Regional Science Inquiry

Regional Science Inquiry

June 2023 Volume XV Number 1

Regional Science Inquiry

THE JOURNAL OF THE
Hellenic Association of Regional Scientists

June 2023
Volume XV
Number 1

The Journal is Indexed in

ECONLIT

RSAI

Scopus

RePEc

SJR

Editor-in-Chief
Professor
Christos Ap. Ladias

RSI J
FOUNDATION YEAR 2008

English Edition
ISSN: 1791-5961 Print
ISSN: 1791-7735 On line

RSI J

Website: http://www.rsijournal.eu, Email: info@rsijournal.eu, publisher@rsijournal.eu
Address: 19b Navarinou Street, 15232 Chalandri, Athens, Greece,Tel./Fax: +30 210 6833700.

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Critical Surveys Editors

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The articles published in RSI Journal are in accordance with the approving dates by the anonymous reviewers.

Regional Science Inquiry, Vol. XV, (1), 2023
Editorial Note

In the first semester of 2023, the Regional Science Inquiry Journal (RSIJ), the scientific journal published under the scientific aegis of the Hellenic Association of Regional Scientists, launches the first issue (2) of its fifteenth volume (Vol. XV) since the first day it was published. The RSIJ is an international, open-access, peer-reviewed journal that publishes research on various topics related to Regional Science. The journal aims to freely promote the academic dialogue in Regional Science worldwide, as well as to serve scientific research with solid quality standards in empirical, methodological, and theoretical contribution. It provides a platform for scholars, policymakers, and practitioners to share their research and insights on regional development and its various dimensions.

In the last five last years, since 2018, the RSIJ has so far published 180 papers, on a wide range of topics, including (but not exhausted to) Regional Economics and Development (Aliha et al., 2019; Syahnur, S. 2020; Tsiotas et al., 2020; Deichmann et al., 2022; Egamberdiev, 2021;), Spatial Analysis and Econometrics (Khairul, 2018; Pnevmatikos, et al., 2019; Lincaru and Pirciog, 2022), Economic Geography and Transportation Economics (Tsiotas, 2022), Urban Planning and Development (Joukes et al., 2018; Lagarias and Sayas, 2018; Havryliuk et al., 2021; Ruxho and Ladias, 2022b; Tsiotas et al., 2022), Tourism Economics and Development (Amoiradis et al., 2021; Tsiotas et al., 2020; Zyberi and Polo, 2021; Krabokoukis and Polyzos, 2022), Urban and Regional Sustainability (Trusova et al., 2021; Vasyltsiv et al., 2021; Shebanin et al., 2022), and Regional Analysis and Policy (Konstantinidis and Pelagidis, 2018; Dunayev et al., 2019; Constantin, 2021; Dionysopoulou et al., 2021; Ruxho and Ladias, 2022a), and many others. The RSIJ has the merit to serve the broad multidisciplinary scope of regional science and thus to provide publication opportunities to researchers from various disciplines, but it is also privileged to provide an open-access platform for regional science research (making it accessible to a wider audience), and also to support a reasonably timely review process (thus acknowledging that timely publication is beneficial both for the authors and the promotion of the academic dialogue). Further, the RSIJ is supported by an editorial board of reputable scholars from worldwide (counting over a hundred members), who ensure that the published papers meet rigorous academic standards. Also, the RSIJ has the merit to provide a forum for ideas exchange, news, and information, by covering topics of broader academic interest, such as events (conferences, workshops, and seminars), academic profiles (which provide insights into the work and accomplishments of leading scholars in the field), and book reviews (which offer a valuable service by summarizing and evaluating important publications), enhancing its value as a resource for scholars and practitioners for readers interested in keeping up with the latest developments in Regional Science.

Following this heritage, the RSIJ continues working hard toward providing a reputable and respected publication, along with a valuable platform for high-quality research for anyone interested in regional science, regional development, and related fields. To this end, this issue (RSIJ, Vol. XV, (1), 2023) includes seven papers that were carefully selected from a large pool of candidacies for publication and comply with the journal's standards. These papers deal with modern and interesting topics of Regional Science research, rural and urban geography and welfare, economic growth in terms of financial globalization, human capital, and local economies, the energy demand in the EU, and a case study of the importance of renewable energy projects as an investment, along with the effect of digitalization in enterprises functionality.

In brief, the first paper, titled "WELL-BEING AND QUALITY OF LIFE: DIFFERENT PERSPECTIVES IN RURAL AND PERI-URBAN AREAS IN THE NORTH OF PORTUGAL", authored by Teresa SEQUEIRA, Herminia GONCALVES, Bruno SANTOS FRANCISCO, Antonio PIRRA, and Veronika JOUKES, studies the level of development of territory to the extent is related to the quality of life. To do so, the study captures the perception of residents in Vila Marim (Portugal), about their quality of life by a survey technique based on the WHOQOL-BREF instrument. The results illustrate (i) that peri-urban areas have better indexes in the domains of the general quality of life, social relations, and the

physical domain, while rural areas have better ones in the psychological and environment domains; (ii) provide insights into the understanding issues related to income and physical security; (iii) show different sensitivities about how the quality of life is experienced and, generally, (iv) may provide a framework for urban policy making.

The second paper, titled "ENERGY CROPS: ASSESSMENTS IN THE EUROPEAN UNION AGRICULTURAL REGIONS THROUGH MACHINE LEARNING APPROACHES", authored by Vitor Joao Pereira Domingues MARTINHO, investigates the potential to produce bioenergy from agriculture, forestry, and other land use in the European Union (EU) farms. To do so, it assesses the current context of the energy crops in the farms of the EU agricultural regions and identifies a model supporting the prediction of these frameworks, on data extracted from the Farm Accountancy Data Network (FADN), and based on multilayer perceptron and artificial neural networks methodologies. The results of the analysis show that energy crops do have not relevant importance in the European Union farms, however, when these crops appear, they are produced by larger farms, with greater competitiveness and which receive more subsidies.

The third paper, entitled "FINANCIAL GLOBALIZATION AND GROWTH REVISITED – INTERNATIONAL AND REGIONAL EVIDENCE", authored by Vladimir SIMIC, attempts to revisit the link between financial globalization and growth using the KOF index of globalization in a sample of 134 world economies in the period 1970-2015. Having available a large number of countries and based on panel data analysis, this paper provides evidence on the link between financial globalization and economic growth, exerting negative and statistically significant effects on economic growth, focusing on the relationships and the negative effects between countries of the East Asia and Pacific; Middle East and North Africa; Latin America and the Caribbean; and Sub-Saharan Africa and Europe and Central Asia regions.

The fourth paper, entitled "HUMAN CAPITAL FORMATION AND ECONOMIC GROWTH RELATIONSHIPS: PANEL DATA INSIGHTS FOR THE INDIAN STATES", authored by Imran HUSSAIN and Ramesh CHANDRA DAS, provides empirical evidence on the associations between human capital formation and education expenditures and income, for the panel of states and union territories of India during the period from 1998-99 to 2018-19. To do so, it applies econometric methods (panel cointegration, Wald's test) to examine the long-run relationships between human capital investment and income of the economy and the direction of the short-run causality. The results demonstrate that human capital and state incomes have a long-term relationship and the existence of a short-run linkage between human capital and income of the state economies (with the causality running from human capital investment to output of the economy), suggested that the governments of the states and union territories make additional investments in sectors such as education and health to secure long-term economic prosperity.

The fifth paper, entitled "THE REGIONAL ECONOMIC INDICATORS AND ECONOMIC DEVELOPMENT OF KOSOVO", authored by Christos Ap. LADIAS, Filipos RUXHO, Fernando Jose Calado e Silva Nunes TEIXEIRA, and Susana Soares Pinheiro Vieira PESCADA, examine the importance of regional economic indicators in the economic development of Kosovo, aiming to provide insights to policymakers into identifying and reducing regional disparities in Kosovo (which currently is experiencing significantly higher levels of poverty and unemployment) and into the design of targeted strategies promoting economic growth. The analysis builds on various indicators, such as income per capita, unemployment indicators, and the poverty rate, aiming to provide a comprehensive overview of regional economic development in Kosovo. The results reveal the existence of significant disparities in different regions and underline the need for targeted policies and interventions, along with the importance of developing a strong and reliable system for the collection and reporting of regional economic indicators, which can inform evidence-based policy-making and support a more equitable and sustainable regional economic development in Kosovo.

The sixth paper, entitled "RENEWABLE ENERGY PROJECT APPRAISAL USING THE REAL OPTIONS METHODOLOGY", authored by Vasileios PAPADIMITRIOU, Serafeim POLYZOS, and Dimitrios TSIOTAS, summarizes the specifics governing Renewable Energy Sources (RES) projects, the main characteristics of the RO methodology,

and an overall framework for its application to RES projects. This framework is used to evaluate an investment in a 500kWp photovoltaic (PV) park in Greece. The uncertainties selected for the analysis of the RO methodology are the electricity sales price and the production from the specific PV project. In addition, the options/rights of the investor that are considered, are to continue or abandon the investment in each phase of the project implementation. The results, based on the current data and have included the possible fluctuation in the values of the two aforementioned uncertainties, show that investing in a PV project of similar size and technology in Greece is advantageous and worth undertaking. The intention to finance a large proportion of the investment by the banks plays an important role in this.

Finally, the seventh paper, entitled "HOW AND HOW MUCH DIGITALIZATION AFFECTED ENTERPRISE PERFORMANCE DURING COVID-19 PANDEMIC, authored by Ermira KALAJ and Erjola BARBULLUSHI, examines the digitalization of enterprises during Covid-19 pandemic and its performance in Albania, based on World Bank Enterprise Survey data of the year 2019, aiming to better understand the firm's experience in the private sector. Applying the analysis in two stages, before and during the Covid-19 pandemic, the paper examines ownership of websites, the increase of business activity online, and the increase of remote work arrangement, measured in terms of sales growth, employment growth, closure, and production adjustment.

All these interesting works are available on the next pages of the RSIJ intending to promote the academic dialogue in Regional Science. Overall, the Editor in Chief, Prof. Christos Ap. Ladias, the Editorial Board, and the signatory of this Editorial welcome the reader to the multidisciplinary journey of Regional Science Inquiry that the current issue promises to conduct on its following pages.

On behalf of the Editor-in-Chief and Editorial Board,
Dimitrios Tsiotas, Ph.D.,
Assistant Professor – RSI J.

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Articles

WELL-BEING AND QUALITY OF LIFE: DIFFERENT PERSPECTIVES IN RURAL AND PERI-URBAN AREAS IN THE NORTH OF PORTUGAL

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Abstract

Quality of life is a multidimensional concept that has been gaining prominence in works intending to study the level of development of a territory, mainly based on secondary data treated statistically. Other approaches have emerged based on primary data, which is the case of this work.

This study captures the perception of residents in Vila Marim, a small parish in Portugal, about their quality of life by a survey technique based on the WHOQOL-BREF instrument.

The results obtained point to different weightings in the several domains of quality of life. In particular, we would like to point out that peri-urban areas have better indexes in the domains of general quality of life, social relations and the physical domain, while rural areas have better ones in the psychological and environment domains.

Additionally, it was added one open question to the original survey, which made possible to understand that issues related to income and physical security are common to all age groups. Health concerns increase with age as well as governance and basic rights are issues with improved importance.

These results show different sensitivities about how quality of life is experienced and, therefore, the importance of the methodology and territorial scale used.

This work was done in partnership with local government agents, and its results may serve as a basis for a more direct and immediate action, providing greater effectiveness and efficiency of policies to support the quality of life of residents in Vila Marim, Portugal and in other rural and peri-urban areas.

Keywords: Quality of Life, Low density territories, WHOQOL-BREF methodology, Regional sustainable development, Cohesion policies

JEL classification: I31, O18, R10

Acknowledgments: This publication is supported with European funds under the Erasmus+ project LEARNVIL- Learning Villages: Citizenship, Entrepreneurship, Heritage & Environmental Education for Rural Sustainable Development (2020-1-ES01-KA227-ADU-096064). The authors also would also like to thanks to their research centre CETRAD for its general support as full researchers (FCT project UIDB/04011/2020) and CQVR (FCT project UIDB, RG-Norte-616-1509).

1. Introduction

Quality of life is a recurring theme with the most diverse outings, often interrelated with development, and emerging unavoidably, as one of the main objectives to be achieved by our modern sustainable, inclusive, and intelligent society. The concept of quality of life or well-being has evolved from a perspective dominated by the economic perspective to a multidimensional approach, where the purely economic dimension is joined by other dimensions such as living conditions, demography, health, education, physical security, leisure and social interactions, governance, and environment.

This multidimensionality, evident in the reports produced by international institutions such as the Organization for Economic and Social Cooperation (OECD) and the European Union (EU), as well as national ones like Statistics Portugal (INE), and in various academic works focusing on different geographies, is supported by a diversified set of methods to measure the level of quality of life, from the construction of numerous indices, to the use of multivariate statistical analysis. These works and indicators are based on secondary data, obtained from official statistical data sources, are easy to obtain and have are reliable. However, they have the major disadvantage of not always having a reduced geographic dimension or not including all the aspects that modern theories consider to be important. In fact, especially in Portugal, official secondary data are very difficult to find at a more micro scale, namely at the level of subareas of municipalities or parishes, and do not include the subjective side of the quality of life.

Thus, works have emerged intending to overcome these limitations, which can be used on a regional or local geographic scale and have the advantage of capturing the so-called subjective dimension of quality of life, or the way by which quality of life is perceived, through primary data. This article follows precisely this perspective: it studies the perception of the quality of life of residents in a small Portuguese parish, in the north of Portugal, using surveys.

It was carried out within the framework of the LEARNVIL - Learning Villages research project, developed by several European partners (for more information, visit: https://www.learnville.eu/). In Portugal there are two partners: UTAD and Ruralidade Verde, both collaborating with the Parish Council of Vila Marim.

This study was developed around four axes: (1) the framework, which includes the conceptual review and the territorial context, (2) the presentation of the objectives and methodology, (3) the obtained results, and finally, (4) their discussion and conclusion.

2. Conceptual and territorial framework

2.1. Theoretical and conceptual review

In a modern society, there is a growing interest in the so-called quality of life of people, going beyond issues merely related to income, physical and/or psychological well-being (Almeida et al., 2020; Dionisio et al., 2023; Haraldstad et al., 2019; Marquez, 2018). The quality of life definition is a very broad concept and has changed over the years; however, some indicators such as psychological well-being, physical well-being, social well-being, financial and material well-being remain with research lacks (Marquez, 2018).

In Lawton's classic text published in 1991 “A multidimensional view of quality of life in frail elders”, the author defined quality of life as the multidimensional and multifactorial evaluation, that includes socio-normative and intrapersonal criteria of the personal/environmental system in the present, past or future. This author overlapped and interrelated psychological well-being, perceived quality of life, behavioral competence, and environmental conditions (Lawton, 1991).

Three years later the World Health Organization (WHO) defined that quality of life can be considered as the individual perception of its position in life.

This is a broad and subjective concept that includes, in a complex way, a person's physical health, psychological state, level of independence, social relationships, personal beliefs and convictions and their relationship with important aspects of the environment (Santos and Souza, 2015). The concept remains and today it is possible to read on the WHO website the brief definition of quality of life as “an individual's perception of their position in life in the

context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns"[1].

The European Union and the OECD have also addressed this issue. As Dionisio et al. (2023) point out, since the 2000s, European organizations have published reports, such as the European Quality of Life Surveys (EQLS), by the European Foundation for the Improvement of Living and Working Conditions. One of the most recently published research says that survey presents data on issues that general statistics often not cover, such as the perceived quality of society, trust in institutions and social tensions. It looks at a range of issues, such as housing, deprivation, family, health and well-being. It also looks at subjective topics, such as people's levels of happiness, how satisfied they are with their lives and their participation in society (Eurofound, 2017).

The OECD also adopted this multidimensionality of the concept, and currently provides two indicators: the "How's Life? Measuring Well-being" (OECD 2021a), and the "Better Life Index" (OECD, 2021b).

At national level a large majority of countries also publish indicators of this type through their official statistical services. In the case of Portugal, the Index of Well-being is published by Statistics Portugal (INE).

Many other authors and institutions have addressed this issue of quality of life, using similar multidimensional concepts with several methods, namely multivariate statistical analysis and different territorial scales. As a recent example, we can find more information in the research of Calcagnini and Perugini (2019), Dardha and Rogge (2020), Ehrlich et al., (2021); Sjöberg (2022), and Yamasaki and Yamada (2022).

In Portugal, several research results have been published (Amado et al., 2019; Diniz and Sequeira, 2008; Dionísio and Rego, 2020; Dionisio et al., 2023; Pinto and Guerreiro, 2010; Rego et al., 2021). A recent study on well-being coordinated by Mauritti (2022) is based on the identification of 11 dimensions: 1-Subjective Well-Being; 2-Civic Participation; 3-Safety; 4-Social Contacts; 5-Environmental Quality; 6-Decent work; 7-Digital Society; 8-Education and Culture; 9-Health; 10-Housing; and 11-Work/Family Balance, and estimates the asymmetries of Portuguese municipalities using a mixed methodology, predominantly quantitative. The results of this study point to the safety and environmental quality of the place where one lives, and especially to the balance between family and work time, the access to housing and education, health and transport services, along with involvement in communities, as the factors that most influence people's perception and experience of well-being, suffering large variations between territories (Mauritti, 2022).

Parallel to these works essentially based on statistical data and multivariable statistical analysis, appeared another type of research, that wants to capture the subjective component of quality of life, obtained through personal individual surveys such as the WHO recommends.

Indeed, from the 2000s onwards, the WHO presents an instrument to measure quality of life, called WHOQOL-BREF, which constitutes "a quality of life assessment developed by the WHOQOL Group, with fifteen international field centers simultaneously, trying to develop a quality of life assessment instrument that would be applicable cross-culturally" in several countries[2].

One year after the presentation of the WHOQOL-BREF, around 150 papers were published, being particularly important the work done by Saxena et al. (2001). It reports the importance of the WHOQOL-BREF items in a pilot trial with 4804 respondents from 14 countries, discussing that quality of life is experienced either individually or with others, bringing people together for a purpose, in order to improve life or at least parts of it.

In 2002 it was possible to verify that this questionnaire could be adapted to the region and place where it will be applied, as observed by Yao et al. (2002) in Taiwan, applying 1068 short interviews in 17 hospitals, in which they validated and verified the reliability of a brief form, as an alternative to the long form of the questionnaire.

[1] *https://www.who.int/, accessed 10 August 22.*
[2] *https://www.who.int/tools/whoqol. accessed 11 August 22.*

The WHOQOL-BREF was tested again and the results showed that it is a solid and cross-culturally valid assessment of the quality of life in its four domains: physical, psychological, social and environmental (Skevington et al., 2004).

The questionnaire is widely used to measure and verify the quality of life of people in different areas, communities and populations ranging from hospital studies (Hsiung et al. 2005; Skevington and Mccrate 2012) to validation studies, learning how to use the questionnaire (Hawthorne et al., 2006; Jaracz et al., 2006; Nedjat et al., 2008), to evaluate the quality of life of the elderly (Chachamovich et al., 2007; Lucas-Carrasco et al., 2011), and to do statistical calculations with its results (Pedroso et al., 2010).

In the last five years, the most relevant studies have addressed questions about quality of life of hospital patients (Almeida-Brasil et al., 2017; Lin et al., 2019), who need medical treatments and procedures (Abbasi-Ghahramanloo et al., 2020), systematic reviews and meta-analyses (Lin and Yao, 2022; Skevington and Epton, 2018), the general population, youth, adults and elderly (Gobbens and Remmen, 2019; Goes et al., 2021; Purba et al., 2018; Singh et al., 2022), the effects of lockdown and Corona virus (Chawla et al., 2020), psychometrics and data validation (Kalfoss et al., 2021).

The WHOQOL-BREF is a self-response questionnaire, which can be self-administered, assisted by the interviewer or administered by the interviewer, with some criteria to avoid error and external influence on the answers. The answers must be given in private and must not be discussed during the application of the questionnaire; the questions must be read in full and classified according to the choice of the respondent. It is also necessary to emphasize that the extra explanations of the interviewer/in the questionnaire must be clear, and to assure that questions are not repeated (Canavarro et al., 2007).

In the case of this study, the questionnaire was made for and used in Vila Marim, a Portuguese parish, with the characteristics presented below.

2.2. Territorial Context

The parish of Vila Marim is located in the district of Vila Real in the north of Portugal. In order to contextualize this research territorially we present some of the main characteristics of this territory. Table 1 presents a comparative summary between Portugal and the European Union. In Table 2, the municipality of Vila Real (which includes the parish of Vila Marim) is compared with the average of Portugal's national values.

Table 1. Portugal in Europe

Indicators	Portugal	EU 27
Aging Index - 2020	165,1	137,2
Population at risk of poverty rate (%), after social transfers - (%) - 2021	18,4	16,8
Early school leavers rate (%) - 2021	5,9	9,7
Unemployment rate (%) - 2021	6, 6	7
GDP per capita (PPS) 2021	23.900	32.300

Source: Francisco Manuel dos Santos Foundation, 2022.

Table 1 shows some key points about the specific context of Portugal. The Portuguese population presents a high risk of poverty regardless of having an unemployment rate and an early school leavers rate lower than the average. The country presents a very low GDP per capita, far below the European Union average. In addition to the significant differences in Portuguese development and well-being compared to its European partners, one of the main problems Portugal is facing, is the development difference between its regions.

Table 2 presents some data from Vila Real, the municipality where Vila Marim is located. As shown, Vila Real has a higher aging rate and a lower purchasing power.

Table 2. Vila Real in Portugal

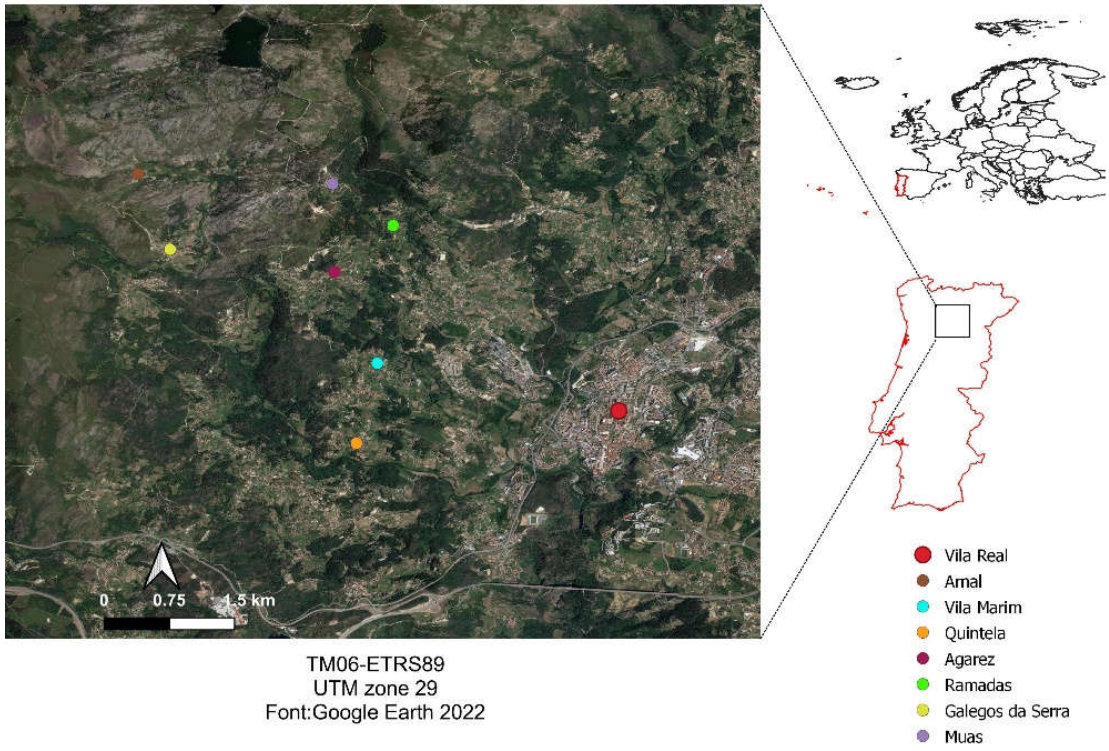
Indicators	Portugal	Vila Real
Aging Index-2021	182,7	195,9
Purchasing power per capita 2019	100	98,3

Source: Francisco Manuel dos Santos Foundation, 2022.

According to recent statistics, Vila Marim has a decreasing resident population (only 1500 residents according to census 2021), most of them being aged and having a low level of education (Statistics Portugal, 2021).

The population of Vila Marim is split into 7 villages or places (Figure 1), from which 5 are more rural places (Arnal, Agarez, Ramadas, Galegos da Serra and Muas), and 2 are considered peri-urban (Vila Marim and Quintela), as they are in a transitional position between strictly rural and urban areas (in this case the city of Vila Real).

Fig. 1. Location of the places/villages studied, belonging to the parish of Vila Marim, in the north of Portugal



Source: Google Earth 2022.

3. Objectives, material and methods

3.1. Objectives

The main goal of this work is to understand how the concept of quality of life is perceived by the local residents in a parish in the north of Portugal (Vila Marim) located in the surroundings of Vila Real, a small-town capital of district.

The secondary objectives are to determine the main domains and terms that are crucial for the quality of life in the residents' understanding, and to verify whether there are differences between the results of places closer to the city and those located further inland.

