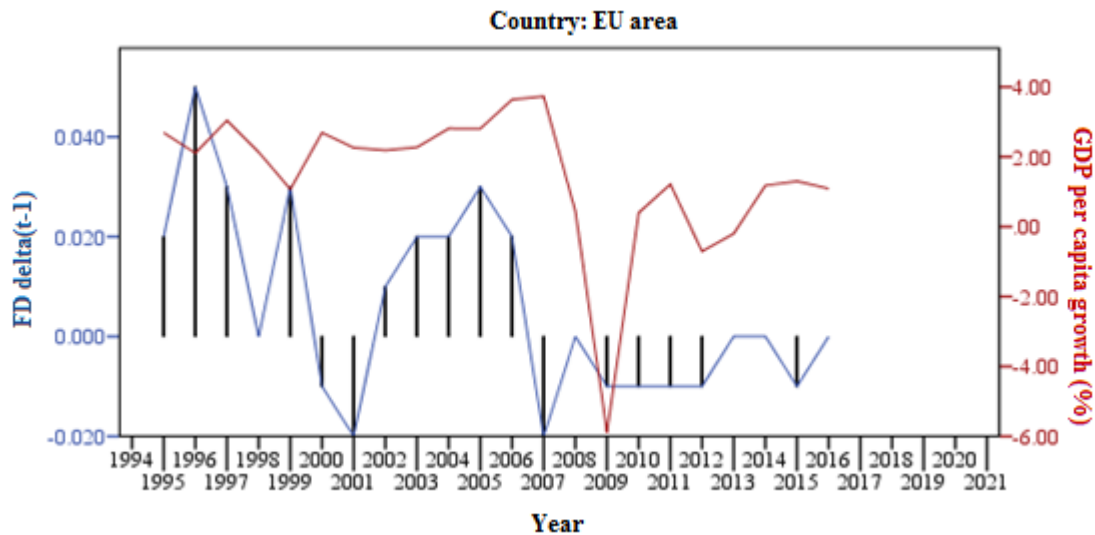
2013 — sixth enlargement (Croatia joined).

Thus, the determined positive linear relationship between the growth in values of financial development and the economic growth confirms the correlation between the abovementioned variables; the growth in values of financial development in general predetermines the economic growth rate, presumably, with the lag of one year. This confirms the hypothesis of “financial supply”.

In order to clarify the data obtained in the previous paragraph, let us consider the dynamics of growth in the average value of the financial development index with the lag  $t-1$ ,  $t+1$  and the growth in the average value of GDP per capita in all EU countries, as well as in different groups of countries in the period 1995-2017.

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:  
@IntoInsights

Figure 5 shows the influence of growth in the values of financial development index on economic growth. The positive linear correlation between the growth indicators of the financial development index and the growth in GDP per capita in all EU countries was determined: the Pearson correlation coefficient for the average value of the financial development index with the t-1 lag comprises 0.326 (p-value<0,05).



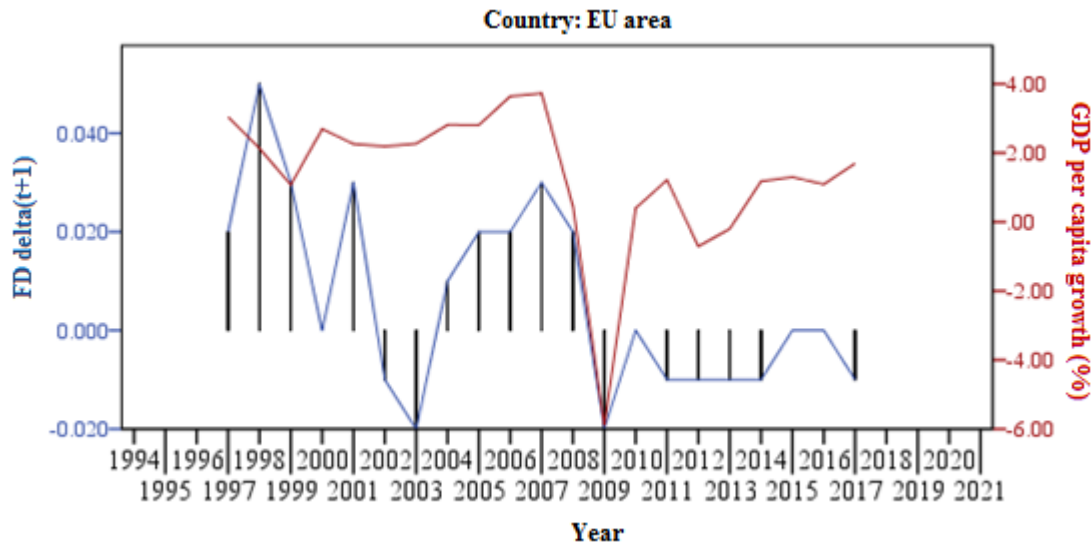
**Fig. 5.** Dynamics of growth in the average value of the financial development index and in the average value of GDP per capita for all EU countries in the period 1995-2017.

*Source:* developed by the authors in SPSS

The positive linear correlation between the growth indicators of the financial development index and the GDP per capita growth for all EU countries was determined: the Pearson correlation coefficient for the average value of the financial development index with the lag t+1 comprises 0.484 (p-value<0.05). The Pearson correlation coefficient for the average value of the financial development index without the lag comprises 0.476 (p-value<0.05). Thus, it can be clearly seen in the figure, as well as it is confirmed by the correlation analysis, the growth in values of financial development as a whole predetermines the economic growth rates the lag by 1 year.

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:

@IntoInsights



**Fig. 6.** Dynamics of growth in the average value of financial development index with the lag  $t+1$  and in the average value of GDP per capita for all EU countries in the period 1995-2017.

Source: developed by the authors in SPSS

Summarized data of the correlation analysis characterizing the linear correlation between the average values of financial development with lags and the GDP per capita growth in the groups of countries in the period 1995-2008 revise the first hypothesis proposed for the groups of countries (Table 3):

**Table 3.** Pearson correlation coefficients ( $p\text{-value} < 0.05$ ) characterizing the linear correlation between the average values of financial development with lags and the GDP per capita growth in the groups of countries in the period 1995-2008.

Country	R (Pearson) <sub>t-1</sub>	R (Pearson) <sub>t+1</sub>	R (Pearson) <sub>t</sub>
Founding country	0.153	0.544	0.536
EU members since 1973	0.245	0.491	0.169
EU members since 1981	0.348	0.192	0.396
EU members since 1986	0.137	0.632	0.493
EU members since 1995	0.137	0.449	0.685
EU members since 2004	0.312	0.495	0.329
EU members since 2007	0.234	0.243	0.358
EU members since 2013	0.200	0.425	0.128
EU	0.326	0.484	0.476

Source: developed by the authors in SPSS

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:  
@IntoInsights

Thus, in general, the EU countries in the period from 1995 to 2017 are characterized by the hypothesis of “financial supply”, according to which the impact of the financial sector on the development of the real economy is explained by the fact that financial markets and institutions, increasing the supply of financial services, create prerequisites for the future economic growth. However, if we consider certain separate groups of countries, the relationship between economic growth rates and financial development is individual and can change its direction over time, so it was necessary to confirm the hypothesis with the correlation analysis results. Therefore, in the groups of countries that joined the EU in 1981, 1995, 2007 the third hypothesis is true: there is a mutual influence of the financial development level and economic growth, i.e. the development of the financial system can contribute to economic growth, and economic development in turn contributes to financial development.

#### **4. Discussion and conclusions**

There is a number of theoretically founded mechanisms through which financial development contributes to economic growth. There are a few channels through which the financial system affects economic growth. In particular, the development of financial markets leads to the reduction in transaction and information costs and helps reduce risks in making investment decisions. The financial system affects capital accumulation by mobilizing savings and distributing them among different capital investments. Financial markets also contribute to growth in the real economy by facilitating the exchange of goods and services (Levine, 1997).

Despite the evident link between the level of financial development and economic growth rates, up to now, there is no consensus on the significance and focus of this link. In this regard, three main hypotheses that explain the relationship between the level of financial development and economic growth were identified. The first hypothesis includes the statement about the directed influence of the financial development level on economic growth. This hypothesis is a “financial supply” hypothesis which explains the impact of the financial sector on the development of a real economy by the fact that financial markets and institutions, increasing the supply of financial services, create prerequisites for the future economic growth. The second hypothesis includes the statement that financial development follows economic growth. This hypothesis is a “financial demand” hypothesis, according to which financial development depends on changes occurring in the real sector. Financial development follows economic growth as a result of the increased demand for financial services. The third hypothesis argues that there is a bi-directional causal link between financial development and economic growth, i.e. development of the financial system can contribute to economic growth, while economic development in turn contributes to the development of financial markets.

The analysis of the impact of financial development in the EU countries on their economic growth in the period 1995-2017 shows that there is a close relationship between the financial development level and the GDP per capita level, manifested both in spatial samples of the EU countries during the period under study and in dynamic rows. The determined positive linear relationship between the growth in the values of financial development and economic growth confirms the dependence of financial development in the EU countries on their economic growth. The analysis of trends in the average values of the financial development index with the lag forwarding by one year, with the lag falling behind by one year, without the lag shows that the increase in the values of financial development in general predetermines the economic growth rate with the lag forwarding by one year for the majority of groups of countries gradually joining the EU. This confirms the “financial supply” hypothesis. However, if we consider separate groups of countries, the relationship between economic growth rates and financial development is individual and can change its direction over time. In this regard, the hypothesis was confirmed by the results of correlation analysis. Therefore, in the groups of countries that joined the EU in 1981, 1995, 2007 the third hypothesis is true: there is a mutual influence of the financial development level and



Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:

@IntoInsights

economic growth, i.e. development of the financial system can contribute to economic growth, and economic development in turn contributes to financial development.

Thus, the direction of the relationship between economic growth and financial development depends on the period of study and structure of the groups of countries under study. Therefore, all three hypotheses may be true under the above-mentioned circumstances, which is confirmed by the works of various researchers discussed in the article.

## References

- Acemoglu, D., Johnson, S. and Robinson, J.A. 2001. The Colonial Origins of Comparative Development: An Empirical Investigation, *American Economic Review* 91(5): 1369 – 1401
- Acemoglu, D., Johnson, S. and Robinson J.A. 2002. Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution, *The Quarterly Journal of Economics* 117(4): 1231-1294
- Acemoglu, D., Johnson, S., Robinson, J. and Thaicharoen, Y. 2003. Institutional Causes, Macroeconomic Symptoms: Volatility, Crises and Growth, *Journal of Monetary Economics* 50: 49–123
- Acemoglu, D., Johnson, S. and Robinson, J.A. 2005. Institutions as the Fundamental Cause of Long-Run Growth, in: Philippe Aghion and Steven Durlauf (ed.), *Handbook of Economic Growth*, Edition 1, Volume 1, Chapter 6: 385-472. Elsevier, North Holland.
- Acemoglu, D. and Robinson, J. 2006. De Facto Political Power and Institutional Persistence, *American Economic Review* 96(2): 325-330
- Arcand, J. L., Berkes E., and Panizza U. 2012. Too Much Finance? *Journal of Economic Growth* 20(2): 105–148
- Ardalan, F., Almasi, N. A., and Atasheneh, M. 2017. Effects of contractor and employer's obligations in buy back contracts: case study of oil exporting country, *Entrepreneurship and Sustainability Issues* 5(2): 345-356. [https://doi.org/10.9770/jesi.2017.5.2\(13\)](https://doi.org/10.9770/jesi.2017.5.2(13))
- Beck, T., and Levine, R. 2002. Industry growth and capital allocation: Does having a market- or bank-based system matter?, *Journal of Financial Economics* 64: 147–180
- Čihák, M., Demirgüç-Kunt, A., Feyen, E., and Levine, R. 2012. *Policy Research Working Paper 6175*. The World Bank Financial and Private Sector Development Vice Presidency & Development Economics Vice Presidency August 2012
- Čižo, E., Ignatjeva, S., and Lavrinenko, O. 2018. Assessment of convergence processes of financial depth indicators in states with different levels of economic development. *Journal of Security and Sustainability Issues* 7(3): 459-476. [https://doi.org/10.9770/jssi.2018.7.3\(8\)](https://doi.org/10.9770/jssi.2018.7.3(8))
- Demetriades, P., and Hussein, K. 1996. Does financial development cause economic growth? Time series evidence from 16 countries, *Journal of Development Economics* 51: 387–411
- Dubauskas, G. 2012. Sustainable growth of the financial sector: the case of credit unions, *Journal of Security and Sustainability Issues* 1(3): 159-166, [https://doi.org/10.9770/jssi/2012.1.3\(1\)](https://doi.org/10.9770/jssi/2012.1.3(1))
- Đekić, I., Radivojević, V., and Krstić, M. 2019. Politika zaštite konkurencije kao faktor ekonomskog razvoja država u tranziciji. *Vojno delo* 71 (7): 372-382
- Economic Backwardness in Historical Perspective. 1962. Gerschenkron, A., Cambridge, The Belknap Press of Harvard University Press

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:

@IntoInsights

Financial Systems for Eastern Europe's Emerging Democracies (occasional papers (international center for economic growth)). 1993.

Joseph E. Stiglitz. Ics Pr.

Goldsmith R. Financial Structure and Development. 1969. New Haven, Yale University Press.

Greenwood, J., and Smith, B. 1996. Financial markets in development, and the development of financial markets, *Journal of Economic Dynamics and Control* 21: 145–181

Hanley, A., Liu, Wan-Hsin, and Vaona, Andrea. 2011. Financial Development and Innovation in China: Evidence from the Provincial Data. Kiel Institute for the World Economy, Hindenburgufer 66, 24105 Kiel, Germany. *Kiel Working Paper No. 1673* | January 2011. [https://www.ifw-members.ifw-kiel.de/publications/financial-development-and-innovation-in-china-evidence-from-the-provincial-data/kwp\\_1673.pdf](https://www.ifw-members.ifw-kiel.de/publications/financial-development-and-innovation-in-china-evidence-from-the-provincial-data/kwp_1673.pdf)

Hossain, A., Biswas, S., Hossain, Md. N., and Poddar, Arnab Kumar. 2017. Financial Sector Development and Economic Growth in Bangladesh: A Factor Analysis Based Causality Approach, *International Journal of Economics and Finance* 9(8): 229-238. <https://doi.org/10.5539/ijef.v9n8p229>

Huybens, E., and Smith, B. D. 1999. Inflation, financial markets and long-run real activity, *Journal of Monetary Economics* 43(2): 283–315

John E. Udo Ndebbio. 2004. Financial Deepening, Economic Growth, and Development: Evidence from Selected Sub-Saharan African Countries, *AERC research paper* (Tom 142), Nairobi August

Kaźmierczyk, J. 2012. Information technology systems and their impact on the employment level in the Polish banking sector, *Journal of Security and Sustainability Issues* 1(3): 187-195. [https://doi.org/10.9770/jssi.2012.1.3\(4\)](https://doi.org/10.9770/jssi.2012.1.3(4))

Khan. M.A., Qayum A., and Sheik A. S. 2005. Financial Development and Economic Growth: The Case of Pakistan. *The Pakistan Development Review* 44: 819–837

King, R. and Levine, R. 1993. Financial Intermediation and Economic Development in the Construction of Europe. Eds. C. Mayer and X.Vives, CEPR London, pp. 156-189

King, R. and Levine, R. 1993. Finance, Entrepreneurship, and Growth: Theory and Evidence. *Journal of Monetary Economics*, 32(3): 513-542

Kitanović, D., and Krstić, M. 2009. Certain methodological problems of contemporary economic science. *Economics and Organization*, 6(3): 199 - 209

Kordík, M., and Kurilovská, L. 2017. Protection of the national financial system from the money laundering and terrorism financing, *Entrepreneurship and Sustainability Issues*, 5(2): 243-262. [https://doi.org/10.9770/jesi.2017.5.2\(7\)](https://doi.org/10.9770/jesi.2017.5.2(7))

Kwan, A., Wu, Y., and Zhang, J. 1998. An exogeneity analysis of financial deepening and economic growth: evidence from Hong Kong, South Korea and Taiwan, *The Journal of International Trade & Economic Development*, Taylor & Francis Journals, 7(3): 339-354

La Porta, R., F. Lopez-de-Silanes, A. Shleifer, and R. Vishny. 2002. Government Ownership of Banks. *Journal of Finance*, 57(1): 265–301. <https://onlinelibrary.wiley.com/doi/full/10.1111/j.1540-6261.1997.tb02727.x>

Law, S. H., and Singh, N. 2014. Does too much finance harm economic growth? *Journal of Banking and Finance*, 41: 36–44

Levine, R. 1997. Financial Development and Economic Growth: Views and Agenda. *Journal of Economic Literature*, 35: 688-726

Levine, R., Loayza, N., and Beck, T. 2000. Financial intermediation and growth: Causality and causes. *Journal of Monetary Economics* 46: 31–77

Levine, R. 2002. Bank-based or market-based financial systems: Which is better? *Journal of Financial Intermediation* 11: 398–428

Levine, R. 2005. Finance and growth: theory and evidence. *Handbook of economic growth* 1: 865–934

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:

@IntoInsights

Lucas R. E. 1988. On the mechanics of economic development. *Journal of Monetary Economics*, 22: 3-42

Merton, R.C., and Bodie, Z. 2004. The design of financial systems: Towards a synthesis of function and structure. *National Bureau of Economic Research Working Paper Number 10620*

Money and Capital in Economic Development by Ronald I. McKinnon. Brookings Institution Press (March 1, 1973)

Novickytė, L., and Pedroja, G. 2014. Banking consolidation as value creation to the buyer and the financial system (case of Lithuania), *Journal of Security and Sustainability Issues* 4(2): 159-173. [https://doi.org/10.9770/jssi.2014.4.2\(5\)](https://doi.org/10.9770/jssi.2014.4.2(5))

Patrick, H. 1966. Financial development and Economic Growth in Underdeveloped Countries. *Economic Development and Cultural Change*, 14(2): 74-189

Petrović, D., and Krstić, M. 2011. Transaction cost i efficiency institutions. *Economics and Organization*, 8(4): 379-387

Robinson, J. 1952. The Rate of Interest and Other Essays. MacMillan, London. Chapter “The generalization of the general theory”

Shaw, E.S. 1973. Financial Deepening in Economic Development. Oxford University Press, New York.

Stasytytė, V. 2015. Conceptualization of financial system sustainability, *Journal of Security and Sustainability Issues* 4(4): 391-402. [https://doi.org/10.9770/jssi.2015.4.4\(6\)](https://doi.org/10.9770/jssi.2015.4.4(6))

Stulz, R.M., Williamson, R. (2003). Culture, openness, and finance. *Journal of financial Economics* 70(3): 313–349. <https://pdfs.semanticscholar.org/6fc0/0079a0d760eed0fcda6bcd6aa5a7c4c43660.pdf>

Rodrik, D. (2005). Growth Strategies. In P. Aghion & S. N. Durlauf (Eds.), *Handbook of Economic Growth*, 1 ed., Vol. 1: 967-1014

Romer P.M. Increasing Returns and Long-Run Growth. 1986. *The Journal of Political Economy*, October: 1002-1037

Voghouei, H., M. Azali, Jamali, M. A. (2011). A survey of the determinants of financial development. *Asian-Pacific Economic Literature* 25(2): 1-20.

## ***Acknowledgements***

*The research is supported by Daugavpils University, Latvia*

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:

@IntoInsights

**Edmunds ČIŽO** is Mg.oec., Department of Economic Sciences and Sociology. Research interests: economics, sustainable economic development, financial depth

ORCID ID: <https://orcid.org/0000-0003-0654-2962>

**Olga LAVRINENKO** is Dr.oec, Leading researcher at the Institute of Humanities and Social Sciences of Daugavpils University, Latvia. She has status of Expert of the Latvian Council of Science in the field of economics. Her research interests: regional economics, sustainable economic development.

ORCID ID: <https://orcid.org/0000-0001-7383-3749>

**Svetlana IGNATJEVA** is Dr. phys. Head of Computer Science Department of Daugavpils University, gives lectures and participates in research at Tyumen State University as a visiting foreign specialist. Research interests: development and adaptation of questionnaires; collection, analysis and data processing using Data Mining methods.

ORCID ID: <https://orcid.org/0000-0002-3608-8409>

Register for an ORCID ID:

<https://orcid.org/register>

---

Copyright © 2020 by author(s) and VsI Entrepreneurship and Sustainability Center

This work is licensed under the Creative Commons Attribution International License (CC BY).

<http://creativecommons.org/licenses/by/4.0/>



Open Access



**Publisher**

<http://jssidoi.org/esc/home>



---

## CIRCULAR ECONOMY AND ECO-INNOVATION IN ITALIAN INDUSTRIAL CLUSTERS. BEST PRACTICES FROM PRATO TEXTILE CLUSTER\*

**Francesca Mazzoni**

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

*Email: [Francesc.mazzoni@student.unife.it](mailto:Francesc.mazzoni@student.unife.it)*

*Received 22 April 2020; accepted 20 June 2020; published 30 September 2020*

**Abstract.** The transition of Italian industrial clusters towards more circular and sustainable models of production could lead to substantial environmental, economic and societal benefits. The aim of this paper is to analyse which specific types of eco-innovations could lead to the implementation of circular economy in industrial clusters. The paper intends to do so not only performing a theoretical analysis but also exploring the case study of the Prato textile industrial cluster that, through the introduction of different circular and symbiotic measures has been able to significantly reduce its environmental impact and at the same time thrive and succeed.

**Keywords:** circular economy; eco-innovation; industrial symbiosis; industrial clusters

**Reference** to this paper should be made as follows: Mazzoni, F. 2020. Circular economy and eco-innovation in Italian industrial clusters. Best practices from Prato textile cluster. *Insights into Regional Development*, 2(3), 661-676. [https://doi.org/10.9770/IRD.2020.2.3\(4\)](https://doi.org/10.9770/IRD.2020.2.3(4))

**JEL Classifications:** F02, L60, O32

### 1. Introduction

The world we live in is characterized by increasingly scarce natural resources, but in spite of that our consumeristic society still relies on a linear economic model of production and consumption, characterized by a simple ‘take-make-dispose’ approach, actively contributing to the depletion of the already limited natural resources and to environmental degradation. Circular economy arose as a sustainable and feasible alternative model to the linear one, which aims at regenerating itself relying less and less on raw materials, and which seems to have the potential to generate better outcomes on both environment, economy and society than the current development path (McKinsey & Company 2016). Circular models of production and consumption can be applied at any level of economy -micro, meso and macro- and almost in any field. In particular, this study will address the meso level of circular economy, which mainly focuses on local ecosystems and industrial networks (Ghisellini et al. 2016). The choice of focusing on this specific level was taken because of the characteristics of Italian economy, which heavily relies on industrial clusters. According to ISTAT (2015), in fact, they represent about

---

\* The publishing was supported by Entrepreneurship and Sustainability Center, Lithuania

one-fourth of Italian economic system, in term of LMAs, workers and local units. However, while industrial clusters play a pivotal role in driving economic development, they also exert a significant impact on natural ecosystems due to their intensive use of natural resources and waste they generate (Cariani 2010).

The idea at the basis of this study is that an overall and effective transition of Italian industrial clusters towards more circular and sustainable models could produce substantial environmental, economic and social benefits not only at a local level, but also at a broader national one, and that this transition could be achieved and accelerated through the implementation of circular economy-related eco-innovations within the clusters.

In order to evaluate the effective benefits that implementing circular economy-related eco-innovations at industrial clusters level could produce, this thesis intends to explore the successful case study of the Prato industrial cluster, which it has been chosen for 3 main reasons: a) Prato Industrial cluster was one of the first ones in Italy to introduce circular economy and sustainable strategies in its organization and business model; b) it is one of the most sustainable clusters in Italy, which is confirmed also by the several awards and recognitions obtained throughout its life; c) Prato industrial cluster is specialized in textile production, which is a relevant aspect since textile industry is one of the most polluting and resource depleting of the world, mainly in terms of water. Textile industry is, in fact, known to be a highly water intensive sector, it has been estimated that it uses 200-400 litres per kg of finished product, and consequently, it also generates large amounts of polluted wastewater (Buscio et al. 2019). Despite its wasteful nature, Prato textile cluster was able to thrive and at the same time substantially reduce its environmental impacts through the introduction of sustainable practices and circular economy-related eco-innovations, specially linked to wastewater management and recycle. In particular, it is important to understand which specific eco-innovations implemented in the cluster were actually able to spur circular economy and to make the cluster thrive and succeed. This analysis could constitute an important starting point for the replication of these circular economy-related eco-innovations in other industrial clusters, especially in textile ones, characterized by similar resource consumption patterns.