We hope that these results can contribute to a better definition of public policies and instruments of action, namely at parish level.

3.2. Sample Definition and Questionnaire

The sample definition of the residents to be surveyed took the number of residents in each place (7 strata, corresponding to each of the villages or places) into account; the composition of this population by sex (2 strata); and by age group (3 strata: groups 0-24 years old, 25-64 years old; and 65 years old or more). The method of proportional stratified sampling was used, according to the methodological terms indicated by Freixo (2018) and Hill and Hill (2009). These last ones show the advantage of this method tending to be more efficient with a lower probability of error associated.

As for the size of the sample, we pointed to 10% of the universe, which represents around 150 questionnaires. As previously mentioned, we used the questionnaire based on the WHOQOL-BREF and adapted for Portugal by Canavarro et al. (2007).

This questionnaire allows to record general and socio-demographic data based on the variables location of the parish, age, date of birth, gender, education, activity or profession, marital status, and general questions about health status, as well as the way questionnaire administration.

The core of the WHOQOL-BREF survey consists of 26 questions (Canavarro et al., 2007; Marques, 2018; Skevington et al., 2004) divided into five domains according to Canavarro et al. (2007), namely:

a) General domain (questions 1 and 2 about quality of life);
b) Physical domain (questions 3. Pain and discomfort, 4. Dependence on medication or treatments, 10. Energy and fatigue, 15. Mobility, 16. Sleep and rest, 17. Activities of daily living, and 18. Work capacity);
c) Psychological domain (questions 5. Positive feelings, 6. Spirituality/religion/personal beliefs, 7. Thinking, learning, memory and concentration, 11. Body image and appearance, 19. Satisfied with yourself and 26. Negative feelings, such as sadness, despair, anxiety and depression);
d) Social relationships domain (questions 20. Personal relationships, 21. Sexual activity and 22. Social support);
e) Environmental domain (questions 8. Physical safety and protection, 9. Home environment, 12. Financial resources, 13. Opportunities to acquire new information and skills, 14. Participation in, and recreation/leisure opportunities, 23. Physical environment, 24. Health and social care: availability and quality and 25. Transportation).

All responses have been measured with a five-point scale, articulated by positive and negative dimensions, being the higher the score the better the quality of life (Marques, 2018).

In addition to the questions from the WHOQOL-BREF questionnaire adapted to Portugal, an initial open-ended question was asked: What are the determining factors for your quality of life? This question was deliberately posted in the beginning, before answering the basic questionnaire, to avoid influencing the possible answers with the knowledge of the different dimensions to be analyzed.

The purpose of this question was to try to find out what the respondents, *a priori*, understood as important for their quality of life, allowing a subsequent comparison with the variables traditionally used by international organizations in multidimensional research with secondary data, such as those mentioned above.

3.3. Procedures and data analysis

After the stratification of the sample, the method to select other residents to inquire was the random method, and the survey was made available on a platform and a call for participation through the Parish Council, the representative entity of the local government, was made.

Due to the relatively low adherence of the inhabitants (online we received only around 40% of the intended inquiries), a group of UTAD students helped to fill the questionnaires out in loco. In this second phase, sampling was carried out by convenience, considering the intended stratification.

The inquiry work took place between April and July 2022, with the voluntary and anonymous participation of 107 participants residing in the parish of Vila Marim, young, adult and elderly of both sexes and aged between 14 and 89 years.

The surveys were completed by the participants and either assisted by the interviewer or through an interview individually and anonymously to avoid third-party influences on the answers and ensure anonymity.

Once the surveys were obtained, they were treated considering the following steps:

- Description of sociodemographic data by means of the abundance and percentage of variables, and considering the rural or peri-urban characteristics of the villages or

places: as mentioned before, Agarez, Arnal, Galegos da Serra, Muas and Ramadas are rural, whereas Vila Marim and Quintela are peri-urban.

- Calculation of the Quality of Life Index (QLI) according to the method proposed by Canavarro et al. (2007) for the WHOQOL-BREF SPSS, based on the formula:

$$IQV = \frac{SD - PMin}{PMax - PMin} \times 100 \quad (1)$$

where:
IQV is a value between 0 and 100,
SD is the sum of the points made by the participant,
PMin is the sum of the minimum possible points in the survey and
PMax is the sum of the maximum possible points in the survey.

- Estimation of the indexes by domain for each group (rural villages and peri-urban villages) and overall sample population.
- Use of the Mann-Whitney test with a significance value of 5% to check whether there was a difference between the domains in rural villages and peri-urban villages.
- Calculation of mean values, standard deviation, minimum and maximum values and mode assigned to each question in the questionnaire and grouping into peri-urban and rural villages.
- Grouping of all the determining factors for quality of life, based on the answers to the open question and for the three defined age groups. All the answers were classified according to the indicators of the nine dimensions (health; education; productive or main activity; material living conditions; natural and living environment; governance and basic rights; economic and physical safety; social relations and leisure; feelings).

All statistical analyzes were performed using the program R Core Team, 2022, with the main results being presented in the next point.

4. Results

A total of 107 residents of the parish of Vila Marim responded to the survey, 55 coming from the two peri-urban sites (the villages of Vila Marim and Quintela), representing 51.4% of the respondents and 52 from the rural villages (Agarez, Arnal, Galegos da Serra, Muas, Ramadas), corresponding to 48.6% of the total.

The number of filled out survey is very close to the numbers fixed at the time of defining the sample, in terms of residents by place, sex and age group.

Table 3 presents the socio-demographic characterization of the 107 participants. With regard to age, the dominant group, 56%, included the respondents aged between 25 and 64 years, followed by a group of 31% with people of 65 or more years and only 13% of the sample was aged under 24. This situation reflects the increased aging of the country which is aggravated in the villages of the interior of northern Portugal.

Among the participants we recorded 64% as women, 35% as men and only one person answered other.

In terms of education, there were still 3% without being able to read or write and in the dominant group almost 30% had only the old basic schooling of 4 years. However, around 22% have university degrees.

Most respondents are employed (51%) or retired (33%). The majority declared as marital status married (58%), followed by single (22%) and widowed (10%).

In terms of health only 40% reported themselves as sick, and within the patient group 86% had medical follow-ups. We would like to add that approximately 34% of the sick participants are monitored by doctors through external consultations.

Table 3. Sociodemographic characterization of the respondents' sample

Variables	Peri-urban areas		Rural areas		Total surveys	
	Number	%	Number	%	Number	%
Age (years)						
0 -24	4	7.3%	10	19.2%	14	13.1%
25 – 64	32	58.2%	28	53.8%	60	56.1%
65 or more	19	34.5%	14	26.9%	33	30.8%
Sex						
Male	15	27.3%	22	42.3%	37	34.6%
Female	39	70.9%	30	57.7%	69	64.5%
Other	1	1.8%	0	0.0%	1	0.9%
Education						
Can't read or write	1	1.8%	2	3.8%	3	2.8%
Up to 4 years of education	18	32.7%	14	26.9%	32	29.9%
5 to 6 years of education	7	12.7%	3	5.8%	10	9.3%
7 to 9 years of education	3	5.5%	11	21.2%	14	13.1%
10 to 12 years of education	10	18.2%	14	26.9%	24	22.4%
University Studies	12	21.8%	6	11.5%	18	16.8%
Postgraduate training	4	7.3%	2	3.8%	6	5.6%
Activity						
Unemployed	1	1.8%	4	7.7%	5	4.7%
Employee	26	47.3%	29	55.8%	55	51.4%
Student	3	5.5%	4	7.7%	7	6.5%
Other	4	7.3%	1	1.9%	5	4.7%
Retired	21	38.2%	14	26.9%	35	32.7%
Marital status						
Married	35	63.6%	28	53.8%	63	58.9%
Divorced	1	1.8%	2	3.8%	3	2.8%
Single	11	20.0%	13	25.0%	24	22.4%
Living together	3	5.5%	3	5.8%	6	5.6%
Widower	5	9.1%	6	11.5%	11	10.3%
Sick						
No	35	63.6%	29	55.8%	64	59.8%
Yes	20	36.4%	23	44.2%	43	40.2%
Treatment						
Outpatient Consultation	17	85.0%	20	87.0%	37	86.0%
Admission to hospital	1	5.0%	1	4.3%	2	4.7%
No treatment	2	10.0%	2	8.7%	4	9.3%

Source: author's elaboration

There are differences of socio-demographic characterization between the more rural and peri-urban villages. The most significant differences were found in the women over 65 years old in the peri-urban areas. They also have a much higher education degree, are less unemployed, are more prone to be married and are healthier.

After the socio-economic characterisation of the population surveyed, we focused on the results obtained through the WHOQOL-BREF surveys. These surveys allowed us to obtain a general overall quality of life index of the villagers for each of the five domains (Table 4).

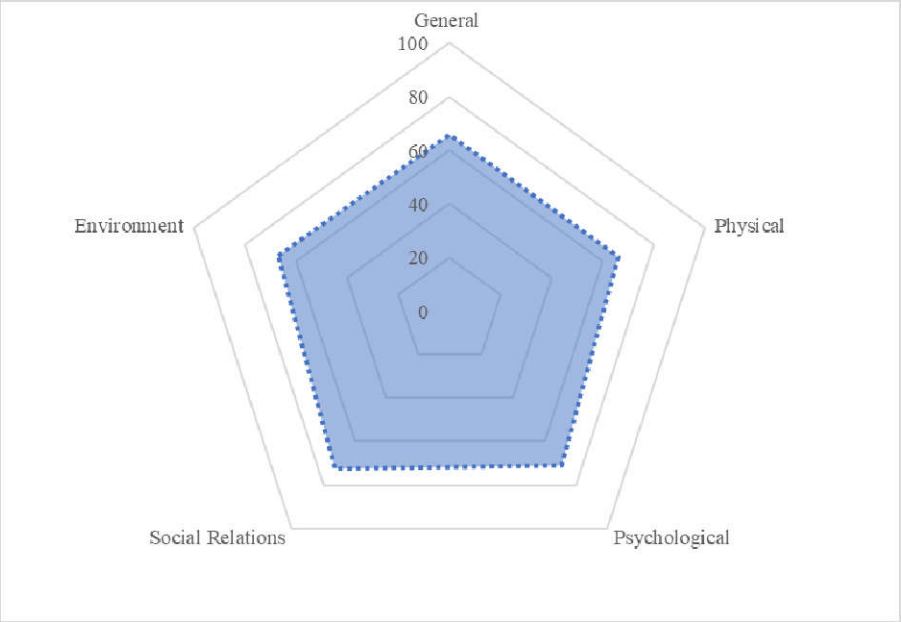
Table 4. Indexes of Quality of life of the population surveyed

Domains	**Index Value**
General	65.9
Physical	65.8
Psychological	71.1
Social Relations	72.8
Environmental	67.1
Global Index	68.6

Source: author's elaboration

The overall quality of life index was calculated for the total population surveyed and is 68.6 for the 107 individuals interviewed (Table 4), being higher for the domain of social relations, followed by the psychological domain, and lower for the general (perception of their quality of life as a whole), physical and environmental domains. These, overall, similar results are shown in Figure 2.

Fig. 2. Radar chart of the domains of Table 4



Source: author's elaboration

In order to better understand the differences between the responses obtained in more rural or peri-urban villages, Table 5 was elaborated.

Table 5. Quality of life Indexes for the population surveyed in peri-urban and rural villages

Domains	Peri-urban villages (index value)	Rural Villages (index value)
General	67.3	64.4
Physical	66.9	64.6
Psychological	69.2	72.9
Social Relations	73.2	72.3
Environmental	64.1	68.8
Global Index	**68.2**	**68.6**

Source: author's elaboration

According to Table 5, the values obtained when we split the interviewees by peri-urban villages or rural villages, just as it has been the case for the total population, both the psychological and social relations domains appear at the top and are above the global averages of 68.2 and 68.6 respectively.

In the rural areas the physical domain represents lower values, but the values for the environmental and psychological domains are higher than those of peri-urban areas. In terms of perception of quality of life in general, it is clear that the value for peri-urban is higher than the one of rural areas.

Concerning the answers obtained by type of region (Table 6), we can highlight the following aspects, in each of the domains:

- General: peri-urban villages have a higher quality of life indicator than rural ones, as a result of higher scores obtained in either of the questions (assessment of quality of life and satisfaction with it).
- Physical: It is the domain where the values of quality of life are the lowest of all domains for population of both areas. For this, contributed questions 3 and 4 (with inverted score, that is, the higher the value, the more difficult the situation) and for rural populations the issue of physical pain and the need for medical care to support daily living becomes more evident.
- Psychological: In the psychological domain most of the questions got a better score by the residents in the rural areas, namely in liking in their life, and feeling that life makes sense and the ability to concentrate.
- Social: Peri-urban villages presented a higher quality of life index value in the personal relationships' domain, since questions 20 and 21 presented respectively an average of 4.25 and 3.60 (Table 6).

- Environmental: In this domain the rural villages stand out positively from the peri-urban. They have a feeling of security and of living in a healthy environment, and they are also more satisfied with their income; the satisfaction is only lower with regard to the access to health services. Respondents from peri-urban villages are more unsatisfied with their security, environmental conditions, access to information, leisure opportunities and income; nevertheless, they are relatively more satisfied with the conditions of the place where they live.

Table 6. Questions and descriptive results obtained through the surveys, by type of area

Questions/Parameters	Peri-urban Areas					Rural Areas				
	Mean	S Dev	Min.	Max.	Mode	Mean	S Dev	Min.	Max.	Mode
General Domain										
1 (G1) How do you assess your quality of life?	3.76	0.81	2	5	4	3.73	0.71	2	5	4
2 (G4) How are you satisfied with your health?	3.62	0.98	1	5	4	3.42	0.95	1	5	3
Physical Domain										
3 (F1.4) To what extent do your (physical) pains prevent you from doing what you need to do?*	2.35	1.24	1	5	1	2.71	1.25	1	5	3
4 (F11.3) To what extent do you need medical care to make your daily life?*	1.98	1.04	1	4	1	2.23	1.03	1	4	2
10 (F2.1) Do you have enough energy for your daily life?	3.64	1.08	1	5	3	3.58	1.13	1	5	3
15 (F9.1) How would you assess your mobility (ability to move and move by yourself?	3.87	1.24	1	5	5	3.81	1.02	1	5	4
16 (F3.3) How satisfied are you with your sleep?	3.15	1.15	1	5	4	3.10	1.15	1	5	4
17 (F10.3) To what extent are you satisfied with your ability to perform your day-to-day activities?	3.64	1.03	1	5	4	3.79	0.86	2	5	4
18 (F12.4) How are you satisfied (a) with your working capacity?	3.78	0.97	1	5	4	3.75	0.94	1	5	4
Psychological Domain										
5 (F4.1) How much do you like life?	4.15	0.84	2	5	5	4.31	0.97	1	5	5
6 (F24.2) To what extent do you feel that your life has meaning?	4.18	0.90	2	5	5	4.27	0.94	1	5	5
7 (F5.3) How can you concentrate?	3.35	0.94	2	5	4	3.60	1	1	5	4
11(F7.1) Are you able to accept your physical appearance?	4.04	0.89	2	5	5	4.12	1.03	1	5	5
19 (F6.3) To what extent are you satisfied with yourself?	4.04	0.95	1	5	5	4.02	0.89	2	5	4
26 (F8.1) How often do you have negative feelings, such as sadness, despair, anxiety or depression?*	2.69	0.97	1	5	3	2.69	0.97	1	5	3
Social Relations Domain										
20 (F13.3) To what extent are you satisfied with your personal relationships?	4.25	0.96	1	5	5	4.17	0.83	2	5	5
21 (F15.3) How are you satisfied with your sex life?	3.60	1.11	1	5	3	3.54	0.72	2	5	3
22 (F14.4) How are you satisfied with the support you receive from your friends?	3.93	1.04	1	5	4	3.96	0.98	1	5	4
Environment Domain										
8 (F16.1) To what extent do you feel safe in your day-to-day life?	3.89	1.12	1	5	5	4.077	1.07	1	5	5
9 (F22.1) How is your physical environment healthy?	3.82	0.81	2	5	4	4.288	0.97	1	5	5
12 (F18.1) Do you have enough money to meet your needs?	3.13	1.08	1	5	3	3.442	1.06	1	5	3
13 (F20.1) To what extent do you have easy access to the information needed to organize your daily life?	3.69	1.06	2	5	4	4.038	1.06	1	5	4
14 (F21.1) How do you have the opportunity to perform leisure activities?	3.13	1.27	1	5	3	3.25	1.33	1	5	4

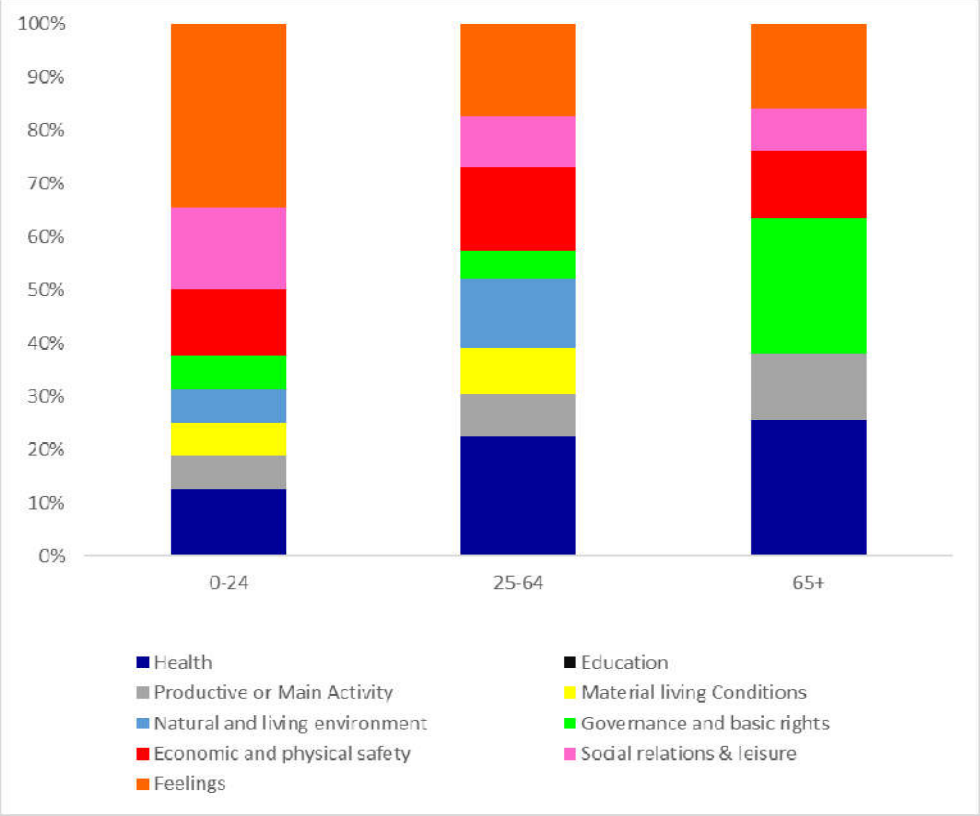
Questions/Parameters	Peri-urban Areas					Rural Areas				
	Mean	S Dev	Min.	Max.	Mode	Mean	S Dev	Min.	Max.	Mode
23 (F17.3) How are you satisfied with the conditions of the place where you live?	4.24	1.01	1	5	5	4.096	1.13	1	5	5
24 (F19.3) How are you satisfied with your access to health services?	3.53	1.17	1	5	4	3.442	1.22	1	5	3
25 (F23.3) How are you satisfied with the transport you use?	3.09	1.34	1	5	4	3.385	1.2	1	5	4

Note: *represents that the question has an inverted formula: these questions were formulated negatively, being 'lower' the better value of the parameter (questions 3, 4 and 26).

Source: author's elaboration, adapted from Canavarro (2007)

Finally, regarding the open question added to the WHOQOL BREF baseline survey, that will allow us to verify the extent to which the interviewees reported, *a priori,* dimensions or variables normally considered in studies with secondary data and multivariate statistics, we proceeded with the treatment of the surveys as described in the methodology and synthesized in Figure 3.

Fig. 3. Factors determining quality of life, based on the answers of the open question, by size and age group



Source: author's elaboration

As observed in Figure 3 the most representative values for the age group up to 24 years old fit the domains feelings, social relations and leisure and health. The majority of respondents in this group answered "quiet", "peace" and "freedom" in the feeling's domain. In the social relations and leisure domain, the main answers were "social life", "conviviality", "friends" and "leisure". In the health domain, the main answer was "being healthy".

In the age group of 25 to 64 years, the most representative domains were health, and feelings, economic and physical safety. In the health domain, the main answer was "being healthy". For the feelings domain the main answers were "tranquillity", "peace", "quiet" and "happiness". In the economic and physical safety domain, the main answers were "money" and "safety".

The most representative domains in the age group aged 65 years or older were health, governance and basic rights and feelings. In the governance and basic rights domain, the

main answers were "improvements in access", "public transport", "sleep", "water" and "light". In the health domain, the main responses were "health" and "no diseases". For the domain feelings "peace", "personal satisfaction" and "stress free" were the most common responses.

Analysing the less mentioned dimensions, the ones that recorded the lowest number of responses from the groups up to 24 years were productive or main activity, material living conditions, natural and living environment, governance and basic rights. For the group of 25 to 64 years governance and basic rights were the most common responses and, for the group of 65 years and older, social relations and leisure were the most referred.

None of the three groups answered anything related to the education domain, and the material domains living conditions and natural and living environment did not obtain any response from the group aged 65 years or older.

These results will be discussed in the next point.

5. Discussion and final remarks

The results previously presented were obtained applying the WHOQUOL BREF questionnaire to 107 residents in the parish of Vila Marim, located in the north of Portugal. This parish contains seven villages, being five considered as rural and two as peri-urban. The surveys were made according to a sample previously stratified by village, age group and gender.

Regarding the socio-economic characterization of the sample, more than 87% of the respondents belonged to the group of 25 years or more, which corresponds to the reality of aging observed in Portugal and in particular in the northern interior. In addition to the low birth rate, many of the few young people born in the parish seek better living conditions in urban centres, in search of new opportunities (Vieira et al., 2015).

Female respondents prevailed in both rural and peri-urban areas. The majority of respondents have basic and middle schooling, a minority (mainly in peri-urban areas) having university and/or post-graduates degrees. Most of them are retired, or work in nearby cities and most respondents are married.

The overall quality of life index for the total of respondents was 68.6, which can be considered good. And considering the various domains, the ones that obtained the best scores were in the domains social relations (72.8), psychological (71.1) and environmental (67.1). These values may be explained by the fact that living in a small village in a predominantly rural area makes it easier to meet neighbours, friends and family. This finding is in line with what Fleck et al. (2003) highlighted: that the factors that allow a good quality of life are mainly in the domains of health, psychological, social relations, environment, spirituality and personal beliefs.

Comparing rural areas with peri-urban areas, we conclude that the overall quality of life index is slightly higher for rural parishes, with 68.6 and 68.2, respectively. The more influencing domains in rural villages were psychological (72.9), social relations (72.3) and environmental (68.8). In peri-urban parishes, the domains that most influenced were social (73.2), psychological (69.2) and quality of life in general (67.3) domains.

Bibliography reports that quality of life is related to a heterogeneity of issues, showing a multidimensional construction based on social and normative criteria of the individuals about present, past and future relationships and their environment (Fleck et al., 2003; Lawton, 1983).

The main differences between the respondents of the two types of villages are in the physical domain, where the situation is much better in the peri-urban areas (66.9 vs 64.6), and in the environmental field, where the situation is reversed, the rural areas presenting the best values (68.8 against 64.1). In fact, the peri-urban areas are closer to the cities and have less contact with wild nature and natural landscapes, while the environment is one of the most important domains that influences people's quality of life (Silva et al., 2022).

Analysing briefly some of the questions and corresponding answers by domain and starting with the general, the peri-urban scored better values. This may be related to the proximity of the village to hospitals, medical health services in cities, family and friends

living in cities, social relationships, social roles, activities and having good neighbours to relate to. Indeed, all are important characteristics for having a good quality of life (Leung et al., 2004; Puts et al., 2007).

With regard to the physical domain, when we compare the answers between villages we notice that respondents from peri-urban villages have more energy for daily life, better mobility and are more satisfied with their night rest, while rural villages' respondents complain that their physical pain scares them in day-to-day activities, and that they need medical care to be able to perform their activities, although they are still satisfied with their ability to develop their daily activities. The best positioning of peri-urban residents may be related to the access to medical care, which those in the rural villages say they have less access to.

For the psychological domain, respondents from rural areas like their lifestyle more, believing that their lives have more meaning, they have a better concentration capacity and accept their physical appearance better. In peri-urban villages respondents are more satisfied with themselves. Unfortunately, in both types of neighbourhood, they do sense negative feelings, such as sadness, despair, anxiety or depression.

When we look at the responses of the social relations domain, respondents in peri-urban areas are more satisfied with their personal and sexual relationships, while respondents from rural areas feel they have more support, especially from their friends and acquaintances.

Surprisingly, in the domain of the environment, in addition to the very positive answers, one would expect from rural residents, who feel safer and appreciate that they are living within a healthier environment, the rural villagers also respond that they have enough money to meet their needs; that they can access the information required to organize their life; that they are satisfied with the available leisure opportunities, and the existing transport offer. It remains to be answered in future work whether their income is an effectively higher or if it is only the result of a better management of their income, less expectations and a lower degree of consumerism.

In peri-urban areas respondents are more satisfied with their life and with the health services they need.

Examining the open question added to the WHOQOL-BREF basic survey, young people up to 24 years of age place more value on the mastery of feelings, considering that, for them, a good quality of life means to have tranquillity, peace and happiness. Among adults (25-65 years), we observed a better balance between all the domains, while for older adults (over 65 years of age) the most important for a good quality of life is to be healthy, and to have good public policies and basic rights.

Concluding, there are differences in the factors that affect the perception of quality of life among the residents in the rural and peri-urban villages of Vila Marim. According to our results, the peri-urban areas of Vila Marim have better indexes in the domains of general quality of life, social relations and the physical domain, while its rural areas have better indexes in the psychological and environmental areas. These findings are according to the literature.

In addition, the open question allowed us to understand that as age increases, health gains importance, as well as governance and basic rights, while feelings and material living conditions lose importance. The importance of social relations remains as well, just as of physical and monetary security.

The answers to the open question have also allowed us to understand that all the dimensions identified and used in research with secondary data have the same weight or importance and that, decidedly, the place and the territory where you live matter.

That is, going down to a more micro scale, that of the parish, and trying to capture the perception of quality of life through an inquiry, is a very valid initiative, while of immediate utility. In fact, the analysis of the answers of this survey can be an important tool for the design of the most effective policies and practices to be developed by the intervening actors in this territory.

Finally, we present a suggestion to enrich this research area by suggesting that this type of work should be done in the learning villages of other country partners of the LEARNVIL

project (or in other small villages), to enable the establishment of comparisons and to open paths to improve our actual knowledge and future studies.

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ENERGY CROPS: ASSESSMENTS IN THE EUROPEAN UNION AGRICULTURAL REGIONS THROUGH MACHINE LEARNING APPROACHES

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Abstract

There is an enormous potential to produce bioenergy from agriculture, forestry and other land use in the European Union (EU) farms. The agricultural sector in the EU member-states has conditions to increase the contributions of renewable energies through better use of the residues and the production of energy crops. Nonetheless, the profitability of these alternative agricultural outputs, in some circumstances, and the need for land for food production, for example, have been obstacles to effective positioning of the EU farms as sources of bioenergy. From this perspective, this study intends to assess the current context of the energy crops in the farms of the EU agricultural regions and identify a model that supports the prediction of these frameworks. For that, data from the Farm Accountancy Data Network (FADN) were considered for the year 2020. This statistical information was analysed through machine learning approaches, namely those associated with multilayer perceptron (MLP) algorithms from the artificial neural networks (ANN) methodologies. The results from these data show that energy crops do have not relevant importance in the European Union farms. On the other hand, when these crops appear, they are produced by larger farms, with greater competitiveness and which receive more subsidies.

Keywords: Agriculture 4.0, Artificial Neural Networks, Multilayer Perceptron
JEL classification: C45, Q12, Q42

Acknowledgments: This work is funded by National Funds through the FCT - Foundation for Science and Technology, I.P., within the scope of the project Refª UIDB/00681/2020. This research is also funded by the Enovo company. This study was carried out under the international project "Agriculture 4.0: Current reality, potentialities and policy proposals" (CERNAS-IPV/2022/008). Furthermore we would like to thank the CERNAS Research Centre and the Polytechnic Institute of Viseu for their support.

1. Introduction

The artificial neural networks approaches and more specifically the multilayer perceptron algorithms have been considered by the researchers for studies focused on the different domains of knowledge and using diverse developments from the theory. In fact, these methodologies have been taken into account, for example, in assessments since the credit risk (Assef et al. 2019), until the agricultural sector (Bakhshi, Pourtaheri, and Eftekhari 2016), passing by the energy dimensions (Sajid, Khan, and Santibanez Gonzalez 2022), ozone concentration prediction (Bekesiene, Meidute-Kavaliauskiene, and Vasiliauskiene 2021), natural hazards forecast (Costache et al. 2022) and health fields (Bourbonne et al. 2021), including clinical diagnoses (Cleophas and Cleophas 2010), treatments (Dias et al. 2005) and medical practices (Goyal et al. 2021).

The artificial neural networks algorithms are considered, by the literature, adjusted methodologies (Navas, Prakash, and Sasipraba 2020) with good accuracies (Ismaila, Odedoyin, and Ajisegiri 2016), showing the relevance of the associated models (Zhang and Tang 2020) for prediction assessments (Kargi 2014), that present in some cases better results compared with other approaches (Mirzakhani et al. 2022). The ANN has several advantages, such as the capacity to deal with the absence of preliminary information and assumptions about the relationships between the dependent variable and the predictors (Nagesha, Kumar, and Singh 2019). In addition, the ANN techniques are flexible and simple, making these models preferred by researchers for specific cases (Vanus, Gorjani, and Bilik 2019).

Specifically, about the energy scenarios in the EU agricultural regions, several dimensions can be deeper explored, even more in the current contexts where the rise of the energy prices contributed to promote inflation worldwide. It is important to improve the efficiency of the energy use in the farms, to support the reduction of the dependency of the countries from external sources and reduce the costs, but it is also fundamental to increase the contribution of the farming sector as a source of renewable energy. This is important for the EU strategy of decarbonisation, as well as to promote the multifunctionality of agriculture and diversify the income of the farmers. The EU agricultural policy instruments in the framework of the CAP (Common Agricultural Policy) play here a determinant role (Martinho 2020).

Considering these scenarios, this research aims to identify a model that can be used to predict the energy crops area in the farms of the EU agricultural regions. These insights may be useful for several stakeholders, namely the national and EU institutions to design policy instruments that better deal with land use for bioenergy production. The land can be used for diverse finalities and these generate often conflicts among the several demands, even more in the current situations resulting from the Covid-19 pandemic and Russia-Ukraine conflict (Martinho 2022b). In any case, it is crucial to bring more contributions and insights about the bioenergy domains in the EU frameworks, namely in terms of land use and more specifically about the energy crops area.

2. Literature survey

The ANN has several advantages compared to other methodologies, some of them are related to the flexibility to deal with incomplete information and this is particularly important in assessments carried out for contexts where the availability of data is limited (Antanasijevic et al. 2013). In some cases, the ANN models are considered among the most appropriate approaches to assess some specific issues, such as fuel use and emissions (Bishop et al. 2016).

There are close relationships between energy use and production and environmental conditions (Jaramillo-Moran and Garcia-Garcia 2019). The European Union energy framework has still, in some circumstances, a problematic and non-sustainable relationship with the environment, namely in cases where the energy resources are obtained from mining activities (Brodny and Tutak 2020). These scenarios call for more responsible and efficient energy use in diverse social and economic activities (Di Gia and Papurello 2022). Better efficiency in energy use is one of the keys to improve the sustainability of the associated systems (Oprea, Bara, and Reveiu 2018), namely in households (Szuts 2014).

In this way, energy production from renewable sources is a concern for researchers and policymakers in EU member-states (Brodny, Tutak, and Saki 2020), namely in the current conjunctures, where artificial intelligence developments may bring relevant contributions (Garcia Marquez and Peinado Gonzalo 2022). A particular focus of the studies carried out in these domains is the prediction of renewable energy production (Buturache and Stancu 2021). To promote a more sustainable and efficient use of energy, the EU institutions have been designing measures and instruments within the framework of energy and environmental policies (Dozic and Urosevic 2019), with implications in the member-states (Khayatian, Sarto, and Dall'O' 2016). This is visible, for example, in the European Green Deal strategy and the Covenant of Mayors initiative, created in 2008 (Javier Abarca-Alvarez et al. 2019). Nonetheless, the impacts of policies to reduce the use of energy from non-renewable sources are not always expected (Mrowczynska et al. 2020), especially for the poorest social classes.

The ANN models are applied by the scientific community with diverse developments (Vistica, Banovac, and Pavlovic 2015) and adjustments (Urosevic and Dozic 2021) for specific contexts (Moustris et al. 2014), and complementing other methods (Data Envelopment Analysis, for instance) (Vlontzos and Pardalos 2017). In some cases, they are applied through new approaches (Magazzino, Mele, and Schneider 2022) and particular methodologies, considering, for example, different presentations of the layers (Tutak and Brodny 2022), such as the Kohonen ANN without a hidden layer (Tutak et al. 2020).

In summary, global warming and the new contexts created by the Covid-19 pandemic and the Russia-Ukraine crisis increased concerns about energy use and its impacts on the environment and global sustainability. These concerns are particularly visible in the EU context. Bioenergy and the agricultural sector have here an important role to play (Martinho 2022a).

3. Material and methods

To achieve the objectives proposed, statistical information, for the year 2020 and the EU agricultural regions, from the Farm Accountancy Data Network (FADN 2022) was considered. The data in this database are presented through a weighting system per farm. The energy crops (ha) variable was considered as output, and as predictors were taken into account the following variables: total utilised agricultural area (ha); total livestock (LU); total crops output (euros/ha); total livestock output (euros/LU); specific crop costs (euros/ha); specific livestock costs (euros/LU); subsidies on investments (euros); farm net value added (euros/AWU); gross investment on fixed assets (euros); total direct payments (euros); and LFA subsidies (euros). The energy crops (ha) variable was categorised in the following categories (to deal with the great number of farms with zero hectares and a small number of cases with a large area for these productions): energy crops area=0, for zero hectares; energy crops area=1, for more than 0 and less or equal to 1 hectare; energy crops area=2, for more than 1 and less or equal to 2 hectares; and energy crops area=3, for more than 3 hectares. The selection of these variables follows, for example, the Martinho (Martinho 2020) findings and intends to capture the effects from the dimension and the competitiveness of the farms.

These data were analysed through multilayer perceptron algorithms from the ANN approaches (McCulloch and Pitts 1943), following IBM SPSS procedures (IBM Corp 2021; IBM SPSS 2022), to identify a model to predict the energy crops area, based on a set of predictors related to the EU farms dimension and dynamics. These methodologies are based on a set of layers for input, output and hidden constituted by units (neurons) that are connected through a network that acquires synaptic weights, imitating the human brain (Aryadoust and Goh 2014; Aryadoust and Baghaei 2016). To complement the assessment, correlation analyses were carried out through a pairwise matrix (Galton 1888; Pearson 1896; Pearson and Filon 1898), following Stata (StataCorp 2017a; 2017b; Stata 2022) software procedures.

4. Data analysis

The information presented in table 1 shows that, in general, the European Union agricultural regions with the highest energy crops area (nominal variable ranging between 0 and 3, obtained from values in hectare) have also the greatest total utilised agricultural area (ha), total livestock units (LU (livestock unit)), farm net value added (euros/AWU (annual work unit)), gross investment on fixed assets (euros) and total direct payments (euros). This is confirmed by the relevant pairwise correlations (with statistical significance at 1%) between the energy crops area and these variables, with the following coefficients, respectively: 0.680; 0.616; 0.465; 0.632; and 0.689.

This means that the EU agricultural regions farms with the biggest energy crops area are the largest ones (more area and livestock units), with the highest competitiveness (more farm net value added/AWU and gross investment on fixed assets) and that receive more direct payment subsidies.

The EU agricultural regions with the greatest results for the energy crops area are the following from Germany or neighbour countries: Czechia; Denmark; Germany, Niedersachsen; Germany, Nordrhein-Westfalen; Germany, Saarland; Germany, Hessen; Germany, Thüringen; Germany, Sachsen-Anhalt; Germany, Sachsen; Germany, Brandenburg; Germany, Mecklenburg-Vorpommern; Germany, Schleswig-Holstein/Hamburg; and Slovakia.

Table 1. Statistical information for the year 2020 across the European Union agricultural regions

Country/Region	Energy crops area[a]	Total Utilised Agricultural Area (ha)	Total livestock units (LU)	Total crops output (€/ha)	Total livestock output (€/LU)	Specific crop costs (€/ha)	Specific livestock costs (€/LU)	Subsidies on investments (€)	Farm Net Value Added (€/AWU)	Gross Investment on fixed assets (€)	Total direct payments (€)	LFA subsidies (€)
Belgium, Vlaanderen	0	39	165	3587	1180	1194	770	2447	39256	59697	14656	0
Belgium, Wallonie	0	74	97	1059	1143	376	560	2485	48072	27012	24506	811
Bulgaria, Yuzhen tsentralen	0	34	19	887	757	245	450	213	10755	9834	11593	628
Bulgaria, Yugoiztochen	0	86	31	593	917	212	559	185	13762	11221	21850	705
Bulgaria, Severozapaden	0	107	16	925	693	251	393	80	24290	36421	21869	320
Bulgaria, Severen tsentralen	0	90	20	841	756	254	482	284	17314	12155	19047	156
Bulgaria, Severoiztochen	0	93	24	708	1163	236	675	154	15940	11775	19916	102
Bulgaria, Yugozapaden	1	36	11	850	919	194	388	88	11854	3444	9245	2241
Czechia, Czechia	3	247	117	863	1323	294	879	7804	27536	65394	75353	11381
Denmark, Denmark	2	132	198	1587	1664	459	970	425	99034	79248	41404	0

Country/Region	Energy crops area[a]	Total Utilised Agricultural Area (ha)	Total livestock units (LU)	Total crops output (€/ha)	Total livestock output (€/LU)	Specific crop costs (€/ha)	Specific livestock costs (€/LU)	Subsidies on investments (€)	Farm Net Value Added (€/AWU)	Gross Investment on fixed assets (€)	Total direct payments (€)	LFA subsidies (€)
Germany, Niedersachsen	3	86	144	1264	1426	424	801	117	49158	45685	25351	19
Germany, Nordrhein-Westfalen	2	60	113	1810	1339	569	769	119	42433	39877	18508	485
Germany, Bayern	1	52	58	1085	1653	325	685	200	35608	39670	15569	2065
Germany, Baden-Württemberg	1	58	54	1194	1582	313	753	728	35517	33993	16901	976
Germany, Saarland	2	117	53	514	1676	187	688	0	37786	36870	33428	1623
Germany, Rheinland-Pfalz	1	60	28	2459	1619	542	680	28	39887	39484	17635	2
Germany, Hessen	2	87	59	804	1503	278	704	792	35601	37493	24834	2264
Germany, Thüringen	3	455	220	1050	1475	315	946	2698	46709	160884	140737	12592
Germany, Sachsen-Anhalt	3	421	159	966	1544	306	972	49	51638	92286	114210	2048
Germany, Sachsen	2	330	194	1021	1740	339	1039	4583	41684	109672	100300	6260
Germany, Brandenburg	3	455	207	997	1630	340	1495	828	31199	132040	138722	8263
Germany, Mecklenburg-Vorpommern	3	488	155	1063	1868	379	960	0	64841	186603	127871	20
Germany, Schleswig-Holstein/Hamburg	3	102	119	1111	1591	399	745	7	50872	44472	28481	16
Estonia, Estonia	0	137	37	527	1380	177	948	3706	27228	31313	24368	0
Ireland, Ireland	0	47	66	260	953	162	492	707	25255	11892	13143	2258
Greece, Makedonia-Thraki	1	12	5	1674	1005	401	594	20	15658	1324	6489	655
Greece, Ipiros-Peloponissos-Nissi Ioniou	0	7	6	2265	965	255	506	84	12011	2800	2568	417
Greece, Sterea Ellas-Nissi Egaeou-Kriti	0	9	7	1900	828	350	467	11	12530	765	4145	726
Greece, Thessalia	0	10	6	1707	1166	425	536	8	16625	313	6647	500
Spain, Navarra	0	65	45	1019	1096	251	489	587	43022	18567	16296	1134
Spain, Asturias	0	26	49	509	1154	92	749	6	15613	1196	12063	1799
Spain, Cantabria	0	37	51	116	1264	14	716	31	19243	1171	11736	2244
Spain, País Vasco	0	38	32	985	1475	276	724	730	21717	13744	10408	2648
Spain, La Rioja	0	33	17	1782	631	461	378	129	33334	7539	8857	5
Spain, Galicia	0	22	49	845	1056	209	560	93	23625	3965	7176	778
Spain, Castilla y León	0	68	57	770	1090	238	628	9	34484	1829	13639	195
Spain, Madrid	0	71	25	391	1507	72	798	34	15352	591	7429	88
Spain, Islas Baleares	0	54	20	828	1232	164	609	420	24998	9142	9263	3319
Spain, Castilla-La Mancha	0	63	28	940	1872	133	814	27	35206	960	8799	441
Spain, Cataluña	0	44	100	1538	506	354	263	713	27086	12635	11449	557
Spain, Aragón	0	76	68	965	543	164	203	74	38887	9070	15222	522
Spain, Andalucía	0	37	15	2345	716	396	339	17	34939	2228	8578	186
Spain, Extremadura	0	72	38	570	1399	125	691	0	25810	198	10062	328
Spain, Comunidad Valenciana	0	14	21	4545	1387	816	666	28	35007	3153	2529	105
Spain, Murcia	0	43	48	2806	388	426	128	6	31892	2984	6184	354
Spain, Canarias	0	4	12	25359	2942	3598	917	140	23541	5673	18181	0
France, Centre	0	141	44	1098	950	406	355	582	36422	36120	31540	1673
France, Basse-Normandie	0	108	137	512	1233	263	416	1983	34263	57673	28385	3371
France, Picardie	1	129	52	1410	1148	521	428	1020	44916	50645	30875	5
France, Haute-Normandie	1	119	75	1334	1161	471	391	1346	35276	51329	28247	120
France, Bourgogne	0	136	78	1099	726	261	306	1464	41810	37119	33724	5066
France, Champagne-Ardenne	1	85	28	1912	1117	435	441	743	48442	27482	20419	1408
France, Île-de-France	0	151	4	1617	2776	555	949	243	49387	40784	33990	0
France, Bretagne	1	69	192	1133	1182	368	500	1118	36414	49682	18168	0
France, Poitou-Charentes	0	107	54	1505	1206	350	536	611	51439	35941	24950	1846
France, Pays de la Loire	1	98	158	846	1215	314	510	1896	32718	39165	26747	651
France, Alsace	0	49	32	2488	1504	565	680	875	31864	29948	12342	495
France, Franche-Comté	1	131	93	438	1748	207	467	882	39946	69435	31216	10638
France, Nord-Pas-de-Calais	0	78	75	1710	1368	608	557	958	32699	49161	19925	0
France, Lorraine	0	161	107	520	1144	237	424	1352	42771	49860	39757	6568
France, Auvergne	0	106	99	223	994	124	340	2690	24916	32811	30079	13981
France, Languedoc-Roussillon	1	47	10	3093	1119	532	424	2550	26128	18541	7754	3383
France, Rhône-Alpes	1	68	58	1256	1309	325	407	2666	27120	40536	16996	7019
France, Provence-Alpes-Côte d'Azur	0	43	11	4834	745	705	285	2094	34201	29938	9987	4704
France, Limousin	0	109	113	147	731	108	286	1758	22329	26815	33925	11835
France, Midi-Pyrénées	0	86	49	708	970	261	369	2579	20961	25973	23702	6980
France, Aquitaine	0	55	36	2019	1422	526	599	1274	18313	26049	15011	2293
France, Corse	0	88	29	1202	1053	172	281	4601	27658	36639	15986	7484
France, Guadeloupe	0	9	10	5826	677	1216	433	1656	16563	8720	21179	774
France, La Réunion	0	10	15	9067	1511	1492	970	4851	23872	33725	17069	1780
Croatia, Jadranska Hrvatska	0	12	4	1771	1471	227	1097	0	12514	1742	3172	1176
Croatia, Kontinentalna Hrvatska	0	16	9	1157	1119	356	869	0	11832	4754	5833	643
Italy, Valle d'Aosta	1	46	24	503	1594	45	627	1503	27808	-7680	15526	6176
Italy, Piemonte	1	27	26	2540	1387	564	781	48	40533	1381	10177	352
Italy, Veneto	1	19	50	3712	1085	887	501	524	48852	7049	9217	612
Italy, Trentino	0	7	5	6892	2250	1368	1122	100	33786	6565	2037	1486
Italy, Alto Adige	0	10	11	4506	2392	649	1339	349	29500	21322	4786	1747
Italy, Lombardia	1	30	78	2119	1424	600	696	0	52799	-3936	15409	149
Italy, Emilia-Romagna	1	26	21	2719	1962	718	837	44	43644	-1194	8751	302
Italy, Toscana	1	24	6	2700	1169	693	427	143	26038	1635	7475	257
Italy, Liguria	0	7	4	8165	1375	2270	386	636	28864	676	2697	936
Italy, Friuli-Venezia Giulia	1	20	16	2891	1216	695	577	730	32762	6167	5802	711
Italy, Lazio	0	20	13	2560	1598	478	658	301	33540	4339	6092	420
Italy, Umbria	1	26	11	1627	1050	391	404	54	34056	-667	10660	460
Italy, Marche	1	24	4	1682	992	400	365	144	26932	1922	7814	781
Italy, Calabria	0	11	3	2266	992	330	375	0	17473	1319	5311	85
Italy, Campania	0	15	14	2993	1176	731	452	29	29381	1043	5195	2014
Italy, Puglia	0	17	3	2253	1704	456	815	152	26237	1992	7382	0
Italy, Molise	0	21	14	1126	996	245	304	163	22322	3610	7083	1362
Italy, Abruzzo	0	15	5	2281	1582	508	468	253	21001	2958	3995	415
Italy, Sicilia	0	20	6	1774	835	355	320	14	26680	2900	5533	378
Italy, Sardegna	1	45	21	645	1127	147	565	569	31454	-1068	10779	1307
Italy, Basilicata	0	32	8	1258	1330	266	497	1077	24655	3795	9062	397
Cyprus, Cyprus	0	11	12	1579	2096	386	1275	411	12121	3117	3913	377
Latvia, Latvia	1	66	24	686	1149	216	711	2376	15491	14457	12451	0
Lithuania, Lithuania	0	46	12	679	1055	220	624	2654	14215	15406	8725	913
Luxembourg, Luxembourg	1	87	110	488	1440	279	619	15030	54770	77533	25109	10938
Hungary, Észak-Magyarország	0	57	13	820	1262	213	717	19	31665	6676	16143	0
Hungary, Alföld	1	40	18	1147	1134	256	790	149	28123	10372	12012	0
Hungary, Dunántúl	0	52	24	1094	1084	343	797	126	25842	15809	15027	0
Malta, Malta	0	3	12	7083	1863	1689	1220	212	10227	4669	1575	503
Netherlands, The Netherlands	0	41	148	6336	1697	2032	941	2503	54854	81635	14983	0
Austria, Austria	1	33	30	906	1755	255	684	864	28863	26879	7516	3124
Poland, Pomorze i Mazury	1	38	19	753	1347	281	785	285	14022	4557	8889	651
Poland, Mazowsze i Podlasie	0	15	11	853	1363	257	757	209	7340	3931	4123	432
Poland, Wielkopolska and Slask	0	26	16	1011	1158	357	621	233	12083	4407	6289	443
Poland, Malopolska i Pogórze	0	11	5	998	1008	294	521	130	5128	1833	2788	265
Portugal, Ribatejo e Oeste	0	13	3	4916	616	1699	155	75	13417	25580	4610	107
Portugal, Alentejo e Algarve	0	72	23	425	479	85	262	50	18981	10771	10344	1745

Country/Region	Energy crops area[a]	Total Utilised Agricultural Area (ha)	Total livestock units (LU)	Total crops output (€/ha)	Total livestock output (€/LU)	Specific crop costs (€/ha)	Specific livestock costs (€/LU)	Subsidies on investments (€)	Farm Net Value Added (€/AWU)	Gross Investment on fixed assets (€)	Total direct payments (€)	LFA subsidies (€)
Portugal, Açores e Madeira	0	13	15	955	950	268	521	667	15133	5374	6020	1569
Portugal, Norte e Centro	1	14	13	1371	912	332	648	538	10964	4173	3861	1262
Romania, Sud-Est	0	28	9	580	923	231	597	45	8045	2507	5994	81
Romania, Sud-Muntenia	0	22	7	634	1027	252	584	0	9585	3475	5681	0
Romania, Sud-Vest-Oltenia	0	11	4	636	1051	220	588	2	4031	501	2322	0
Romania, Nord-Vest	0	14	9	830	741	195	535	0	6951	1268	3379	0
Romania, Centru	0	16	12	768	1068	180	767	21	8391	901	4670	0
Romania, Nord-Est	0	14	7	686	807	211	578	13	7086	1514	3001	0
Romania, Vest	0	25	10	821	814	203	554	12	12146	3457	5816	0
Romania, Bucuresti-Ilfov	0	38	2	554	2030	108	1307	0	11548	-394	6991	0
Slovenia, Slovenia	0	11	11	1336	934	295	737	624	6742	9090	3185	1023
Slovakia, Slovakia	3	438	141	806	1417	271	1139	2476	26009	68870	92281	16363
Finland, Pohjanmaa	0	66	38	1018	1996	320	1226	2362	43570	47289	27512	16648
Finland, Pohjois-Suomi	0	77	34	726	2251	245	1751	2445	32792	40150	41032	19242
Finland, Sisä-Suomi	0	60	29	675	2123	232	1445	1401	25837	30330	27229	15175
Finland, Etelä-Suomi	0	70	25	986	1441	315	910	1007	39863	30591	21725	16059
Sweden, Slättbyggdslän	1	106	54	1229	1442	393	948	6	43302	54677	23396	2235
Sweden, Skogs- och mellanbygdslän	1	108	67	517	1488	173	1056	1	31839	37494	24994	6778
Sweden, Län i norra Sverige	0	93	59	399	1422	135	1089	830	28962	30196	37594	22238

Note: [a], Nominal variable ranging between 0 and 3; Coloured cells identify the highest values for each variable.