Thus, the research questions this paper aims at answering are:

*Which kinds of eco-innovations could spur circular economy, specifically in industrial clusters?*

*Are industrial clusters a suitable environment in which to introduce circular economy practices?*

The paper will try to answer the research questions studying the subject both theoretically and practically, which means by making a careful analysis of previous literature and by investigating the real-life case study of the Prato textile industrial cluster.

The paper is organized as follows: the second section addresses the concept of circular economy. Its meaning, origins and levels are explored and deepened. In the third section the focus is on eco-innovation as a driver of circular economy. This section is aimed at clarifying the link between eco-innovation and circular economy and at explaining how a systemic eco-innovation, as industrial symbiosis, can contribute to the implementation of circular principles in industrial clusters. The fourth section focuses on Italian industrial clusters, with a particular emphasis on the textile ones and on their environmental impacts, as also on the emergence and diffusion of eco-industrial clusters. In the fifth section, the focus is entirely on the Prato industrial cluster, the circular and resource efficient eco-innovations it has implemented and the obtained results. Finally, in the conclusions of the paper, we will try to answer our original research questions.

## **2. An exploration of the concept of circular economy**

The concept of circular economy has gained momentum since the late 1970s (Ellen MacArthur Foundation 2013), but it's in the last years that it started attracting more and more attention from both scholars and practitioners from different fields. This seems to be indicated also by the rapid growth of peer-reviewed articles related to circular economy: 30 were published in 2014, compared to more than 100 in 2016 (Geissdoerfer et al. 2017). Despite



circular economy increasing importance, a common and unanimously accepted definition doesn't seem to exist yet. Kirchherr et al. (2017) identified and collected 114 different definitions from different peer-reviewed articles, policy papers and reports, further evidence that circular economy is still a blurred concept that means many different things to different people. This is probably due to the fact that circular economy is a broad and heterogeneous concept that can be applied to many different fields and which covers a big number of activities, but still this confusion and inconsistency could be problematic and even result in the collapse of the concept (Kirchherr et al. 2017). In the framework of this study we decided to follow a very clear definition that sums up the most important aspects of circular economy, the one provided by Geissdoffer et al. (2017), who define Circular Economy as *“a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling”*.

Circular economy aims at delinking economy from the linear model of production and consumption our society, since early industrialization, has always relied on (Ellen MacArthur Foundation 2013). The linear economy model is based on the 'take-make-dispose' pattern and it basically works as follows: companies extract raw materials and, with the use of energy, transform them into products, which are then sold to consumers, who will use them until they don't serve their purpose anymore and are finally discarded as waste. This consumption-based linear system is not sustainable, and it entails extensive losses of resources and value all along the value chain. During the entire 20<sup>th</sup> century, linear economy's wasteful system was supported by the declining real prices of natural resources. Since obtaining new resources and materials as well as disposing of them was so cheap and easy, a conscious use and reuse of those materials was not considered as a priority or as something particularly necessary. However, things started to change with the beginning of the new century, when real prices of natural resources started to increase. Not only commodity prices increased, but also their price volatility augmented. Together, high and volatile commodity prices slowed down global business growth, and ultimately economic growth. This is making companies and business leaders realize that the linear model of production is risky and wasteful in terms of resources and costs, and as a consequence many of them are moving or are taking into consideration the idea of moving towards an alternative industrial model that can decouple revenues from material inputs, which is circular economy (Ellen MacArthur Foundation 2013). Differently from the linear model, circular economy promotes a system in which products are intentionally designed to be easily reused, recycled, disassembled and refurbished, with the understanding that it is the reuse of large amounts of material reclaimed from end-of-life products, rather than the extraction of resources, the basis of economic growth. In this context, the economic system relies much more on unlimited resources, like labour, rather than on finite natural resources, which instead, assume just a supporting role.

Circular economy is attracting so much attention among academics, industry and policymakers because it is expected to produce big benefits and gains on both economy, environment and society. It can be applied at any level of the economy: micro, meso and macro. It is important to make this specification in order to better understand the focus of this study. Let's now see what each one of these levels consists of.

- *Micro level:* at this stage, circular economy focuses on individual actors, especially companies (Zhu et al. 2010), which put in action different strategies and processes in order to improve circularity of their production, as for example, eco-design, cleaner production strategies, resource efficiency initiatives and labelling systems (Ghisellini et al. 2016).
- *Meso level:* at this level, circular economy focuses on actors interactions, particularly on inter-firm networks, that include, for instance, industrial symbiosis, eco-industrial parks and green supply-chain management. In these systems, industries that traditionally work separately, decide to engage in complex interplays of resource exchange (water, energy, materials and by-products), with the objective of obtaining economic and environmental benefits (Ghisellini et al. 2016).

- *Macro level:* finally, at this level, circular economy is considered from a national or global point of view, with an emphasis on legislation, environmental policy impact, zero waste regimes, recycling- oriented societies and so on (De Jesus et al. 2017).

This study mainly focuses on the meso level of circular economy. The Prato industrial cluster is, in fact, an eco-industrial cluster that has implemented industrial symbiosis and other circular practices and strategies. However, before exploring these themes, it is necessary to introduce another equally important concept: eco-innovation. In the framework of this study, it is useful to previously introduce eco-innovation for two main reasons: a) eco-innovation is a fundamental lever for the implementation of circular economy at any level; b) industrial symbiosis itself can be considered as an organizational and systemic eco-innovation.

### 3. Eco-Innovation as a driver of circular economy in industrial clusters

The term ‘eco-innovation’ gained momentum during the second half of the 1990s, in the wake of the debates preceding and following the 1992 Rio Earth Summit (Fussler and James 1996; Rennings 2000). The debate on eco-innovation has kept attracting increasing attention over the last decade, especially since eco-innovation has been explicitly recognized as a critical factor for meeting sustainable development goals (SDGs) (UN 2015). According to the report written by the Innovation for Sustainable Development Network (Inno4seeds.net 2019), eco-innovation, if largely diffused and effectively implemented, could help reaching at least 9 different SDGs<sup>†</sup> and could be beneficial for 3 additional SDGs in low- and middle-income countries<sup>‡</sup>. Several different definitions of eco-innovation have been produced up until now, we report as follows the one proposed by Kemp and Pearson (2007), which is one of the most widely accepted and recognized. According to them, “*Eco-innovation is the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organisation (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use (including energy use) compared to relevant alternatives*”. As it can be noticed in the definition, eco-innovation is a very broad concept that covers many different areas. In fact, eco-innovations can be classified into several types. Usually, a main distinction is made between product, process and organizational eco-innovations:

- A product eco-innovation is a new or improved good or service that reduces environmental risk, pollution and negative impacts compared to the products previously produced or used by the organization. The innovative characteristics of a product eco-innovation can be linked to: lower resource content and reduced use of hazardous materials; lower levels of resources used during production or delivery; longer life; improved recyclability; reduced environmental impact linked to the use of the product.
- A process eco-innovation is a new or improved process that reduces environmental risk, pollution and negative impacts compared to the process technology previously used by the organization. The characteristics of an eco-innovative process can be linked to: lower levels of energy, material, water or other inputs used to produce or deliver one unit of product; lower air, water, soil or noise pollution due to the production or delivery of one unit of product; replacement of hazardous materials used during the processes.
- An organizational eco-innovation is a new or improved organizational method that contributes to the reduction of environmental risk, pollution and negative environmental impacts compared to the organizational methods previously used by the unit. The characteristics of organizational eco-innovation can include: new or improved ways and strategies to manage a reduction in the environmental impacts of

<sup>†</sup> industry, innovation and infrastructure (SDG 9), responsible consumption and production (SDG 12), good health and wellbeing (SDG 3), affordable and clean energy (SDG 7), sustainable cities and communities (SDG 11), climate action across the world (SDG 13), life below water (SDG 14), life on land (SDG 15), and partnerships for the goals (SDG 17).

<sup>‡</sup> clean water and sanitation (SDG 6), zero hunger (SDG 2), and no poverty (SDG 1).

the unit's activities and operations; new or improved methods to reduce or better managing the amount of waste produced per unit; new or improved ways to increase operations energy efficiency.

According to the report written by the Inno4seed.net (2019), apart from this basic distinction, it can be possible to distinguish at least 4 additional kinds of eco-innovations:

- Marketing eco-innovations, which are new or improved marketing methods used to promote eco-friendly products. Stimulating the demand and the adoption of this kind of products, marketing eco-innovations can contribute to lower environmental impacts.
- Business model eco-innovations, which consist of “new business models that reshape the way users receive value based on lower environmental impacts of products (goods and services) and the way these products are produced and delivered” (Inno4seeds.net 2019). It needs to be said that sometimes different types of eco-innovations can overlap, so for example, a business model eco-innovation can also be an organisational innovation, which involves also processes and marketing eco-innovations.
- Systemic eco-innovation, which consists in a change or implementation of a system, with the objective of reducing the environmental impacts of the multiple actors involved in the system in a coordinated way, improving its overall environmental performance in a more comprehensive and efficient way than the individual actors would have been able to do.
- Social eco-innovations, that are new social arrangements aimed at reaching environmental benefits. These could result, for example, from a group of people that starts using fewer natural resources or that establishes and follows circular economy principles.

These eco-innovation categories are not mutually exclusive. An eco-innovation, for example, could include both a product and a process element or a business model eco-innovation could also be a systemic or a social eco-innovation.

After having explored the different levels of circular economy and the different types of eco-innovation, it is time to investigate what are the links between eco-innovation and circular economy, and to understand how specific types of eco-innovation can have an impact on specific levels of circular economy. First of all, it needs to be said that eco-innovation aims at achieving not only environmental but also economic benefits (Ekins 2010). The novelty of eco-innovation lies, in fact, in its potential capability to lead to win-win situations, in which economic growth and enhanced environmental quality coexist. According to Popp et al. (2010), the decoupling between economic growth and environmental degradation, which is also one of the main objectives circular economy aims at achieving, depends heavily on technological improvements that can reduce pressure on the environment. Barbieri et al. (2016), instead, bring the concept even further than the simple conception of technological improvements. According to them “moving towards a circular economy involves a rethinking of production cycles, production technologies, consumer behaviour and environmental policies, which are all factors that hinge heavily on the concept of EI” (Barbieri et al. 2016). At this point, it is possible to intuitively understand that the two concepts of eco-innovation and circular economy are closely related, but their boundaries still appear a bit blurred, so that it's not an easy task to define this link. This is also due to the fact that this topic has not been taken much into account in academic literature. Increasing attention started to be devoted to the link between the two concepts with the EU Action Plan for the Circular Economy (European Commission 2015), as also with the Eco-Innovation Action Plan (European Commission 2011). However, there are still just few studies considering the explicit importance of eco-innovation for a circular economy (Eco-Innovation Observatory 2016). One of the most comprehensive studies regarding this topic is the one by De Jesus et al. (2017), who performed a careful literature review and analysed over 140 peer-reviewed articles related to eco-innovation and circular economy. According to it, not every eco-innovation is linked to circular economy, and not all dimensions of circular economy require innovation, but there is no doubt that some overlapping do exist and that they are strictly bounded to each other.

For what concerns circular economy macro level, process and organizational eco-innovations seem to be the most emphasized and relevant ones for the actual realization and achievement of a circular economy. Moreover, technological eco-innovations appear to be particularly important, especially when they consist of incremental innovations that redesign already existing products and production methods, and when they are focused on increasing resource productivity (De Jesus et al. 2017).

For what concerns circular economy micro level, instead, the focus is on goods and services eco-innovations and partially also on process eco-innovations, which are aimed at increasing product durability, quality and efficiency, and at designing circular business models (De Jesus et al. 2017).

Finally, for what concerns circular economy meso level (the level this study is focused on and that consequently we will try to deepen the most), organizational or systemic eco-innovations appear to be particularly important for its realization and development, especially incremental ones aimed at increasing resource productivity and material reuse and recycling. Eco-innovations at meso levels are usually designed to exploit potential synergies within the value chain and the territory, or to enable new types of “green collective innovation”, like sharing services or other strategies that can lead to a maximisation of the value of common resources (De Jesus et al. 2017). As previously explained, the meso level of circular economy mainly deals with networks and interactions, which are usually built in order to share materials and by-products, but also utilities and infrastructures, or to enhance cooperation in research and investments and to reduce costs. At the meso level, thus, eco-innovation is fundamental in order to build, develop and enhance these networks, such as industrial symbiosis, eco towns, urban symbiosis and so on. Industrial symbiosis, for example, is an eco-innovation which involves many different processes and activities and, as a consequence, is often considered and categorized as a different kind of eco-innovation, depending on the author. Pigosso et al. (2018), for example, defined it as a systemic eco-innovation, while others as a business model eco-innovation (Inno4sd.net 2019). Anyway, as previously explained, eco-innovation categories are not mutually exclusive, furthermore we believe the existence of different definitions or categorizations is not problematic.

Based on what we just said, industrial symbiosis can be considered as an eco-innovation that can help the implementation of circular economy at the meso level; but what is it in practical terms? One of the definitions that is most commonly cited and reported in academic literature is the one by Chertow (2000), according to whom industrial symbiosis is that part of industrial ecology that “*engages traditionally separate industries in a collective approach to competitive advantage involving physical exchange of materials, energy, water and by-products. The keys to industrial symbiosis are collaboration and the synergistic possibilities offered by geographic proximity*”. With the passing of time, the conception of industrial symbiosis evolved and extended also to other kind of networks, that did not require geographic proximity for example. Consequently, still using the definition by Chertow as a basis, many new definitions arose, as the one by Domenech et al. (2019), that defines industrial symbiosis as “a system approach to a more sustainable and integrated industrial system, which identifies business opportunities that leverage underutilised resources (such as materials, energy, water, capacity, expertise, assets etc)”. Moreover, it needs to be said that industrial symbiosis doesn’t involve just the exchange of by-products or materials, but also the sharing of services or infrastructures between all the actors involved (van Berkel et al. 2009; De Jesus et al. 2018). As a tool of circular economy, also industrial symbiosis aims at achieving environmental, economic and social benefits. Environmental gains are mainly generated by the reduction of waste, emissions, primary inputs and energy (Chertow 2000). Economic benefits mainly arise from the lower costs for waste disposal as also from lower purchase of raw resources (Albino et al. 2016). For what concerns social benefits instead, industrial symbiosis seems to have a positive impact on the generation of new jobs and the creation of new firms (Mirata 2004).

#### 4. Italian industrial clusters and their environmental impact

After deepening the concepts of circular economy and eco-innovation, we now address the notion of industrial clusters. The purpose of this section is to make clear why implementing circular economy at industrial clusters level can be so important and beneficial, especially in a country like Italy.

Firms agglomeration was for the first time described by Alfred Marshall in his famous work “Principles of Economics” (1890), chapter X of book IV, named “The Concentration of Specialized Industries in Particular Localities”. Marshall defined these agglomerations as ‘industrial districts’ and theorized that they could lead to positive economic benefits for the firms included in the district, such as higher productivity, knowledge spillover, labour pooling, growth of subsidiary trades among the firms, hereditary skills and the presence of specialized suppliers (Marshall 1890; Belussi et al. 2008). Michael Porter revived the concept of firms agglomeration in the 1990s. He labelled them as ‘clusters’ and defined them as “geographic concentrations of interconnected companies and institutions in a particular field” (Porter 1998).

According to Becattini (2002), industrial clusters in Italy started to bloom after the second world war, during the “economic miracle” phase, which led to higher incomes and better life conditions for a big share of the middle class. This, in turn, led to new sets of needs and to higher demand for personalized and differentiated goods. These changing needs and desires had a detrimental impact on big factories that mainly produced standardized goods, and added to a) the incapacity of other countries to provide these kinds of goods and b) the vast presence of artisanal productive specialization that provided skilled workforce, led to the emergence of smaller factories, which produced more differentiated goods and which tended to organize themselves in clusters. With the passing of time, industrial clusters kept developing and spreading on the entire national territory, until becoming one of the distinctive traits and, most importantly, one of the driving forces of Italian economy (Schillirò 2017). Italian production system is, in fact, characterized by a vast number of small and medium enterprises, mainly organized in clusters. According to ISTAT (2015), in 2011 they amounted to 141 units and they represented one-fourth of the Italian economic system, both for what concerns LMAs<sup>§</sup> (23.1% of the total), workers (24.5%) and local units (24.4%). Moreover, manufacturing employment of industrial clusters represents over one-third of overall employment in Italy.

However, while they represent a determinant driver of Italian economic development, they can also be considered as a driver of environmental degradation (Cariani 2010). According to the report “Ecodistretti 2009”, environmental performances of industrial clusters got worse and worse in last years for what concerns both energy and water consumption as also waste production. Cariani (2010) reached these conclusions analysing sectorial data and aggregated data. However, it needs to be said that data regarding environmental externalities produced by industrial clusters are quite limited. This is mainly due to the fact that up until now research has been much more focused on the environmental impacts of industrial sectors, rather than on the impacts of industrial agglomeration (Montini and Zoboli 2004), even though it was clear since the beginning of industrial revolution that ‘Marshallian’ industrial districts were an important source of environmental degradation and damages, particularly for what concerns acidic air depositions and ecosystem alterations (Ponting 1991). Another problematic aspect of analysing environmental impact (pollution in particular) of industrial clusters is linked to the difficulties in distinguishing externalities generated by them and those generated by other local sources of pollution. In spite of all these problematics, some studies on the topic have been conducted anyway, as the one by Montini and Zoboli (2004), who tried to assess the impact of existing industrial clusters in Emilia Romagna, and whose results suggest that local industrial concentration has an important impact on local environmental pressures, especially for what concerns air pollutant emissions.

Even though industrial clusters represent a source of pollution and environmental degradation, they have the potential to become more sustainable and to reduce their impacts, thanks to their intrinsic characteristics. According to Cainelli et al. (2012), in fact, industrial clusters appear to be suitable environments in which to

---

<sup>§</sup> LMAs stands for labour market areas, which are geographical areas where the greatest part of the labour force lives and works.



introduce and implement eco-innovations -in particular systemic eco-innovations-, due to their intrinsic characteristics, and in the specific due to their:

- a) *Networking nature*. Firms in industrial clusters are part of a network in which they cooperate and compete at the same time, and this has the potential to drive the adoption of innovations and eco-innovations. Networking appears to be essential in order to achieve more radical eco-innovations, that a firm alone, due for example to insufficient resources, would probably not being able to implement. Moreover, networking positively affects environmental-knowledge spillovers, and can also increase the efficiency of some innovation or eco-innovations implemented in clusters.
- b) *Geographical proximity*. Knowledge spillovers and learn-by-interacting (both made possible by geographical proximity) appear to increase technological innovation of firms embedded in industrial clusters (Cainelli 2008). This seems to work also for eco-innovations, some studies found out that firms belonging to the same industrial cluster, due to complementarity effects, are more likely to influence each other and to innovate and pursue environmental innovation simultaneously (Mazzanti & Zoboli 2008). Moreover, embeddedness of firms in environmental-friendly institutional set-ups seems to be a positive stimulus for implementation of eco-innovations (Mazzanti & Zoboli 2009).

In the last decades, industrial clusters more attentive of environmental protection started to spread in Italy. They are known as “Ecologically Equipped Productive Area” (“Area Produttiva Ecologicamente Attrezzata” or APEA) and can be described as industrial areas provided with the necessary infrastructures and systems to ensure health and environmental protection (ISPRA 2014). They were formally introduced in 1998, with the Legislative Decree n. 115, article 26, which established that “the Regions should discipline, by means of their own laws, the industrial areas and the ecologically equipped areas, fitted out with the necessary infrastructures and systems suitable to guarantee the safeguarding of health, safety and the environment”. The definition of APEA is quite broad and includes clusters that introduced measures to contain their environmental impact very different one from the other. For instance, Rete Cartesio, which is a network that periodically publishes reports about Italian eco-industrial clusters, the ranking of the best performing ones and the best practices they implemented, takes into account many different characteristics and parameters in order to identify and rank eco-industrial clusters (Rete Cartesio 2013), such as:

- a) Presence and typology of environmental infrastructures aimed at reducing pollution, manage waste and energy and promote environmental innovation;
- b) Diffusion of environmental technologies in the firms;
- c) Increase in the number of firms with environmental certification;
- d) Presence of eco-labels;
- e) Realization of environmental monitoring programmes by public authorities;
- f) Implementation of eco-innovation projects;

Eco-industrial clusters can implement many different kinds of eco-innovations within themselves, but not all of them are linked or are expected to produce circular systems or practices. It can be said that ‘circular clusters’ can be considered as APEAs and as eco-industrial clusters, but not every eco-industrial cluster can be considered as a circular one.

After having introduced the notions of industrial cluster and eco-industrial cluster, it’s the moment to take into account specifically the textile ones and their environmental impacts. Textile and clothing sector in Italy has always been one of the most important ones and a fundamental driver of economic growth. Italian textile firms have been mainly focused on producing high-quality products, which lead Italian fashion industry to be renowned worldwide. One of the main factors that made it possible was textile industrial clusters, characterized by strong technical knowledge and a high differentiation and specialization, which represented their competitive advantage.



In 2011 industrial clusters specialized in textile and clothing sector were 32, which corresponded to 22% of total industrial clusters and which absorbed 26,1% of the total workforce employed by industrial clusters (ISTAT 2015). At this point, the relevance of textile sector and textile clusters for Italian economy is quite clear, but what about their environmental impact? Textile industry affects environment from many different points of view: resource consumption, water use and water pollution, energy use, chemical release, greenhouse gas emissions and waste production are just some of them.

- a) *Resource consumption.* Textile sector is one of the most resource consuming ones. It relies heavily on both renewable, like natural fibres, and non-renewable resources, like oil used to produce synthetic fibres or chemicals used to dye and process textiles (Ellen MacArthur Foundation 2017). It has been estimated that in 2017, 675 million tonnes, which means 1,321 kg per person, of raw materials were used in order to produce clothing, footwear and household textiles purchased by all European households (ETC/WMGE 2019). This comprises every kind of resource, except for water, that we take into consideration separately afterwards.
- b) *Water consumption and pollution.* Textile industry is well known for being a highly water intensive sector, in fact it requires large amounts of water for most of its operations, starting from the washing of fibres, till bleaching and dyeing of textiles and the washing of finished products. On average, 200-400 litres of water are necessary to produce 1 kg of finished product (Buscio et al. 2019). According to Toprak et al. (2017), the average water consumption of a medium textile firm is about 1,6 million litres per day. Moreover, textile industry's intensive use of water produces also huge amounts of polluted wastewater, whose components and pollution levels mainly depend on the processing and on the kind of fibre used (Buscio et al. 2019). Wastewater, in fact, can contain a wide variety of different chemicals and, if not properly treated before being released into the environment, it could cause big health and environmental damages.
- c) *Energy consumption.* Textile industry is also very consuming from the energy point of view. Energy is used to heat, to dry, to make the machines work, to execute the different processes and of course this has an impact on its greenhouse gas emissions and on the sector's carbon footprint. Different types of energy are necessary in the textile sector, electricity is the main energy source, but also coal, and LPG are commonly used. They are usually incinerated to produce steam, releasing at the same time big shares of greenhouse gasses (Toprak et al. 2017).
- d) *Air emissions.* According to the Ellen MacArthur Foundation (2017), greenhouse gas emissions generated by textile production amounted to 1.2 billion tonnes CO<sub>2</sub>-eq in 2015, which just to give an idea corresponds to more than international flights and shipping emissions together. Gaseous emissions are considered to be the second biggest pollution problem due to textile industry (after effluent quality). It needs to be said that data regarding air emissions generated by textile industry are not easily available, but it is known that many different phases and processes release air emissions. Textile firms are likely to emit, among the others, dust, lint, acid vapor, solvent mists, oil fumes, boiler exhausts and odor (Toprak et al. 2017).
- e) *Solid waste generation.* Solid waste produced by textile industry is mainly non-hazardous, such as scraps of fabric and yarn, packaging waste, dirt, waxes, cardboard reels and so on. However, to a smaller extent, textile industry also produces hazardous solid waste, such as sludge and dye and chemical tanks, since they contain toxic material.