5. Results

The machine learning approach, through artificial neural networks, for the model proposed, considered for training a sample of 68% and for testing 32% (table 2). For this approach, 3 layers were considered, with 11, 3 and 4 units for the input hidden and output layers, respectively (table 3). The synaptic weights between the different units of these layers, including bias units, are presented in figure 1. Table 4 complements the information of this figure and both highlight the strong connections, for example, among the hidden units and the following predictors: total utilised agricultural area (ha); farm net value added (euros/AWU); and total direct payments (euros). For the interrelationships between the hidden layer units and the output units, the strongest connections are with the "energy crops area=3" (output layer unit for the farms with the highest energy crops (ha)).

Table 5 reveals that the percent incorrect predictions are 27.6% for the training sample and 29.3% for the testing part. The main difficulties of the model were with the prediction of the intermediate categories (1 and 2) of the dependent variable (table 6). Similar results were found in figure 2 for the relationships between the observed categories and the predicted pseudo-probability of categories. The ROC (Receiver Operating Characteristic) curve (figure 3) and the area under the curve (table 7) for the chance that the predicted pseudo-probability of being in one category is bigger for a randomly selected example in that category than for a randomly selected example not in that category confirm the difficulties of the approach here considered with the classification of the categories 1 and 2. The cumulative gain (figure 4), related to the percentage of the whole number of cases in a category increased by considering a percentage of the total number of cases, shows that for the curve of the energy crops area=3, the top 10% would contain approximately 100% of the cases for this category. The lift curves (figure 5) are obtained from the cumulative gains curves and the values on the yaxis represent the ratio of the cumulative gain for each case to the baseline.

Table 8 and figure 6 show the most important predictors, with the following decreasing order: farm net value added; total direct payments; total utilised agricultural area; specific livestock costs; total crops output; total livestock units; gross investment of fixed assets; LFA subsidies; subsidies on investments; total livestock output; specific crop costs.

Table 2. Information for case processing summary

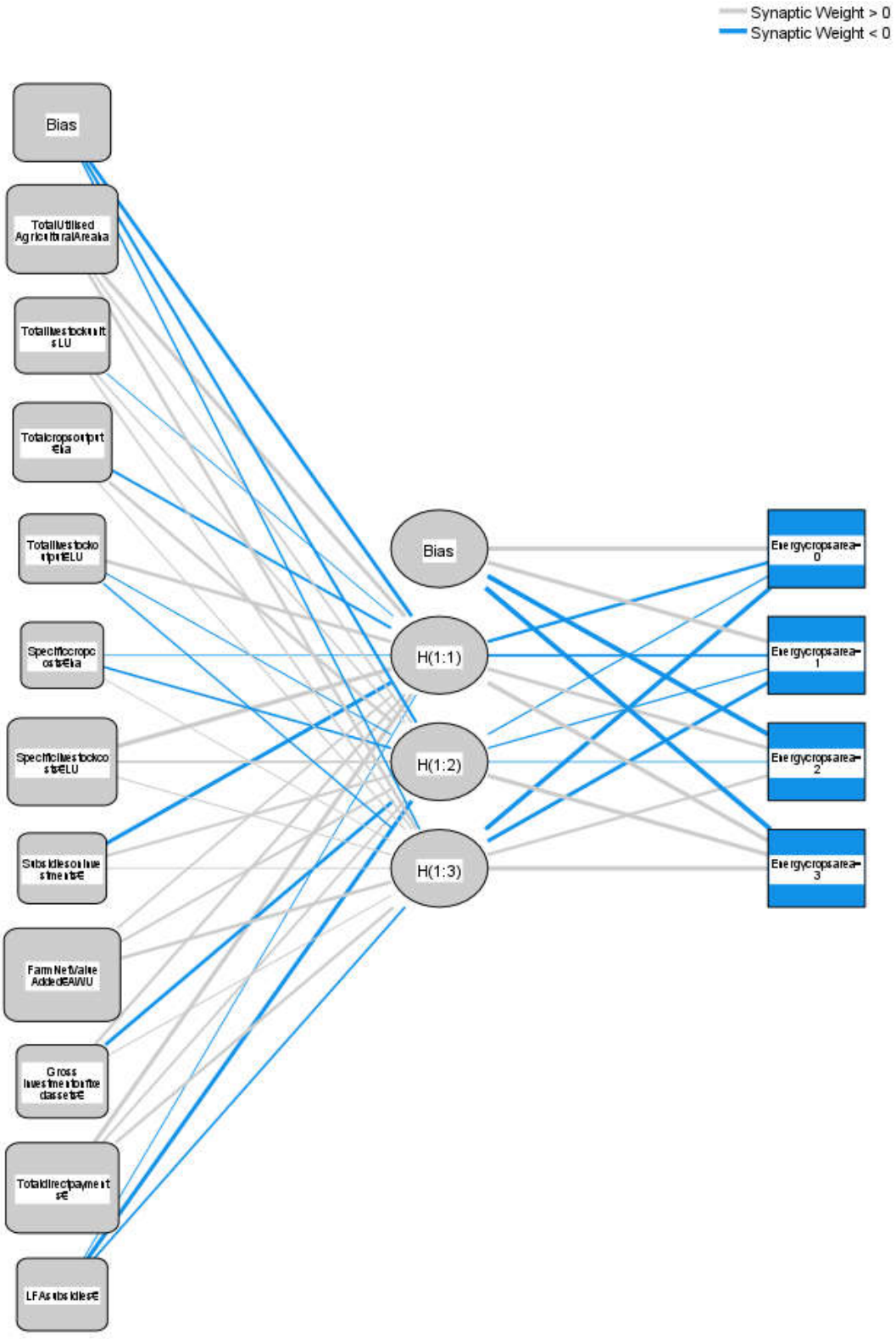
		Number	Percent
Sample	Training	87	68.0%
	Testing	41	32.0%
Valid		128	100.0%
Excluded		0	
Total		128	

Table 3. Outputs for network information

Network Information			
Input Layer	Covariates	1	Total Utilised Agricultural Area (ha)
		2	Total livestock units (LU)
		3	Total crops output (€/ha)
		4	Total livestock output (€/LU)
		5	Specific crop costs (€/ha)
		6	Specific livestock costs (€/LU)
		7	Subsidies on investments (€)
		8	Farm Net Value Added (€/AWU)
		9	Gross Investment on fixed assets (€)
		10	Total direct payments (€)
		11	LFA subsidies (€)
	Number of Units[a]		11
	Rescaling Method for Covariates		Standardized
Hidden Layer(s)	Number of Hidden Layers		1
	Number of Units in Hidden Layer 1[a]		3
	Activation Function		Hyperbolic tangent
Output Layer	Dependent Variables	1	Energy crops area
	Number of Units		4
	Activation Function		Softmax
	Error Function		Cross-entropy

Note: [a], Excluding the bias unit.

Figure 1. Synaptic weights between the several layers



Hidden layer activation function: Hyperbolic tangent

Output layer activation function: Softmax

Table 4. Outputs for the parameter estimates

		Predicted						
		Hidden Layer 1			Output Layer			
	Predictor	H(1:1)	H(1:2)	H(1:3)	[Energy crops area=0]	[Energy crops area=1]	[Energy crops area=2]	[Energy crops area=3]
Input Layer	(Bias)	-0.629	-0.495	-0.337				
	Total Utilised Agricultural Area (ha)	0.699	0.421	0.547				
	Total livestock units (LU)	-0.081	0.336	0.397				
	Total crops output (€/ha)	-0.465	0.564	0.258				
	Total livestock output (€/LU)	0.660	-0.157	-0.278				
	Specific crop costs (€/ha)	-0.003	-0.427	0.121				
	Specific livestock costs (€/LU)	1.126	0.462	0.208				
	Subsidies on investments (€)	-0.762	0.491	0.044				
	Farm Net Value Added (€/AWU)	0.430	0.489	0.574				
	Gross Investment on fixed assets (€)	0.501	-0.613	0.192				
	Total direct payments (€)	0.858	0.455	0.531				
	LFA subsidies (€)	-0.084	-0.762	-0.426				
Hidden Layer 1	(Bias)				1.549	0.905	-1.722	-1.784
	H(1:1)				-0.554	-0.475	0.672	0.995
	H(1:2)				-0.269	-0.269	-0.019	0.917
	H(1:3)				-1.014	-0.678	0.531	1.209

Table 5. Model summary statistics

Model Summary		
Training	Cross Entropy Error	59.398
	Percent Incorrect Predictions	27.6%
Testing	Cross Entropy Error	27.421
	Percent Incorrect Predictions	29.3%
Dependent Variable: Energy crops area		

Table 6. Classification information

		Predicted				
Sample	Observed	0	1	2	3	Percent Correct
Training	0	56	0	0	0	100.0%
	1	19	0	0	0	0.0%
	2	3	0	0	2	0.0%
	3	0	0	0	7	100.0%
	Overall Percent	89.7%	0.0%	0.0%	10.3%	72.4%
Testing	0	28	0	0	0	100.0%
	1	12	0	0	0	0.0%
	2	0	0	0	0	0.0%
	3	0	0	0	1	100.0%
	Overall Percent	97.6%	0.0%	0.0%	2.4%	70.7%
Dependent Variable: Energy crops area						

Figure 2. Results for the predicted pseudo-probability

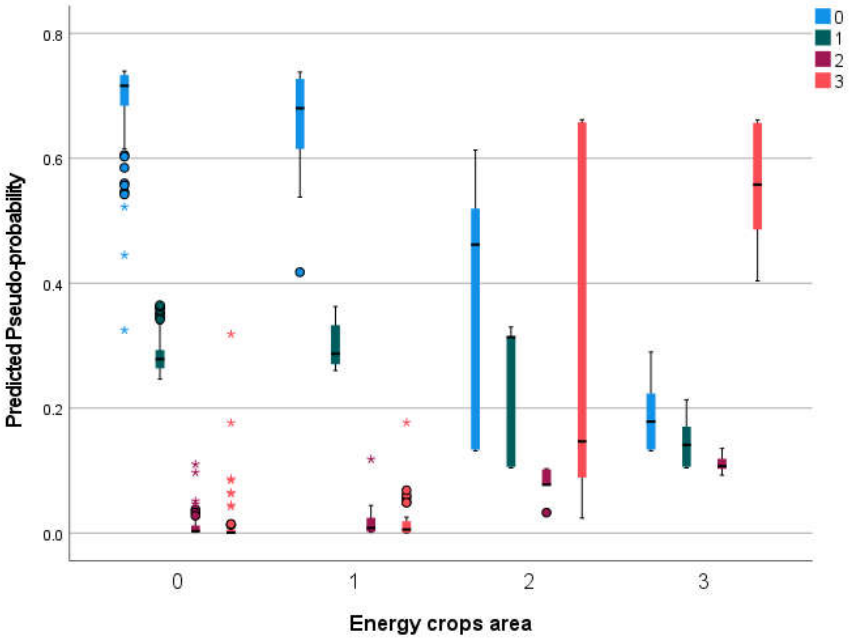


Figure 3. Results for the sensitivity/specificity

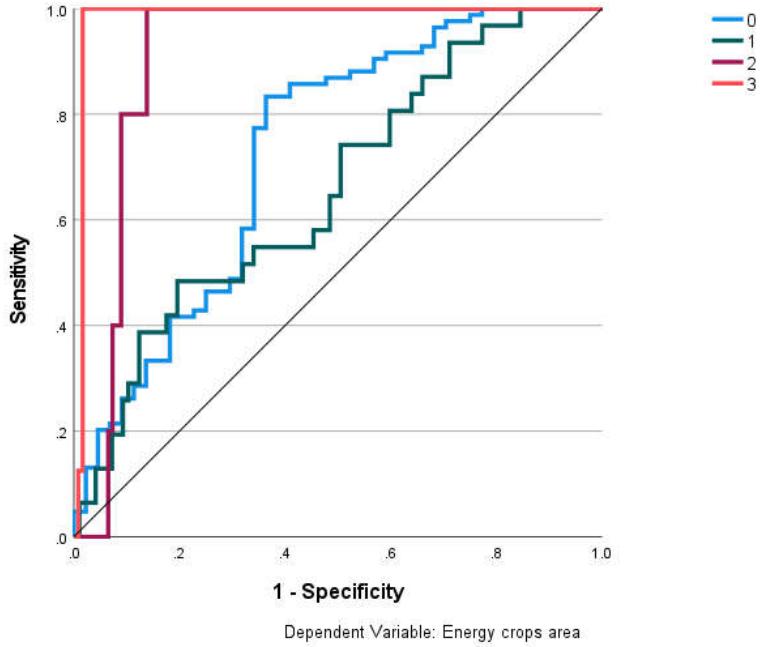


Table 7. Information for the area under the curve

		Area
Energy crops area	0	0.729
	1	0.658
	2	0.909
	3	0.984

Figure 4. Results for the gain

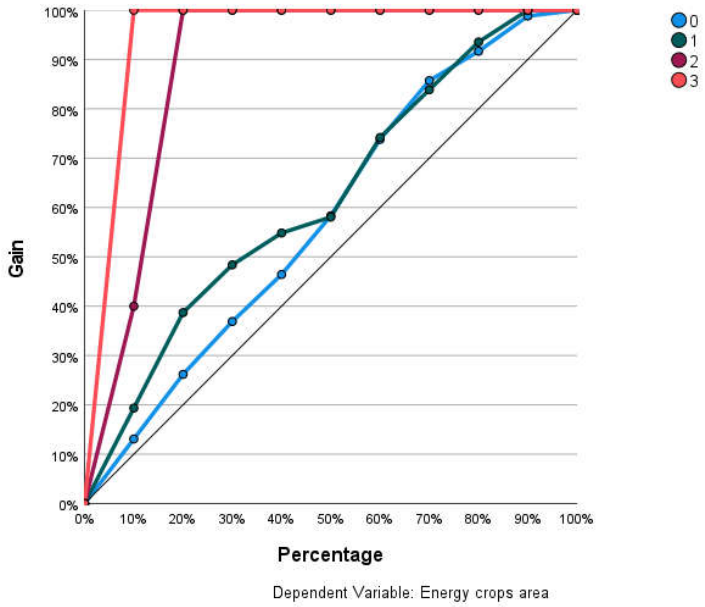


Figure 5. Results for the lift

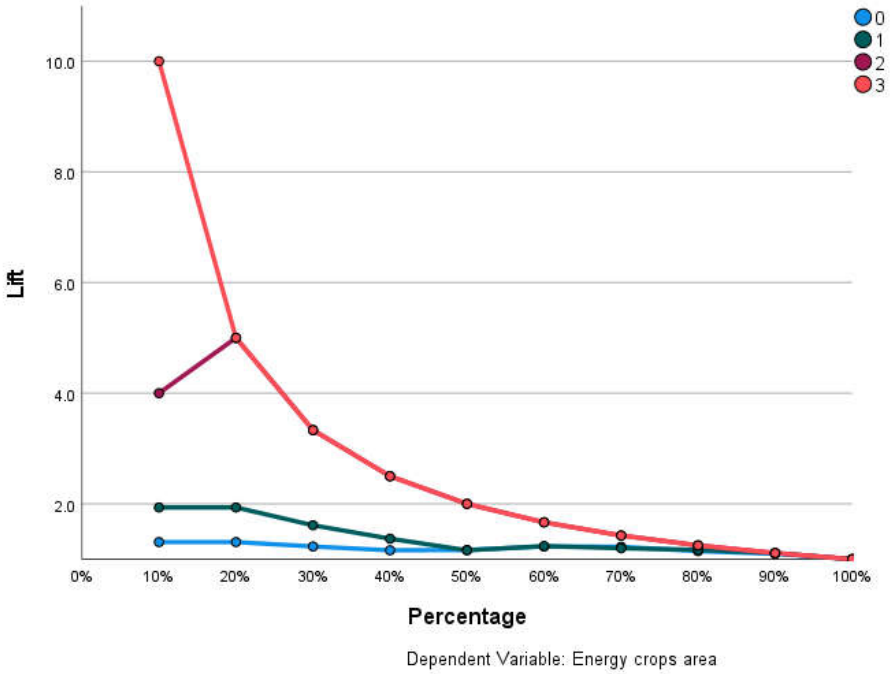
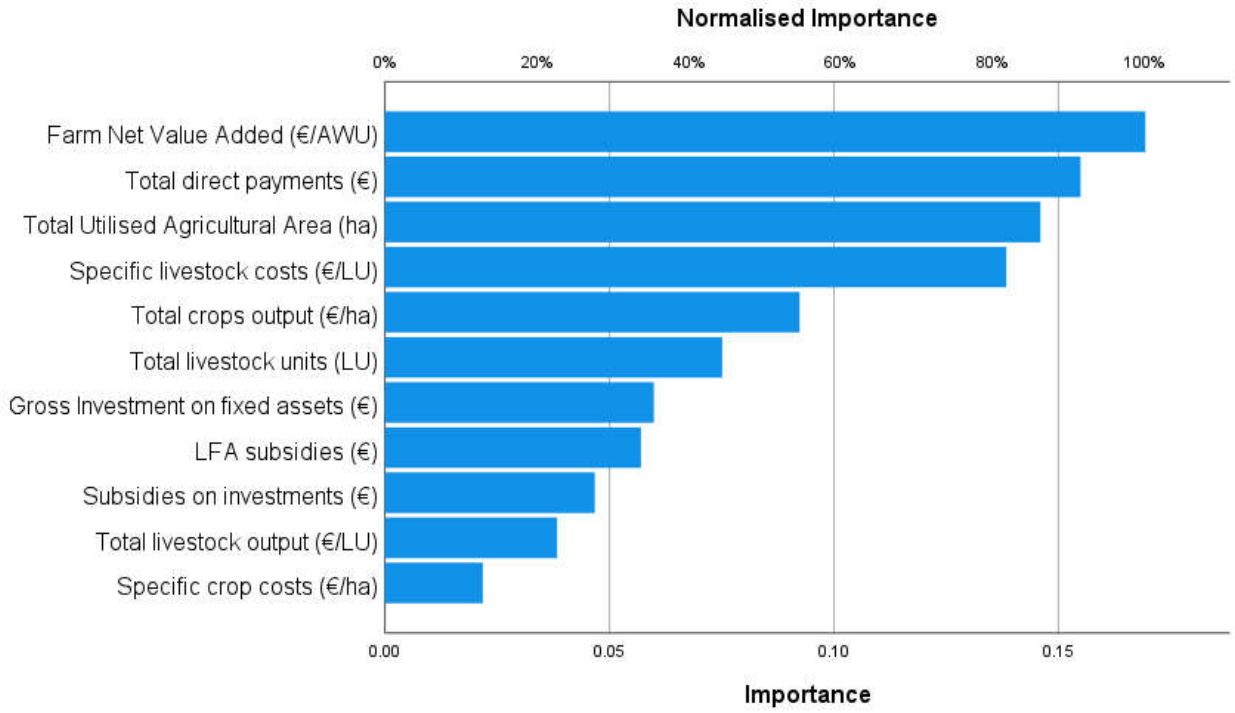


Table 8. outputs for independent variable importance

	Importance	Normalized Importance
Total Utilised Agricultural Area (ha)	0.146	86.2%
Total livestock units (LU)	0.075	44.3%
Total crops output (€/ha)	0.092	54.5%
Total livestock output (€/LU)	0.038	22.6%
Specific crop costs (€/ha)	0.022	12.9%
Specific livestock costs (€/LU)	0.138	81.7%
Subsidies on investments (€)	0.047	27.6%
Farm Net Value Added (€/AWU)	0.169	100.0%
Gross Investment on fixed assets (€)	0.060	35.4%
Total direct payments (€)	0.155	91.5%
LFA subsidies (€)	0.057	33.7%

Figure 6. Results for the normalised importance of the predictors



6. Discussion and conclusions

This research aimed to identify a model to predict the energy crops area, in the framework of the EU bioenergy, based on a set of predictors related to the farms' dimension and competitiveness (through variables weighted by the number of hectares and annual work units). This statistical information was obtained from the Farm Accountancy Data Network for the year 2020 and the agricultural regions. To analyse this information, artificial neural networks methodologies were considered through multilayer perceptron algorithms.

The literature review highlights the concerns of the EU institutions with energy use sustainability, namely to deal with the global warming challenges and to increase self-sufficiency to satisfy energy needs, specifically in times of crisis as those verified currently worldwide. Renewable energy sources may bring here relevant contributions, where the bioenergy from land use activities (agriculture and forestry, for example) is included. These concerns of the EU policymakers have been represented in the environmental and energy policies (European Green Deal strategy, for instance). In addition, the literature survey reveals the importance of the new technologies, particularly those associated with artificial intelligence, where artificial neural networks models are encompassed.

The data analysis (with data from the FADN database) shows that there is still a long way to run in the domains of EU energy crops production. A relevant number of farms from the EU agricultural regions has zero, or close to zero, hectares of these crops. Of course, several factors explain these scenarios, but maybe there are conditions and potentialities to increase the energy crops area, with added value for the farmers, without compromising the food production. In general, there is a relevant correlation among the energy crops area (categorised) and the following variables: total utilised area; total livestock units; farm net value added; gross investment on fixed assets; and total direct payments. These correlations show the interrelationships between the energy crops area and dimensions and competitiveness of the EU farms from Germany and neighbouring countries.

The results from the ANN approaches reveal that it is possible to predict the energy crops area through the model proposed with accuracies above 70%. On the other hand, the model confirms the importance of variables, such as the farm net value added, total direct payments and total utilised area in the frameworks of the EU energy crops.

In terms of practical implication, there are here relevant insights for several EU stakeholders, namely farmers, researchers and policymakers, showing that there is here

potential to be assessed and explored in the farms of the European agricultural regions. On the other hand, for policy recommendations, it is suggested more adjusted instruments in the context of the CAP to better address these frameworks. For future research, it is suggested to bring more insights about the factors that justify the reduced (or even null) area for energy crops in the farms of the member-states.

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FINANCIAL GLOBALIZATION AND GROWTH REVISITED – INTERNATIONAL AND REGIONAL EVIDENCE

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Abstract

The effects of financial globalization on economic growth have been put in focus by a more recent branch of globalization literature. In academic circles and international policy arena a strong push towards capital openness and free movement of capital across borders had been seen during the 1990s. While the early arguments suggested positive effects of financial globalization on economic growth, more recently, both theoretical and empirical studies have started seriously questioning this benign view of financial globalization calling for additional evidence. This paper revisits the link between financial globalization and growth using the KOF index of globalization in a sample of 134 world economies in the period 1970-2015. With a large number of countries and application of the panel data estimations techniques this paper provides strong evidence on the link between financial globalization and economic growth. In the broad sample of world economies financial globalization exerts a negative and statistically significant effects on economic growth. The paper also investigates this relationship in the regions of East Asia and Pacific, Middle East and North Africa, Latin America and the Caribbean, Sub-Saharan Africa and Europe and Central Asia and the negative effects are also predominant in the regional grouping of countries.

Keywords: Financial globalization, Growth, International evidence
JEL classification: F4, F6, O4

1. Introduction

Globalization and its effects have been extensively investigated in economic literature. This in particular applies to the effects of globalization on economic growth. Theoretical arguments provided in the older literature suggest these effects are expected to be positive. Empirical literature, however, appears to be less unison and both positive and negative effects can be found in empirical studies, but the positive evidence has been predominant. The effects of financial globalization on economic growth have been put in focus by a more recent branch of globalization literature. A strong push in academic circles and international policy arena has been seen during the 1990s towards capital openness and free movement of capital across borders. This was especially on the agenda of the most important international institutions like the IMF and World Bank. Similarly as with the overall globalization the early arguments put forward suggested the positive effects of financial globalization on economic growth, but again the empirical evidence has proven that these positive effects were not to be taken for granted and more research is needed to tackle this important issue. More recently, both theoretical and empirical studies have started seriously questioning the benign view of financial globalization calling for additional evidence. This becomes even more important with the world repeatedly being hit by financial crises and with the crises spreading internationally very swiftly. In this context the effects of financial globalization deserve additional attention and this paper contributes to the literature by revisiting the financial globalization-economic growth nexus.

This paper revisits the link between financial globalization and growth using the KOF index of globalization in a sample of 134 world economies covering the period 1970-2015. The KOF index of globalization is of particular value as it allows the use of the readily available subcomponents of the KOF index – KOF indexes of trade and financial globalization and in addition also their versions in the de facto and de jure forms. With a large number of countries and application of the panel data estimations techniques this paper provides strong evidence on the link between financial globalization and economic growth. In addition, the paper also investigates this relationship in the regions of East Asia and Pacific

(eap), Middle East and North Africa (mena), Latin America and the Caribbean (lac), Sub-Saharan Africa (ssa) and Europe and Central Asia (eca).

This paper is structured as follows. Section 2 provides the theoretical basis and briefly reviews the related literature. Empirical investigation is conducted and results presented in Section 3. Conclusions are provided in Section 4.