At this point, after having summarized the numerous environmental impacts that are normally produced by textile industry, in next section it will be extensively analysed how textile industrial clusters can deal with them and substantially reduce them, as the Prato 1<sup>st</sup> industrial Macrolotto was able to do, implementing circular economy-related eco-innovations.

## 5. Prato 1<sup>st</sup> industrial Macrolotto case study

Prato textile industrial cluster is one of the biggest industrial clusters in Italy, the largest textile site in Europe and among the most important ones of the world, mainly for what concerns production of woolen yarns and fabrics. It

comprises about 7200 firms specialized in the fashion sector -among which 2000 specialized specifically in the textile sector strictu sensu- that employ about 35,000 workers, and which produce 17% of overall Italian textile exports (Barberis et al. 2018). Prato industrial cluster comprises three different 'Macrolotti': Macrolotto 0, Macrolotto 1 and Macrolotto 2. A macrolotto can be defined as a subdivision of the territory that can be done for different purposes, in this case productive ones. Each one of them has different characteristics and is managed by different management bodies. The focus of our study is specifically on the 1st industrial Macrolotto, which hosts about 700 small and micro firms and employs about 3000/4000 workers<sup>\*\*</sup>. It was the first productive area in Italy to engage in voluntary and continuative environmental improvement programmes, in order to implement the legislative decree n. 112/1998. The decree also establishes that each APEA needs to have a unique management body that has different functions and responsibilities, among which the one of ensuring the engagement of the cluster in sustainable activities and environmental-friendly programmes. In the case of the 1<sup>st</sup> industrial Macrolotto, the unique management body is constituted by CONSER, whose partners are all the owners of the buildings present on the industrial area and whose functions are to safeguard and promote services and infrastructures investments in the area, to coordinate and maintain relationships between CONSER members and local authorities, as also to properly manage and maintain the industrial aqueduct and the centralized implant of wastewater recycle. CONSER and its 1<sup>st</sup> industrial Macrolotto was not only the first one to engage into environmental and social sustainability practices, but according to the ranking by Rete Cartesio (2013), also the best performing Italian Eco-industrial cluster. CONSER introduced in the Prato 1<sup>st</sup> industrial Macrolotto different practices of different nature. Let's analyse them more in depth:

*Water.* Water management is probably the most important sphere of this analysis, due to the heavy impact textile industry usually has on consumption and pollution of water, and in spite of that to the amazing results 1<sup>st</sup> industrial Macrolotto has been able to reach. Prato 1<sup>st</sup> industrial Macrolotto was, in fact, the first industrial cluster in Italy to equip itself since 1990 with a centralised water recycling plant, with annexed an industrial aqueduct and a firefighting system (Cariani 2013). The main idea of this closed system was to purify wastewater already utilised by industries and citizens from Prato, for then being reused within the district for industrial processes, productive activities, cooling towers, firefighting systems and sanitary facilities (CONSER 2009). At the beginning, in 1990, the system was able to produce 1.750.000 cubic meters per years of recycled water, but after different improvements, in 2005, it was able to produce an amount of 5.000.000 cubic meters per year (CONSER 2009). The main reasons for implementing this system are linked to the preservation of the water table that also represents the main water source for all citizens living in Prato, since it is clear that using water for drinking purposes is more important than using it for industrial ones. Moreover, it is crucial also to preserve water for future generations. It is estimated that this system will allow to save for future generations an amount of water that corresponds to the drinking needs of 100.000 citizens a year (Cariani 2013). On their side, instead, firms located in the cluster will never lack their water supply. It is clear that the costs borne for production and distribution of recycled water are higher than the ones the cluster would borne if it used table water, due to costs for employees, chemicals, energy and so on. Thus, in order to make the use of recycled water competitive, CONSER between 1996 and 1999 collaborated with the Italian Environmental Ministry, providing its unique experience, to the formulation of the legislative decree 152/1999 article 26, which incentivizes the use of recycled water and at the same time disincentivizes the use of primary water, through the use of a tax on water purification, higher for polluters of primary waters, lower for polluters of recycled water. With the implementation of this law, firms working in the Prato industrial cluster and using recycled water were able to save a cumulative amount of 300.000 euros per year (CONSER 2009). Burdens of this incentive, instead, fall on firms that keep using primary water. This water recycling system had so much success and has been so widely recognized as a revolutionary project that the Municipality of Prato in 2016 was chosen as the Italian representative for the EU "Urban Agenda: Circular Economy Partnership" initiative, a project aimed at enhancing the EU understanding of specific problems

---

<sup>\*\*</sup> The information source is CONSER official site: [http://www.conseronline.it/?page\\_id=122](http://www.conseronline.it/?page_id=122)

and sharing best practices among member states. In this context, Prato leads the debates regarding wastewater reuse (Barberis 2018).

*Energy.* CONSER main objectives regarding energy are to promote the use of clean energy, the reduction of energy costs for the firms of the cluster and the realization of centralized or distributed energy systems. The most significative and durable initiative in this field that CONSER promoted was a convention with a local bank that would allow firms to implement photovoltaic systems, being entirely funded by the bank. While the funds had to be returned in 10 years maximum, at the same time, firms could use since day one all the energy produced by their solar power systems. The convention was stipulated in 2010, and in 2012 already more than 20 hectares of photovoltaic systems were built on firm's roofs. These solar power systems reduced firms' energy costs of an aggregated amount of over 4,5 million euros per year and avoided the release in the atmosphere of over 16.000 tonnes of CO<sub>2</sub> per year (Cariani 2013).

*Services and facilities.* In this section, different practices implemented in different fields will be discussed. CONSER not only tried to address environmental problems, but also social ones. Safety has always been a crucial aspect for CONSER, in fact, even though a specific law about safety procedures into productive areas did not exist yet, it decided to introduce some innovative measures in order to secure the entire area of the 1<sup>st</sup> industrial Macrolotto, among which:

- Firefighting aqueduct fuelled by recycled water, planned in order to operate as a centralised firefighting system covering the entire area of the 1<sup>st</sup> industrial Macrolotto. The objective was not only to secure the entire area, but also to eliminate the costs associated with the previously existing 380 firefighting systems present in single firms.
- Centralised parking lots in the busiest areas of the cluster in order to reduce potential road accidents.

Safety-related services are not the only ones provided by CONSER. It also implemented different kinds of other measures aimed at improving workers' quality of life, such as:

- An inter-company kindergarten, available for employees of all the firms working in the cluster at reduced tuition fees.
- Centralised laundry, pharmacy, post and grocery services, directly delivering the different products and services to workers houses, all of them with reduced prices for the employees.

Objective of these services is not only to facilitate workers of the firms operating in the cluster by reducing their expenses and time lost travelling, but also to contain pollution and the overall environmental impact of the working area by reducing traffic and transportation. Moreover, one last project implemented by CONSER, which unfortunately did not succeed but the consortium would like to reproduce, is linked to shared and sustainable mobility. CONSER, together with the Municipality of Prato -which provided some electric minibuses for free to the 1<sup>st</sup> Macrolotto- introduced a free car-pooling and car sharing service available for all firms operating in the cluster. This service was introduced in order to reduce pollution due to transportation of people and goods and associated costs. The results obtained showed that the service had an actual impact on reducing the use of traditional means of transport and on reducing CO<sub>2</sub> emissions (CONSER 2009).

On the basis of what it has been explained in this last section, can we actually affirm that the different actions and practices introduced by CONSER in Prato 1<sup>st</sup> industrial Macrolotto can be considered as circular economy-related eco-innovations? In order to answer this question, some definitions we gave in previous sections should be briefly retaken. To describe industrial symbiosis we used the definition provided by Domenech et al. (2019), according to whom industrial symbiosis is "a system approach to a more sustainable and integrated industrial system, which identifies business opportunities that leverage underutilised resources (such as materials, energy, water, capacity, expertise, assets etc)". Then we added some specifics, as that it doesn't involve just exchange of by-products and materials, but also sharing of services or infrastructures between all actors involved (van Berkel et al. 2009; De Jesus et al. 2019). In accordance with the above description, it can be said that: the centralised water recycling

system and the firefighting aqueduct fuelled by recycled water, as also the inter-company kindergarten, the centralised laundry, pharmacy, post and grocery services, the centralised parking and the car-pooling and car-sharing services implemented in the 1<sup>st</sup> industrial Macrolotto can be all considered as real-life applications of the broad concept of industrial symbiosis, which in turn can be considered as “an eco-innovation that help the implementation of circular economy at the meso level”. For what concerns, instead, the implementation of photovoltaic systems in the district, they cannot be considered as an application of industrial symbiosis nor an eco-innovation that can spur circular economy. However, they can be considered as important eco-innovations that can increase firms and the overall industrial cluster sustainability.

## 6. Conclusions

The paper aims at exploring how industrial clusters can become more circular through the implementation of eco-innovations and, in the specific, which kinds of eco-innovations can spur circular economy at the level of industrial clusters, as also if industrial clusters can be considered suitable environments for the implementation of circular economy. The paper aims at answering these questions from both a theoretical and a practical point of view, thus performing an analysis about previous literature regarding the topic, as also exploring a real-life case study of an industrial cluster which was actually able to implement circular economy-related eco-innovations and at the same time thriving and obtaining optimal environmental outcomes.

First of all, the paper starts clarifying the concept of circular economy and investigating how it can be implemented at any level of economy, both micro, meso and macro. Our focus, however, is specifically on the meso level, since it deals with inter-firms networks, actors interactions and eco-industrial clusters. At this point the question is which kind of eco-innovations could actually spur meso-level circular economy. The third section starts exploring the concept of eco-innovations and all the different types of eco-innovations, which can be categorized as: products, processes, organizational, systemic, social, business model and marketing eco-innovations. Critically analysing previous studies regarding the concept, it has been seen that eco-innovations that can spur meso level circular economy are mainly organizational or systemic ones. They are usually designed to exploit potential synergies within the value chain and the territory, or to enable new types of “green collective innovation”, like sharing services or other strategies that can lead to a maximisation of the value of common resources. At the meso level, eco-innovation is fundamental in order to build, develop and enhance these networks, such as, industrial symbiosis, which is also one of the most famous and recognized examples. Consequently, we defined Industrial symbiosis as an eco-innovation that can help the implementation of circular economy at the meso level. In the next section we took into account specifically the context of Italian industrial clusters, which are particularly important for Italian economic growth, but at the same time, also exert a considering impact on the environment, especially textile industrial clusters which are very wasteful in terms of resources, water in particular.

The purpose was to study the case study of the Prato industrial cluster, specifically the 1<sup>st</sup> industrial Macrolotto, that even though is specialized in textile production, is considered one of the best eco-industrial clusters in Italy. We explored which kinds of sustainable techniques and practices it implemented: the centralised water recycling system and the firefighting aqueduct fuelled by recycled water, the inter-company kindergarten, the centralised laundry, pharmacy, post and grocery services, the centralised parking and the car-pooling and car-sharing services. According to us they can all be categorized as real-life applications of industrial symbiosis. In fact, comparing these practices and the description of the systemic eco-innovations that can lead to circular economy at the meso level, including the definition of industrial symbiosis, we can see they match. This seems to confirm that circular economy in industrial clusters can be spurred by systemic eco-innovations.

At this point, it is possible to answer also the second question regarding the suitability of industrial clusters as environments in which to implement circular economy practices. Cainelli et al. (2012) suggested that industrial

clusters are suitable environments in which to introduce and implement eco-innovations, in particular systemic eco-innovations, due to their networking nature and their geographical proximity. Since, according to our studies, systemic eco-innovation in industrial clusters are likely to spur circular economy, we believe it is possible to take this theory even further, suggesting that industrial clusters, given their nature and characteristics, such as geographical proximity and networking nature, seem to be suitable environments in which to implement and maintain a circular economy. This can be particularly important especially in a country like Italy, whose economy heavily relies on industrial clusters. In fact, a general shift of Italian industrial clusters from linear to circular economy could lead to great results in terms of environmental impacts, as also in terms of economic and social impacts. However, further studies are necessary in order to assess the actual impact that the implementation of circular economy practices and eco-innovations in other industrial clusters could have on environment, society and economy.

## References

- Albino, B.; Fraccascia, L.; Magno, M. 2016. Business models for industrial symbiosis: A guide for firms. *Procedia Environmental Science, Engineering and Management*, 3, 83-93.
- Barberis, V.; Borsacchi, L.; Pinelli, P. 2018. Circular economy and industrial symbiosis: The role of the municipality of Prato within the EU Urban Agenda partnership. The 24<sup>th</sup> ISDRS Conference “Action for a sustainable world: from theory to practice”. June 13-15 2018, Messina, Italy.
- Barbieri, N.; Ghisetti, C.; Gilli, M.; Marin, G.; Nicolli, F. 2016. A survey of the literature on environmental innovation based on main path analysis. *Journal of Economic Surveys*, 30(3), 596-623. <https://doi.org/10.1111/joes.12149>
- Becattini, G. 2002. From Marshall’s to the Italian “Industrial Districts”. A Brief Critical Reconstruction. Complexity and industrial clusters. *Physica-Verlag HD*, pp. 83-106. [https://doi.org/10.1007/978-3-642-50007-7\\_6](https://doi.org/10.1007/978-3-642-50007-7_6)
- Belussi, F.; Caldaro, K. 2008. At the origin of the industrial district: Alfred Marshall and the Cambridge school. *Cambridge Journal of Economics*, 33(2), 335-355. <https://doi.org/10.1093/cje/ben041>
- Buscio, V.; López-Grimau, V.; Álvarez, M.D.; Gutiérrez-Bouzán, C. 2019. Reducing the environmental impact of textile industry by reusing residual salts and water: ECUVal system. *Chemical Engineering Journal*, 373, 161-170. <https://doi.org/10.1016/j.cej.2019.04.146>
- Cainelli, G. 2008. Spatial agglomeration, technological innovations, and firm productivity: Evidence from Italian industrial districts. *Growth and Change*, 39(3), 414-435. <https://doi.org/10.1111/j.1468-2257.2008.00432.x>
- Cainelli, G.; Mazzanti, M.; Montresor, S. 2012. Environmental Innovations, Local Networks and Internationalization. *Industry and Innovation*, 19(8), 697-734. <https://doi.org/10.1080/13662716.2012.739782>
- Cariani, R. 2009. *Ecodistretti 2009. Made “Green” in Italy: le politiche ambientali dei sistemi produttivi locali e dei distretti industriali*. Milano: FrancoAngeli.
- Cariani, R. 2013. *Eco-aree produttive, Guida all’eco-innovazione, alle politiche per la sostenibilità e ai progetti operativi nelle Aree Produttive Ecologicamente Attrezzate (APEA)*. Milano: Edizioni Ambiente.
- Chertow, M.R. 2000. Industrial symbiosis: Literature and Taxonomy. *Annual review of energy and the environment*, 25(1), 313-337. <https://doi.org/10.1146/annurev.energy.25.1.313>
- CONSER 2009. Rapporto ambientale e sociale anno 2009. <http://www.arpat.toscana.it/notizie/arpatnews/2010/allegati/086-Conser-rapp-ambsoc.pdf>



De Jesus, A.; Antunes, P.; Santos, R.; Mendonça, S. 2017. Eco-innovation in the transition to a circular economy: An analytical literature review. *Journal of cleaner Production*, 172, 2999-3018. <https://doi.org/10.1016/j.jclepro.2017.11.111>

De Jesus, A.; Mendonça, S. 2018. Lost in Transition? Drivers and Barriers in the Eco-innovation Road to the Circular Economy. *Ecological economics*, 145, 75-89. <https://doi.org/10.1016/j.ecolecon.2017.08.001>

Domenech, T.; Bleischwitz, R.; Doranova, A.; Panayotopoulos, D.; Roman, L. 2019. Mapping Industrial Symbiosis Development In Europe - typologies of networks, characteristics, performance and contribution to the Circular Economy. *Resources, Conservation and Recycling*, 141, 76-98. <https://doi.org/10.1016/j.resconrec.2018.09.016>

European Commission 2011. Innovation for a Sustainable Future - the Eco-innovation Action Plan. <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52011DC0899>

European Commission 2015. Closing the Loop - an EU Action Plan for the Circular Economy. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52015DC0614>

Eco-Innovation Observatory 2016. Eco-innovate! A guide to eco-innovation for SMEs and business coaches. 2<sup>nd</sup> edition. <https://www.eco-innovation.eu/index.php/guide-for-smes>

Ekins, P. 2010. Eco-innovation for environmental sustainability: concepts, progress and policies. *International Economics and Economic Policy*, 7(2-3), 267-290. <https://doi.org/10.1007/s10368-010-0162-z>

Ellen MacArthur Foundation 2013. Towards the Circular Economy. Economic and business rationale for an accelerated transition. <https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf>

Ellen MacArthur Foundation 2017. Circular Fashion - A New Textiles Economy: Redesigning fashion's future. [https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy\\_Full-Report.pdf](https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report.pdf)

ETC/WMGE 2019. Textiles and the environment in a circular economy. <https://www.eionet.europa.eu/etcs/etc-wmge/products/etc-reports/textiles-and-the-environment-in-a-circular-economy>

Fussler, C. and James, P. 1996. Driving eco-innovation: A breakthrough discipline for innovation and sustainability. London: Pitman.  
Geissdoerfer, M.; Bocken, N.; Savaget, P.; Hultink, E. 2017. The Circular Economy – a new sustainability paradigm? *Journal of cleaner production*, 143, 757-768. <https://doi.org/10.1016/j.jclepro.2016.12.048>

Ghisellini, P.; Cialani, C.; Ulgiati, S. 2016. A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner production*, 114, 11-32. <https://doi.org/10.1016/j.jclepro.2015.09.007>

Inno4seeds.net 2019. Maastricht Manual on Measuring Eco-innovation for a Green Economy. <https://www.inno4sd.net/uploads/originals/1/inno4sd-pub-mgd-02-2019-fnl-maastrich-manual-ecoinnovation.pdf>

ISPRA 2014. Indagine conoscitiva sull'applicazione di EMAS nei Distretti Italiani. [http://www.isprambiente.gov.it/it/pubblicazioni/rapporti/R\\_192\\_14\\_Indagine\\_conoscitiva\\_sullattuazione\\_di\\_EMAS\\_new2.pdf](http://www.isprambiente.gov.it/it/pubblicazioni/rapporti/R_192_14_Indagine_conoscitiva_sullattuazione_di_EMAS_new2.pdf)

ISTAT 2015. 9° Censimento dell'industria e dei servizi e Censimento delle istituzioni non profit. I distretti industriali 2011. <https://www.istat.it/it/files/2015/10/I-distretti-industriali-2011.pdf>

Marshall, A. 1890. *Principles Of Economics*. London: Macmillan.

Mazzanti, M.; Zoboli, R. 2008. Complementarities, firm strategies and environmental innovation: empirical evidence for a district-based manufacturing system. *Environmental sciences*, 5(1), 17-40. <https://doi.org/10.1080/15693430701859638>

Mazzanti, M.; Zoboli, R. 2009. Embedding environmental innovation in local production systems: SME strategies, networking and industrial relations. *International Review of Applied Economics*, 23(2), 169-195. <https://doi.org/10.1080/02692170802700500>

McKinsey&Company 2016. The circular economy: Moving from theory to practice. <https://www.mckinsey.com/business-functions/sustainability/our-insights/the-circular-economy-moving-from-theory-to-practice>



Mirata, M. 2004. Experiences from early stages of a national industrial symbiosis programme in the UK: determinants and coordination challenges. *Journal of Cleaner Production*, 12(8-10), 967-983. <https://doi.org/10.1016/j.jclepro.2004.02.031>

Montini, A.; Zoboli, R. 2004. Environmental impact and innovation in industrial districts. The evolution of industrial districts. *Physica, Heidelberg*, pp. 272-315. [https://doi.org/10.1007/978-3-7908-2700-2\\_13](https://doi.org/10.1007/978-3-7908-2700-2_13)

Pigosso, D.C.A.; Andersen, M.; Schmiegelow, A. 2018. Measuring the Readiness of SMEs for Eco-Innovation and Industrial Symbiosis: Development of a Screening Tool. *Sustainability*, 10(8), 2861. <https://doi.org/10.3390/su10082861>

Ponting, C. 1991. *A Green History of the World: The Environment and the Collapse of Great Civilizations*. New York: Penguin books.

Popp, D.; Newell, R.; Jaffe, A. 2010. Energy, the environment, and technological change. *Handbook of the Economics of Innovation*. Vol 2, pp. 873-937. [https://doi.org/10.1016/S0169-7218\(10\)02005-8](https://doi.org/10.1016/S0169-7218(10)02005-8)

Porter, M. E. 1998. Clusters and the New Economics of Competition. *Boston: Harvard Business Review*. Vol. 76, No. 6, pp. 77-90. <https://hbr.org/1998/11/clusters-and-the-new-economics-of-competition>

Rennings, K. 2000. Redefining innovation. Eco-innovation research and the contribution from ecological economics. *Ecological economics*, 32(2), 319-332. [https://doi.org/10.1016/S0921-8009\(99\)00112-3](https://doi.org/10.1016/S0921-8009(99)00112-3)

Rete Cartesio 2013. Ecodistretti 2012, politiche ambientali dei distretti e cluster nazionali verso il Made Green in Italy. <http://docplayer.it/19079595-Ecodistretti-2012-politiche-ambientali-dei-distretti-e-cluster-nazionali-verso-il-made-green-in-italy.html>

Kemp R., Pearson P., 2007. Final report MEI project about measuring eco-innovation. <https://www.oecd.org/env/consumption-innovation/43960830.pdf>

Kirchherr, J.; Reike, D.; Hekkert, M. 2017. Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, conservation and recycling*, 127, 221-232. <https://doi.org/10.1016/j.resconrec.2017.09.005>

Schilirò, D. 2017. Italian Industrial Districts: Theories, Profiles and Competitiveness. *Management and Organizational Studies*, 4, 1-11. <https://doi.org/10.5430/mos.v4n4p1>

Toprak, T.; Anis, P. 2017. Textile industry's environmental effects and approaching cleaner production and sustainability, an overview. *Journal of Textile Engineering and Fashion Technology*, 2(4), 429-442. <https://doi.org/10.15406/jteft.2017.02.00066>

UN 2015. Transforming our world: The 2030 agenda for sustainable development. <https://www.unfpa.org/resources/transforming-our-world-2030-agenda-sustainable-development>

van Berkel, R.; Fujita, T.; Hashimoto, S.; Geng, Y. 2009. Industrial and urban symbiosis in Japan: analysis of the Eco-Town Program 1997-2006. *Journal of Environmental Management*, 90(3), 1544-1556. <https://doi.org/10.1016/j.jenvman.2008.11.010>

Zhu, Q.; Geng, Y.; Lai, K. 2010. Circular economy practices among Chinese manufacturers varying in environmental-oriented supply chain cooperation and the performance implications. *Journal of Environmental Management*, 91(6), 1324-1331. <https://doi.org/10.1016/j.jenvman.2010.02.013>

**Francesca MAZZONI** holds a Master Degree in Green Economy and Sustainability from the University of Ferrara and a Bachelor Degree in International Development and Cooperation from the University of Bologna. Her current research interests revolve around the broad concepts of Circular Economy and Sustainability.