2. Theoretical basis and literature review

This section provides theoretical background for the empirical investigation to follow in Section 3 on the link between financial globalization and economic growth. Before reviewing the studies on the effects of financial globalization a brief outline of growth literature is given. While many different approaches in the literature have been applied, it still appears that one of the simplest, but still most influential attempts is due to Solow (1956) and his neoclassical exogenous growth model. Using this framework it can be shown that output growth can be well explained with accumulation of physical capital and exogenous labour and technological progress. Investment in this model stands as a crucial factor influencing growth with GDP increasing strongly in economies with high savings and investment rates contributing to the capital stock. As argued by Mankiw et al. (1992) this simple Solow model, when extended with human capital depicts successfully the growth experiences across countries. In particular, Mankiw et al. (1992) report that human and physical capital, and population growth explain around 80% of the international differences in incomes. Ensuing empirical studies used the theoretical Solow model as a basis of investigation, but often additional determinants were included. The range of these additional determinants is huge. Thus, commenting on the previous literature D'Andrea (2022) reports that Durlauf et al. (2005) identify 145 potential determinants of growth in empirical literature since the 1990s. The list of potential growth determinants is rather extensive including physical capital and human capital, trade, demographics, fiscal policy, monetary policy and financial and technological factors. In addition, in developing countries potential determinants also include foreign aid, FDI, natural resources, reforms (institutions), as well as geographic, regional and financial factors. Indeed, the list is broad and when it comes to empirical modelling authors have to simplify this wide-ranging list not only because of availability of the data but also in order to have a meaningful and theoretically based empirical investigation. This nicely shows why Barro (2003) claims that growth economists have to face the problem of model uncertainty seriously or as to why Brock and Durlauf (2001) warn about the issue of open-endedness of theories.

In this context and with globalization being one of the most powerful processes in the post-World War II period it was only natural to account for the importance of openness for growth. An impressively huge literature has emerged investigating the effects of globalization on growth. The typical theoretical rationale suggests that globalization is expected to affect economic growth positively. Among many arguments that can be listed Grossman and Helpman (2015) and Potrafke (2015) mention international knowledge spillovers, access to larger markets, increased competition, better opportunities to exploit comparative advantages and gains from specialization as the most important ones. With strong theoretical priors and abundant empirical evidence predominantly positive effects were reported (see for example Dreher, 2006; Potrafke, 2015; Gygli et al., 2019; Ali and Malik, 2021 to list a few). This, however, was related to trade openness leaving the issue of financial openness relatively under-investigated. When it comes to financial openness or financial globalization early theoretical arguments (see for example Fischer, 1997; Dornbusch, 1998) were pretty inclined towards finding positive effects of financial openness (financial globalization) on growth. The usual benefits included additional (foreign) funding of growth, more diversification opportunities and deeper financial systems. All of these were expected to result in long term growth. Unfortunately, these arguments have not been supported by empirical evidence strongly questioning whether the countries around the world prematurely and too quickly embraced financial globalization. This in particular applies to less developed economies that followed the recipes and dictates of the IMF and the most powerful world economies.

The literature on financial globalization and its effects on economic growth remains far from a definitive account. A good example of the distinctively opposed views in the literature are the papers by Mishkin (2009) and Rodrik and Subramanian (2009) appearing in the same issue of the IMF Staff Papers. Mishkin (2009) thus argues that financial globalization can be a

powerful force in promoting economic growth and that the world should not turn its backs on financial globalization. Financial globalization encourages financial development and this in consequence enables the financial system to allocate capital to most productive uses which brings about economic growth in the long term and has a potential to reduce poverty, particularly in developing countries. Mishkin (2009) is at the same time also aware of the dangers related to financial globalization, especially about the possibility of financial crises occurring, but still remains pretty confident that the benefits strongly outweigh the costs, and that once a number of prerequisite reforms be adopted, financial globalization will start paying off. Rodrik and Subramanian (2009) on the other hand provide strong arguments that financial globalization had disappointed and that financial globalization had not lead to economic growth. The supporting references in Rodrik and Subramanian (2009), in particular Prasad et al. (2007) and Gourinchas and Jeanne (2007) oppose the supposed link that foreign capital and economic growth go hand in hand and suggest that countries with higher growth rates actually relied less on foreign capital. Thus, while it can be understood that financial globalization brings many opportunities, it also appears that the typical benefits of the capital openness with poorer countries borrowing foreign accumulation to finance their growth did not materialize. Indeed, Lucas (1990) warned long time ago about the paradox that contrary to expectations international capital does not flow from rich to poor economies, i.e. from North to South. Instead, a typical movement of international capital flows observed in the literature is North-North, i.e. between rich economies (see for example Alfaro et al., 2008). Rodrik and Subramanian (2009) offer a novel theoretical rationale based on the distinction between savings-constrained and investment-constrained economies to explain why financial globalization may impact growth negatively. These authors provide strong arguments suggesting that most of the developing countries are investment constrained economies and capital inflows will not be of much help in their case. Even worse, capital inflows could even endanger the existing profitable projects because the strong inflow of foreign capital might lead to appreciation of the domestic currency which will further endanger competitiveness of poor economies in international markets hurting the tradable goods sector and long term economic growth. Indeed, these theoretical arguments seem supportive of the missing positive link between financial globalization and economic growth. In a different context, Broner and Ventura (2016) also demonstrate that financial globalization need not necessarily lead to economic growth. They argue that financial globalization can lead to a variety of outcomes and the effects of financial globalization depend on the level of development, productivity, domestic savings, and the quality of institutions. Abraham and Schmukler (2017) also suggest that despite the predicted large gains from financial globalization positive effects have been limited. As suggested earlier in this review of related literature it comes as no surprise to find both positive and negative effects of financial globalization on economic growth reported in the empirical literature. With this mix of evidence on the effects of financial globalization on economic growth, it appears new empirical studies are desirable. To that end we conduct the empirical investigation of this link in the broad context of 134 world economies in the rest of this paper.

3. Empirical investigation and results

3.1. Model and the data

Empirical investigation in this section builds of from the discussion and review of previous studies in the preceding section. The growth model to be estimated econometrically is set quite broadly accounting for the standard determinants of economic growth – physical and human capital, together with population growth. As discussed previously, Mankiw et al. (1992) suggest that the model thus defined is pretty powerful in explaining the growth dynamics across countries. To allow for the impact of physical capital we include in the model investment as a share of GDP and for the human capital we add secondary education completed or average years of total schooling, both due to Barro and Lee (2013). In accordance with our review in the previous section and other empirical studies investigating growth, we allow for other determinants as well. This extension brings us on the safe side to avoid possible misspecification, but also allows us to test empirically the importance of other

determinants of economic growth. Thus we add government consumption as percent of GDP and inflation to the model, but also allow for the impact of quality of institutions as institutions in many growth studies stood out as a potentially important determinant of growth (see for example Aron, 2000; Rodrik, 2007; Mehlum et al., 2006; Isham et al., 2005; Acemoglu et al., 2019; Durlauf, 2020). To account for the quality of institutions we use the institutional indicator Autocracy-democracy (Polity 2) from the POLITY IV project due to Marshall at al. (2014). Finally, as the focus of the present paper is on the impact of financial globalization on economic growth, we add the globalization variables as potential determinants of growth. Following Dreher et al. (2006) and Gygli et al. (2019) we use the KOF index of globalization which is particularly useful because it, in addition to being used as a strong proxy for globalization in empirical studies, also disentangles between trade and financial globalization, as well as between their de facto and de jure versions. If we take the studies that use the KOF indexes of globalization as representatives of the most recent empirical studies investigating the link between globalization and growth, we also experiment and add as a robustness check the investigation using the trade openness and financial openness as represented in the older literature. Trade openness is thus measured as trade as percent of GDP and financial openness as cross-border holdings of assets and liabilities as percent of GDP, due to Lane and Milesi-Ferretti (2007). Thus, taking into account what was previously discussed we set up the following model to be estimated empirically:

$$GDP\ growth_{it} = \beta_1 Investment_{it} + \beta_2 Population\ growth_{it} + \beta_3 Human\ capital_{it} + \beta_4 Trade\ globalization_{it} + \beta_5 Financial\ globalization_{it} + \beta_6\ Government\ consumption_{it} + \beta_7\ Inflation_{it} + \beta_8\ Institutions_{it} + \varepsilon_{it} \quad (1)$$

where i refers to a country and t to a time period.

The variables used in our empirical investigation are detailed in Table 1. We collected the data for the period 1970-2015. As we are interested in the effects of financial globalization on economic growth and economic growth is a long run phenomenon we calculated five-year averages of our data to smooth the usual business cycle volatility.

Table 1. Used variables and data sources

Variable	Definition	Source
GDP growth	GDP growth rate (%)	World Bank World Development Indicators
Investment	Gross fixed capital formation (% of GDP)	World Bank World Development Indicators
Population growth	Population growth (%)	World Bank World Development Indicators
Human capital – Schooling	Average years of total schooling	Barro and Lee (2013), v. 2.2, 2018
Human capital – SecondaryC	Secondary education completed, percent of population aged 25 and over	Barro and Lee (2013), v. 2.2, 2018
Trade globalization	KOF index of trade globalization	Gygli et al. (2019)
Financial globalization	KOF index of financial globalization	Gygli et al. (2019)
Trade openness	Trade (Exports plus imports, % of GDP)	World Bank World Development Indicators
Financial openness	Cross-border holdings of assets and liabilities (% of GDP)	Lane and Milesi-Ferretti (2007)
Government	General government final consumption expenditure (% of GDP)	World Bank World Development Indicators
Inflation	Annual rate of inflation (%)	World Bank World Development Indicators
Institutions	Autocracy-democracy index (polity2) ranging between -10 (total autocracy) and 10 (total democracy)	Polity IV dataset (Marshall et al. 2014)

The sample includes as many as 134 world economies. The initial intention was to include all world economies, but availability of the data resulted in a maximal number of countries amounting to 134. This large number of countries provides a representative sample of world economies. The use of panel data estimation techniques results in large number of observations which adds to reliability of our findings, but additionally allows us to investigate econometrically the effects of financial globalization on economic growth across different country groupings (regions) by geographical criterion. Thus, in final stages of this paper we investigate the effects of financial globalization separately in the following regional groupings: East Asia and Pacific (eap), Middle East and North Africa (mena), South Asia (sa), Latin America and the Caribbean (lac), Sub-Saharan Africa (ssa), Europe and Central Asia (eca) and North America (na). Unfortunately, due to a low number of countries, and related to that low number of observations, the separate (specific) estimations were not possible across the countries in North America (only 3 countries) and South Asia (5 countries).

3.2. Results

After we described the model and the data we report the results of our econometric estimations. Since we use the panel data estimations techniques, the Hausman test was calculated and reported at the bottom of each table to decide whether to use the random effects or fixed effects models. With only a few exceptions, the Hausman test and the associated p values suggested that random effects should be preferred. We first report the results of our econometric estimations using the KOF indexes of trade and financial globalization (Table 2). Later on we substitute these indicators with the alternative globalization indicators to check the robustness of our findings but also to probe deeper into the relationship between financial globalization and economic growth.

Table 2. Financial globalization and economic growth – estimations based on the KOF indexes of globalization

VARIABLES	(1)	(2)	(3)	(4)
Investment (total as % of GDP)	0.164***	0.155***	0.164***	0.155***
	(0.016)	(0.016)	(0.016)	(0.016)
Population growth	0.522***	0.557***	0.477***	0.488***
	(0.108)	(0.100)	(0.113)	(0.108)
Human capital (SecondaryC)	0.004	0.003		
	(0.009)	(0.009)		
Human capital (Schooling)			-0.036	-0.055
			(0.058)	(0.056)
Trade globalization	0.027***	0.029***	0.029***	0.032***
	(0.010)	(0.010)	(0.010)	(0.010)
Financial globalization	-0.030***	-0.031***	-0.027***	-0.027***
	(0.009)	(0.009)	(0.009)	(0.009)
Government (% of GDP)	-0.136***	-0.147***	-0.136***	-0.146***
	(0.023)	(0.022)	(0.023)	(0.022)
Inflation	-0.002**	-0.002**	-0.002**	-0.002**
	(0.000)	(0.001)	(0.000)	(0.000)
Institutions (Polity 2)	-0.013		-0.010	
	(0.019)		(0.020)	
Number of countries	122	134	122	134
Number of observations	822	882	822	882
Hausman test (test statistic and p value)	6.99 (0.54)	6.28 (0.51)	9.77 (0.28)	7.88 (0.34)
	Random effects	Random effects	Random effects	Random effects

Standard errors in parentheses; *** significant at 1% level, ** significant at 5% level, * significant at 10% level - Source: Authors' calculations

Table 2 reports our main findings on the relationship between financial globalization and economic growth. Before turning our attention to our main variable of interest – financial globalization, let us point out that in this table (Table 2) we ran four models including the variables in accordance with previous studies and our discussion of the potential growth determinants in Section 2. Thus, in model 1 (Column 1) we estimated the impact of investment, population growth, human capital (as represented by the completed secondary education), trade globalization, financial globalization, government consumption, inflation and institutional development on economic growth. Model 2 (Column 2) includes the same variables except for institutions. The reason for excluding institutions lies in the fact that despite strong theoretical arguments that institutional quality is an important determinant of growth, empirical evidence often does not find this variable to exert a statistically significant impact. Since in Model 1 institutions are not found to be statistically significant, we also ran the model without them included as a robustness check to see whether our main findings may be impacted by the inclusion/exclusion of this variable. It should be also noted that in Model 3 (Column 3) and Model 4 (Column 4) we repeat the models 1 and 2 substituting completed secondary education with the total years of schooling as a representative of human capital. The reason for this was that human capital stands theoretically as an important determinant of economic growth, and should be part of a growth regression. Our finding in models 1 and 2 that it is statistically insignificant, led us to experiment with an alternative human capital variable, but as can be seen in models 3 and 4 the human capital variable changes sign but still it is not significantly different from zero. Also inclusion of this alternative indicator does not change the main findings on other growth determinants which adds to robustness of these findings.

Now we turn our attention to commenting on the variables that were found to be statistically significant. For spatial reasons we comment across all four models simultaneously as the signs, size and statistical significance of the estimated coefficients remains practically unchanged. Investment exerts positive and statistically significant impact on growth, as expected theoretically and confirmed in previous studies. Population growth has positive impact, which on the first sight may be surprising as usually in the literature population growth exerts negative influence on economic growth. Note however that this is the case when the dependent variable is GDP per capita growth. In our models, we have only the GDP growth as the dependent variable and hence the positive coefficient on population is expected. Government consumption is found to exert the negative impact on economic growth, the same as inflation. Trade globalization appears to be positive and statistically significant and this finding is accordance with the most of the previous literature which finds the positive impact of the overall, and in particular of the trade globalization on economic growth. Financial globalization is of the greatest interest for the present study and it is with this variable that the literature has found least consensus. This first set of our results suggests that financial globalization exerts a negative and statistically significant effect on economic growth. This findings is consistent across all four specifications in Table 2. Since this negative impact has important policy implications and contradicts strong theoretical priors related to the impact of financial globalization on economic growth, we extend our analysis to check the robustness of this result. Thus, following the older literature on (financial) globalization instead of the KOF indexes of globalization becoming recently available, we use the traditional indicators in the form of trade openness and financial openness. The results with these indicators but using the same models as before are presented below in Table 3.

Table 3. Financial globalization and economic growth – estimations based on trade and financial openness

VARIABLES	(1)	(2)	(3)	(4)
Investment (total as % of GDP)	0.190***	0.167***	0.192***	0.169***
	(0.029)	(0.028)	(0.029)	(0.028)
Population growth	0.443***	0.565***	0.338*	0.464**
	(0.193)	(0.188)	(0.208)	(0.210)
Human capital (SecondaryC)	-0.021	-0.010		
	(0.016)	(0.012)		
Human capital (Schooling)			-0.181*	-0.108
			(0.097)	(0.089)
Trade openness	0.017**	0.019***	0.018***	0.020***
	(0.007)	(0.007)	(0.007)	(0.007)
Financial openness	-0.195***	-0.200***	-0.182***	-0.194***
	(0.059)	(0.059)	(0.059)	(0.059)
Government (% of GDP)	-0.120***	-0.151***	-0.113***	-0.145***
	(0.039)	(0.038)	(0.040)	(0.039)
Inflation	-0.001	-0.001*	-0.001*	-0.001*
	(0.001)	(0.001)	(0.001)	(0.001)
Institutions (Polity 2)	-0.016		0.004	
	(0.032)		(0.035)	
Number of countries	35	41	35	41
Number of observations	260	289	260	289
Hausman test (test statistic and p value)	10.97 (0.20)	13.10 (0.07)	11.91 (0.16)	13.31 (0.07)
	Random effects	Random effects	Random effects	Random effects

Standard errors in parentheses; *** significant at 1% level, ** significant at 5% level, * significant at 10% level - Source: Authors' calculations

Before commenting on the estimated models and coefficients in Table 3, please note that the number of countries and observations (reported at the bottom of the table) drops to approximately a little less than one third of those numbers in Table 2. This is due to the fact that the alternative indicators are available for less countries. Still we have 260 or 289 observations which allows us to obtain reliable results. It appears that the obtained estimations provide strong support to our findings reported in Table 2 which we take as a benchmark. Since we will have additional robustness checks we will refrain from commenting in detail the obtained findings in new tables, but instead focus only on our main variables of interest, those related to globalization. With this general principle on mind, we focus our attention on the financial openness (financial globalization) estimates in Table 3. It appears that both trade openness and financial openness confirm our benchmark findings on trade and financial globalization from Table 2, with trade openness again exerting the positive and financial openness again the negative influence on economic growth, as before. It should be spotted that with this new set of globalization variables, we confirm our findings from before, but in addition we can notice that the coefficients on financial openness are bigger in size in comparison to coefficients on trade openness.

We take our investigation further by distinguishing between trade and financial globalization in their de facto and de jure forms. This particular advantage stems from the KOF indexes of globalization being reported in these forms as well. Again we have a higher number of countries and observations and the obtained estimations are reported in Table 4 below.

Table 4. Financial globalization and economic growth – estimations based on the de facto and de jure KOF indexes of globalization

VARIABLES	(1)	(2)	(3)	(4)
Investment (total as % of GDP)	0.162***	0.154***	0.175***	0.171***

VARIABLES	(1)	(2)	(3)	(4)
	(0.016)	(0.016)	(0.016)	(0.016)
Population growth	0.593***	0.527***	0.450***	0.457***
	(0.106)	(0.097)	(0.111)	(0.103)
Human capital (SecondaryC)	0.006	0.006	0.005	0.003
	(0.009)	(0.009)	(0.009)	(0.009)
Trade globalization – de facto	0.028***	0.027***		
	(0.007)	(0.007)		
Financial globalization – de facto	-0.026***	-0.024***		
	(0.007)	(0.007)		
Trade globalization – de jure			-0.001	-0.000
			(0.007)	(0.007)
Financial globalization – de jure			-0.010	-0.013*
			(0.007)	(0.007)
Government (% of GDP)	-0.126***	-0.136***	-0.125***	-0.130***
	(0.022)	(0.021)	(0.023)	(0.022)
Inflation	-0.001**	-0.002**	-0.002**	-0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
Institutions (Polity 2)	-0.013		-0.013	
	(0.019)		(0.020)	
Number of countries	122	134	121	132
Number of observations	822	882	820	874
Hausman test (test statistic and p value)	6.89 (0.55)	6.16 (0.52)	8.07 (0.43)	7.86 (0.35)
	Random effects	Random effects	Random effects	Random effects

Standard errors in parentheses; *** significant at 1% level, ** significant at 5% level, * significant at 10% level - Source: Authors' calculations

Table 4 provides another robustness check of our benchmark models from Table 2 but this time using the KOF indexes in their de facto (Columns 1 and 2) and de jure forms (Columns 3 and 4). It appears that the findings on the non-globalization variables in our models (investment, population, human capital, government consumption, inflation and institutions) remain as before (in Table 2), but it seems that with the globalization variables this is not the case. Estimated coefficients on trade and financial globalization indexes in de jure form (in columns 3 and 4) lose statistical significance, while the coefficients on globalization variables in the de facto form (columns 1 and 2) remain statistically significant and of the same signs as before. Thus, it appears that it is globalization de facto and not globalization the jure that is generating the statistically significant impact on economic growth. As our main interest is on financial globalization, we conclude again that the impact of financial globalization on economic growth is negative, and that the previous findings reported in Table 2 are confirmed here in Table 4 but only with the KOF indexes of globalization in the de facto forms.

Overall, from what was reported and discussed so far, we can conclude that strong and robust evidence is offered to support the negative influence of financial globalization on economic growth. This finding emerges from the broad sample of 130+ countries and using different models. It should be added that we also ran our econometric estimations in additional forms to be on the safe side. Namely, our models reported above included certain variables which were found to be statistically insignificant. One example refers to the human capital variables (secondary education completed or total years of schooling) which were found to be predominantly statistically insignificant but we decided to leave them in the estimated models due to strong theoretical reasons as to why they should be appearing in a growth function. We did however run our models excluding human capital variable and it did not change our results reported above. These results are not included in the text for spatial reasons, but are available upon request. Let us also mention that there could be an additional question raised. Given our primary interest on the impact of financial globalization on economic growth, why in addition to financial globalization was also trade globalization included in the models. To avoid possible criticisms we ran the model without trade globalization included in our estimations, but the results on the impact of financial

globalization remained the same, negative and statistically significant. These results are again not included in the text for spatial reasons, but are available upon request. We conclude this part of our investigation with strong international evidence on the negative impact of financial globalization on economic growth. A broad coverage of countries with 134 world economies included and a relatively long data set (1970-2015) adds to reliability of this finding. In addition different robustness checks were applied, alternative indicators for trade and financial globalization were used, and different growth specifications were also experimented with but our main finding remained unchanged. Financial globalization impacts economic growth negatively and this effect is statistically significant and robust.

An additional line of inquiry was followed in the remaining part of this paper. Namely, a question could be raised whether the robust negative impact of financial globalization on economic growth established in an international setting also holds across different regions in the world. Given the breath of our sample we decided not to miss the opportunity to investigate this question empirically and estimated the impact of financial globalization on economic growth in the regions of East Asia and Pacific (eap), Middle East and North Africa (mena), Latin America and the Caribbean (lac), Sub-Saharan Africa (ssa) and Europe and Central Asia (eca). The results of these estimations are reported in Table 5, 6 and 7 below.

Table 5. Financial globalization and economic growth – regions EAP and ECA

VARIABLES	(1) EAP	(2) EAP	(3) EAP	(4) ECA	(5) ECA	(6) ECA
Investment (total as % of GDP)	0.126***	0.116***	0.130***	0.074*	0.037	0.083**
	(0.036)	(0.036)	(0.037)	(0.040)	(0.033)	(0.039)
Population growth	0.700*	0.722**	0.657*	-0.043	0.269	-0.364
	(0.363)	(0.359)	(0.363)	(0.353)	(0.193)	(0.339)
Human capital (SecondaryC)	-0.027	-0.031	-0.024	-0.037*	-0.007	-0.031*
	(0.022)	(0.022)	(0.024)	(0.022)	(0.009)	(0.018)
Trade globalization	-0.013			-0.001		
	(0.020)			(0.028)		
Financial globalization	-0.050**			-0.004		
	(0.021)			(0.019)		
Trade globalization – de facto		-0.001			0.061***	
		(0.017)			(0.011)	
Financial globalization – de facto		-0.050***			-0.044***	
		(0.019)			(0.009)	
Trade globalization – de jure			-0.021			-0.077***
			(0.017)			(0.022)
Financial globalization – de jure			-0.034**			0.049***
			(0.017)			(0.019)
Government (% of GDP)	-0.195***	-0.181***	-0.188***	-0.413***	-0.256***	-0.459***
	(0.070)	(0.070)	(0.071)	(0.081)	(0.042)	(0.079)
Inflation	-0.161***	-0.162***	-0.137***	-0.038***	-0.040***	-0.043***
	(0.052)	(0.053)	(0.051)	(0.006)	(0.006)	(0.006)
Institutions (Polity 2)	-0.073*	-0.094**	-0.064	-0.055	-0.095**	-0.024
	(0.044)	(0.044)	(0.044)	(0.058)	(0.043)	(0.056)
Number of countries	16	16	16	38	38	38
Number of observations	116	116	116	246	246	246
Hausman test (test statistic and p value)	10.59 (0.23) Random effects	6.27 (0.32) Random effects	12.71 (0.12) Random effects	18.98 (0.02) Fixed effects	11.76 (0.16) Random effects	26.76 (0.00) Fixed effects

Standard errors in parentheses; *** significant at 1% level, ** significant at 5% level, * significant at 10% level

Source: Authors' calculations

Table 5 reports the results of our estimations in the regions of East Asia and Pacific (eap) and Europe and Central Asia (eca). Again for spatial reasons we comment only on the globalization variables and in particular on the impact of financial globalization on economic growth. Thus, in the countries of East Asia and Pacific (Columns 1, 2 and 3) financial globalization is found to exert a negative and statistically significant impact on economic growth. Interestingly this effect prevails across the models with the overall KOF index of financial globalization, but also in its de facto and de jure forms. At the same time trade globalization is also found to exert negative influence on economic growth but this effect is not statistically significant. In Europe and Central Asia countries the effect of financial globalization on growth is again negative, but the overall KOF index of financial globalization is not statistically significant (Column 4). Interestingly both its de facto and de jure versions are found to be statistically significant with the de facto version being estimated negatively and the de jure version to have a positive impact (Columns 5 and 6).

Table 6. Financial globalization and economic growth – regions LAC and MENA

VARIABLES	(1) LAC	(2) LAC	(3) LAC	(4)MENA	(5)MENA	(6)MENA
Investment (total as % of GDP)	0.192***	0.216***	0.209***	0.332***	0.332***	0.311***
	(0.055)	(0.056)	(0.051)	(0.066)	(0.067)	(0.068)
Population growth	1.078***	0.966***	1.024***	-1.314***	-1.250***	-1.255***
	(0.401)	(0.389)	(0.382)	(0.460)	(0.464)	(0.488)
Human capital (SecondaryC)	0.048	0.067*	0.009	0.243*	0.129	0.217
	(0.039)	(0.039)	(0.037)	(0.127)	(0.120)	(0.143)
Trade globalization	0.036			-0.139*		
	(0.024)			(0.083)		
Financial globalization	-0.038*			-0.110*		
	(0.022)			(0.067)		
Trade globalization – de facto		0.014			-0.071	
		(0.017)			(0.064)	
Financial globalization – de facto		-0.043**			-0.092*	
		(0.019)			(0.055)	
Trade globalization – de jure			0.031*			-0.078
			(0.018)			(0.062)
Financial globalization – de jure			-0.006			-0.069
			(0.015)			(0.056)
Government (% of GDP)	-0.178***	-0.157***	-0.180***	-0.148	-0.095	-0.140
	(0.058)	(0.056)	(0.057)	(0.115)	(0.115)	(0.123)
Inflation	-0.001*	-0.001*	-0.001*	-0.038*	-0.022	-0.035
	(0.001)	(0.001)	(0.001)	(0.022)	(0.022)	(0.024)
Institutions (Polity 2)	0.014	0.016	0.003	-0.140	-0.076	-0.224
	(0.039)	(0.038)	(0.039)	(0.210)	(0.216)	(0.219)
Number of countries	19	19	19	13	13	12
Number of observations	143	143	143	90	90	88
Hausman test (test statistic and p value)	5.73	5.85	5.65	28.15	21.82	20.37
	(0.68)	(0.55)	(0.69)	(0.43)	(0.01)	(0.01)
	Random effects	Random effects	Random effects	Fixed effects	Fixed effects	Fixed effects

Standard errors in parentheses; *** significant at 1% level, ** significant at 5% level, * significant at 10% level

Source: Authors' calculations

Table 6 reports the results for the regions Latin America and the Caribbean (lac) and Middle East and North Africa (mena). Financial globalization also in these two regions exerts

a negative influence on economic growth, but the effects are not as strong as in previously reported regions. Financial globalization is negative with all three KOF indexes of financial globalization used (overall, de facto and de jure), but it appears that when the de jure form is used in estimations, it loses statistical significance. With the other two versions of the KOF index (overall and de facto) financial globalization is statistically significant, but mostly at the 10% level of statistical significance.

Table 7. Financial globalization and economic growth – SSA

VARIABLES	(1)	(2)	(3)
Investment (total as % of GDP)	0.093**	0.117***	0.116***
	(0.016)	(0.039)	(0.037)
Population growth	1.524***	1.479***	1.505***
	(0.268)	(0.270)	(0.269)
Human capital (SecondaryC)	-0.013	0.002	-0.026
	(0.044)	(0.043)	(0.044)
Trade globalization	0.096***		
	(0.034)		
Financial globalization	-0.030		
	(0.029)		
Trade globalization – de facto		0.036	
		(0.023)	
Financial globalization – de facto		-0.008	
		(0.021)	
Trade globalization – de jure			0.051**
			(0.023)
Financial globalization – de jure			0.001
			(0.021)
Government (% of GDP)	-0.102**	-0.080	-0.085
	(0.053)	(0.053)	(0.053)
Inflation	-0.027	-0.023	-0.020
	(0.023)	(0.023)	(0.023)
Institutions (Polity 2)	0.069	0.093*	0.090*
	(0.051)	(0.051)	(0.050)
Number of countries	28	28	28
Number of observations	168	168	168
Hausman test (test statistic and p value)	9.84 (0.28)	11.14 (0.19)	10.49 (0.23)
	Random effects	Random effects	Random effects

Standard errors in parentheses; *** significant at 1% level, ** significant at 5% level, * significant at 10% level

Source: Authors' calculations

Table 7 reports the results of our estimations in the region of Sub-Saharan Africa (ssa). It appears that in this region financial globalization has no effect on economic growth. Namely, the estimated coefficients are negative but none of them is statistically significant. Unlike financial globalization, in this region trade globalization (when the overall and de jure KOF indexes of trade globalization are used) exerts a positive and statistically significant impact on economic growth.

To summarize the evidence on the impact of financial globalization on economic growth across different world regions we can say that the effects are negative and predominantly statistically significant, although not in all cases. It might be that the loss in statistical significance is due to lower number of observations, but anyhow it appears that there exist differences across world regions. This question of different findings across regions on the impact of financial globalization on economic growth certainly deserves more attention but it is out of scope of the present study. It might be an avenue for further studies worth pursuing.

Overall, as it stands, although not being as strong and robust as the evidence using the sample of all available world economies, the obtained evidence across five world regions seems supportive of the negative relationship between financial globalization and economic growth.

4. Conclusions

This paper investigated empirically the effects of financial globalization on economic growth. This becomes particularly important as the financial crises have intensified in recent decades with strong and swift spreading around the globe. As a reaction a number of theoretical contributions have been provided to suggest that caution should be exerted as financial openness may not be as beneficial as suggested by the early literature on this very important issue. New arguments have been put forward warning that financial globalization can also have detrimental effects on growth. Empirical evidence also started providing support to this cautious view, but still both positive and negative effects of financial globalization are reported. As the previous studies provided a mixed evidence on the link between financial globalization and growth, new studies are needed to shed additional light on this important issue.

This paper contributes to the literature by revisiting the financial globalization-economic growth nexus. The link between financial globalization and growth was investigated using the KOF index of globalization in a sample of 134 world economies in the period 1970-2015. The KOF index of globalization was found of particular value as it allows the use of the readily available subcomponents of the KOF index – KOF indexes of trade and financial globalization and in addition also their versions in the de facto and de jure forms. With a large number of countries and application of the panel data estimations techniques this paper provides strong evidence on the link between financial globalization and economic growth. In the broad sample of world economies financial globalization exerts a negative and statistically significant effects on economic growth. The paper also investigated this relationship in the regions of East Asia and Pacific, Middle East and North Africa, Latin America and the Caribbean, Sub-Saharan Africa and Europe and Central Asia. The negative effects of financial globalization are also predominantly confirmed in the regional grouping of countries.

These findings have important policy recommendations. The usual benign view on financial globalization should be further explored and caution should be exerted when countries are pushed towards more financial openness. Recent financial crises and their spreading around the world only add to this argument.

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HUMAN CAPITAL FORMATION AND ECONOMIC GROWTH RELATIONSHIPS: PANEL DATA INSIGHTS FOR THE INDIAN STATES

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Abstract

The various endogenous growth theories as well as empirical studies have proved that human capital works as an important factor for economy's growth. The role of income on human capital formation cannot be overlooked so far as the essences of the endogenous growth theories are concerned. Considering this interconnection among the human capital and income of the economy, the present study provides quantitative evidence to show the associations amongst human capital formation as quantified by the governments' health and education expenditures and income of the economy measured by states' gross domestic products for the panel of states and union territories of India during the period from 1998-99 to 2018-19. The technique of panel cointegration is used to show the long run relationships among human capital investment and income of the economy, and then the Wald test is used to examine the direction of short-run causality. The empirical results demonstrate that human capital and state incomes have a long-term relationship. The Wald test reveals a short-run linkage between human capital and income of the state economies, with the causality running from human capital investment to output of the economy. i.e., human capital has an immediate influence on the progress of the economy. It is consequently suggested that the governments of the states and union territories make additional investments in sectors such as education and health in order to secure long-term economic prosperity.

Keywords: Human capital, education, health, growth, panel cointegration, Indian states
JEL classification: I1, I2, O3, C32, C33

1. Introduction

Human capital, together with physical capital and labour force, is recognized as one of the most essential components of production in the modern world. It is generally related with economic growth since investments in human capital tend to raise the efficiency and throughput of an economy's present force of labour. It is said that increased human capital leads to increased progress of the economy. Smith (1776) contends that progress of the economy is determined by the skill, deftness, and decision through which labour is employed in general, emphasizing on the components that determine labour productivity increase. To Lucas (1988), the gathering of human capital is vital for long term progress of the economy, and education is the main resources of gathering human capital. As per Romer (1986, 1990), human capital generates innovations and ultimately rouses economic growth. Contrary to these results, Barro and Sala-i-Martin (1995) discovered that education is directly connected with growth rates of per capita GDP across countries. Various empirical evidences indicate the significance of health as the component human capital with regard to growth of an economy. Economic growth, it is often assumed, leads to better living standard, longer life expectancy, and improved health conditions. To start with, expansion of an economy involves increasing per capita wealth, and a portion of this increased wealth is converted to rising intake of nutrients in both the quantitative and qualitative aspects. Economic growth contributes to the human capital accumulation (Mincer, 1995). The existing theories on endogenous growth incorporating human capital factor established favorable growth effects in some countries and not so relevant in other countries. As a result, the prevailing macroeconomic theories inferred causal chain between human capital accumulation and

growth of the economy and appears to be somewhat vague; it differs across countries or across groups of countries. Thus, the present study aims to show the interconnections of human capital formation with growth of income at the micro level by taking the panel of 29 Indian states and UTs (union territories) for the period of 1998-99 to 2018-19.

2. Review of Extant Works

First the study covers up the review of works on the relationships between human capital (in different forms) and economic growth and development in countries and groups other than India. Then it goes for capturing the studies on the same field for India only.

Becker (1964) created an economic approach to human capital by focusing on the assumptions about general-purpose and firm-specific human capital. Mankiw, Romer and Weil (1992) suggested that the outcomes of the Solow's model were consistent with international evidence if the amounts of human capital and physical capital were valued equally. Benhabib and Spiegel (1994) highlighted the finding that human capital had a negligible influence on per capita income growth rates, and then employed an alternative model in which human capital had a direct effect on the total factor productivity growth. Brempong and Wilson (2004) looked into the effects of health capital on the growth of per capita income in the Sub-Saharan African and OECD group and revealed a quadratic relationship of health as human capital had with the growth of per capita income. According to the estimations, health capital books for 22% and 30% of the changeover growth rates in the respective groups. Using panel data including 93 countries, the study of Agiomirgianakis (2002) showed that education as factor of the economic output had a substantial and direct long run effects. In addition, as the level of education increased the size of this effect also get stronger. Wolff (2000) inspects the upshot of education in growth of the economies in the 24 OECD group from 1950 to 1990. The rise in educational attainment appears to be in lockstep with the rise in labour productivity. However, across a wide variety of specifications, a variable quantifying the figure of engineers and scientists employed per head is found to be important. From 1980 to 2008, Yardimciolu and Gürdal (2014) explored the long run link among growth of the economy and education levels in the group of 25 OECD nations and found a long run one-way causal influence from growth of the economy to the level of education.

Hanushek (2013) mainly focused on developing countries in terms of school attainment, school quality. He argued and found that without improvement of school quality, developing countries doesn't achieve of improve their long run economic performance. Bas van Leeuwen (2008) observes, during 20th century, that human capital base is cointegrated with the total income base in Indonesia and India which supports the outcomes of the Lucas model. Edrees (2016) studied Arab World countries from 1974 to 2013, and found non-uniform causal relationships at diverse heights of affluence. According to Permani (2009), education is important for economic growth, but it is not adequate in East Asia. Regardless of whether education may boost productivity, it continuously appears as a substantial income determinant and, as a result, a growth component. McMahon (1998) started a production function with the externality effects of education to the East Asian countries. It is discovered that, because most nations had universal primary education early on, the rate at which secondary education grew (which is required for successful exports) was critical in obtaining sizable rates of asset creation in the education sector and per capita income growth. After primary enrolment is universal, secondary and higher education costs become more significant. Oketch (2006) establishes a link between the development of human resources as a result of formal education and per capita economic growth. The study's conclusion is that the per capita income growth is a determining factor of investment in education which is statistically consistent. Kouton (2018) investigated the association for Côte d'Ivoire during 1970-2015 and shows a unidirectional causality relationship runs from education spending to income growth. The study of Qadri and Waheed (2011) for Pakistan using time series data during 1978 to 2007 shows that both education and health spending leading to the generation of human capital are cointegrated with the growth of the country. Islam, Wadud, and Islam (2007) used data of 1976-2003 for Bangladesh and the evidence of a two-way causal interplay between education level and income growth is seen in the empirical findings. On the other hand, Rahman (2011) explored the causal relationship between health expenditure, education expenditure, and GDP

in Bangladesh for the period 1990-2009 and discovered feedback causal relation between GDP and education spending as well as one-way causal influence as of health spending to the GDP of the country. Korres and Tsamadias (2009) investigated the relationship between productivity and technological change and its consequences upon regional economic growth in Europe and found a close relationship between innovation and productivity levels. However, there were large technological disparities between the member states, which affected productivity performance, increased economic disparities and hinders economic integration. In another study, Korres and Kokkinou (2011) elucidated the consequences of innovative activities on the process of regional convergence in Europe and found divergence. Mehrara and Musai (2013) found a causal association of education level with the levels of GDP in the developing nations. They discovered a substantial link between the two in developing countries for 1970-2010. Avdi (2013) focused on the structure of health insurance system's contribution in Albania. According to the study, one of Albanian politics' biggest issues had been and will continue to be the need for healthcare reform which might enhance the quality of human capital in the country. According to Purnastuti (2016), education had a large positive impact on labour productivity, which was a key factor in both economic growth and overall human development. Malesevic et al (2019) obtained the results for EU15 countries during 1995-2014, where the single most important government expenditure item was education among aggregate expenditure for economic growth. In the Troso traditional waving business, where human capital had a substantial impact on competitive advantages and company success, Ngatindriatun et al. (2020) examined the relationship between intellectual capital and competitive advantage and company performance. Vasyltsiv et al (2021) looked at how the national economy's technical competitiveness impacted fundamental measures of social and economic growth such GDP per capita, the proportion of high-tech exports, capital investment, and quality of life for fostering technological advancement. Osiobe (2020) examined the connection among education and economic progress and concluded that government education investment had a favourable impact on the countries of Latin America. Bajrami and Leka (2020) paid attention to the effects of higher education upon income of the countries. The model revealed substantial relationships and a positive correlation between the variables mean years of education and enrolment in higher education and GDP per capita. Myzrova et al (2020) aimed to estimate the innovative potential of the mesoeconomic system as a criterion which ensures development in a given direction and the results proved that the ability and determination to develop innovative activity was determined by the accumulated aggregate potential of the mesoeconomic system as a whole. In a recent study, Hussain et al (2022) examines the long-term relationship between intellectual capital and human capital formation in different income groups and show that long-term association exists between these two forms of capital for both the panels of high and low and middle-income nations. But the short-run causal interplay works in high-income group only where human capital formation is making a cause to the intellectual capital formation. Recently, Hussain et al (2022) examine the long-term relationship between intellectual capital and human capital in case of some countries from the high-income group (HIG) and low and middle-income group (LMIG) during the period of 1998 to 2018. The findings show that long-term association exists between these two forms of capital for both the panels of high and low and middle-income nations, but in the short-run, causal interplay from human capital formation to the intellectual capital formation works in high-income group only. There are a list of research works on the interrelationships between R&D activity, a source of knowledge capital, economic growth and trade liberalizations in world's leading countries that demonstrate no linkage from R&D to income, etc. (Das and Mukherjee, 2019; Das, 2020; Rahmi & Alliasuddin, 2020; Das and Chatterjee, 2020).

Let us come to the review of the studies for India. Haldar (2009) attempts to examine Lucas model in the context of income growth in India from 1950–51 to 2003–04. Applying cointegration tool he finds that investment on human capital has important contribution to income growth of the country in both the long run and short run. The theoretic and experiential rationale for government's educational investment in India is reviewed by Dastidar, Mohan and Chatterji (2013). Education spending is essential but not enough for economic growth. However, the efficacy of spending on education appears to be influenced by the economy's institutional and labour market features. Sharma and Sahni (2015) affirmed

the long run associations between human capital investment and economic growth in India through co-integration test during 1991 to 2012. Further, there is the occurrence of bidirectional causal interplays between human capital and economic growth. Self and Grabowski (2003) investigate if the causal outcomes differ depending on gender in India. The findings display that basic education is having large causal influence on income growth, whereas secondary education offers less evidence of such an impact. Finally, there is overwhelming evidence that education to the female, at all stages, is also having the ability to spur growth of Indian economy. According to Pradhan (2009), India should focus on the development of human capital too with the physical capital in order to get sustained growth of the country. On the other hand, education is important in Pakistan as it has positive effects on economic growth both in the long run and short run (Afzal et al, 2010). Chandra (2010) examines the causative associations of educational expenses with growth of the Indian economy from 1951 to 2009 and results show that, regardless of any lag effects, income growth impacts the level of public spending on the education head, and also the reverse causality is observed after a time lag. Chakraborty and Krishnankutty (2012) look at education spending as one of the crucial factors of India's growth. However, education spending as a percentage of total spending is not significant in the North Eastern States. On the other study, the effect of educational expenses on India's growth was investigated by Abubakar and Abdulkadir (2015) and it did not find any such cointegrating relations between the two variables. Shukla (2017) investigated the role of expenditure on health care in India's economic growth from 1995 to 2014, and observes a strong and direct associations among them. Not only health, but the secondary School enrollment also affects the Indian economy positively. Parika and Singh (2020) examine the function of human capital in determining output in the Indian market from 1980 to 2017 and the study finds long term impact of human resource upon the economy.

3. Research Gaps and Research Questions

Although there are some studies on the interrelationships between human capital formation and income of India in particular and other economies in general the extant literature does not have any studies on the same theme at the state levels of India. Keeping in mind the fact that human capital is much more affected by the state governments' policies; the present study aims to visualize the interconnections of investment upon human capital formation (which is the sum of education expenditure and health and healthcare expenditure) with income by taking a panel of 29 states/UTs of India from 1998-99 to 2018-19.

The research questions under the study are two folds which are as follows:

1. Are there long run relationships and short run dynamics between human capital investment and income in the panels of Indian states and union territories?
2. Do there exist causal interplays between human capital investment and income in the panels of Indian states and union territories?

3.1. Major Hypotheses of the Study

1. There are no long run relationships and short run dynamics among the panels of human capital investment and output in Indian states and union territories during 1998-99 to 2018-19.
2. No causality exists between the panels of human capital investment and income in Indian states and union territories during 1998-99 to 2018-19.

3.2. Contributions of the Study

The study has contributed to the field of research in the following ways-

1. It addresses how the public expenditure on education and health help in generating human capital and as a result, how human capital influences economic growth.
2. Though there has been a list of works in the related areas in aggregate economy levels, no studies so far have gone through to investigate the same relations in a further micro levels like state/county levels. The present study has focused upon the states and union territory of India to examine whether human capital patronized by education and health expenditures by the state governments have any long run and short run relationships.

4. Theoretical Model

The neoclassical growth theory assumes the exogenous technological progress and diminishing marginal productivity to capital which allows the countries to make convergence to a unique steady state income and per capita capital. Nonetheless the empirical evidence of the performance of the so called developed nations in the eighties showed that the countries, having far greater amount of the stock of physical capital, outperformed the less developed economies having very low levels of physical capital, thereby negated the validity of the predictions of the neoclassical growth theory. A new group of economists emerged who opined that the growth difference in the eighties was due to the working of some factors other than the savings rate, population growth rate etc. as supposed by the neoclassical theory, which broke the assumption of exogenous technological progress, in place they postulated the endogenous technological progress in terms of human capital generation, knowledge capital formation, institutional supports, etc. which are evidenced from the studies such as Romer (1986 &1990); Lucas (1988); Barro and Sala-i-Martin (1995).

There have been lots of empirical verifications of the endogenous growth postulations; the present study is based upon the impact of human capital formation in the states' and union territories' economic growths as well as in whole India. For that purpose, the study is based upon the theoretical structure of Lucas (1988).

It is assumed that labour force, proxied by the stock of population, is capable of producing both the physical as well as human capital. Introduction of the effects of human capital is capable of breaking the diminishing marginal productivity property of capital, and allowing the aggregate production function to follow increasing returns in the system.

Suppose, the neoclassical production function looks like –

1. $Y = AK^{\alpha}L^{\beta}$

where $0< \alpha, \beta<1$ and $\alpha + \beta \leq 1$. 'α' and 'β' respectively indicate output elasticity of capital and labour, and A stands for the factor of exogenous technological progress that makes changes in the factor productivity. Here marginal productivity of capital (MPK) is diminishing.

The rent on capital 'r' is the difference between MPK and rate of depreciation (d), i.e.

2. $r = MPK - d = A\alpha\, K^{\alpha-1}L^{\beta} - d$

Rate of growth of r is-

3. $dr/dt = A\alpha\,(\alpha-1)K^{\alpha-2}L^{\beta}.(dK/dt) + A\alpha\,\beta K^{\alpha-1}L^{\beta-1}.(dL/dt)$

At the steady state, $dr/dt = 0$

Hence,

4. $A\alpha\,(\alpha-1)k^{\alpha-2}L^{\beta}.(dK/dt) = -A\alpha\,\beta K^{\alpha-1}L^{\beta-1}.(dL/dt)$

5. Or, $(\alpha-1)(dK/dt)/dt = -\beta.\,(dL/dt)/L$

6. Or, $(dK/dt)/K = -[\beta/(1-\alpha)].(dL/dt)/L)$

Taking the growth of labour force at the rate n (i.e.$(dL/dt)/L = n$), the above relation is reduced to-

7. $(dK/dt)/K = -\beta n/(1-\alpha)$

This means, the rate of growth of physical capital is directly related to the growth rate of labour force.

In endogenous growth models, labour force is assumed to generate human capital besides physical capital. Following Lucas (1988) structure, the revised production function can be written as-

8. $Y = AK^{\alpha}H^{\theta}L^{\beta}$

Here $0<\alpha, \beta, \theta<1$ and $\alpha + \beta + \theta > 1$ which ensures the break or non-working of the diminishing marginal productivity channel and generating the scope of positive growth rates of income even with high values of capital/income in the initial time point. The rate of growth of K and H are now related to the rate of growth of labour force in the following way-

9. $(dK/dt)/K + (dH/dt)/H = (dL/dt)/L$

The marginal productivity of capital is now-

10. $dY/dK = A\alpha K^{\alpha-1}L^{\beta}H^{\theta}$

or, $New\ dY/dK = Old\ dY/dK.H^{\theta}$

This means,

11. $New\ dY/dK > Old\ dY/dK$

Hence, the growth rate of per capita consumption expenditure and per capita income remain positive in the longer runs. As the physical capital becomes more productive now with the inclusion of human capital than that under the neoclassical model it can now be considered that growth of income will now be greater if human capital is considered as another source of capital in the production system. Lucas model of endogenous growth is thus having the explanatory power to why the so called developed economies in the world grew more than the less developed economies in the 1980's.

The present study follows this theoretical concept in examining the interrelationships between human capital and income of the panel of states and union territories in India during 1998-99 to 2018-19. Here in the study, the level of human capital is substituted by the state governments' expenditures on the education and health sectors.

5. Data Source

Government expenditure on health (GEH) and government expenditure on education (GEE), and economic output as proxied by the Net State Value Added (NSVA) are the three major variables in this study. All of them are measured in INR lakh at the base period 2004-05. Education spending, as well as sports, art, and cultural spending, are all included in GEE. Medical, public health, and family welfare spending are all included in GEH Both GEE and GEH are based on revised budget estimates, with expenditures computed as the ratio of the total government expenditure. The secondary data is gathered from annual publications of the Reserve Bank of India (visit www.rbi.org.in) for the period 1998-99 to 2018-19. Total human capital investment (HCI) is the sum of GEH and GEE. There are 28 states and one union territory, Delhi, which are considered for the study. The new state Uttarakhand is sometimes called Uttaranchal.

6. Empirical Methodology

To carry out the study, the panel unit root tests in lines of Levin, Lin, and Chu (LLC) (2002), Breitung and Das (2005), and Im, Pesaran and Shin (2003), Fisher (1932) and Hadri (200) are implemented. For testing the panel cointegration, the present study uses the Engle-Granger (1987) two-step-residual-based-cointegration tests such as of Pedroni and Kao. Also it uses the Fisher test which is a combined Johansen test. After that, the Vector Error Correction Model (VECM) and Wald test are exercised for examining short run dynamics and causal interplays between the variables.

6.1. Panel unit root test

6.1.1. Common unit root process

The ADF equation for the LLC technique is-

$$Q\Delta Y_i = \mu_i Q + \rho Q Y_{i,t-1} + \sum_{j=1}^{p_i} \beta_{ij} Q\Delta Y_{i,t-j} + Q\varepsilon_i \quad (12)$$

Where, Q is idempotent transformation matrix. In LLC, the testing hypotheses are H_0: $\rho = 0$ and H_1: $\rho < 0$.

The t-ratio is-

$$t_\rho = \frac{\sum_{i=1}^{N} \hat{\sigma}_i^{-2} \Delta Y_i' Q Y_{i,-1}}{\sqrt{\sum_{i=1}^{N} \hat{\sigma}_i^{-2} \Delta Y_i' Q Y_{i,-1}}} \text{ where} \hat{\sigma}_i^2 = \frac{\Delta Y_i' Q Y_i}{T-2}$$

Breitung (2005) method differs from LLC. The perseverance factor ρ is estimated by the help of the following pooled equation-

13. $\Delta Y_{it}^{*} = \rho\, Y_{it-1}^{*} + v_{it}$

Where $Y_{it}^{*} = \tilde{Y}_{it} - \tilde{Y}_{i1} - \frac{t-1}{T-1}(\tilde{Y}_{iT} - \tilde{Y}_{i1})$

Breitung confirms that the resulting estimator ρ^{*} is asymptotically distributed as a standard normal under the null hypothesis.