**ORCID ID:** <https://orcid.org/0000-0001-9902-8326>

***Acknowledgement***

*The publishing was supported by Entrepreneurship and Sustainability Center, Lithuania*

---

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:  
@IntoInsights

---

Copyright © 2020 by author(s) and VSI Entrepreneurship and Sustainability Center  
This work is licensed under the Creative Commons Attribution International License (CC BY).  
<http://creativecommons.org/licenses/by/4.0/>



**Publisher**<http://jssidoi.org/esc/home>

## THE SIGNIFICANCE OF STRATEGIC MANAGEMENT ACCOUNTING ON THE PERFORMANCE OF TRANSPORT BUSINESSES IN NIGERIA

Adetayo Olaniyi Adeniran <sup>1</sup>, Oluwabukunmi Eunice Obembe <sup>2</sup>

<sup>1</sup>Department of Transport Management Technology, of the Federal University of Technology Akure, Nigeria

<sup>2</sup>Department of Accounting, of the National Open University of Nigeria

E-mails: <sup>1</sup>[adeniranao@futa.edu.ng](mailto:adeniranao@futa.edu.ng), <sup>2</sup>[oobembe97@gmail.com](mailto:oobembe97@gmail.com)

Received 15 March 2020; accepted 20 July 2020; published 30 September 2020

**Abstract.** The study provided that strategic management accounting is related to the provisions and use of accounting information by people in the organization such as the management and the managers, to make business decisions that would enhance competitive advantage and effective control of the firm's activity. The major purpose of this study is to investigate the significance of the strategic role of strategic management accounting in realizing the better performance of transport businesses in Nigeria. The study generated data from 230 transport businesses in Nigeria through a cross-sectional questionnaire survey approach using drop and pick means of data distribution. The findings revealed that factors such as information, people, and government policy are significant factors impacting the performance of the transport business. Hence, it was suggested that the factors are essential in realizing the performance of transport businesses. Also, the findings reveal that technology has a significant effect on the performance of transport businesses, and revealed the relationship between strategic management accounting and business performance. It is pertinent to note that this study would be of advantage to all transport business owners and researchers as it would give a plausible guideline for taking vibrant decisions concerning business performance, and will be a basis for future research. Based on the findings, it is therefore concluded that information, people, government policy, and technology are the significant factors necessary to induce the efficient performance of the transport business in Nigeria.

**Keywords:** Strategic management accounting, Transport business, performance, Nigeria

**Reference** to this paper should be made as follows: Adeniran, A.O., Obembe, O.E. 2020. The significance of strategic management accounting on the performance of transport businesses in Nigeria. *Insights into Regional Development*, 2(3), 677-688. [https://doi.org/10.9770/IRD.2020.2.3\(5\)](https://doi.org/10.9770/IRD.2020.2.3(5))

**JEL Classifications:** R4, R5

### 1. Introduction

Commonly, the strategic management accounting concept is not new in most fields like accounting, marketing management, business management, etc. Hence, it has come across many fields of human endeavor. Strategic management accounting is considered both financial and non-financial in dynamic and it is often used for the purpose such as making decisions, execution of decisions and controlling decisions to ensure it does not go beyond the boundary of such decision. The accounting section or department, in particular, is saddled with the

responsibility of providing management accounting information that is necessary and required by the management.

Strategic management accounting according to France (2006); Uyar (2010) is the provision and usage of accounting information by people in the organization such as the management and the managers, to make business decisions that would enhance competitive advantage and effectively control the firm's performances. Strategic management accounting is quite dominant in large firms. However, lately, the popularity has been extended to enterprises. In other words, the role of strategic management accounting cannot be underestimated (Uyar, 2010; Senan, 2018; Vejera et al., 2018; Wakula, 2020).

It stands as a foundation for making business decisions that would improve or positively affect the performance of firms. It helps firms to have a better competitive advantage over competitors.

Nonetheless, one major issue confronting business enterprises across the globe is the inappropriate financial management resulting from the lack of strategic management accounting practices (Shehab, 2008). Okpara *et al.* (2007) pointed out that the lack of financial management has contributed to business failures. The case of enterprises in Nigeria is no different as many of them are lacking proper financial planning and decision-making. No doubt, good financial planning, and decision making are indispensable for the enterprise's performance particularly in these present days where competition seems to be very high among the enterprise (Shehab, 2008).

To address this problem requires firms to practice a strategic management accounting system as suggested by Sheheb (2008). This study is set to examine the significance of strategic management accounting on enterprise performance in Nigeria. In today's competitive environment, enterprises must seek and rely on correct information. This information should be used to analyze and predict future decisions that would affect firm performance. Therefore, the enterprise should be concerned with what the rate of return on the money is, whether to buy one piece of equipment or another and which one would generate better profit but not necessarily which one will work best on an operational basis, and how to maximize profits from future decisions. Thus, achieving this requires the role of strategic management accounting in ensuring that decisions concerning the performance of the firm are duly met.

Nigeria is a country that has experienced a different form of devastation such as terror acts, violence, corruption, political instability, and decentralized practices which may have negative implications on the economy. Enterprises, which are the root of a country's economy, have made little progress and this is due to lack of smooth flow of goods and services to fulfill the functions of regional complementarity, intervening opportunities and spatial transferability, and high start-up costs and limited government funding, and inaccurate financial information from the enterprise owners.

Critical observation would indicate that many business firms have always focused on the traditional financial accounting information in making decisions concerning product quality, operational efficiency, cost reduction, and others and this has proven very difficult and sometimes, badly affected the management decisions. Thus, the traditional financial accounting information could not do much for the management in affecting enterprise decisions that could improve firm performance. This is because the information provided by traditional financial accounting seems very unsystematic and has limited functions (Norma and Paolo 2010).

Despite the actions of the government to resuscitate the enterprises, there seems to be a slight uplift. On this note, the significance of strategic management accounting becomes very crucial to aid the enterprise to improve its performance. Therefore, business enterprises must look for an alternative approach that would help them to improve their decision making, cost efficiency, and operational efficiency and in turn, improve their performance.

To achieve this, the firm must re-evaluate its management practice of decision making and one of the ways of getting this information is through a strategic management accounting system.

Because strategic management accounting involves a well and systematically planned system of data collection, processing, storage and dissemination of data and execution of the data by the management for decision making and performance improvement, it is, therefore, crucial that the role of strategic management accounting in firms should be investigated. On this premise, this study examines the significance of strategic management accounting on the performance of the transport business in Nigeria.

The objectives of this study are to:

- i. investigate the relationship between strategic management accounting and the performance of the transport business in Nigeria;
- ii. determine the strategic role of strategic management accounting in enhancing transport business performance; and
- iii. explore the factors affecting the performances of transport businesses in Nigeria.

## **2. Literature Review**

### **2.1. Strategy and management accounting**

The concept of strategy is quite ambiguous and it has several definitions. To start with, the concept of strategy could be divided into a corporate, business unit, and functional strategies. Strategy research could be broadly divided into three phases: the classical strategy and structure research, analytic strategy research including so-called generic strategies, and more recent subjectivist oriented and process-oriented research (Quinn, James and Mintzberg 1988). Cooper (1996) introduced such concepts as survival zone, confrontation strategy, and simultaneous importance of product functionality, quality, and price under intensive competition. Miles and Snow (1978) categorized different strategic types such as defenders, prospectors, analyzers, and reactors. Based on this, the firms respond to environmental factors that in one way or the other configure technology, organizational structure, and processes to achieve the firms' strategic objectives.

The first two categories of strategic management orientation and thought treated strategy as quite an unproblematic field. Strategies are believed to be formulated in linear, rational, systematic, and analytical ways and they are seen as proactive and formal plans for achieving firm objectives in ensuring its survival (Dent 1990). However, Lindblom (1959) saw strategies surviving somehow by "muddling through" of incremental and unrelated decisions and actions. Mintzberg et al. (1976) argued that decision making was continuously interrupted, continued, and repeated, thus precluding any element of consistency. Expressing a similar position, Pettigrew (1985) averred that the strategic decision making constituted conflicts and fights between different coalitions or segments within an organization. These organizationally grounded researches see strategic decisions as a messy, disorderly, and disjointed activity with conflicting interests. According to the incremental strategy perspective, strategic management is not linear and rational action but strategies are formulated or emerged through social processes, and the emphasis is thus in the process view and the role of actors in this process can be seen as increasing (Pettigrew, 1985).

According to Quinn (1980), incrementalism in strategic management formulation did not arise via muddling through, but it is a purposeful, conscious, effective, and systematic executive practice based on iterative series where strategies are generated and implemented incrementally. The interpretative strategy perspective assumes that reality is socially constructed and it holds that the complexity of strategic management is due to the attitudinal and cognitive complexity among diverse stakeholders (Johnson 1987, Santala 1996). Thus, it is argued that managers shape the minds and attitudes of the organization's members in a way that is expected to produce

favorable results (Chaffee 1985, Pettigrew 1985, Santala 1996), while strategy is a mental image, an abstraction, which exists only in minds. In essence, strategic management is a tool to manage an organization's culture while motivation and commitment are essential success factors and the scope of the strategic management is not just on top management, but it is an organization-wide issue.

According to Quinn (1980), incrementalism in strategic management formulation did not arise via muddling through, but it is a purposeful, conscious, effective, and systematic executive practice based on iterative series where strategies are generated and implemented incrementally. The interpretative strategy perspective assumes that reality is socially constructed and it holds that the complexity of strategic management is due to the attitudinal and cognitive complexity among diverse stakeholders (Johnson 1987, Santala 1996). Thus, it is argued that managers shape the minds and attitudes of the organization's members in a way that is expected to produce favorable results (Chaffee 1985, Pettigrew 1985, Santala 1996), while strategy is a mental image, an abstraction, which exists only in minds. In essence, strategic management is a tool to manage an organization's culture while motivation and commitment are essential success factors and the scope of the strategic management is not just on top management, but it is an organization-wide issue.

## **2.2. Development of strategic management accounting**

The management and practice of accounting have witnessed a significant transformation. Roslender and Hart (2002) note that it has been the site for a growing array of developments designed to restore the relevance of accounting to management. One of the most noted vanguards in the re-invention of management accounting practices in contemporary time was Kaplan. Kaplan's contribution to the re-invention of management accounting practices in the 1980s involves the promotion of Activity-Based Costing. As Otley (2001) notes, Activity-Based Costing has given rise to the prominence of other management accounting sub-issues- the most important being Activity-Based Budgeting, Activity-Based Cost Management, and Activity-Based Management. Otley (2001) contends that perhaps it is in the cost management process itself that the biggest adaption in management accounting practices has taken place. Thus, Kaplan's work can be seen as part of a more general movement to adapt and change the management accounting practice. Arguably, one of the most noted outcomes of the process of adaption and change that the work of Kaplan gave rise to in the process of management accounting practice was the emergence of strategic management accounting as a new form of management accounting practices and processes.

### **Technology**

ECA (2001) notes that to foster the economic performance and competitiveness of enterprises, functional, high-quality basic infrastructure is required. An optimal physical and information technology infrastructure includes a good, well-maintained road network, functional airport, and seaport, a stable power supply, and an extensive telecommunication network. Othman (2005) affirmed that technology infrastructure impact in a significant manner on rural development as it has the potential to stimulate the establishment of new enterprise and buoyed the growth of previously existing ones. Technology which deals with modern computer application and software assist the enterprise in the processing of information for effective and efficient organizational management. However, this is contingent on the optimal provision of other infrastructural facilities notably stable power supply. Arowomole (2000) noted that the impact of technology on the enterprises is overwhelming as it facilitates speedy making and communication of management decisions within firms and to other establishments.

### **Information**

The present globalization of business has compelled many firms including Enterprise to seek and rely on the information. This information is used to analyze and predict future decisions that would affect the enterprise



performance. Soleman (2008) noted that the information system which is part of the information could affect the organization. Therefore, the enterprise must concern them with accurate information that would translate to enterprise performance.

### ***People***

The Economic Commission for Africa in a report on enhancing enterprise performance notes that it is widely acknowledged that the development of a country's industrial and entrepreneur capabilities requires investment in human capital (ECA, 2001). ECA (2001) notes that with the increasing pace of technological change, the spread of information technologies, and intensifying competitive pressures, the need for specific skills have become even more demanding. People imbued with skills in technologies and entrepreneurship is not just employees, they constitute the heart and driving force of any business whether small or large.

### ***Government policy***

Government actions and policy decisions play significant roles in determining firm performance and the level of their contribution to national economic growth and development. Malhotra, *et.al* (2006) note that over the past two decades, the enterprise has become targets of policies aimed at promoting economic growth and employment in developing countries. This was mainly in recognition of the roles that enterprise play in development. Governments and donor agencies have advocated paying special attention to enterprise given their particular contribution to poverty reduction, employment generation, and private sector development. However, Malhotra *et.al* (2006) note that despite this growing interest, the debate on enterprise remains controversial within the development community, especially in light of the poor results of traditional pro-enterprise government policies especially in developing and transitional economies. In particular, the conceptualization of enterprise assistance in terms of welfare and social protection rather than firm efficiency and sustainability has led to overly protectionist policies that have hindered the development of the private sector.

### **2.3. Small and Medium Enterprises (SMEs)**

Small and medium-sized enterprise is said to be the most important sector of a nation's economy based on their perceived and actual contribution to economic growth and national development. Ruth (2000) notes that business enterprise provides and create jobs; especially during the time of economic recession; they are a source of business innovation and entrepreneurial spirit; they harness individual creative effort, and they create competition and are the seedbed for businesses of the future. It is in recognition of their importance, that one can appreciate Hill (2001) positions that enterprise plays an increasingly important role in many economies. Ruth (2000) also acknowledges that small and medium-sized firms are of vital importance for a healthy and dynamic market economy.

According to OECD (2004), the establishment and nurturing of enterprise is a vital ingredient in creating dynamic market economies in the economic and social development of transition and developing countries. Entrepreneurs are the big drivers of economic growth, innovation, regional development, and job creation. A strong and vibrant enterprise sector provides a strong foundation to increase standards of living and to reduce poverty. Small and Medium-sized Enterprises have become one of the best means of economic growth. They also suit emerging economies as proven by the large success of various types of companies. The growth of a healthy, competitive enterprises sector will be maximized when there is a strong enterprise culture in the society at all levels; continuous growth in the quality stock of independent business; maximum potential for growth of existing small businesses; and a highly supportive economic, social and stakeholder environment.

### *Firms' performance*

Murphy, Trailer, and Hill, (1996) argued that accurate performance measurement is critical to understanding small businesses' success and/or their failure. Also, Trkman (2009) noted that performance measure is indispensable for small firms because it helps them to ascertain the success or failure of the firm and also acts as an indicator to achieve sustainable improvement in entrepreneurial and business activities. This implies that the issue of performance in the discussion of small firms cannot be ruled out since their success and/or failure is hinged on performance measurement.

According to Neely et al. (1995), the measurement could be viewed as the process of quantification and by which action is assessed against the outcome seen as a performance. However, there are two major methods by which measurement can be achieved. They include the objective and subjective methods of performance measurement. According to Simons (2000) objectives methods mostly measure independently and also verified independently. On the other hand, subjective measures are based on subjective evaluation. Thus, it can be argued that subjective measure provides data for determining the worth of the evaluation.

### **3. Methodology**

In this study, a cross-sectional research design which is also referred to as social design is adopted. This research design is often used by the social scientists or social science field in carrying their research work (Neil, 2009). It mainly concentrates on collecting data on a single point not only that but also at a particular time, unlike the longitudinal design which has to collect data in various periods and different points. The research design of this study will assist to establish the relationship between the dependent variable and independent variables.

From the study of Shehab (2008), the unit of analysis of this study is an organization that is, transport business owners and the accountants, in line with the aim of this study which is to determine the significance of strategic management accounting in realizing business performance.

According to Shehab (2008), these individuals are the most suitable to provide information about the dimensions of this study. The population of this study comprises the transport businesses in Nigeria which is unknown. The use of the sampling size determination formula of Zikmund was applied at a random error allowance of 0.05 was applied to realize 384. According to Zikmund (2003), the various error allowances were determined and the suitable one was chosen based on the discretion of the researcher. The chosen error allowance of 0.05 was employed to establish the sample size as shown in the equation below:

The formulae for achieving sample size  $n = \frac{Z^2}{4E^2}$

where;

n = sample size;

Z = Z score for the confidence interval (1.96);

E = Error allowance (0.05)

When inserted into the formula, Sample Size was 384. It is therefore crucial that the questionnaire distribution will target three hundred and eighty-four respondents who are owners, middle and top managers and accountants in the transport businesses.

Information was obtained via the face-to-face questionnaire and telephone/WhatsApp questionnaire administration to transport businesses, specifically, owners and the accountants. Hence, the actual sample of the study is 230 giving a response rate of 59.9 percent.

#### 4. Results and Discussions

To ensure that that data collected from the field survey was devoid of wrong data; the researcher first, screened the data. One of the major reasons for screening the data is to detect the error if any, in particular those data which are out of range. Julie (2007) suggests that data screening is necessary to ensure that data is error-free. Conversely, there was no data error or out of range reported in this study. On this note, data analysis can be conducted.

From the descriptive analysis conducted, out of 230 respondents that participated in the survey, 45.22 percent are managing directors, 54.78 percent are managers, or operating officers or employees. Furthermore, all the businesses surveyed are private companies. To determine the nature of the transport business, the following are surveyed: 9.57 percent are into warehousing, 24.35 percent are into spare parts dealing, 31.3 percent are into tyre dealing, and vulcanizing, 15.65 percent are into vehicle maintenance and repairs, and 19.13 percent are bus operators. Out of 230 transport businesses that took part in the study, 55.7 percent of them apply computerized strategic management accounting method while 44.3 percent applies the manual method of strategic management accounting

In this study, a multiple linear regression analysis was carried out to establish the relationship between the dependent variable and independent variables. This was employed to examine the dynamic relationship between the dependent (performance of transport business) variable and the independent (Strategic management accounting, technology, information, people, and government policy) variables under study.

#### Regression Analysis Result

Generally, there are five steps involved in hypothesis testing. In the study of Adeniran (2018), they are;

- a. State the assumptions. The assumptions are:

Null Hypothesis  $H_0$  (there is no significant relationship between the dependent variable(s) and the independent variable(s). Also, Alternate Hypothesis  $H_1$  or  $H_a$  (there is a significant relationship between the Dependent variable(s) and the independent variable(s).

- b. Determine the table value from the Degree of Freedom and the already set critical region or significance level (0.05, or 0.01, or 0.025). There are different Degrees of Freedom for each test; it depends on the type of test being carried out (parametric or non-parametric test).
- c. Calculate or compute the test statistics using either the parametric test or the non-parametric test.
- d. State the decision rule. The decision rule for the calculated test states that if the calculated value of the test statistics is more or greater than the table value, the Null Hypothesis will be rejected, but if the calculated value of the test statistics is less than the table value, the Null Hypothesis cannot be rejected. The decision rule for the computed test states that if the significance level of the computed test statistics (p-value) is less than the chosen critical region commonly 0.05, the Null Hypothesis will be rejected, but if the significance level of the computed test statistics (P. Value) is more than the chosen critical region commonly 0.05, the Null Hypothesis cannot be rejected.
- e. The calculated value will be compared with the table value, or the significance level of the computed test (P.Value) will be compared with the chosen critical region, and the decision rule either to reject or not reject the Null Hypothesis will be concluded.

Adeniran (2018) reaffirmed that it is important to be meticulous about the term “reject” and “cannot reject”. Even if the Null Hypothesis was decided not to be rejected that does not mean that it will be accepted. A Null Hypothesis is a hypothetical statement that is expected to be disproved therefore it can never be accepted but it might not be rejected. Instead of using the statement “accept the Null Hypothesis” it is best to adopt the statement that “Null Hypothesis cannot be rejected”.

The result reveals that strategic management accounting significantly influences the performance of the transport business at a *p-value* of 0.000 which is less than the critical region at 0.05. Also, the level of explanation (64.4 percent) is a numerical implication that the performance of the transport business is influenced by strategic management accounting at 64.4 percent. Also, the correlation value of 0.803 implies that the performance of the transport business is positively, and strongly caused by strategic management accounting.

Furthermore, the level of technology involved is significantly influencing the performance of the transport business at a *p-value* of 0.002 which is less than the critical region at 0.05. Also, the level of explanation (80.5 percent) is a numerical implication that the performance of the transport business is highly influenced by technology at 80.5 percent. Also, the correlation value of 0.897 implies that the performance of the transport business is positively, and strongly caused by the level of technology expended.

Moreover, the level of information obtained in running the business is significantly influencing the performance of the transport business at a *p-value* of 0.044 which is less than the critical region at 0.05. Also, the level of explanation (35.1 percent) is a numerical implication that the performance of the transport business is influenced by the information at 35.1 percent. Also, the correlation value of 0.401 implies that the performance of the transport business is positively caused by the level of information obtained for running the business.

Additionally, the number of people in the business is significantly influencing the performance of the transport business at a *p-value* of 0.002 which is less than the critical region at 0.05. Also, the level of explanation (33.3 percent) is a numerical implication that the performance of the transport business is influenced by the number of people at 33.3 percent. Also, the correlation value of 0.364 implies that the performance of the transport business is positively caused by the number of people working in the business enterprise. It is paramount to note that it does not only depend on the number of staff but the knowledge of staff in respective offices.

Finally, on the analysis, the government policy is significantly influencing the performance of the transport business at a *p-value* of 0.000 which is less than the critical region at 0.05. Also, the level of explanation (90.8 percent) is a numerical implication that the performance of the transport business is to a greater extent influenced by the government policy at 90.8 percent. Also, the correlation value of 0.953 implies that the performance of the transport business is positively, and strongly caused by government policy (See Table 1).

**Table 1.** Summary of regression result

<b>Performance of Transport Business</b>	<b>R</b>	<b>R<sup>2</sup></b>	<b>Sig</b>	<b>Decision</b>
1. Strategic management accounting	0.803	0.644	<b>0.000</b>	Sig
2. Technology	0.897	0.805	<b>0.002</b>	Sig
3. Information	0.401	0.351	<b>0.044</b>	Sig
4. People	0.364	0.333	<b>0.002</b>	Sig
5. Government	0.953	0.908	<b>0.000</b>	Sig

\*P<0.001, \*\*<0.05, \*\*\*p<0.001, Sig =Significant, NS = Not Significant

Source: SPSS Version 20

## 5. Conclusions

The central aim of this study is to examine the significance of strategic management accounting towards the realization of better performance regarding transport businesses in and Nigeria. Transportation is a derived demand that is mostly demanded to satisfy other purposes. Hence, the businesses centering on transportation are usually essential as it enhances regional complementarity of goods and supply between locations, intervening opportunities, and spatial transferability. Primary data was gathered from different owners, top and middle managers of transport enterprises in Nigeria. The study found that there was significance between the impact of strategic management accounting and technology on the performance of the business in Nigeria. This implies that strategic management accounting has an influence on business performance, and technology has to influence business performance. Also, strategic management accounting is well driven by technology which enhances the efficiency of value creation, competitive intensity, and competitive advantage between competitors.

Furthermore, there was a significant impact between information, people, and governmental policy on business performance in Nigeria. Hence information, people, and government policy should be properly given great attention to realize the significant performance of the transport business in Nigeria. Finally, strategic management accounting is considered to give varying results in a different environment especially the non-crises areas. Hence, there is a need for further studies.

## References

- Adeniran, A. O. (2018). Establishing chi-square as a non-parametric test in descriptive statistics. *Science and Technology*, 4, 106-113
- Arowomole, K.A. (2000). *Modern Business Management (Theory and Practice)*.1<sup>st</sup> Edition. Sango-Ota, Ogun State: Ade-Oluyinka Commercial Press.
- Bryman, A., and Bell, E. (2007). *Business Research Methods* (2<sup>nd</sup> ed.). New York: Oxford University Press.
- Chaffee, E. (1985). Three Models of Strategy. *Academy of Management Review*, 10(1), 89-98.
- Cooper, R. (1996). Costing Techniques to Support Corporate Strategy: Evidence from Japan. *Management Accounting Research*, 7, 219-246.
- Dent, J. F. (1990). Strategy, Organization, and Control: Some Possibilities for Accounting Research. *Accounting, Organizations, and Society*, 15(1-2), 3-25.

Economic Commission for Africa, ECA (2001). Enhancing the Competitiveness of Small and Medium Enterprises in Africa: A Strategic Framework for Institutional Support, Addis Ababa: Economic Commission for Africa Publication.

Enterprises Struggle in Iraq: Retrieved on Thursday, 20th February 2020 from <http://www.internationalbusinessreview.net/SouthAsiaTheMiddleEast/NewsInBrief/tabid/290/vw/1/ItemID/1277/Default.aspx>.

France, A. (2006). *An Alternative Approach to Surveying Management Accounting Practices*. Waikato Institute of Technology (Wintec), New Zealand, 1-20.

Hill, J. (2001). A Multidimensional Study of the Key Determinants of Effective SME Marketing Activity: Part I. *International Journal of Entrepreneurial Behaviour and Research*, 7(5), 171-204.

Johnson, G. (1987). *Strategic Change and the Management Process*. Oxford: Blackwell Publishers.

Julie, P. (2007). *SPSS Survival Manual: A Step-by-Step Guide to Data Analysis using SPSS for Windows* (version 15). (3<sup>rd</sup> ed.). Australia: Allan and Unwin.

Lindblom, C. (1959). The Science of Muddling Through. *Public Administration Review*, 19, 79-88.

Malhotra, M., Chen, Y., Criscuolo, A., Fan, Q., Hamel, I. I., and Savchenko, Y. (2006). *Expanding Access to Finance: Good Practices and Policies for Micro, Small, and Medium Enterprises*. Washington. DC: The World Bank Institute.

Miles, R. E., and Snow, C. C. (1978). *Organizational Strategy, Structure, and Process*. New York: McGraw-Hill.

Mintzberg, H., Raisinghani, O., and Theoret, A. (1976). The Structure of Unstructured Decision Process. *Administrative Science Quarterly*, 21, 246-275.

Neely, A. M., and Gregory, K. P. (1995). Performance Measurement System Design: A Literature Review and Research Agenda. *International Journal of Operations and Production Management*, 15(4) 80-116.

Neil, J. (2009). *Exploring Research*. 7<sup>th</sup> Edition. New Jersey: Pearson Education International, Inc.

Norman, B. M., and Paolo, Q. (2010). *Management Accounting and Control System: An Organizational and Sociological Approach*.

OECD (2004). *Effective Policies for Small Business: A Guide for the Policy Review Process and Strategic Plans for Micro, Small, and Medium Enterprise Development*. Paris: Publication of the Organization for Economic Cooperation and Development.

Okpara, J. O., and Wynn, P. (2007). Determinants of Small Business Growth Constraints in a Sub-Saharan African Economy. *SAM Advanced Management Journal*, 72(2), 24-35.

Othman, R. (2005). *A Comprehensive Analysis of Electronic Government Blueprint for Implementation towards the Actual E-government Implementation*. MSc (IT) thesis, Universiti Utara Malaysia.

Otley, D. (2001). Extending the Boundaries of Management Accounting Research: Developing Systems for Performance Management. *British Accounting Review*, 33, 243-261.

Quinn, J. (1980). *Strategies for Change: Logical Incrementalism*. Homewood Ill: Richard Irwin.

Roslender, R., and Hart, S. J., (2002). Integrating Management Accounting and Marketing in the Pursuit of Competitive Advantage: The Case for SMA. *Critical Perspectives on Accounting*, 13, 255-277.

Ruth, J-PS. (2000). So Far Small Biz is only Dabbling in E-Commerce. *Business News*, 13(23), New Jersey.

Santala, R. (1996). *Post-Acquisition Integration of Strategic Management in an MNC*. Publications of the Turku School of Economics and Business Administration, Series A-2:1996.



Sekaran, U., Robert, Y. C., and Brain, L. D. (2001). *Applied Business Research* (1<sup>st</sup> ed.). Australia: John Wiley and Sons Australian Ltd.

Senan, N.A.M. (2018). Developmental review program impact on enhancing the effectiveness of "Teaching and Learning" in accounting program: a case study in a Saudi University. *Entrepreneurship and Sustainability Issues*, 6(2), 1001-1017. [http://doi.org/10.9770/jesi.2018.6.2\(35\)](http://doi.org/10.9770/jesi.2018.6.2(35))

Shehab, M. A. (2008). *Factors Influencing Accounting Information System Performance among Small and Medium Enterprises (SMEs) in Tripoli*. MSc Theses, Universiti Utara Malaysia.

Simons, R. (2000). *Performance Measurement and Control Systems for Implementing Strategy, Text, and Cases*. Prentice-Hall, Upper Saddle River, NJ.

Soleman, A. M. (2008). *Factors Influencing the Adoption of Web-Based Information System: A Case Study at Lada in Langkawi, Kedah*. MSc Thesis, Universiti Utara Malaysia.

Trkman, P. (2009). The Critical Success Factors of Business Process Management. *International Journal of Information Management*, 30(2), 125-134. <https://doi.org/10.1016/j.ijinfomgt.2009.07.003>

Uyar, A. (2010). Cost and management accounting practices: A Survey of Manufacturing Companies. *Eurasian Journal of Business and Economics*, 3(6), 113-125.

Vegera, S., Malei, A., Sapeha, I. and Sushko, V. (2018). Information support of the circular economy: the objects of accounting at recycling technological cycle stages of industrial waste. *Entrepreneurship and Sustainability Issues*, 6(1), 190-210. [http://doi.org/10.9770/jesi.2018.6.1\(13\)](http://doi.org/10.9770/jesi.2018.6.1(13))

Wakula, M. (2020). The importance of accounting and reporting in the process of finance management in a basic unit of the territorial government. *Entrepreneurship and Sustainability Issues*, 7(3), 1996-2011. [https://doi.org/10.9770/jesi.2020.7.3\(37\)](https://doi.org/10.9770/jesi.2020.7.3(37))

Zikmund, W.G. (2003). *Business Research Methods* (7<sup>th</sup> ed.). South-Western.

#### Contributions of Authors

Name of the Author(s)	Contribution of authors (%)	Description of the contribution of authors (concepts, design, analysis, and interpretation of data, methods, etc. )
Adetayo Olaniyi ADENIRAN	60	Design, Methodology, and final edited
Oluwabukunmi Eunice OBEMBE	40	Design, Literature, and Methodology

**Adetayo Olaniyi ADENIRAN** is a Doctoral student in the Department of Transport Technology, Federal University of Technology, Akure. He is the founder of the Buty Global research network.

**ORCID ID:** [orcid.org/0000-0002-6870-1212](https://orcid.org/0000-0002-6870-1212)

**Oluwabukunmi Eunice OBEMBE** is a graduate of Accounting in the Department of Accounting, Faculty of Management Science, National Open University of Nigeria. She is currently a lead researcher in Buty Global research network ([www.butyglobal.com](http://www.butyglobal.com))

**ORCID ID:** [orcid.org/0000-0002-3529-0648](https://orcid.org/0000-0002-3529-0648)

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:

@IntoInsights

---

Copyright © 2020 by author(s) and VsI Entrepreneurship and Sustainability Center

This work is licensed under the Creative Commons Attribution International License (CC BY).

<http://creativecommons.org/licenses/by/4.0/>





**Publisher**

<http://jssidoi.org/esc/home>



---

## DEVELOPMENT OF THE RADIO MARKET IN THE SLOVAK REPUBLIC IN THE YEARS 2016 TO 2019\*

**Marcel Lincenyi <sup>1</sup>, Fabus Michal <sup>2</sup>**

<sup>1,2</sup> *Department of Economics and Finance, Economics and Management Institute, School of Economics and Management of Public Administration in Bratislava, The Slovak Republic*

*E-mails: <sup>1</sup>[marcel.lincenyi@vsemvs.sk](mailto:marcel.lincenyi@vsemvs.sk); <sup>2</sup>[michal.fabus@vsemvs.sk](mailto:michal.fabus@vsemvs.sk)*

*Received 15 March 2020; accepted 15 July 2020; published 30 September 2020*

**Abstract.** The paper is a part of a long-term research of the mass media market in the Slovak Republic under the conditions of globalization. The main objective of the research study is to analyse the development trends of the market of selected radios in the Slovak republic in the monitored period 2016-2019. The authors focus on the analysis of the development of listening and the volume of financial resources spent on advertising (number of spots, number of broadcast hours, value of advertising broadcasts) for selected radios with nationwide coverage. Among other things, the research showed a decrease in market share for all monitored radios and a decrease in listening for most of the monitored radios. The authors think that the above is because radio managements are not able to adapt sufficiently to the time that affects the listeners. From the above, the authors also warn the management of radio stations to increase the emphasis on development, the structure of broadcasting and to try to stop the clear decline in the development of radio.

**Keywords:** radio stations; broadcast; market development; market of radio stations; analysis, advertising amount

**Reference** to this paper should be made as follows: Lincenyi, M., Michal, F. 2020. Development of the radio market in the Slovak Republic in the years 2016 to 2019. *Insights into Regional Development*, 2(3), 689-702. [https://doi.org/10.9770/IRD.2020.2.3\(6\)](https://doi.org/10.9770/IRD.2020.2.3(6))

**JEL Classifications:** M21, Y80

---

\* *The paper is the output of a scientific project IGA no. 3/2017 „Development of international business and international management in the conditions of globalization” (Funder: VSEMvs IGA VSEMvs, i.e. School of Economics and Management in Public Administration)*

## 1. Introduction

The size of the radio market can be analyzed by examining two basic variables: the audience of radios and the evolution of the volume of radio advertising placed in a broadcast. „Audience share is in media industry research, the percentage of all households tuned to a particular radio station/TV channel or programme at a particular time. A programme's share is affected factors such as competing.“ Chandler, Munday, 2011, p. 25) As he states (Burton, Jiráček, 2001, p. 322), "an advertiser is usually interested in the viewership data, which tells how many people are watching the station at the time his ad is broadcast." Advertising attractiveness is something he does "a product that is particularly attractive or interesting to the recipients of the advertising message." (Světlik, Bulanda, 2019, p. 324)

## 2. Methodology

The main objective of the presented research study was to analyse the development trends of the selected Slovak broadcasters in the monitored period 2016-2019.

The secondary research goal of the research part was to analyse of listening and the volume of financial resources spent for advertising for selected radios in the Slovak republic with nationwide coverage. The market share of radios and the number of listeners, together with radio coverage, is an important parameter for the advertiser.

The contribution in the research context follows to the analysis of the development trends of the radio market in the Slovak Republic in the years 2011 to 2015, which showed, among other things, that the radio market was more or less stable, while the order of radio stations did not change at the highest ranks. Although there were smaller deviations in the recalculation of the market share of radios, either in decrease or increase, the order of these radios did not change in a single year. (Fabuš, Lincényi, 2018, p. 591)

In the case of further planning and research, we identified one main research question (VO), which we have developed into three more specific research questions.

The main research question: What were the development tendencies of the market of selected radios in the Slovak republic with nationwide operation in the observed period in the year 2016 to 2019?

Specific question n. 1: What is the development of listening to selected radios in the Slovak republic with nationwide coverage in the period from 2016 to 2019?

Specific question n. 2: What was the development of the volume of advertising in selected nationwide radios in the years 2016 to 2019?

Research material: In the Slovak Republic there are dozens of radio stations and radios: public, multiregional (broadcast nationwide), regional (broadcast in one or more) and local radio stations (broadcast only in one city), internet (broadcast only via the Internet), student internet radios. Due to the extensive research file, we decided to focus on the 5 most popular 5 Slovak radio stations: Radio Expres, Radio Slovakia, Radio Fun, Europa 2 radio and Fine radio.

We used several research methods to examine research goals and research questions. We processed data on listening and market share from the results of the national MML-TGI survey of MEDIAN SK. We analysed the volume of radio advertising (number of spots, number of hours, value of advertising broadcasts) on the basis of the results of Kantar Slovakia, Ltd. We further evaluated the data using statistical methods (statistical average, time series analysis) as well as a comparative method.

### 3. Result and Discussion

#### Radio market analysis in 2016

In the first annual follow-up in the wave 1+2/2016, Radio Slovensko listened to 794 983 listeners, in second half of 2016, listening listened to 777 112 listeners. On an annual average, the number of listeners is 786 048 and market share was 21,65 %, the most so far in the period analysed by us.

Radio Expres also got worse, when 869 370 listeners listened to the radio in the wave 1 + 2/2016 and in the period 3 + 4/2016 their number dropped to 865 969. This year the radio listened to an average of 867 669 listeners and its market share was 22, 76%.

Fun radio also recorded a decrease compared to last year, when 497,008 listeners listened to it in the wave 1 + 2/2016 and even less in the period 3 + 4/2016, namely 491 738. The annual average of listeners was 494 373 and the total market share of the radio was 12.45%.

Radio Europe 2 maintained its market position with 326,657 listeners in the first half of the year, and there were fewer 320,170 in the 3 + 4/2016 wave. After averaging the radio in 2014, 323,413 people listened, and its market share remained the same as last year at 7.95%. Slightly lower market share compared to last year was achieved by Radio Jemné with 343,136 listeners for the wave 1 + 2/2016 and in the wave 3 + 4/2016 the listening listened to 328,431 listeners. As the radio listened to an average of 335,783 listeners, its share of the radio market was 7.94%. The volume of listening to other radios that they broadcast in the monitored year was a total of 27.25%. For more see Fig 1.

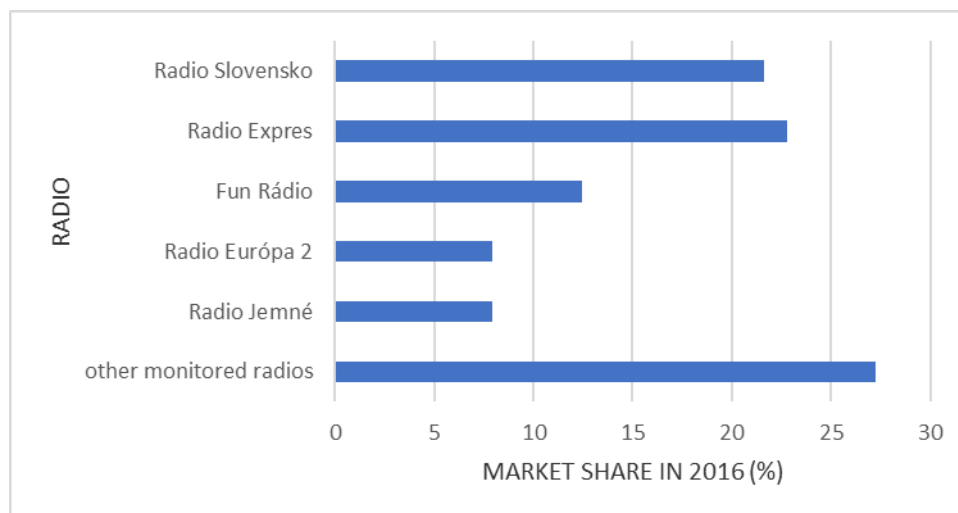


Fig. 1. Market share in 2016

Source: Processed form the results of the MML-TGI National Survey of MEDIAN SK

The media advertising market continued to grow in 2016, when total advertising spending in Slovakia, according to Kantar, reached € 1,358,970,300, an increase of 6.02% over the previous year (€ 1,277,139,448). € 83,908,907 was invested in advertising space via radios in Slovakia, and a total of 1,910 hours of advertising were broadcast. Radio Slovensko recorded an increase in the number of spots (27,751) and the total number of hours (200), but on the contrary a decrease in the value of advertising broadcasts (7,912,742), which is a decrease of 11.57% compared to the previous year.

In 2016, Radio Expres broadcasted more spots than in the previous year (53,210) in a smaller number of hours (328), for which it recorded an amount of € 28,745,377, which is a decrease of 1.58% compared to the previous year.

Fun radio broadcasted fewer commercials (57,013), with fewer hours (370), while the value of its commercials in 2016 was € 21,943,687, which is less than in the previous year.

Radio Europe 2 broadcast more commercials (36,078) with more hours (246) and its advertising space was valued at € 7,094,872 this year. This was a record increase of 20.6% in recent years for this radio and also the highest increase for all radios in that year.

After a dramatic increase last year, radio Jemné recorded a drop in 54,124 broadcast spots in 2016 with a total of 367 hours of advertising and a value of advertising broadcasts of € 11,795,132, which is a decrease of 8.79%. For more see Fig.2.

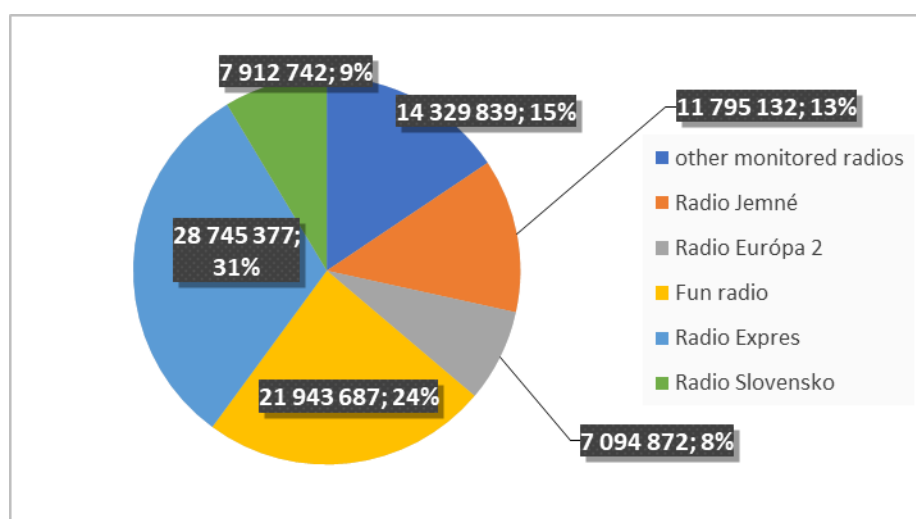


Fig. 2. Share of radio volume in the year 2016

Source: Processed form the results of Kantar Slovakia Ltd.

### Radio market analysis in 2017

In the first annual follow-up in the wave 1 + 2/2017, Radio Slovensko dropped to 757,498 listeners, in the second half of 2017, listening listened to 768,012 listeners. On an annual average, the number of listeners is 762,755 and the market share was 21.375%.

Radio Expres also got worse, when 858,144 listeners listened to the radio in the wave of 1 + 2/2017 and in the period 3 + 4/2016 their number dropped slightly to 857,321. This year the radio listened to an average of 857,732 listeners and 22.615%.

Fun Radio also recorded a decrease compared to last year, when 496,081 listeners listened to it in the wave 1 + 2/2017 and even less in the period 3 + 4/2017, namely 489,935. The annual average of listeners was 493,008 and the total market share of the radio was 12.815%.



Compared to last year, Radio Europe 2 also recorded a decrease in listening list, with 311,044 listeners in the first half of the year, and slightly more in the 3 + 4/2017 wave - 312,159. After averaging the radio in 2017, 311,601 people listened, and its market share fell to 7.62% compared to last year.

Slightly lower market share compared to last year was achieved by Radio Jemné with 325,609 listeners for the wave 1 + 2/2017 and in the wave 3 + 4/2016 the audience dropped to 324,210 listeners. As the radio listened to an average of 324,909 listeners, its share of the radio market was 7.625%.

The volume of listening to other radios that they broadcast in the monitored year was a total of 27.95%. For more see Fig. 3.

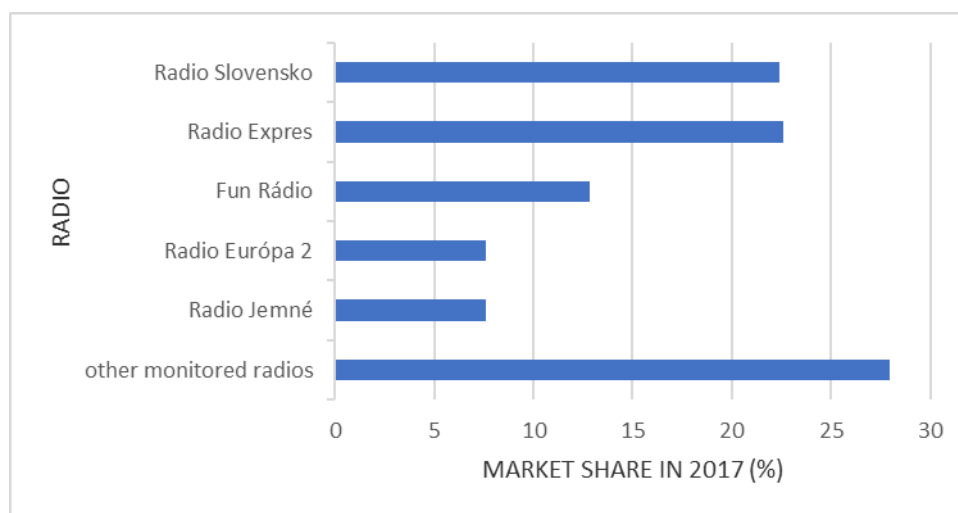


Fig. 3. Market share in 2017

Source: Processed form the results of the MML-TGI National Survey of MEDIAN SK

The media advertising market also grew in 2017, when total advertising spending in Slovakia, according to Kantar, amounted to € 1,609,201,169, which is an increase of 15.55% compared to the previous year (€ 1,358,970,300). In 2017, € 88,445,044 was invested in advertising space on radios in Slovakia, and a total of 1,912 hours of advertising were broadcast.

Radio Slovensko recorded a decrease in the number of spots (26,800) and the total number of hours (187), but on the contrary a decrease in the value of advertising broadcasts (7,601,193), which is a decrease of 3.94% compared to the previous year.

In 2017, Radio Expres broadcast more spots (56,456) in a larger number of hours (355), for which it recorded an amount of € 31,152,265, which is an increase of 7.72% compared to the previous year.

Fun radio broadcasted more commercials (57,750), with fewer hours (344), while the value of its commercials in 2017 was € 22,189,335, which is more than in the previous year.

Europe 2 broadcasted significantly more commercials (46,203) with more hours (304) and its advertising space was valued at € 9,278,743 this year, which is another record increase of 23.54% in recent years for this radio and at the same time also the highest increase for all radios in a given year.

Radio Jemné continued the decline in broadcast spots (50,167) with a total of 339 hours of advertising and the value of advertising broadcasts of € 10,731,149, which is a decrease of 9.02%. For more see Fig. 4.

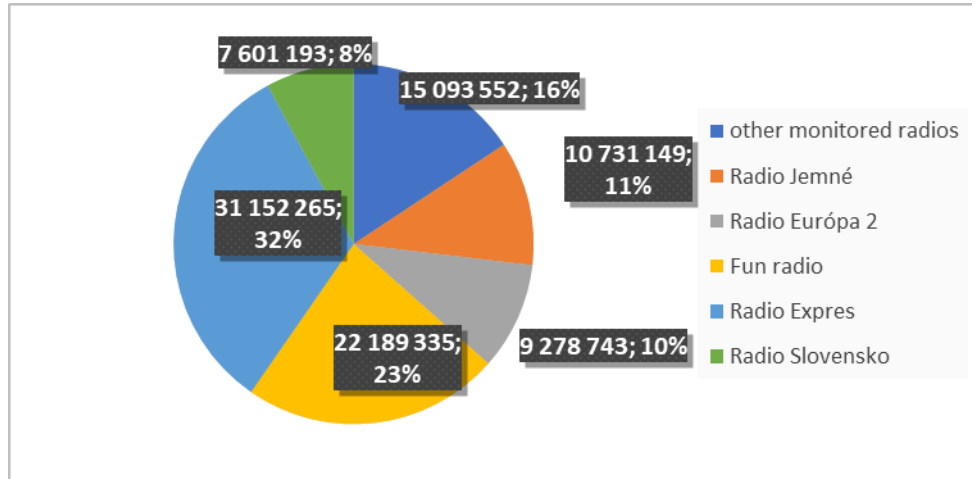


Fig. 4. Share of radio volume in the year 2017

Source: Processed from the results of Kantar Slovakia Ltd.