6.1.2. Individual unit root process

In a relatively more flexible and simple method, Im, Pesaran and Shin (2003) (*IPS*) established the panel unit root test using the likelihood method. It is basically a set of ADF tests where the hypotheses are- $H_0 : \rho_1 = \rho_2 = \ldots = \rho_N = \rho = 0$ and $H_1 : \rho_1 < 0, \rho_2 < 0, \ldots, \rho_{N1} < 0$, $N_1 < N$.

The test statistic is $\bar{t} = \frac{1}{N}\sum_{i=1}^{N} t_i$ where t_i is the DF t-statistic of ith cross section and is presumed to be i.i.d. with finite values of the mean and variance. The expression for t_i is $t_i = \frac{\Delta Y_i' Q Y_{i,-1}}{\hat{\sigma}_i^2 \sqrt{\Delta Y_i' Q Y_{i,-1}}}$.

Fisher (1932)-type test uses the level of significance (p_i) of the ADF statistics for the ith (i= 1, …, N) cross section unit. The hypotheses under this test are- H_0: $\rho_i = 0$ and H_1: $\rho_i < 0$, and $\rho_i = 0$ for $i = N_1 + 1, \ldots, N$, with $0 < N_1 \leq N$. The test statistic is $P = -2 \sum_{i=1}^{N} \log(P_i)$ which is used in Choi (2001) model.

The test technique of Hadri (2000) (common unit root process) is based on residual and is done by the Lagrange multiplier test. The test is on the ratio of variances. The hypotheses under the test are- H_0: $\lambda = \frac{\sigma_u^2}{\sigma_e^2} = 0$ and H_1: $\lambda > 0$ where the LM statistic is, $LM = \frac{1}{\hat{\sigma}_e^2}\frac{1}{NT^2}(\sum_{i=1}^{N}\sum_{t=1}^{T} S_{it}^2)$.

6.2. Panel cointegration test

The Engle-Granger paradigm is extended to panel data testing by Pedroni (1999, 2004) and Kao (1999). Pedroni presents a number of cointegration tests that take into account non-homogeneous intercepts and trends in different identities. The regression form of the test is as follows-

14. $Y_{it} = \alpha_i + \delta_i t + \beta_{1i} X_{1i,t} + \beta_{2i} X_{2i,t} + \ldots + \beta_{mi} X_{mi,t} + e_{it}$

Where all the Xs are taken to be I (1). Individual and trend effects are controlled via the parameters α_i and δ_i which, if desired, can be fixed to zero. The residuals e_{it} will be I(1) for no cointegration null hypothesis. The residuals are generated by the following equation-

15. $e_{it} = \rho_i e_{it-1} + \sum_{j=1}^{\rho_i} \phi_{ij} \Delta e_{it-j} + v_{it}$

Pedroni test has again many dimensions depending upon within or between estimates incorporating trends, intercepts and both.

The Kao test goes in line with the residual test where the test statistics is-

16. $\text{ADF} = \frac{t_{\bar{\rho}} + \sqrt{6N}\hat{\sigma}_v / (2\hat{\sigma}_{0v}}{\sqrt{\hat{\sigma}_{0v}^2 / 2\,\hat{\sigma}_v^2 + 3\hat{\sigma}_v^2 / (10\hat{\sigma}_{0v}^2)}}$

Fisher (1932) develops a combined test for cointegration. If Ω_i is the probability value (*p*-value) after a cross sectional cointegration test, then the following will hold when the null hypothesis will work-

17. $-2 \sum_{i=1}^{N} \log(\Omega_i) \rightarrow \chi^2 2N$

EViews reports the χ^2 value for the test based on MacKinnon-Haug-Michelis (1999) p-values.

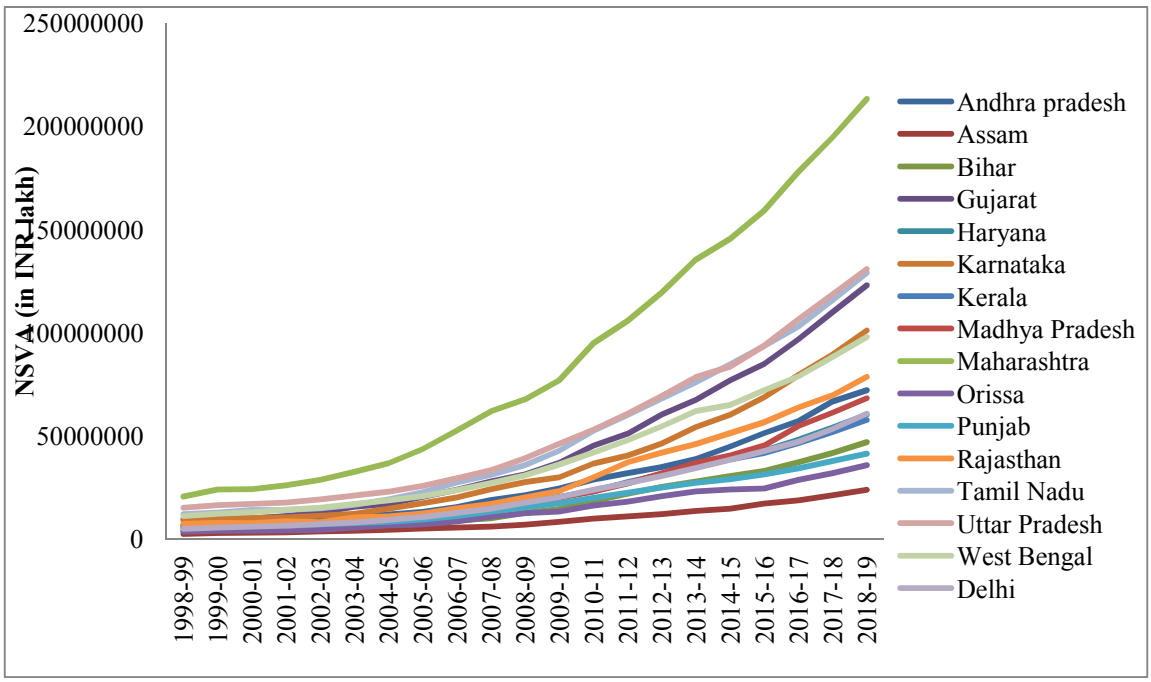
6.3. Vector Error Correction Model (VECM) estimation and Wald Test

After the confirmation of the prevalence of cointegration among the variables, the short run dynamics is investigated by means of VECM. VECM also indicates the speed of adjustment in the deviations. And finally, short run causal interplays are done by Wald test.

7. Empirical Results and Discussion

Before moving for proposed econometric exercises, the study presents the data on NSVA and HCI in two sets of line diagrams for each to have ideas about their trends at a glance. Figure 1 and 2 show NSVA and Figure 3 and 4 show HCI.

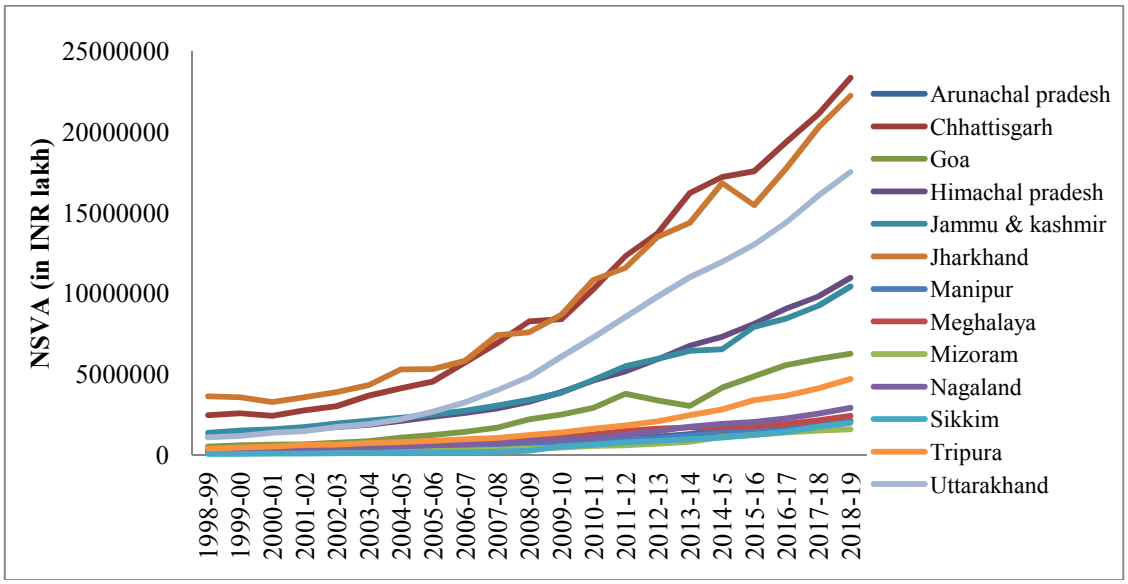
Figure 1. Trends of NSVA for the leading states in India



Source: Drawn by the Authors

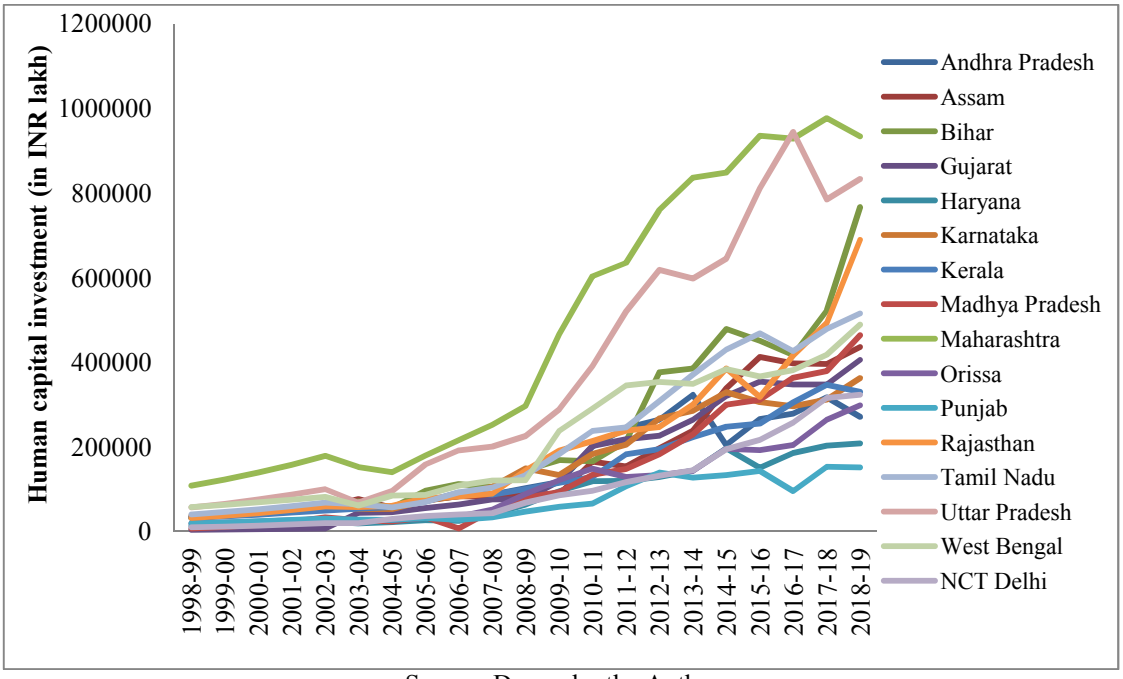
It is seen from Figure 1 and 2 that the trends of NSVA are increasing for all the states. Maharashtra leads the group followed by Uttar Pradesh and West Bengal. On the other hand, Sikkim is at the bottom level preceded by Mizoram and Meghalaya.

Figure 2. Trends of NSVA for the follower states in India



Source: Drawn by the Authors

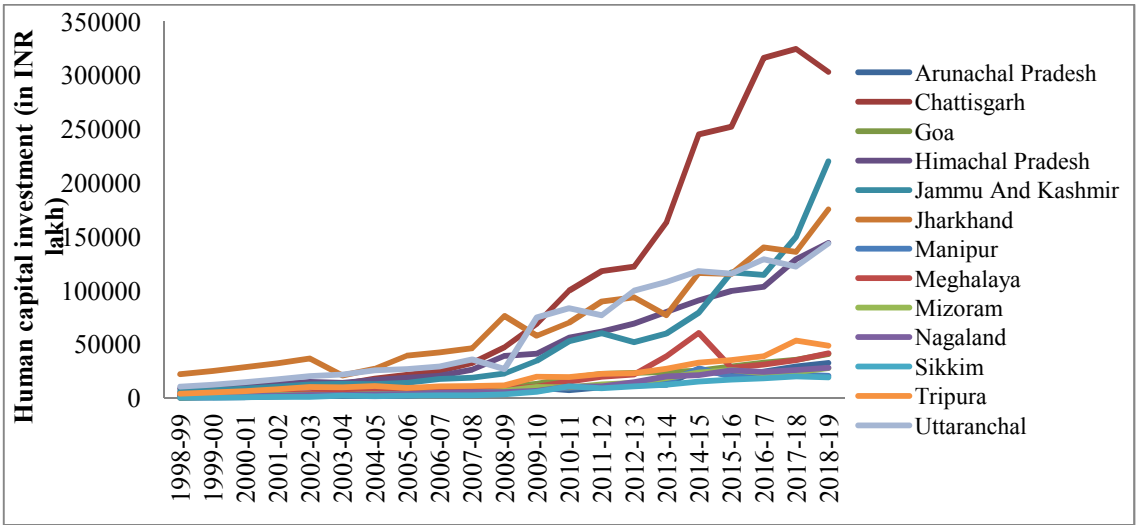
Figure 3. Trends of HCI for the leading states in India



Source: Drawn by the Authors

It is observed from Figure 3 and 4 that the trends of HCI are increasing for all the states in India. Maharashtra still holds the top position followed again by Uttar Pradesh and West Bengal. On the other hand, Sikkim stays at the bottom preceded by Nagaland and Meghalaya.

Figure 4. Trends of HCI for the follower states in India



Source: Drawn by the Authors

Comparing the figures 1 to 4, it can be said that the incomes of the states are associated with their human capital investment, the sum of education and health expenditures by their governments. The study thus goes for investigating the interrelationships between income and HCI in the panel of the states and union territory.

In this section the study presents the results of panel unit roots to Wald test as mentioned in the methodology section.

7.1. Panel unit root test results

The study finds that the series belonging to NSVA and HCI are non stationary in their level values and they are converted to stationary series after taking their first differences. The upper part of Table 1 reports the results of panel unit root test for NSVA and the lower part is that of the HCI.

Table 1. Panel unit root test results

Series: D(NSVA)				
Hypotheses	Methods	Statistic	Prob	Obs.
H_0: Presence of unit root (Assuming common unit root)	LLC t* test	-8.74679	0.0000	535
	Breitung's t-stat	0.84097	0.7998	506
H_0: Presence of unit root (Assuming individual unit root)	IPS W-stat	-8.58389	0.0000	535
	ADF-Fisher χ^2	184.198	0.0000	535
	PP- Fisher χ^2	243.912	0.0000	551
H_0: No unit root (Assuming common unit root)	Hadri Z-stat	6.76786	0.0000	580

Series: D(HCI)				
Hypotheses	Methods	Statistic	Prob	Obs.
H_0: Presence of unit root (Assuming common unit root)	LLC t* test	-12.4961	0.0000	527
	Breitung's t-stat	-0.49152	0.3115	498
H_0: Presence of unit root (Assuming individual unit root)	IPS W-stat	-13.0258	0.0000	527
	ADF-Fisher χ^2	265.708	0.0000	527
	PP- Fisher χ^2	310.737	0.0000	551
H_0: No unit root (Assuming common unit root)	Hadri's Z-stat	8.82052	0.0000	580

Note: Automatic lag selection is based on SIC: 0 to 3

Source: Authors' calculations

The null hypothesis of 'no cointegration' is rejected in the case of first differenced series which implies, as per majority of the results, both the series are first difference stationary making the series to be I(1).

7.2. Lag length selection results

It is also a precondition to compute the optimum lag of the two series before going for further time series econometric exercises such as cointegration and causality analyses in a panel data. There are many criterions of selecting optimum lags, mostly used criterions are Schwarz Information Criterion (SIC), Akaike Information Criterion (AIC), and Hannan-Quinn Information Criterion (HQIC). The present study derives the optimum number of lags on the basis of AIC, SIC and HQIC. The results are given in Table 2. It is observed that two criteria, SIC and HQIC, give lowest values at lag four which means the influence of the variables of four years lag is significant upon the current period's values of the variables in the panel.

Table 2. Lag length selection criteria

Lag	AIC	SIC	HQIC
0	63.22600	63.24961	63.23543
1	54.78938	54.86020	54.81766
2	54.73871	54.85674	54.78584
3	54.67161	54.83685	54.73760
4	54.57171	54.78417*	54.65656*
5	54.57112	54.83079	54.67482
6	54.58097	54.88785	54.70352

Note: * implies lag order pointed out by the noted criteria.

Source: Authors' calculations

7.3. Panel cointegration test results

The study presents the results of cointegration in the selected panel data using the methods mentioned above which are the Pedroni test, Kao test and Fisher Johansen test. For the Pedroni test and Kao test, the results are derived using individual intercepts. The results are given in Table 3.

Table 3. Panel cointegration test results

Name of the test	Category of the test	Statistic	Probability
Pedroni test (Individual intercept)	Panel v-stat.	12.91524	0.0000
	Panel rho- stat.	-1.44553	0.0742
	Panel PP- stat.	0.789887	0.7852
	Panel ADF- stat.	-4.33163	0.0000
	Group rho- stat.	-2.89984	0.0019
	Group PP- stat.	-4.21197	0.0000
	Group ADF- stat.	-2.66644	0.0038
Kao test	ADF- stat.	0.427674	0.3344
Fisher (Combined Johansen) test	Fisher stat.	485.8000	0.0000
	Fisher stat. (Max. Eigen value)	395.3000	0.0000

Source: Authors' calculations

Pedroni test has seven diverse statistics. Out of them, the first four are within-dimension and the remaining three are for between-dimension estimates. The majority of the test statistics under Pedroni test reject the hypothesis of 'no cointegration'. It implies both the panels of the variables, NSVA and HCI, maintain an equilibrium or long-run relationship among them. Further, the Kao ADF-Statistic does not reject the hypothesis of 'no cointegration' implying no long run relations among the variables in the panel data. But the cointegrating relation among the variables has been shown by Fisher combined test.

Considering the results of all the test statistics, the majority of the results reject the hypothesis of 'no cointegration'. Therefore, the study arrives at the conclusion that the two unit root variables NSVA and HCI are cointegrated. In other words, there is the presence of long run association among economic prosperity and the human capital investment in the panel of the states and UTs in India. The budgetary expenses of the state governments in India upon education and health sectors have anyway maintain co-movements with their incomes. It is a good sign so far as the motives of the state governments towards generation of human capitals are concerned. We thus move to our next step of investigations, the VECM.

7.4. Estimation through VECM

With the objective of examining the dynamics of the associations observed in long run in the panel of states/UTs with respect to income and human capital formation, the VEC model is constructed for the lag of four years (refer to Table 2) in the following way-

18.

$$\Delta NSVA_t = C(1) + C(2)\,\Delta(NSVA)_{t-1} + C(3)\,\Delta(NSVA)_{t-2} + C(4)\,\Delta(NSVA)_{t-3} + C(5)\,\Delta(NSVA)_{t-4} + C(6)\,\Delta(HCI)_{t-1} + C(7)\,\Delta(HCI)_{t-2} + C(8)\,\Delta(HCI)_{t-3} + C(9)\,\Delta(HCI)_{t-4} + Cons.$$

The estimated VEC model is:

19.

$$\Delta(\hat{NSVA})_t = \underset{Prob:}{\underset{(0.0124)}{\underset{(0.0056)}{0.1147} + \underset{(0.0000)}{0.1472}\,\Delta(NSVA)_{t-1} + \underset{(0.8039)}{0.0142}\,\Delta(NSVA)_{t-2} + \underset{(0.0002)}{0.2236}\,\Delta(NSVA)_{t-3}}} + \underset{(0.0000)}{\underset{(0.0078)}{0.1580}}\,\Delta(NSVA)_{t-4} + \underset{(0.0000)}{11.0041}\,\Delta(HCI)_{t-1} + \underset{(0.0000)}{9.5984}\,\Delta(HCI)_{t-2} + \underset{(0.3904)}{2.0397}\,\Delta(HCI)_{t-3} + 7.0195\,\Delta(HCI)_{t-4} + 1826762$$

The coefficient of $\hat{\varepsilon}_{t-1}$ is found to be positive and statistically significant. Prevalence of the result of positive coefficient of $\hat{\varepsilon}_{t-1}$implies that the divergence from the equilibrium will persist and the relationships among the variables will be temporary, other variables may work in the interim other than the human capital to justify the growths of incomes of the states. Such diverging relations will further imply that there will be no causal effects from human capital to income in the long run framework. But there can be short run causal interplays among the variables. Here the coefficient of ΔHCI such as C(6), C(7), C(8) and C(9) give the indications of short-run causal relationships between investment upon human capital and output of the states and UTs. The derived results through Wald test (Table 4) show that the individual coefficients of the regressions are significant statistically which show the occurrence of the causal influence from investment upon human capital to economic output in the short-run as the value of the Chi-square statistic is 35.67 with very low value of the probability.

Table 4. Wald test results

H_0:C(6) = C(7) = C(8) = C(9) = 0 [No short-run causality running from HCI to NSVA]			
Test Statistic	Value	df	Probability
Chi-square	35.66898	4	0.0000

Source: Authors' calculations

Further, the three coefficients of the lag terms of HCI, C(6), C(7) and C(9), are found to be positive and significant. They present the degree of influence of the human capital formation upon the incomes of the panel of the states/UTs. One unit rise in the change of HCI in the last year makes to 11 unit rise in the change of state incomes of the current year. The value for lag 2 is 9.6 and for lag 4, it is 7. Therefore, the impacts of 1-4 years' lag in the human capital are observed to be significant upon the current period's incomes of the states and UTs.

7.5. Linkage with intellectual capital and regional policy practices

The results so far are justified to conclude that the human capital generated in the states and UTs in India is one of the sources in the increases in the incomes of the states and UTs as it has associations with the incomes of the states/UTs at least in the short run with respect to its significant causal influences to the incomes. A large population size in India like countries should not be considered as the negative items to the growth of income as the neoclassical growth model claims. It rather helps in generating extra demand in one side and generating human capital through government supported education and health initiatives. Once the stock of human resource is sufficiently generated by means of school and higher levels education and increasing life expectancy, reducing infant mortality rates, etc. then there can be automatic generation of intellectual/knowledge capital. Although the nature of human capital is somewhat private and rivalry in nature, the knowledge capital or R&D (research and development) is mostly public in nature with non-rivalry and non-excludability features. Therefore, the chain of effects, in the long run, human capital formation→ knowledge capital formation→ positive per capita income growth, can be expected to work and the country as a whole will be benefitted in terms of attaining the true stage of development. The governments of the states and UTs are, therefore, recommended to make further investments in the sectors, such as education and health, to ensure better economic growths of them.

Formation of good human capital is not only helpful for a country in terms of economic progress, it can also be a good content for development so as to maintain sustainability at the global level. If the countries focus in this area to strengthen their human capital base by means of research and development activities, good innovation practices, the volume of good quality human capital will increase leading to good use of environmental resources, save the nature and promoting the achievement of sustainable development. So, the leaders at the global level as well as the regional levels should focus upon developing human capital base through proper collaborations and participations.

8. Conclusion

Human capital is, without a doubt, one of the most significant components of production function in the today's world so far as the development of the endogenous growth theories are concerned. Human capital investments tend to boost the efficiency and productivity of an

economy's existing labour force; hence it's often linked to the growth of the economy. Improved human capital, as it is generally contended, leads to increased level of economic output and side-by side, output expansion leads to human capital formation. Thus, the present study aimed to examine whether there could be empirical evidences on the co-movements or associations among investment in human capital and economic output for panel of states/UTs of India during the period from 1998-99 to 2018-19. In this regard the study applied panel cointegration technique to show long run association and then used Wald test to show the short run direction of causal interplay between human capital investment and economic output. The empirical results show that there arises a long run association among human capital formation and economic progress. Employing Wald test, it is also found that a short run association between human capital and economic output exists and the causality is in the direction from human capital investment to economic output. i.e., economic progress is influenced by human capital instantly. Keeping the merit and depth of the findings, the study, therefore, recommends that the governments of the states and UTs should make further investments in the sectors, such as education and health, to ensure better economic growths to their economies in the long run.

9. Limitations and Future Directions of the Study

The present research, although covers the panel of the states and union territories of India, considers government spending on the sectors such as health and education as the key variable for human capital formation and its implications to state outputs. But the study could be better if it could consider human capital stock such as number of literate persons, number of higher educated persons, life expectancy, child care, health care, etc. Again, the study could also focus on the linkage among human capital and intellectual capital and their implications with state and territorial incomes. The present study restores all of the undone works as its future research agenda.