### Radio market analysis in 2018

In the first annual follow-up in the wave 1 + 2/2018, Radio Slovensko dropped slightly to 756,145 listeners, in the second half of 2018, listening listened to 737,642 listeners (on average 746,893 listeners). In 2018, data on the market share of radios for the 1 + 2/2018 wave are not available, therefore for all radios we only present data for the 3 + 4/2018 wave. Radio Slovakia achieved a market share of 22.08%.

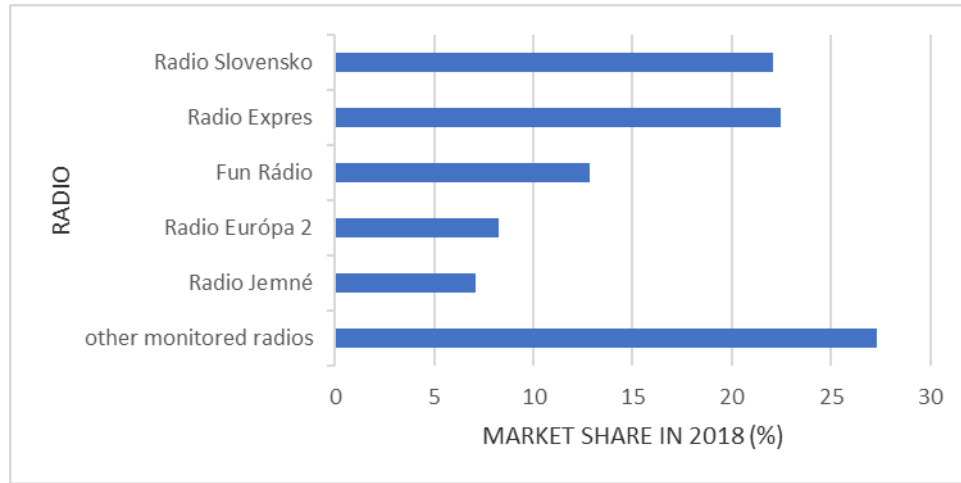
Radio Expres also got worse, with 838,761 listeners listening to the radio in the 1 + 2/2018 wave, and in the 3 + 4/2018 period their number dropped slightly to 828,576 (an average of 833,668 listeners). Radio Expres achieved a market share of 22.44% this year.

Fun radio also recorded a decrease compared to last year, when 488,467 listeners listened to it in the 1 + 2/2018 wave and even less in the 3 + 4/2018 period, namely 473,611 (on average 481,039 listeners). In 2018, Fun radio achieved an annual market share of 12.82%.

Compared to last year, Radio Europe 2 recorded an increase in listening with 329,017 listeners in the first half of the year, in the 3 + 4/2017 wave there were slightly more - 326,332 (on average 327,674 listeners). In Europe, Radio Europe 2 achieved a share of 8.26%.

Slightly lower market share compared to last year was achieved by radio Jemné with 323,482 listeners for the wave 1 + 2/2018 and in the wave 3 + 4/2018 listening listened to 315,792 listeners (on average 319,637 listeners). Radio Jemné achieved a share of 7.11% this year.

The volume of listening to other radios that they broadcast in the monitored year was a total of 27.29%. For more see Fig. 5.



**Fig. 5.** Market share in 2018

*Source:* Processed form the results of the MML-TGI National Survey of MEDIAN SK

The media advertising market grew at a record high in 2018, when total advertising spending in Slovakia, according to Kantar, reached € 2,261,565,020, an increase of 39.910% over the previous year (€ 1,358,970,300). € 91,855,095 was invested in advertising space via radios in Slovakia, and a total of 2002 hours of advertising were broadcast.

Radio Slovensko recorded a decrease in the number of spots (25,503) and a decrease in the total number of hours (169), but on the contrary an increase in the value of advertising broadcasts (7,755,034), which is an increase of 1.98% compared to the previous year.

In 2018, radio Expres broadcast fewer spots (54,410) in a smaller number of hours (343), for which it recorded an amount of € 30,179,111, which is a decrease of 3.22% compared to the previous year.

Fun radio also broadcast fewer commercials (56,720), with fewer hours (320), while the value of its commercials in 2018 was € 22,593,661, which is more than in the previous year.

Radio Europe 2 broadcast significantly more commercials (52,541) with more hours (354) and its advertising space was valued at € 10,683,332 this year, which is an increase compared to last year.

Radio Jemné broadcast more spots (55,490) with a total number of 385 hours of advertising and a value of advertising broadcasts of € 12,223,814, which is an increase of 12.21%. For more see Fig. 6.

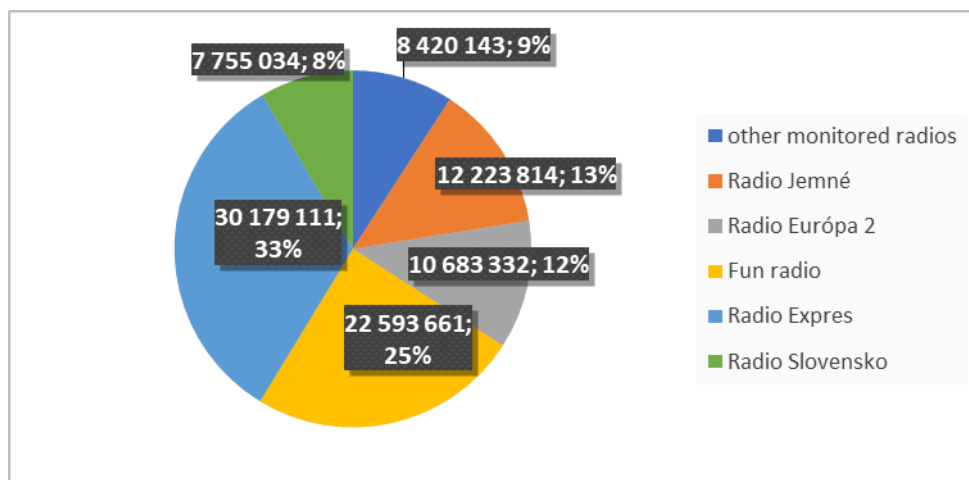


Fig.6. Share of radio volume in the year 2018

Source: Processed form the results of Kantar Slovakia Ltd.

### Radio market analysis in 2019

In the first annual follow-up in the wave 1 + 2/2019 Radio Slovensko dropped to 729,165 listeners, in the second half of 2019 the listenership dropped to 704,174 listeners. On an annual average, the number of listeners is 716.669 and the market share was 20.685%.

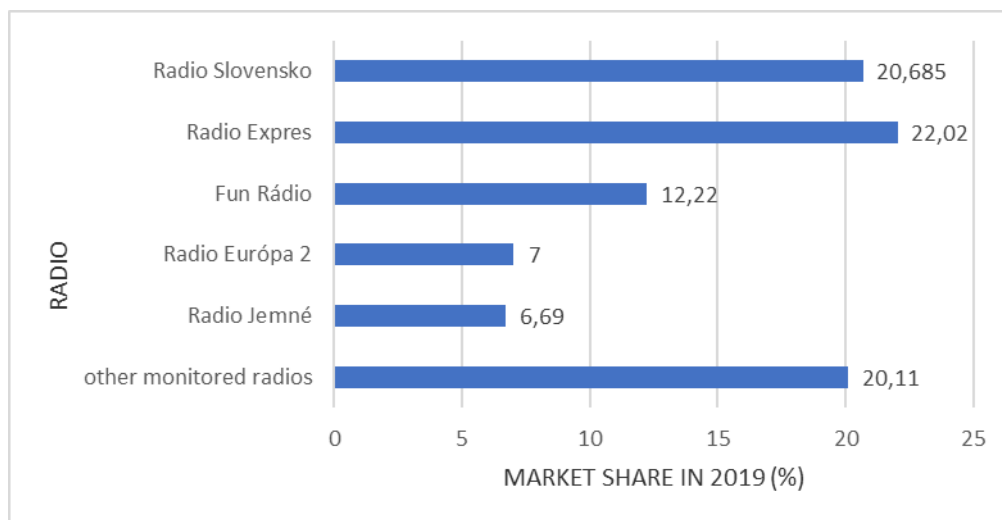
Radio Expres also got worse, when the radio listened to 810 081 listeners in the wave 1 + 2/2019 and in the period 3 + 4/2019 their number dropped slightly to 800 263. Radio this year listened to an average of 805,172 listeners and its market share was 22.02%.

Fun radio recorded a slight increase compared to the previous year, when 448,745 listeners listened to it in the wave 1 + 2/2019 and slightly less in the period 3 + 4/2019, namely 441 705. The annual average of listeners was 445.225 and the total market share of radio was 12.22%.

Compared to last year, Radio Europe 2 recorded a decrease in listening with the number of listeners in the first half of the year at 318,810, in the wave 3 + 4/2019 there were slightly more of them - 322,535. the market fell compared to last year to 7.005%.

Radio Jemné achieved a lower market share compared to last year with 302,008 listeners for the 1 + 2/2019 wave and in the 3 + 4/2019 wave, listening listened to 293,271 listeners. As the radio listened to an average of 297,639 listeners, its share of the radio market was 6.69%.

The volume of listening to other radios that they broadcast in the monitored year was a total of 20.11%. For more see Fig. 7.



**Fig. 7.** Market share in 2019

*Source:* Processed form the results of the MML-TGI National Survey of MEDIAN SK

The growth of the media advertising market continued in 2019, when total advertising spending in Slovakia, according to Kantar, reached € 2,522,637,958, which is an increase of 10.35% compared to the previous year (€ 2,261,565,020). € 104,326,654 was invested in advertising space via radios in Slovakia, and a total of 2016 hours of advertising were broadcast in total.

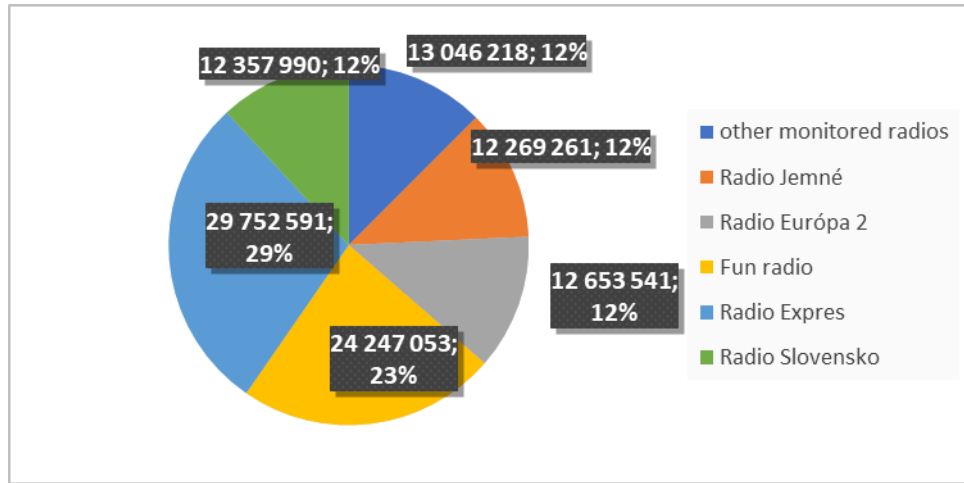
In 2019, Radio Slovensko recorded an increase in the number of spots (34,176), an increase in the total number of hours (212), as well as an increase in the value of advertising (12,357,990), which is a record increase of 62.75% compared to previous years and other radios.

In 2019, Radio Expres broadcast fewer spots (52,853) in a smaller number of hours (318), for which it recorded an amount of € 29,752,591, which is a decrease of 1.41% compared to the previous year.

Fun radio broadcast more commercials (59,706), with more hours (359), while the value of its commercials in 2019 was € 24,247,053, which is more than in the previous year.

Radio Europe 2 broadcast more commercials (55,767) with more hours (364) and its advertising space was valued at € 12,653,541 this year, an increase of last year.

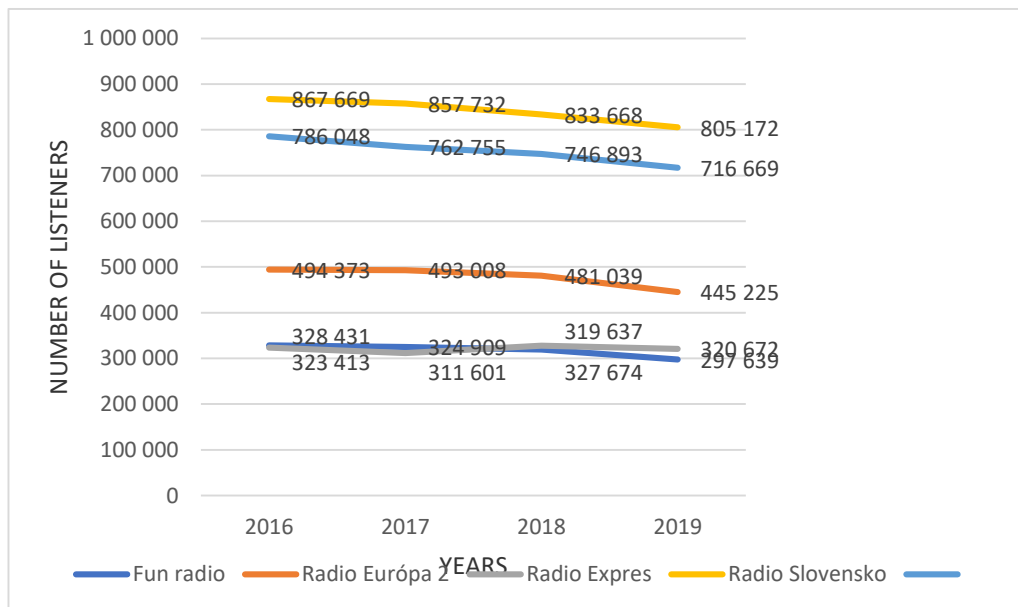
Radio Jemné broadcast fewer spots (54,996) and less 367 hours of advertising and the value of advertising broadcasts was € 12,269,261, which is a slight increase compared to last year. For more see Fig.8.



**Fig .8.** Share of radio volume in the year 2019

Source: Processed form the results of Kantar Slovakia Ltd.

Based on the analysis of listening to selected five radios in the Slovak Republic with nationwide coverage in the period from 2016 to 2019, the following conclusions can be stated within individual years. The most listened radio in Slovakia in 2016 remains Radio Expres with an average number of 867,669 listeners, followed by Radio Slovakia, Fun Radio, Radio Jemné and Radio Europe 2. Even in 2017, the most listened radio in Slovakia remains Radio Expres with an average number of 857,732 listeners, followed by Radio Slovakia, Fun Radio, Radio Jemné and Radio Europe 2. In 2018, Radio Expres remains the most listened-to radio station again, with an average number of 833,668 listeners, followed by Slovakia Radio, Fun Radio, and Radio Europe 2 and Radio Jemné exchanged fourth and fifth place. In 2019, in terms of listening, he copies the rankings from 2018: Radio Expres, Radio Slovakia, Fun Radio, Radio Europe 2, and Radio Jemné. The summary overview of listening for the monitored period 2016 to 2019 is shown using Fig. 9 and contains precise figures on the number of listeners in each year.



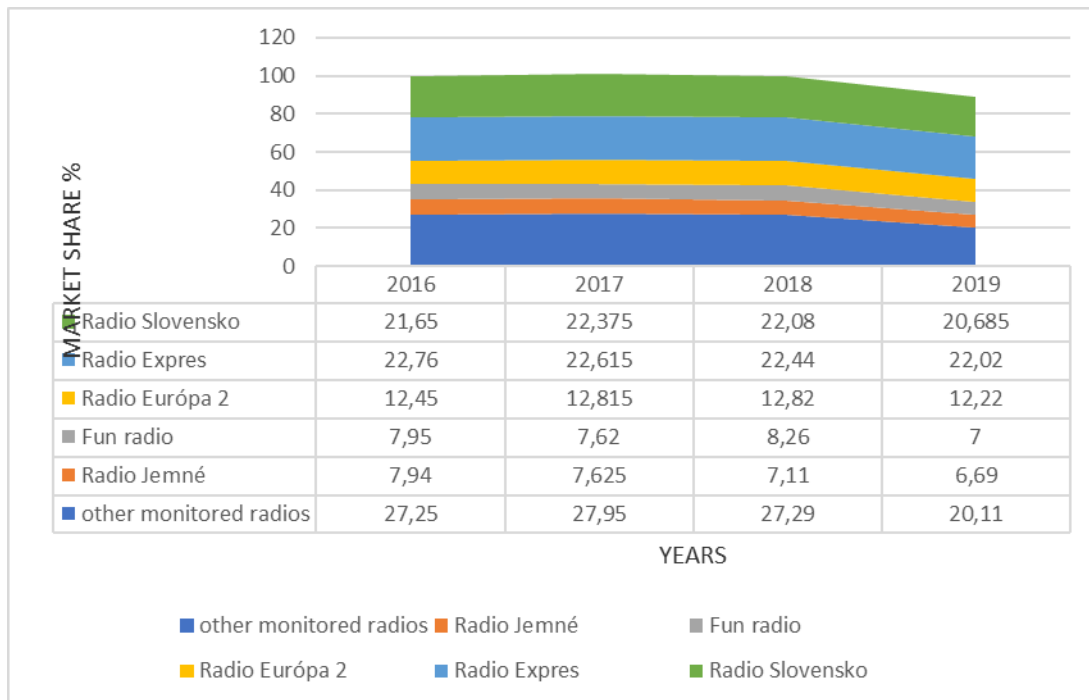
**Fig. 9.** Radio listening report 2016 – 2019 (in audience count)

Source: Processed form the results of the MML-TGI National Survey of MEDIAN SK



Based on the analysis of the market share of selected five radios in the Slovak Republic with nationwide operations in the period from 2016 to 2019, the following conclusions can be stated within individual years:

In 2016, all monitored radios recorded a decrease in the average number of listeners, but on the other hand, all monitored radios achieved a higher average annual market share. In 2017, all monitored radios achieved a slight decrease in the average number of listeners and, except for Fun radios, all radios also achieved a slight decrease in market share. Fun radio improved from an average market share of 12.45 in 2016 to 12.815% in 2017. In 2018, we also registered a slight decrease in the average number of listeners for most of the monitored radio stations, except for Fun Radio, which as the only radio reached a higher average number of listeners than in the previous year. In the case of the average market share, Radio Slovensko and Radio Európa 2 improved, while other radios declined. In 2019, we also recorded a slight decrease in the average number of listeners for all monitored radios. A summary overview of the development of the market share of individual radios for the monitored period from 2011 to 2019 is shown using Fig. 10



**Fig. 10.** Overview of the share of radios in 2016 – 2019 (%)

*Source: Processed form the results of the MML-TGI National Survey of MEDIAN SK*

Based on the analysis of the development of the volume of advertising in selected nationwide radios in the years 2016 to 2019, the following conclusions can be stated:

The decrease in the volume of advertising can be observed in most radios also in 2016. The only radio Europe 2 in 2016 recorded a higher inflow in advertising than in the previous year. Slightly better in the case of investments in radio advertising was the year 2017, when 2 radios (Radio Expres, Radio Europe 2) out of 5 monitored recorded a higher volume of advertising than in the previous year. The year 2018 was economically successful for most radios, when they had a higher volume of advertising than in the previous year. In 2018, Radio Slovakia received the same amount for advertising as in the previous year. For a change, 2019 saw a decline in advertising revenue for most radios (Fine Radio, Fun Radio, Expres Radio), with Radio Europe 2 receiving the same amount

of advertising revenue as the previous year. Radio Slovakia was the only radio in the year that received more advertising revenue than in 2018. A summary overview of the development of the volume of advertising of individual radios for the observed period from 2011 to 2019 is shown using Fig. 11.

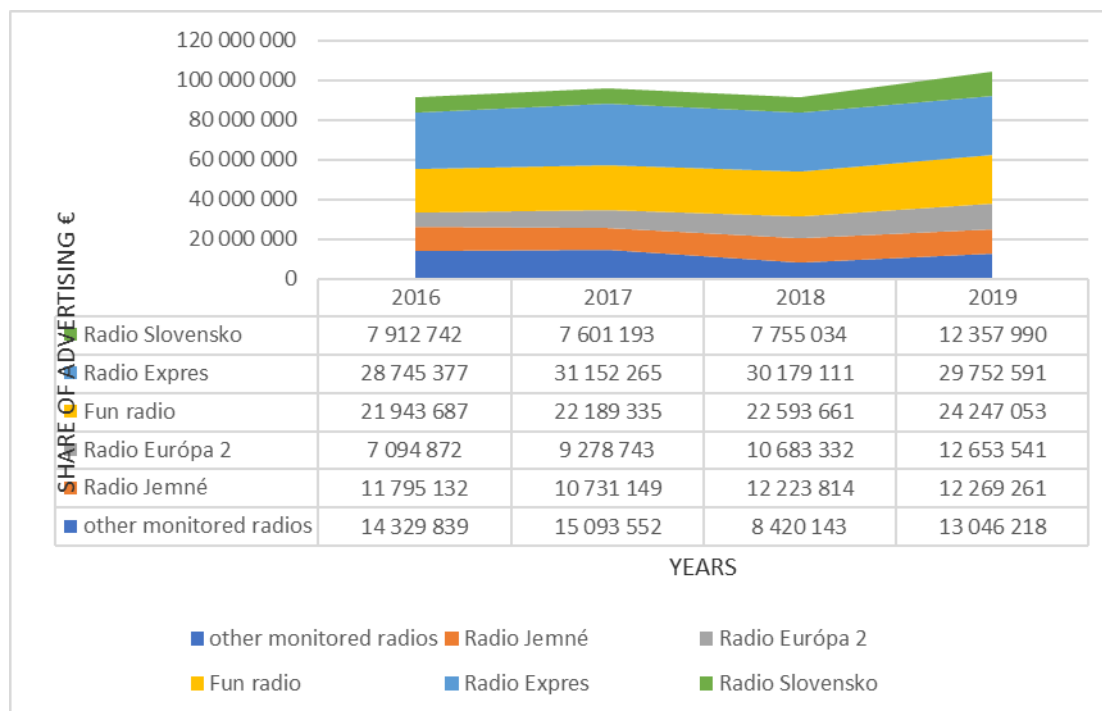


Fig. 11. Overview of the volume of radio advertising in 2016 – 2019 (€)

Source: Processed form the results of Kantar Slovakia Ltd.

## Conclusions

Based on the analysis of the development tendencies of the market of selected five all-Slovak radios in the Slovak Republic for the observed period in the years 2016 to 2019, several development tendencies can be observed:

In the monitored period, the listening of most monitored radios continued to decline. For most of the monitored radios (Radio Jemné, Fun radio, Radio Európa 2, Radio Slovakia), listening was at the end of the analyzed period in 2019 lower than at the beginning in 2016. The only exception was Radio Expres. The radio market was stable in terms of radio ranking in 2016-2017 (Radio Expres, Radio Slovakia, Fun Radio, Radio Jemné, Radio Europe 2), while in 2018 the last 2 radios exchanged their rankings. The situation is even worse in the case of the market share of radios, where a decrease in market shares can be observed for all monitored radios, as they all achieved a lower market share in 2019 than at the beginning in 2016. In the case of the analysis of the volume of investments in radio advertising, no clear development trend can be observed. For the three monitored radios (Radio Slovakia, Radio Europe 2), the volume of acquired advertising at the end of the monitored period in 2019 was higher than in 2011, while for the remaining 3 radios the volume was lower or stagnated. It should be noted, however, that the increase and decrease in advertising volume was for individual radios in different periods. At the beginning of the period under review, after the economic recession and the decline in marketing investment after the financial and economic crisis, it is possible to observe an increase in the development of investment in radio advertising. It should be noted that the development of investment in radio advertising is influenced by

several factors, with priority not only on the economic and market situation of investors, economic development, but also on the growing number of broadcasters and the media market.

Behind the decline in listening and market share, we can see the popularity of network media. As stated by Vavrečka (2016), especially the Internet and the tools derived from it create new possibilities in the field of communication tools, which in a way create a counterweight to the traditional mass means of communication.

Fortunately, in the case of radio, the situation is not as dramatic as in the case of declining sales and readability of the daily press, as confirmed by several studies at home and abroad. (Lincényi, Fabuš, 2017). The authors believe that the management of radio stations needs to constantly work on its development, the structure of broadcasting and adapt to the time that affects listeners, which can not only stop the decline in listening, but also have a chance to increase it.

## References

- BURTON, G., JIRÁK, J. 2001. *Introduction to Media Studies*. (Úvod do studia médií.) Praha: Barrister & Principal, ISBN 978-80-85947-67-6.
- LINCÉNYI, M., FABUŠ, M. 2017. Economic trends of business actors on daily newspaper market: case of the Slovak Republic. *Entrepreneurship and sustainability issues*, 5(1), 91 – 104. [https://doi.org/10.9770/jesi.2017.5.1\(7\)](https://doi.org/10.9770/jesi.2017.5.1(7))
- FABUŠ, M., LINCÉNYI, M., 2018. Analysis of the development terms of the radio market in the Slovak republic. *Entrepreneurship and sustainability issues*, 6(2), 591 – 602, [https://doi.org/10.9770/jesi.2018.6.2\(9\)](https://doi.org/10.9770/jesi.2018.6.2(9))
- MEDIAN SK, MML-TGI. 2016. 1. + 2. vlna 2016, [19.03.2020]. <https://www.radia.sk/pocuvanost/mml-tgi/vlny/2016-2>
- MEDIAN SK, MML-TGI. 2016. 3. + 4. vlna 2016 [19.03.2020]. <https://www.radia.sk/pocuvanost/mml-tgi/vlny/2016-4>
- MEDIAN SK, MML-TGI. 2017. 1. + 2. vlna 2017 [19.03.2020]. <https://www.radia.sk/pocuvanost/mml-tgi/vlny/2017-2>
- MEDIAN SK, MML-TGI. 2017. 3. + 4. vlna 2017 [19.03.2020]. <https://www.radia.sk/pocuvanost/mml-tgi/vlny/2017-4>
- MEDIAN SK, MML-TGI. 2018. 1. + 2. vlna 2018 [19.03.2020]. <https://www.radia.sk/pocuvanost/mml-tgi/vlny/2018-2>
- MEDIAN SK, MML-TGI. 2018. 3. + 4. vlna 2018 [19.03.2020]. <https://www.radia.sk/pocuvanost/mml-tgi/vlny/2018-4>
- MEDIAN SK, MML-TGI. 2018. 1. + 2. vlna 2019 [19.03.2020]. <https://www.radia.sk/pocuvanost/mml-tgi/vlny/2019-2>
- MEDIAN SK, MML-TGI. 2018. 3. + 4. vlna 2019 [19.03.2020]. <https://www.radia.sk/pocuvanost/mml-tgi/vlny/2019-4>
- SVĚTLÍK, J. BULANDA, I. 2019. The shift of value types of the Czech population and its influence on the formation of creative advertising strategy. In *Marketing Identity: Offline Is the New Online*. Conference Proceedings from the International Scientific Conference. Trnava: Faculty of Mass Media Communication, University of SS. Cyril and Methodius in Trnava, Slovakia, 2019, pp. 323-334.
- VAVREČKA, V. 2016. Role a síla tradiční marketingové komunikace v kontextu trendů jejího vývoje (The role and strength of traditional marketing communication in the context of its development trends) In *Média – moc – manipulácia*. Bratislava: Paneurópska vysoká škola v Bratislave, 2016, pp. 455-478.
- VENKATACHALAM, S., WONG, F., UYAR, E., WARD, S., AGGARWAL, A., 2015. Media Company Uses Analytics to Schedule Radio Advertisement Spots. *Interfaces*, 45(6), 485-500. <https://doi.org/10.1287/inte.2015.0825>

### ***Acknowledgements***

*The paper is the output of a scientific project IGA no. 3/2017 „Development of international business and international management in the conditions of globalization”. (Funder: VSEMs IGA VSEMs, i.e. School of Economics and Management in Public Administration)*

**Marcel LINCÉNYI, PhD.** in Media studies, obtained at Constantine the Philosopher University in Nitra, currently at Department of Management as associate professor, School of Economics and Management in Public Administration in Bratislava (VSEMs), Slovakia.

**ORCID ID:** <https://orcid.org/0000-0002-9076-026X>

**Michal FABUS, PhD.** in International Economics Relations, obtained at University of Economics in Bratislava, Vice-rector for Foreign Affairs, Head of Department of Economics and Finance, School of Economics and Management in Public Administration in Bratislava (VSEMs), Slovakia.

**ORCID ID:** <https://orcid.org/0000-0002-3792-179X>

---

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:  
@IntoInsights

---

Copyright © 2020 by author(s) and VSI Entrepreneurship and Sustainability Center

This work is licensed under the Creative Commons Attribution International License (CC BY).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

**Publisher**<http://jssidoi.org/esc/home>

## CYBER-ATTACKS TO CRITICAL ENERGY INFRASTRUCTURE AND MANAGEMENT ISSUES: OVERVIEW OF SELECTED CASES\*

**Tomas Plėta<sup>1</sup>, Manuela Tvaronavičienė<sup>2</sup>, Silvia Della Casa<sup>3</sup>, Konstantin Agafonov<sup>4</sup>**

<sup>1,2</sup> Vilnius Gediminas Technical University, Saulėtekio al. 11, LT-10223 Vilnius, Lithuania

<sup>2</sup> General Jonas Zemaitis Military Academy of Lithuania, Šilo 5a, LT-10322, Vilnius, Lithuania

<sup>3</sup> Daugavpils University, Parades Str. 1-421, Daugavpils, LV-5401,

<sup>3</sup> NATO Energy Security Center Of Excellence, Šilo g. 5a, LT-10322 Vilnius, Lithuania

<sup>4</sup> Mykolas Romeris University, Ateities g. 20, LT-08303 Vilnius, Lithuania

E-mails:<sup>1</sup> [Tomas.Pleta@vgtu.lt](mailto:Tomas.Pleta@vgtu.lt); <sup>2</sup> [Manuela.Taronaviciene@vgtu.lt](mailto:Manuela.Taronaviciene@vgtu.lt); <sup>3</sup> [Silvia.DellaCasa@enseccoe.org](mailto:Silvia.DellaCasa@enseccoe.org); <sup>4</sup> [KA1979@gmail.com](mailto:KA1979@gmail.com)

Received 15 March 2020; accepted 15 July 2020; published 30 September 2020

**Abstract.** The purpose of the paper is to analyze the vulnerabilities of Critical Energy Infrastructures' systems in the event of cyber-attack. The global tendency of cyber-attacks puts Critical Energy Infrastructures on one of the first places for targets. Critical Infrastructure Protection (CIP) has become an increasingly relevant topic in the global industrial environment, as the consequences of cyber-attacks toward ICS can result in physical disruption and loss of human lives. The analysis presented in the paper will take into consideration three different case scenarios of cyber-attacks to Critical Energy Infrastructures, and will evaluate the outcomes and the tactics used by the organizations' response and recovery.

**Keywords:** critical infrastructure; management; cyber-attack; energy security; cybersecurity

**Reference** to this paper should be made as follows: Plėta, T., Tvaronavičienė, M., Della Casa, S., Agafonov, K. 2020. Cyber-attacks to critical energy infrastructure and management issues: overview of selected cases. *Insights into Regional Development*, 2(3), 703-715. [https://doi.org/10.9770/IRD.2020.2.3\(7\)](https://doi.org/10.9770/IRD.2020.2.3(7))

**JEL Classifications:** M15, Q48

**Additional disciplines** political sciences; information and communication; energetics and thermoenergetics; informatics

\*This research was partly supported by the project, which has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 830892



**European Research Council**

Established by the European Commission

## 1. Introduction

With the beginning of a new decade, the world in which we live is changing constantly, with continuous implementation of new types of technologies. The constant updating of new infrastructural possibilities has, on the one hand, the consequence of bringing more power onto our hands, but on the other, a world that is more and more “connected” can be subject to non-indifferent threats. The implementation of devices connected to the Internet of Things (IoT) is increasingly popular among the population, and it presents undeniable advantages as well for businesses. With IoT-based systems, there is the possibility of having more connected devices, and at the same time eliminating partially the need for human intervention for the control of the edge devices (Bhayani, 2016). However, with the possibility of faster and more precise information comes also a new set of expected threats to the software’s security. The expected number of devices that by 2025 will be connected to the Internet is 75 billion (Resul Das, 2019), but the digital integration of industrial control systems will probably be more vulnerable to cyber-attacks. If we consider the number of “external attacks”, such as hackers, the number has increased by 9 percent from 2017 to 2018 alone (Accenture Security, 2018).

The dependency that the Industrial Control Systems (ICS) are developing to the Internet of Things (IoT) connections is a big potential risk especially in terms of Critical Infrastructures (CI). Malicious forms of cyber-attacks have brought an increase of security breaches, increasing 11% from 2017 to 2018 and an outstanding 67% from 2013 (Accenture Security, 2019). The growing targets of cyber-attackers are part of the Operational Technology (OT) environments, such as water systems, energy plants, transportation, communication, critical manufacturing i.e. every type of CI. Critical Infrastructure Protection (CIP) has become an increasingly relevant topic in the global industrial environment, as the consequences of cyber-attacks toward ICS can result in physical disruption and loss of human lives. Each country has a different approach towards cyber threats in CI, and the increasing number of disrupting episodes brought to huge investments in cybersecurity strategies. The cybersecurity of many businesses is hardly adequate: the proposed techniques to secure vulnerable networks are many, from Blockchain technology to mechanical analogic “unhackable” components (Marszal, 2019). However, the main cause of cybersecurity breaches remains the human factor, source of 95% of network infection (Ahola, 2019), both unintentional errors to lack of proper action.

The purpose of the paper is to consider techniques, viruses or attacks done against CIs, in particular of energy-related production. The analysis is conducted with the focus on types of frameworks developed for the response to cyber incidents in critical infrastructures. The latter will be evaluated in terms of prevention and solution applied after the end of the threat. This focus of the paper is due to the lack of effective comprehensive framework applicable to critical energy infrastructure protection, maybe because of its high complexity. An issue can be the lack of willingness to share information by a damaged company after the cyber-attack, as it may seem a sign of weakness for the company. Usually, the security breaches are possible because of obsolete or inefficient industrial infrastructures and, thereafter, they do not share vital information to maintain the reputation of the company. On the other, open access to data regarding new types of cyber-attacking techniques could be taken from hacking groups and used to damage other targets.

Examples of cyber-attacks in the next chapter will have a double function: firstly, they will help to highlight the usual critical elements of cyber emergencies, and then to assess the possible solution taken following that event. Even if there are plenty of proposed guidelines for cyber-attack management models, concerning critical energy infrastructures there is no clear classification of the degree of effectiveness of the attack, the degree of protection of the critical infrastructures or evaluation of the security system. The goal of this article is to highlight the variety



of vulnerabilities encountered in the event of cyber attacks in critical energy infrastructures and to verify if it is possible to formulate adequate criteria to compose a comprehensive cybersecurity strategy.

**The methodology** that will be used to conduct this research will be of comparative approach: the phenomenon that will be analyzed will highlight the response and the cybersecurity level of critical energy infrastructures against cyber-attacks. The cases will be analyzed individually in order to determine the type of responses of the attacked organizations and their mistakes during and after the attack. Then the results will be classified in terms of type of mistake and the results will be compared in order to determine the most frequent mistakes in this type of infrastructures. However, before diving into the analysis it is important to understand in general the level of security in critical energy infrastructures.

## 2. Vulnerabilities in critical energy infrastructure

The possibility represented by the Internet of Things (IoT) was appealing at first for many businesses. For many, it meant safety and efficiency in the delivery of data, assisted decision-making and overall comfort. Before the updating of these systems, technology control was divided in Informational Technology (IT) and Operational Technology (OT) environments. IT is used mainly for systems that store, process and deliver information of an organization, while OT is for physical plant equipment, such as the aforementioned SCADA systems and embedded computer technologies (Inductive Automation, 2020). With the introduction of the IoT, however, the two environments started to converge, with industrial organizations introducing the Industrial Internet of Things (IIoT), a new kind of environment in which OT and IT coexist in the same environment. If OT technologies before were relegated to closed networks, with the IIoT the chances of being targeted for cyber-attack have risen to a critical point. If the convergence of OT and IT environments has been a rapid procedure, the same cannot be said for the development of an adequate response strategy for cyberattacks against industrial systems. Of these systems, Critical Infrastructures represent a major part, such as energy service sectors, dams, financial services, nuclear reaction sectors, agriculture, healthcare, communication, manufacturing, etc.

In the event of cyber-attacks, the role of the security manager of the attacked company is fundamental in ensuring the correct procedure for an efficient response. The work of the security manager can be divided into three major phases: before, during, and after the attack. For each phase, the common goal is to ensure a safe environment to exchange sensitive data, and to be able to restore the system if the latter is damaged due to external or internal factors. To develop an effective method to prevent cyber-security breaches there is the need to keep up-to-date firewalls and anti-virus in every device since outdated systems are most vulnerable to cyber-attacks (Ryder, 2019). Another necessary element onto which the company should rely on in the case of cyber-attack is the presence of efficient backup: many companies have not standardized cybersecurity risk meters; hence, they do not know its normal operating behavior (Israel, 2019). The majority of management strategies tend to reserve the same approach, minus some specifics, to every type of business: the distinction is usually made on “big vs small enterprise” type of model.

As aforementioned, the updating of ICS to the IoT has brought more vulnerabilities to cyber-attacks, as hackers developed different kinds of techniques to breach the systems' security. Cyber-attacks to critical infrastructures can threaten human life as well as physical damage to the facilities, using multiple techniques at the same time (Resul Das, 2019). Attacks can be divided into five major groups, divided by the objective pursued by the attacker: *corruption of information*, *denial of service (DoS)*, *disclosure of information*, *theft of resources* and *physical destruction* (Limba et al., 2017). However, the most used techniques for targeted cyber-attacks are *phishing*, sending multiple emails asking for sensitive information, and *ransomware*, with theft of sensitive data and the demand of a ransom in exchange for their restoration. Another example can be the deployment of *botnets* or the *subversion of the supply chain*, by attacking directly the equipment (CESG, 2015).

Cybersecurity in enterprises can present a challenge both in the implementation and in the case of cyber-attack event. It is important to remember that there is not a possible “one solution fits all” model for what concerns businesses, as each company or organization possesses different kinds of infrastructures and technical aspects. There are effective guidelines for the management of cyber incidents, however usually the attacked companies were caught unprepared in emergencies, both from the preparation of effective security measures and from immediate responses. The following chapter will try to depict the possible vulnerabilities of critical energy infrastructures, and to assess their possible consequences.

If we talk about the cybersecurity of power grids, the situation needs to be issued by keeping some key aspects in mind. Firstly, when talking about power grids, there is a need to divide the various types of energy infrastructures by the type of resource. Besides fossil fuels, the most extended power grid is issued by electricity coming from nuclear energy, geothermal energy, hydro turbines, combustion turbines, wind turbines, and solar direct (Blume, 2007). The vulnerability of power grids depends on their dynamic infrastructure systems that are usually multi-layered in their structure (Amin, 2010). Cyber-attacks targeting power grids require a higher level of urgency at a developing level, as the consequence of the hack of one of the parts of the systems brings potential risk to human life, environment, and businesses. In general, even though power grids are extremely complex and extended in their organization, the trend in the past few years has been of centralizing the control of electric power systems. As aforementioned, there have been several attacks against electric grids, which shows how easy it has become for hackers to gain control of the interfaces and send orders to the mechanical components, such as switches and connectors, and to halt the electricity flow in the plant, possibly causing blackouts or explosions (Kshetri, 2017).

The issues related to the electric power grids are a priority to each state's security, in a world increasingly dependent on the Internet and hence electricity such as in healthcare and businesses. Possible development of so-called “smart grids”, grids with digital technology that allows two-way communication between the utility and the consumers, represented a big step in the development and the reliability of electricity. However, the digitalization of the grid has raised the vulnerability to cyber-attacks, as it blurred the lines between operational, informational and communication technologies (Oracle, 2012). The European Network and Information Security Agency (ENISA) differentiate the parts of ICS systems that support the smart grids and can be vulnerable to cyber-attack. The list differentiates *operational systems, classic IT systems, communication, networks and protocol and endpoints* (Egozcue, 2012). The interconnectivity brought by the digitalization of such systems assures efficiency and improve consumer service (Amin, 2002), but there are plenty of examples of attacks towards smart grids. In particular, to keep the security systems up-to-date, there is the periodical updating of security patches, but the issue is that sometimes it is not supplied to end-users, or are supplied but not applied for fear of affecting the software performance (Amin, 2010). One of the most significant components of smart grids is the Advanced Metering Infrastructure (AMI), which measures and gathers the information of the energy consumption to the households. The AMI usually consists of billions of low-cost commodities devices that are usually located in marginal positions, depending on the size of the grid (McLaughlin, 2010). If the Smart Meter (SM) is compromised by a cyber-attack, the hacker will be in control of the household power supply and use the SM as an entry point to further attacks to the system's network (Mahmud, 2015).

Many companies are using ICS, operated by a specialized assembly-like code on a programmable logic controller (PLC) that are usually not connected to the Internet (Falliere, 2011). The term ICSs systems can be used for several types of systems, such as DCS (Distributed Control Systems), SCADA (Supervisory Control and Data Acquisition), IAS (Industrial Automation System), IACS (Industrial Automation and Control System) and PLC (Programmable Logic Controller) (Drias, 2015). DCS is generally used for plants for process and generation, while SCADA systems regulate the distribution. The so-called “air-gapped” networks, as physically isolated from unsecured networks, are a common procedure for companies to enhance their resilience to external threats, such

as malicious codes. However, it is possible to infect any end device of the network by the introduction of a USB containing malicious code that could affect the whole system.

Most of the cyber-attacks are caused by the human factor, and the introduction of malicious codes in the system via USB\CD is a good example of it. It is a much-used technique for hackers to throw in the targeted company's parking lot or however near its facilities an infected USB card. As one of the employees will find it and, because of curiosity, will plug into the computer to see what is inside of it. A second option is to pay off an employee (or a former one) to plug in the USB. In both cases, however, it depends on the degree of security of the system: for what concerns the next step, or the control of the PLC, as a preventive measure, it can be needed a signature of driver files with a private key, unknown to external actors (Falliere, 2011). Yet in this scenario, the problem is mainly relying on the individual employee behavior, as he\she could agree to either steal or copy the signature in exchange for money. Another issue is the vulnerability of the network to malicious attacks: seldom hackers exploit the so-called zero-day vulnerabilities, meaning flaws in the system undetected from the programmers during the installation of the software. In general, there are many issues with the vulnerability of ICS of critical energy infrastructure in particular, since many companies do not possess an adequate plan of response to the event of a cyber-attack, and the staff is unprepared or unaware of the correct procedure.

### **3. Examples of cyber-attacks**

In the following chapter, an analysis will be performed among cyber -attacks against Critical Energy Infrastructures (CEI). As aforementioned, Critical Infrastructures are being targeted for cyber-attacks, and the number has grown in the past years. The oldest on record is the Stuxnet malware, which in 2010 targeted Iranian uranium enrichment facilities (Kerr, 2010) before spreading to other countries. The 2012 Shamoon malware as well as disrupted the servers of Saudi Aramco, the biggest oil producer in the world located in Saud Arabia (Alshathry, 2017). Finally, the 2015 attack to the Ukraine power grid caused power outlets and was made appositely for the electric grid. These events, in particular, were chosen to represent the examples of critical energy infrastructures cyber-attack firstly because of the common target-type of critical energy infrastructure as well as highlighted substantial lacking in the organization and security of the attacked networks. The analysis will focus on the responses of the company\government during and after the attack, and to the determination of the "correct" procedure to follow in similar situations.

The cases that were chosen for the analysis represent the most well-known events of cyber-attacks to critical energy infrastructure. The Stuxnet case traced back in 2010, was one of the first-ever recorded cyber-attacks that were appositely designed targeting specifically a nuclear plant, so one critical energy infrastructure. It is also interesting to consider how, despite almost a decade passing, the case did not report a confirmed culprit, and that there still is no current solution to the worm's effects. The second case, the Shamoon malware, was also particularly interesting because the company in question, Saudi Aramco, was targeted by cyber-attack both in 2012 and 2017, also with a similar pattern in both of the cases. The analysis will be conducted on the 2012 attack since it was the first occasion to observe the organization's response. About the Ukrainian case, it would be unfitting to perform an analysis of cyber-attacks and leave out the events happening in Ukraine in the last decade. The country was repeatedly targeted by cyber-attacks and other examples of hybrid warfare, mostly from Russian origin. The 2015 attack as well represents a case in which a cyber-attack caused physical disruption that affected directly the Ukrainian citizens (power losses).

#### **[1] The Stuxnet worm (2010)**

The first attack that will be taken into the analysis is the Stuxnet worm, which was discovered in 2010. The worm aimed to possibly disrupt Iranian nuclear installations. The attack was conducted to the Iranian nuclear plant and

uranium enrichment site in Natanz, during a difficult period of tension between the US and Iran (Baezner, 2017). Although the official perpetrators of the attacks are still unknown and the virus managed to spread to approximately 100,000 infected hosts (Falliere, 2011), the virus presented some elements that put Iran as the targeted country. The worm, programmed to infect SCADA systems, in particular, PLCs organized in groups of 164 objects, and the cascades of the Natanz plant arranged in 164 centrifuges. The attack was conducted by an insider since the facility was using air-gapped software to carry out the production (Beazner, 2017).

The modality of attack following the implementation of malicious code can vary, as from a peripheral device the worm could either retrieve sensitive information, modify the supply chain by overriding ICS and at the same time to fool the plant operators into believing that the process is operating as usual (T. Ayrat, 2016). However, to effectively gain PLC control, it is needed to know deeply its structure and functioning. The case of the 2010 worm Stuxnet represents a valid example of it, as the research before the attack allegedly took at least six months by a team of five to ten programmers, who developed the program to target exactly the PLCs of an Iranian nuclear plant and uranium enrichment facilities (Baezner, 2017). Thanks to the exploit of four zero-day vulnerabilities the hackers managed to gain control of the system and to spread the malicious worm to more than 10.000 hosts (Falliere, 2011).

In this case, the attack was made possible by an *insider*, meaning the introduction of external malicious codes that disrupted the system. For this reason, the main error that was made by the management system was first to *lack of testing* and *lack of communication*. The first represents the lack of adequate testing of the security responses, necessary to find the flaws of the systems via simulations, considering the zero/days vulnerabilities of the Microsoft Windows operating system used to spread the virus. The second concerns the behavior of the organization during and after the attack. Since the attack in itself was probably politically motivated, as it targeted Iranian uranium enrichment facilities, Iran did not denounce publicly the attacks' impact right away. After the Iranian officials admitted that some personal computers resulted infected with a computer virus, Iran abruptly stopped its production of enriched uranium for apparently no reason (Beazner, 2017). The latter is a usual mistake made by attacked organizations, as admitting to having been targeted and damaged from a cyber-attack affects their public image and so seldom the tendency is not to disclose any detail, making the eradication and recovery process even harder. In the case of Stuxnet, the physical damage was caused to the centrifuges controlled by the PLC. From the centrifuges used by the Natanz facility, ranging from 6000 to 9000 objects, 1000 had to be changed (De Falco, 2012).

The best practices advised contrasting this type of attack are targeting the management strategy of cyber incidents since the attack was made possible by the attackers' possession of digital certificates necessary for entering the system unnoticed (Beazner, 2017). Hence, the first thing to consider in building an effective security system is the creation of working groups that have to review the protocols and the overall security of SCADA systems. It is fundamental to introduce encryption and mutual authentication for every device connected to the system (De Falco, 2012). As aforementioned, it is fundamental also to apply strict rules for the management of digital certificates, such as the *storing of private keys* and the quality of the certificate.

Concerning this scenario, the main management mistakes concerned the communication techniques and the lack of testing of the system's flaws. The communication was uneven and unclear to national and supranational authorities, unacceptable behavior in CEI: transparency and collaboration are fundamental to ensure the readiness of response. The flaws of the system, in particular the zero-day vulnerabilities, allowed the hackers to infiltrate the malware and affect the functioning of the PLC. Continuous testing is required to discover potential weak spots of the system and to fix them without exposing the whole infrastructure at risk.

## [2] The Shamoon malware (2012)

The second type of attack that will be considered for the analysis in the case of the Shamoon malware of 2012, which targeted mainly Saudi Aramco, the largest oil production company of the entire world, centered in Saudi Arabia. Also known as *W32.Disttrack*, the malware consisted of three components, which affected an estimated 30,000 computers in the facilities of Saudi Aramco (Wuuest, 2014). The *dropper*, the main component, dropped components in the infected computer, copied and executed itself every time Windows was opened. The *wiper*, second component, is the destructive module which erased files from specific locations in the computer: after sending the information to the attacker, it overwrote the files with corrupted jpeg files. The final component was the *reporter*, which sent information back to the attacker's central computer (Mackenzie, 2012).

This type of attack, despite being associated with the target to the Stuxnet malware, represents an interesting case for cyber-attacks to energy infrastructures. The attack was probably brought out by an insider, someone who got access to users' credentials and gained access to the domain controller (Wuuest, 2014). Although it was compared to Stuxnet, the perpetrators were described as "skilled amateurs", because of the inferior level of competence and programming skills detected by the authorities (Bronk, 2013). The type of attack in consideration is *APT* (*Advanced Persistent Threat*), meaning that the attackers have found the password hashes of the administrative accounts and gained the access to higher levels of the system (Alshathry, 2017).

The issues presented in this case are focused on the response of the organization to the cyber-attack. The issue that was mainly raised by the international authorities about the actual impact of the attack on the organization's system. The company declared shortly after the cyber-attack to have reduced its electronic systems from the outside to avoid further attacks. Saudi Aramco declared that, despite the wipe-out of data from the server, no physical disruption was recorded and the recovery of the company was complete (Alshathry, 2017). Nevertheless, the downtime of the organization's websites was recorded also after the declaration of complete recovery (Bronk, 2013).

The main issue represented by this attack is the *lack of communication*, so the behavior of the organization during and after the attack. The information regarding the attack was partial during and after the attack, considering that the infection spread beyond the initially targeted organization onto other companies, losing drilling and production data. The drilling procedures produce a huge quantity of data, which is sent to the Saudi Aramco database. The data was then centered and filtered and sent back manually twice a day. Perhaps because it was Ramadan, there were no backups for drilling and production data, and the filtered data got lost (Bronk, 2013). However, the company declared complete recovery almost immediately after the attack, in a way to assure other vendors and costumers that the damage was peripheral and contained. As aforementioned, this is a wrong approach in responding to cyber-attacks, especially in Critical Energy Infrastructure.

The main management problem identified in this scenario is the lack of security and lack of communication. The attack highlighted the lack of backups in the systems, which caused the websites and the data to be wiped out. In the management of cyber incidents, the solutions that are offered to mitigate the problem have to be implemented in the preparation phase. The most effective in this case is *redundancy*, an alternative response to a failing condition. In Critical Energy Infrastructure a failure in the system can resolve in physical damage, hence it is fundamental to ensure a homogenous process. *Redundancy* consists in the presence of a backup that is constantly updated to "mirror" the used components and, in case of the failure of the latter, immediately assumes control (ICS Engineering Inc., 2017). The implementation of this type of device should be mandatory in Critical Energy Infrastructures, as it makes the recovery from the attack a quicker process.



### [3] Ukraine cyber-attacks (2015-16)

The last case scenario that will be considered for the paper's analysis will be the cyber-attack that took place in Ukraine in 2015-2016, targeting the Ukrainian power grid. The attack was due to an intruder in the company's computer and SCADA system (E-ISAC, 2016). On December 23, 2015, approximately 30 substations were disconnected from three hours, causing a power outage in three of its regional electricity distribution companies, Kyivoblenergo, Prykarpattiaoblenergo, and Chernivtsioblenergo, cutting out of power more than 200,000 costumers (FireEye, 2016). The perpetrators have been recognized as the *Sandworm Team*, a Russian hacker group that targeted NATO, European governments and ICSs in general (Park, 2017).

The attackers were highly skilled for the job, and the technical components used to conduct the attack were many. Firstly, *spear-phishing* was used to gain access to the business networks of the facilities (E-ISAC, 2016). The next phase was to implement the malware *BlackEnergy3*, the third variant of *BlackEnergy*, used by the Russian underground in *distributed denial-of-service* attacks (FireEye, 2016). The access then was used to steal the credentials from the business networks, including Virtual Private Networks (VPN) to enter the ICS network (E-ISAC, 2016). Then the attackers used existing remote access tools to issue commands from a remote station, and used a modified *KillDisk*, a hard drive eraser software, to erase the attacked organizations' systems. The power outages were caused by the *UPS systems* of the facilities, which usually provides emergency power to a load during electric fails, that impacted instead the connected load and caused the outage. The last part was to issue a *Distributed Denial of Service (DDoS)* attack to the call center so that costumers were not able to report the issue (E-ISAC, 2016).

From the management perspective, the mistakes that led to the attack can be traced both in the phase of preparation against cyber-attacks and the phase during the attacks. The opportunities that the hackers exploited in this case were many, from the availability of open-source information on the type of ICS system that was used in the facilities and the lack of *two-factor authentication* in the VPNs (E-ISAC, 2016). Moreover, the media indicated that the facilities did not possess any capability of network security monitoring, with no one able to manually monitor the ICS network (E-ISAC, 2016). Firstly, it is necessary to enhance networking security monitoring capability, as the attack managed to gain control of the system also because of the lack of controls on its access points (FireEye, 2016). Moreover, implementing measures such as *Area of Responsibility (AoR)* limitations, meaning that only one operator could control some components of the system, could limit the possibility of the hackers to gain the control of the *HMI (Human Machine Interface)* (E-ISAC, 2016). Finally, the implementation of *two-factor authentication*, *blockchain technology* or *application whitelisting* could improve the secure management of access into the system.

### 4. Observations and recommendations

In the following chapter, there will be a comparison of the results that were shown in the analysis of the cases of cyber-attacks. As seen in the introduction, the expected results that will emerge from the comparison will be hopefully useful in determining the more vulnerable areas in cybersecurity. The model that was chosen to determine the criteria of comparison and to evaluate the common mistakes and areas of interest will be the one adopted by Limba et al. in *Cyber Security Management Model for Critical Infrastructure* (Limba et al., 2017). According to the article, the criteria which determine a cybersecurity management model are six: first, the *legal regulation*, which concerns the legal proceedings and aspects achieved by the organization in terms of legislation acts such as security instructions, information security officials, etc. (Limba et al., 2017). Then, *governance* concerns the understanding of the need for minimizing the impact of cyber incidents into the organizations and



*risk management* instead analyzes the growing risks around the organization (Limba et al., 2017). *Cyber Hygiene* is important for every organization as well, meaning that security must be understandable for every member of the organization (Limba et al., 2017). Finally *Technology management and Incident Management*: the first is about the knowledge about each component controlled by IT, while the second is more about the legal dimension, concerning special plans that need to be applied in case an incident occurs (Limba et al., 2017). It follows a summarization of the cases analyzed in the article and the aforementioned categories. The x marks the presence of a lack in the concerned area, and the cases are in the order in which they were presented in the paper (see Table 1).

**Table 1.** Identified gaps in cybersecurity model dimensions

	Governance	Law and information	Cyber hygiene	Risk Management	Technology Management	Incident Management
<i>Case [1]</i>	x			x		
<i>Case [2]</i>		x	x			x
<i>Case [3]</i>	x		x			

Sources: estimated by authors; used model (Limba et al., 2017)

The first analyzed cyber-attack in the article, Stuxnet, presents an interesting case for what concerns the gaps in the organization's cybersecurity model (Natanz nuclear plant). As mentioned in the analysis, the organization dealt with a *lack of communication* and a *lack of security*, but it can be tailored to the model presented in the table. As the table shows, the Stuxnet case (*Case [1]*) presents gaps in *governance* and *risk management*. As said in the previous paragraph, to have *good governance* is fundamental to ensure proper cybersecurity, and that means as well that each project of activity planned in the organization must be reviewed from a security perspective (Limba et al., 2017). The Stuxnet case showed the vulnerabilities of the system of the Natanz power plant, and the organization seemed to not to worry about cyber vulnerabilities. The same type of gaps was as well recorded in *Case [3]* (Ukraine 2015 attack), because in that case the cyber-attack was conducted thanks to spear-phishing emails, implying that the system was not protected enough. About the *risk management* gap recorded in the Stuxnet case, it implies that the lack of security and testing provided multiple zero-days vulnerabilities that were then used by the hackers to introduce malicious codes into the system (Falliere, 2011).

The *Case [2]*, as the Shamoon malware, recorded a *lack of communication*, as mentioned in the previous analysis. As the table indicates the gaps in cybersecurity model dimensions, this case was classified under *law and information*, *cyber hygiene* and *incident management*. The malware disrupted the system of the Saudi Aramco oil plant and wiped away the filtered data from many computers (Mackenzie, 2012), but the lack of backups for drilling and production data worsened the damages. Besides the lack of a built-in (not manual) backup system, there was no personnel checking on the missing filtered data, hence a gap in *cyber hygiene* (Mackenzie, 2012). The Ukrainian case as well presented a gap in *cyber hygiene*, since the method of spear-phishing was used to gain control of the business networks of the facilities (E-ISAC, 2016). For what concerns the *incident management*, the Shamoon malware was badly handled in terms of communication with the authorities since the organization passed just a part of the information (Bronk, 2013).

In conclusion, both the *governance* and *cyber hygiene* present the most targeted dimensions of cybersecurity gaps, since they are both presents in two cases out of the analyzed three. However, it is important to mention that, even with the provided model of identification of cybersecurity model dimensions, six categories are still not enough to cover all the aspects that are typical of critical energy infrastructure. The peculiarity of the latter depends on the

interconnectivity and on the overlap of IT and OT environments necessary to have full coverage of the system. There are still no calculations that offer adequate criteria to measure the impact of cybersecurity measures on critical energy infrastructure, but this analysis can be taken as an example of the multitude of elements to take into consideration.

## 5. Conclusions

The convergence on IT and OT technology brought to life a new concept of online systems, alongside multiple innovations in the management of Critical Infrastructures(CI). However, alongside the innovation comes a new concept of cybersecurity, as the protection of CI is becoming more difficult to achieve from both IT and OT perspective. The global tendency shows that the Critical Energy Infrastructures are due to be one of the main targets of cyber-attacks, hence the priority is both to increase their protection and to raise awareness on the general lack of preparation concerning the development of an effective cybersecurity strategy for critical energy infrastructures. The analysis of the paper showed three case scenarios that depicted different cyber-attacks to Critical Energy Infrastructures, analyzing the response of the organizations and the mistakes of the management in the preparation and the response.

As aforementioned, the human factor plays an important role in cybersecurity: it is one of the main causes of cyber-attack, both in lack of knowledge or in incorrect behavior. The analysis showed that in all of the cases of cyber-attacks, given the political nature of the conflict, information was not disclosed entirely, or was partially excluded from the reports. This type of error, alongside security issues, is the most dangerous to Critical Energy Infrastructures, as it not only compromises the integrity of the attacked organization but leaves out the possibility of studying the used worm or technique, so for the hackers potentially to replicate them somewhere else. To develop a correct response to cyber incidents, it is necessary to communicate and cooperate on a national and international level.

The model that was introduced in this article should shed some light on the issue of cybersecurity of Critical Infrastructure and should be aiming to measure adequately the cybersecurity level of an organization. As aforementioned, critical energy infrastructure require an additional level of preparation and complexity due to the merging of IT and OT environments. Moreover, in the comparison of the results, it merged a possible model to evaluate cybersecurity level of critical energy infrastructure, but the calculations and the described areas are far from being adequate.

## References

- Accenture Security. (2018). *Gaining ground on the cyber attacker: 2018 State of Cyber Resilience*. USA: Accenture Security. Retrieved from <https://www.accenture.com/us-en/insights/security/2018-state-of-cyber-resilience-index>
- Accenture Security. (2019). *The Cost of Cybercrime*. Traverse City, Michigan: Ponemon Institute. Retrieved from [https://www.accenture.com/\\_acnmedia/pdf-96/accenture-2019-cost-of-cybercrime-study-final.pdf](https://www.accenture.com/_acnmedia/pdf-96/accenture-2019-cost-of-cybercrime-study-final.pdf)
- Ahola, M. (2019, October 18). *The Role of Human Error in Successful Cyber Security Breaches*. Retrieved from usecure: <https://blog.getusecure.com/post/the-role-of-human-error-in-successful-cyber-security-breaches>

- Alshathry. (2017, February). Cyber Attack on Saudi Aramco. *International Journal of Management of Information Technology*, 11(5), p. 3037. [doi:https://doi.org/10.24297/ijmit.v11i5.5613](https://doi.org/10.24297/ijmit.v11i5.5613)
- Amin, M. (2002). Security challenges for the electricity infrastructure. *Computer*, 35(SUPPL.), 8-10. [doi:https://doi.org/10.1109/MC.2002.989920](https://doi.org/10.1109/MC.2002.989920)
- Amin, S. M. (2010, Spring). Securing the Electricity Grid. *The Bridge: Linking Engineering and Society*, 40(1), 13-19. Retrieved from <http://massoud-amin.umn.edu/publications/Securing-the-Electricity-Grid.pdf>
- Ayral T., O. J. (2016, July). *Minimize industrial cyber security risk in plants in 12 steps*. Retrieved from Hydrocarbon Processing: <https://www.hydrocarbonprocessing.com/magazine/2016/july-2016/process-control-and-instrumentation/minimize-industrial-cyber-security-risk-in-plants-in-12-steps>
- Beazner M., R. P. (2017). *CSS Cyber Defence Hotspot Analysis: Stuxnet*. Zurich: Center for Security Studies (CSS), ETH Zurich. Retrieved from <https://css.ethz.ch/content/dam/ethz/special-interest/gess/cis/center-for-securities-studies/pdfs/Cyber-Reports-2017-04.pdf>
- Bhayani M., P. M. (2016). Internet of Things (IoT): In a Way of Smart World. In B. Y. Satapathy S., *Proceedings of the International Congress on Information and Communication Technology. Advances in Intelligent Systems and Computing* (Vol. 438). Singapore: Springer.
- Blume, S. W. (2007). *Electric Power System Basics*. (I. o. Engineers, A cura di) Wiley and Sons, INC.
- Bronk C., T.-R. E. (2013). *Hack or Attack? Shamoon and the evolution of Cyber Conflict*. SSRN. [doi:http://dx.doi.org/10.2139/ssrn.2270860](http://dx.doi.org/10.2139/ssrn.2270860)
- CESG. (2016). *Common Cyber Attacks: Reducing The Impact*. London: CESG. Retrieved from [https://www.ncsc.gov.uk/static-assets/documents/common\\_cyber\\_attacks\\_ncsc.pdf](https://www.ncsc.gov.uk/static-assets/documents/common_cyber_attacks_ncsc.pdf)
- Chesla, A. (2012, October 25). *Cyber War Rooms: Why IT Needs New Expertise To Combat Today's Cyberattacks*. Retrieved from Security Week: <https://www.securityweek.com/cyber-war-rooms-why-it-needs-new-expertise-combat-todays-cyberattacks>
- Darville C., D. B. (2015). *Cyber Security Incident Management Guide*. (C. f. Belgium, A cura di) Belgium: Cyber Security Coalition. Retrieved from <https://b-ok.cc/book/3704644/d3244d>
- Das R., Z. G. (2019). Analysis of Cyber-Attacks in IoT-based Critical infrastructures. *International Journal of information Security*, 8(4), 122-133. Retrieved from [http://www.ijiss.org/ijiss/index.php/ijiss/article/view/490/pdf\\_80](http://www.ijiss.org/ijiss/index.php/ijiss/article/view/490/pdf_80)
- De Falco, M. (2012). *Stuxnet Facts Report: A Technical and Strategic Analysis*. Tallinn: NATO Cooperative Cyber Defence Centre of Excellence. Retrieved from [https://ccdcoe.org/uploads/2018/10/Falco2012\\_StuxnetFactsReport.pdf](https://ccdcoe.org/uploads/2018/10/Falco2012_StuxnetFactsReport.pdf)
- Dragos. (2017). *CRASHOVERRIDE: Analysis of the Threat to Electric Grid Operations*. Hanover: Gragos.Inc. Retrieved from <https://www.key4biz.it/wp-content/uploads/2017/06/CrashOverride-01.pdf>
- Egozcue E., R. D. (2012). Annex II. Security aspects of the smart grid. In D. H. E. Egozcue, *Smart Grid Security: Recommendations for Europe and Member States*. European Network and Information Security Agency (ENISA). Retrieved from [https://www.enisa.europa.eu/topics/critical-information-infrastructures-and-services/smart-grids/smart-grids-and-smart-metering/ENISA\\_Annex%20II%20-%20Security%20Aspects%20of%20Smart%20Grid.pdf](https://www.enisa.europa.eu/topics/critical-information-infrastructures-and-services/smart-grids/smart-grids-and-smart-metering/ENISA_Annex%20II%20-%20Security%20Aspects%20of%20Smart%20Grid.pdf)
- E-ISAC. (2016). *Analysis of the Cyber Attack on the Ukrainian Power Grid: Defense Use Case*. Washington: SANS ICS. Retrieved from [http://www.nerc.com/pa/CI/ESISAC/Documents/E-ISAC\\_SANS\\_Ukraine\\_DUC\\_18Mar2016.pdf](http://www.nerc.com/pa/CI/ESISAC/Documents/E-ISAC_SANS_Ukraine_DUC_18Mar2016.pdf)
- Falliere N., M. L. (2011). *W32.Stuxnet Dossier*. Cupertino, CA: Symantec Security Response. Retrieved from <https://css.csail.mit.edu/6.858/2014/readings/stuxnet.pdf>

- FireEye. (2016). *Cyber Attacks on the Ukrainian Grid: What you should know*. Milpitas, CA: FireEye. Retrieved from <https://www.fireeye.com/content/dam/fireeye-www/global/en/solutions/pdfs/fe-cyber-attacks-ukrainian-grid.pdf>
- ICS Engineering Inc. (2017). *Types of Redundancy*. Retrieved from ICS Engineering Inc.: <http://www.icsenggroup.com/types-of-redundancy.shtml>
- Inductive Automation. (2020, February 28). IIoT: Combining the Best of OT and IT. *Industrial Ethernet Book*, 95\14. USA: IEB Media GdR. Retrieved from <https://iebmedia.com/index.php?id=11673&parentid=63&themeid=255&hft=95&showdetail=true&bb=1>
- Israel, M. (2019, April). No More Dangling from Rooftops: Integrating Cybersecurity. *Advancing Automation Cybersecurity into the Connected Plant Transformation*, XV, p. 5-9.
- Kerr P., R. J. (2010). *The Stuxnet Computer Worm: Harbinger of an Emerging Warfare Capability*. Washington: Congressional Research Service. Retrieved from <https://fas.org/sgp/crs/natsec/R41524.pdf>
- Kshetri N., V. J. (2017). Hacking Power Grids: A Current Problem. *IEEE Security & Privacy*, 91-95. [doi:10.1109/MC.2017.4451203](https://doi.org/10.1109/MC.2017.4451203)
- Limba, T., Plêta, T., Agafonov, K., & Damkus, M. (2017). Cyber security management model for critical infrastructure. *Entrepreneurship and Sustainability Issues*, 4(4), 559-573. [http://dx.doi.org/10.9770/jesi.2017.4.4\(12\)](http://dx.doi.org/10.9770/jesi.2017.4.4(12))
- Mackenzie, H. (2012, October 25). *Shamoon Malware and SCADA Security – What are the Impacts?* Retrieved from Tofino Security: <https://www.tofinosecurity.com/blog/shamoon-malware-and-scada-security---what-are-impacts>
- Mahmud R., V. R. (2015). A survey on smart grid metering infrastructures: Threats and solutions. *2015 IEEE International Conference on Electro/Information Technology (EIT)* (p. 386–391). IEEE.
- McLaughlin S., P. D. (2010). Energy Theft in the Advanced Metering Infrastructure. *International Conference on Critical Information Infrastructures Security* (p. 176-187). Berlin: Springer-Verlag Berlin Heidelberg. [doi:10.1007/978-3-642-14379-3\\_15](https://doi.org/10.1007/978-3-642-14379-3_15)
- NATO. (2020, March 17). *Cyber Defence*. Retrieved from NATO: [https://www.nato.int/cps/en/natohq/topics\\_78170.htm](https://www.nato.int/cps/en/natohq/topics_78170.htm)
- OpUtils. (2020, February 21). *Rogue Device Detection Software*. Retrieved from ManageEngine: <https://www.manageengine.com/products/oputils/rogue-detection-tool.html?lhs>
- Oracle. (2012). *Mitigating Cyber-Security Risk of Smart-Grid AMI*. Oracle. Retrieved from [www.oracle.com/us/technologies/bpm/mitigate-cyber-security-risk-1533517.pdf](http://www.oracle.com/us/technologies/bpm/mitigate-cyber-security-risk-1533517.pdf)
- Park D., S. J. (2017, October 11). *Cyberattack on Critical Infrastructure: Russia and the Ukrainian Power Grid Attacks*. Retrieved from The Henry M. Jackson School of International Studies: <https://jsis.washington.edu/news/cyberattack-critical-infrastructure-russia-ukrainian-power-grid-attacks/#/>
- Ryder R., M. A. (2019). *Cyber Crisis Management*. New Delhi: Bloomsbury India.
- Wuust, C. (2014, January 13). Targeted Attacks Against the Energy Sector. *Security Response*. Retrieved from [https://bluekarmasecurity.net/wp-content/uploads/2014/09/Symantec\\_Targeted-Attacks-Against-the-Energy-Sector\\_whitepaper.pdf](https://bluekarmasecurity.net/wp-content/uploads/2014/09/Symantec_Targeted-Attacks-Against-the-Energy-Sector_whitepaper.pdf)
- Z. Drias, A. S. (2015). Analysis of Cyber Security for Industrial Control Systems. *2015 International Conference on Cyber Security of Smart Cities, Industrial Control System and Communications (SSIC 2015)* (p. 83-91). Shanghai, China: IEEE.

## Acknowledgements

*This research was partly supported by the project, which has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 830892*

**Tomas PLĖTA** is a Communications and Information System Security Officer / Head of Division at the NATO Energy security Center of Excellence and PhD student at Vilnius Gediminas Technical University. His PhD topic related to cyber security management for critical energy infrastructure. His research interests also include information and data security, data protection and Industrial control system cybersecurity.

**ORCID ID:** <https://orcid.org/0000-0002-5376-6873>

**Manuela TVARONAVIČIENĖ** is professor at Vilnius Gediminas Technical University and Jonas Zemaitis Military Academy of Lithuania. She is national head of several international projects, financed by European Commission, author of numerous papers, editor of a book, published by Elsevier. Her research interests embrace wide range of topics in area of sustainable development and security issues.

**ORCID ID:** <https://orcid.org/0000-0002-9667-3730>

**Silvia DELLA CASA** is an intern in the NATO Energy Security Centre of Excellence (ENSEC COE) in Vilnius (e-mail: slv.dellacasa@gmail.com). Her MA paper topic is related to cyber security management and energy security management. Her research interests also include hybrid warfare and cyber security issues.

**ORCID ID:** <https://orcid.org/0000-0003-3231-8323>

**Konstantin AGAFONOV** is a PhD student at the Mykolas Romeris University (e-mail: ka1979@gmail.com). His PhD topic is related to cyber security management for e-voting systems. His research interests also include information and data security, data protection and cyber security issues.

**ORCID ID:** <https://orcid.org/0000-0002-8962-0083>

---

Make your research more visible, join the Twitter account of INSIGHTS INTO REGIONAL DEVELOPMENT:  
@IntoInsights

---

Copyright © 2020 by author(s) and VsI Entrepreneurship and Sustainability Center  
This work is licensed under the Creative Commons Attribution International License (CC BY).  
<http://creativecommons.org/licenses/by/4.0/>