10. Practical Implications

The study so far with the results have strong practical significance with the public operating systems of India in its states and territorial levels in the heads of education and health in particular, and human capital in general. Higher representations of the total population in education sector and good quality health through proper infrastructural development will be the key to India’s future. The study can be applicable to other countries as well. All the governments at the provincial and territorial levels in each country should focus on this area to out-progress the peers at the global level.

11. Authors’ Contributions

The entire work is the outcome of combined effects. The second author has provided the theoretical and empirical ideas, constructed the theoretical model, relate the work with intellectual capital, and edited the entire work. The first author has intervened in literature review, empirical methodology and empirical estimations.

12. Disclosure Statements

It is declared that the authors did not face any conflict of interests with anybody while developing the full paper. Also, it is disclosed that there was no funding agency behind the work, and there was no use of animals/human beings in the work.

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THE REGIONAL ECONOMIC INDICATORS AND ECONOMIC DEVELOPMENT OF KOSOVO

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Abstract

This paper examines the importance of regional economic indicators in the economic development of Kosovo. Regional economic indicators provide valuable insights into the economic performance and potential of different regions within a country. By analyzing these indicators, policymakers can design targeted strategies that promote economic growth and reduce regional disparities. In Kosovo, regional economic disparities have been a persistent challenge, with some regions experiencing significantly higher levels of poverty and unemployment. The paper argues that the adoption of regional economic indicators can help identify and address these disparities. Several indicators are examined, including income per capita, unemployment indicators, and the poverty rate to provide a comprehensive overview of regional economic development in Kosovo. Analysis of secondary data through the method of descriptive statistics reveals significant disparities in different regions and underlines the need for targeted policies and interventions. In conclusion, it underlined the importance of developing a strong and reliable system for the collection and reporting of regional economic indicators, which can inform evidence-based policy-making and support a more equitable and sustainable regional economic development in Kosovo.

Keywords: dicator, regional development, income per capita, decent work
JEL classification: J30, J80, O10, M10, R10, R58

1. Introduction

Regional economic indicators play a crucial role in the economic development of Kosovo. These indicators provide important information about the performance of different regions in the country, which in turn helps policymakers to identify areas that require more attention and investment. Here are some of the key ways in which regional economic indicators contribute to the economic development of Kosovo:

Identifying regional strengths and weaknesses: Regional economic indicators help to identify the areas of the economy that are performing well and those that are lagging behind. This information allows policymakers to devise strategies that build on the strengths of the region and address the weaknesses. For example, if a region has a strong agricultural sector, policymakers may focus on policies that promote agricultural exports or boost agribusiness investments.

Promoting investment: Investors look at regional economic indicators to decide where to invest their money. Regions with strong indicators of economic growth, such as a high GDP per capita or a low unemployment rate, are more likely to attract investment. This investment can help to fuel economic growth, create jobs and improve living standards in the region.

Planning infrastructure development: Regional economic indicators can inform decisions about infrastructure development, such as transport networks, energy systems, and communication facilities. By identifying the regions that need improvement in certain infrastructure areas, policymakers can allocate resources to these areas, enhancing connectivity and facilitating trade, making it easier and cheaper for business and community to connect with each other and with the rest of the world.

Informing social policy: Regional economic indicators also help inform social policies, such as education and health care. For example, a region with a high poverty rate and low education levels may require more investment in education and health care facilities. Social policy needs to be informed and shaped by economic indicators, including poverty and inequality measures, unemployment statistics, and wellbeing indicators.

2. Research problem

The research problem in this case would be: What is the relationship between regional economic indicators and the economic development of Kosovo, and how can regional economic indicators be used to promote economic growth in Kosovo? Specifically, how can local economic data like GDP, employment rates, and income levels be leveraged to create targeted policies and strategies that address the economic challenges and opportunities specific to each region within Kosovo? Additionally, what are the key limitations or challenges to using regional economic indicators in Kosovo, and how can these be addressed to ensure that policymakers and stakeholders have access to timely, accurate, and actionable data? This research problem is important because understanding the relationship between regional economic indicators and economic development will be critical to promoting sustainable and inclusive growth in Kosovo over the long term.

3. Research methodology

An extensive review of the literature on regional economic development and the role of regional economic indicators was conducted, including examination of academic journals, reports, papers and other relevant sources of information. Secondary data have been collected for regional economic indicators in Kosovo, which include information on GDP, income per capita, unemployment rates, economic growth rates, poverty rates and other relevant indicators which have been analyzed and processed through the method of descriptive statistics. Regions in Kosovo that have experienced positive economic development have been analyzed, identifying the role of regional economic indicators in promoting growth and economic development. From the analysis of the statistical data, the regional economic indicators are clearly defined, which have been adequately taken into account in the formation and implementation of development policies and strategies. Based on the findings of the study, conclusions and recommendations are drawn for policy makers, researchers and other stakeholders on how to use regional economic indicators to promote economic development in Kosovo.

4. Theoretical Framework

4.1. Country's macroeconomic stability

Following a very strong rebound in 2021, Kosovo's economic growth moderated in the first quarter of 2022. Before the pandemics, i.e. in 2016-2019, the average rate of GDP growth was well over 4%. Real GDP surged by 10.5% in 2021, on the back of the revival of diaspora travelling, increasing remittances and investment as well as a strong growth in household loans. Further support came from the pandemic-related government measures. Robust growth in 2021 brought Kosovo's economy above the pre-pandemic level in real terms. Economic growth slowed down to 4.8% in the first quarter of 2022, in line with historical trend. Rapidly rising energy and food prices in the first half of 2022 started to erode the disposable income of households. Slowly advancing economic diversification, high import dependency and an unreliable energy supply make Kosovo vulnerable to adverse external shocks. Kosovo's per capita GDP remains the lowest in the region. It stood at 26 %

of the EU average in 2021. Due to a large informal sector and high inactivity rates, especially among women, Kosovo has high income inequalities. (World bank 2022).

Table 1: Kosovo Key Economic Indicators

Kosovo - Key economic figures	**2019**	**2020**	**2021**
Population in million	1.8	1.8	1.8
GDP (current US$ Billion)	7.19	7.72	9.41
Real GDP growth (%)	4.8	-5.3	10.5
GDP per capita (% of EU-27 in PPS)	26	26	
GDP per capita (US$)	4,416	4,310	5,269
Unemployment rate (%)	25.7	25.9	25.8
Net foreign direct investment, FDI (% of GDP)	2.7	4.2	4
General government debt (% of GDP)	17.6	22.4	21.9
Current account balance (% of GDP)	-5.7	-7	-8.6

Source: Kosovo Agency of Statistics, World Bank and IMF

4.2. Economic development and competitiveness

In line with the conclusions of the European Council in Copenhagen in June 1993, EU accession requires the existence of a functioning market economy and the capacity to cope with competitive pressure and market forces within the Union. Economic governance has become even more central in the enlargement process in recent years. The Commission's monitoring takes place in two processes: The Economic Reform Program exercise and the assessment of compliance with the economic criteria for accession. Every year, each enlargement country prepares an economic reform programme (ERP), which sets out a medium-term macro-fiscal policy framework and a structural reform agenda aimed at ensuring competitiveness and inclusive growth. The country has made limited progress and is at an early stage in terms of ability to cope with competitive pressure and market forces in the EU. Little progress was made on improving the quality of education and addressing skill gaps in the labor market. Kosovo made some progress in improving road infrastructure and increasing investment in renewables, but the coal-based, outdated and unreliable energy supply remains a concern.

4.3. Regional policy and coordination of structural instruments

Regional policy is the EU's main investment policy for sustainable and inclusive economic growth. Member States bear responsibility for implementation, which requires adequate administrative capacity and sound financial management of project design and execution. Kosovo is at early stage of preparation regarding regional policy and coordination of structural instruments. During the reporting period, Kosovo adopted the Law on Regional Development.

The Regional Development Strategy 2020-2030 adopted in February 2021, as well as draft Law on Regional Development, envisage that Kosovo would have seven regions at NUTS III level, and hence, seven regional development agencies. However, the legal basis, the law on Regional Development has not yet been approved by the government, setting out the basic principles of regional development management, the responsibilities of institutions, financial instruments, and the rules for balanced regional development. The amended Law on Regional Development that should be adopted in 2022, will improve regional development policy. The institutional framework for the management of the EU funds is not yet established. However, structures for the management of national regional development programs and projects are in place and functional.

Kosovo made some progress on the economic criteria, and is at an early stage of developing a functioning market economy. The economy demonstrated resilience during the pandemic. Nevertheless, long-standing structural challenges, such as the widespread informal

economy, the high prevalence of corruption and the overall weak rule of law, continue to hinder the private sector. While the fiscal rule has been suspended since 2020, the economic recovery as well as formalization gains led to a strong increase in tax revenue and a low public deficit in 2021. Driven by surging commodity prices, inflation increased substantially. The financial sector remained stable, and lending continued to expand. Despite strong political opposition, the government took fiscally prudent positions regarding war veterans' pensions and the Kosovo Pension Savings Trust. (EU Kosovo* report, 2022).

4.4. Regional key economic indicators

In order to support regional development policies according to the EU model that aims to reduce inequalities between different European regions, Kosovo also takes into account a number of economic and social dimensions of the regions for a sustainable and prosperous development. A large part of the EU budget is devoted to the promotion of inclusive development and the evaluation of the economic impact of such policies is of crucial importance to policy makers. Macroeconomic variables such as GDP per capita and employment are all interrelated and it is important to understand how they react to policies and other external factors.

GDP per capita compared

Considering that we have selected GDP per capita as the main indicator to understand how income inequality affects regional and national development in the country, in table 2 we present the comparative analysis of Kosovo with the main international indicator to understand the current reality and what it aims Kosovo to do in a short-term and long-term to ensure stability in its path towards the European Union.

Table 2. GDP per capita compared

GDP per capita, current prices	USD
Kosovo	5,300
Emerging market and developing economies	7,300
World	13,920
European Union	33,000
Advanced economies	55,040

Source: IMF and World bank 2023 and Author's Calculations

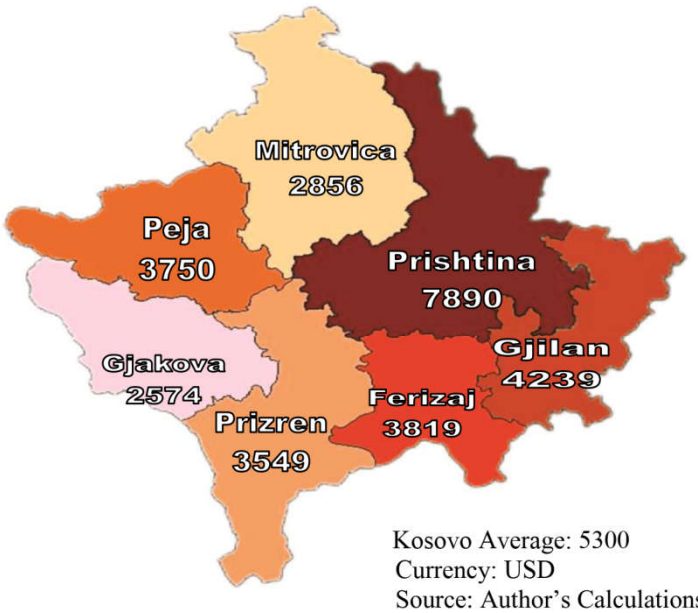
Table 2 shows the GDP per capita of Kosovo, which is 5,300 USD compared to emerging markets and developing economies GDP per capita with 7,300 USD, the world with 13,920 USD, the European Union with 33,000 USD and advanced economies with 55,040 USD. This table clearly shows the deep imbalance between the income per capita of Kosovo, which is far from the average of developing economies, half of the world income per capita, and far from the European Union income per capita that Kosovo intends to join.

Therefore, the author has focused on the analysis of GDP per capita according to the seven administrative regions of Kosovo to understand the existing differences between them and the importance of harmonizing the development policies that will reduce inequalities and promote the economic development of Kosovo. The detailed data by regions are reflected in the table 3 below:

In the table are presented the GDP per capita for the seven main districts of Kosovo where the main capital district Prishtina leads with 7,890 USD income per capita, twice the other districts followed by Gjilan with 4,239 USD, Ferizaj 3,819 USD, Peja 3,750 USD, Prizren 3,549 USD, Mitrovica 2,856 USD and Gjakova with 2,574 USD. Based on the analysis of table 3., we can clearly see how deep the disparities between the districts are.

Table 3. Kosovo GDP per capita at regional level

GDP per Capita at Regional Level in 2022



Kosovo Average: 5300
Currency: USD
Source: Author's Calculations

4.5. Kosovo Unemployment at district level

However, according to a report by the Kosovo Agency of Statistics, the unemployment rate in Kosovo for the year 2021 was 25.6%. The highest unemployment rate was reported in the region of Gjilan with 33.20%, while the lowest unemployment rate was reported in the region of Prizren with 17.9%. However, generally, Kosovo's economic indicators can be analyzed based on different regions as per the table 4 below:

Table 4. Kosovo Unemployment at district level

Kosovo main Districts	2021
Prishtina	25.30%
Prizren	17.83%
Gjakova	29.70%
Peja	26.50%
Mitrovica	28.39%
Ferizaj	30.10%
Gjilan	33.20%

Source: Kosovo Agency of Statistics and Author's calculations

Pristina with unemployment of 25.30%, as a capital city of Kosovo is the main economic hub of the country. It has a diversified economy with significant contributions from the services sector, manufacturing, and construction industries. Mitrovica with unemployment rate of 28.39% is located in northern Kosovo, this region is primarily known for its mining and manufacturing industries. Peja with unemployment rate of 26.50%, this western region of Kosovo is known for its agricultural production, particularly in fruit and vegetable cultivation and its tourism industry development. Gjilan with unemployment rate of 33.20%, this southeastern region of Kosovo has a strong agricultural sector, especially in crop and livestock production with growing manufacturing industry as well and Prizren with unemployment rate of 17.83%, located in southwestern Kosovo, this region has a diverse economy with contributions from agriculture, tourism, and small-and medium-sized enterprises.

These are just two examples of how the economic indicators of Kosovo can be according to the region, and in this case the differences between the regions are very deep, becoming a source of economic and social imbalances.

4.6. Sustainability and regional development

Economic growth and decent work

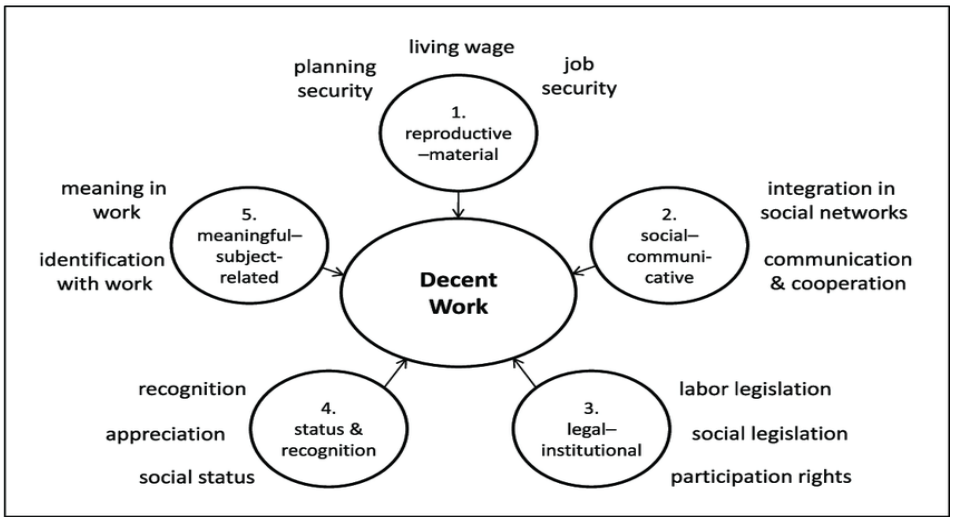
The 2030 Agenda for Sustainable Development, adopted by the 193 Member States of the United Nations at the General Assembly in September 2015 including Kosovo, outlines a transformative vision for economic, social and environmental development and will guide the work of the Organization towards this vision for the next 15 years. This new road map presents a historic opportunity for Kosovo, since it addresses some of the region's most urgent priorities, such as ending extreme poverty, reducing inequality in all its dimensions, promoting inclusive economic growth with decent work for all, creating sustainable cities and addressing climate change. The 17 Sustainable Development Goals (SDGs) associated with the Agenda help the region's countries to gauge the starting point from which they set out towards this new, collective vision of sustainable development set forth in the 2030 Agenda and its implementation. The SDGs also represent a planning and follow-up tool for the countries at the national and local levels. With their long-term approach, they offer support for each country on its path towards sustained, inclusive and environmentally friendly development, through the formulation of public policies and budget, monitoring and evaluation instruments. The 2030 Agenda is a civilizing agenda that places dignity and equality at the center. At once far-sighted and ambitious, its implementation will require the engagement of all sectors of society and of the State. Accordingly, the representatives of governments, civil society, academic institutions and the private sector are invited to take ownership of this ambitious agenda, to discuss and embrace it as a tool for the creation of inclusive, fair societies that serve the citizens of today as well as future generations.

4.7. SDG8 Economic Growth and decent work

The SDG8 Promote inclusive and sustainable economic growth, employment and decent work for all. Roughly half the world's population still lives on the equivalent of about US$2 a day. And in too many places, having a job doesn't guarantee the ability to escape from poverty. This slow and uneven progress requires us to rethink and retool our economic and social policies aimed at eradicating poverty. The UN has defined 12 *Targets* and 17 *Indicators* for SDG 8. Targets specify the goals and Indicators represent the metrics by which the world aims to track whether these Targets are achieved. Below in the table 5 we present the elements of decent work recommended to be applicable by policy makers of all countries including Kosovo as a successful mechanism for unemployment reduction, inequalities reductions and sustainability enforcement.

Table 5. Decent work elements

Five dimensions of decent work



Source: SDG tracker 2021

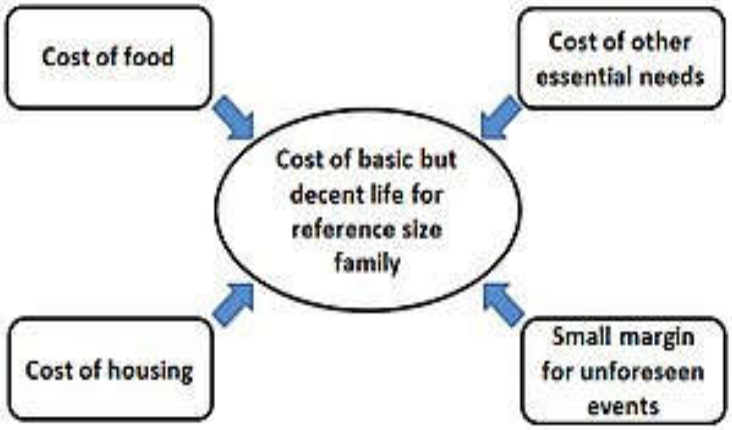
Decent work is employment that "respects the fundamental rights of the human person as well as the rights of workers in terms of conditions of work safety and remuneration, respect for the physical and mental integrity of the worker in the exercise of his/her employment. (SDG8 Economic Growth and decent work).

Decent work is applied to both the formal and informal sector. It must address all kind of jobs, people and families. According to the International Labour Organization (ILO), decent work involves opportunities for work that are productive and deliver a fair income, security in the workplace and social protection for families, better prospects for personal development and social integration, freedom for people to express their concerns, organize and participate in the decisions that affect their lives and equality of opportunity and treatment for all women and men.

The ILO is developing an agenda for the community of work, represented by its tripartite constituents, to mobilize their considerable resources to create those opportunities and to help reduce and eradicate poverty. The ILO Decent Work Agenda is the balanced and integrated programmatic approach to pursue the objectives of full and productive employment and decent work for all at global, regional, national, sectoral and local levels.

One of the most important elements of decent work is the income for a decent living, which is presented in detail in table 6, which basic costs must be met for a decent living, such as: cost of foods, cost of housing, cost of other essential needs and small margin for unforeseen events.

Table 6. Decent living wages



Source: SDG 8 Economic growth and decent work 2022

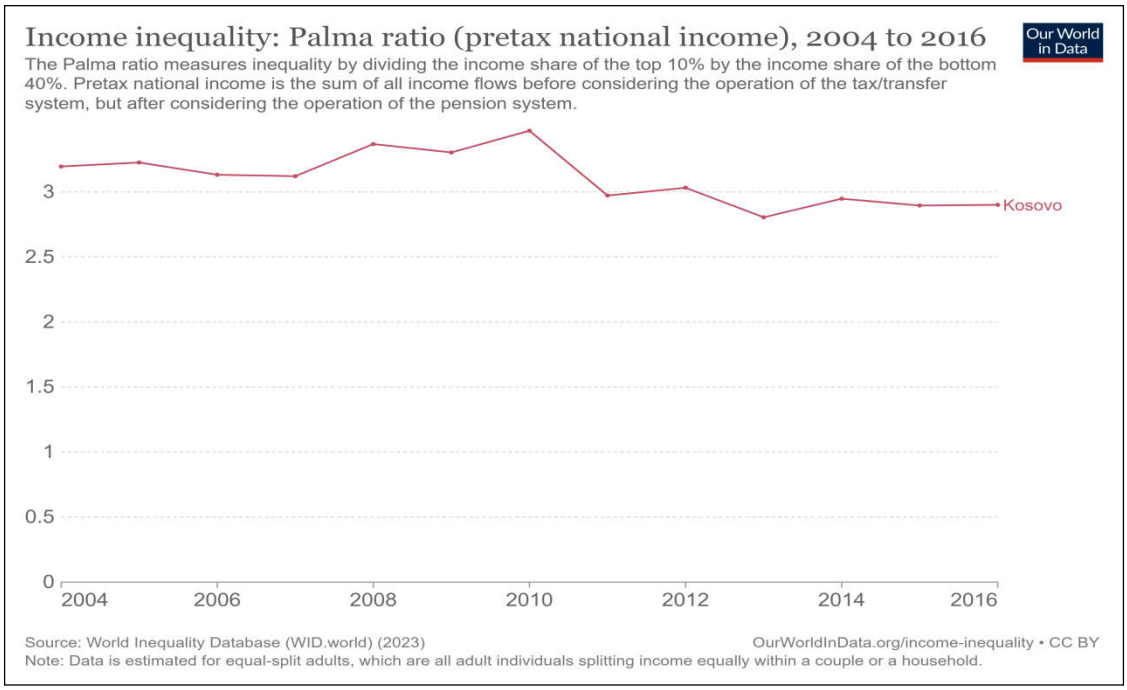
Recently, in Kosovo, a wide discussion has been opened about the wage law, which was voted in the parliament amid many opinions, and for the first time a sound legal basis has

been created that, through amendments, offers the possibility of its readjustment according to developments of the labor market and society. Referring to SDG 8 of sustainable development, Kosovar policymakers, within the SDG's framework, have all the support of the United Nations and the European Union, to integrate into the wage law, the elements of decent income for a decent living in order to eliminate regional inequalities and promote the economic development of the country.

4.8. Kosovo's Palma Ratio of inequalities

Income is defined as household disposable income in a particular year. It consists of earnings, self-employment and capital income and public cash transfers; income taxes and social security contributions paid by households are deducted. The income of the household is attributed to each of its members, with an adjustment to reflect differences in needs for households of different sizes. Income inequality among individuals is measured here by five indicators. The Palma ratio is the share of all income received by the 10% people with highest disposable income divided by the share of all income received by the 40% people with the lowest disposable income. The table 7 generated by our world in data, clearly shows the deep inequality, where the income of 10% of the population of Kosovo is 3 times more than the income of 40% of the population of Kosovo, taking into account that the Palma Ratio equal to 1 is considering the imbalances in income sustainable.

Table 7. Kosovo's income inequalities Palma ratio



Source: Our world in data 2016

5. Conclusions

In conclusion, regional economic indicators play a vital role in the economic development of Kosovo. They inform policymaker's decisions, promote investment, help plan infrastructure development, and inform social policy. By using these indicators to guide decision-making, the country can achieve sustainable economic growth and create better economic opportunities for its citizens.

In the aforementioned analysis, starting from table 2, we have clearly noticed that the level of income per capita is lower than the average of the homogeneous emerging and developing economies and almost half of the world's average income per capita. Compared to the European Union in which Kosovo intends to join, it turns out that they are far from the European reality, something that complicates the path to membership and the difficulties that Kosovar citizens will face in the living costs of the union.

Also, large differences in income per capita have been observed between the seven main districts of the Republic of Kosovo, referring to table 3, which emphasizes the need to develop regional policies to reduce these disparities.

As far as the unemployment indicator is concerned, even in this field we have large inequalities that have blocked human capital from having access and being absorbed by the labor market. If we connect these inequalities with the phenomenon of high informality of the market, we make it even more difficult to reduce unemployment due to the lack of data.

The Palma ratio shows big differences in the distribution of income among the population with high income, resulting three times higher than the level that guarantees sustainable income for society and the country's economy. The Palma ratio in the role of an additional indicator confirmed to us that inequalities in regional economic indicators are a source of long-term instability and their treatment is required through development policies to guarantee sustainability.

6. Recommendations

Referring to the deep imbalances and inequalities that exist in the income per capita within the seven regions of the state of Kosovo, as well as the fact that the national income per capita is lower than the average of the emerging and developing economies that Kosovo is a part of, it is recommended, that the government of Kosovo implement the Regional Development Strategy 2020-2030 approved in February 2021 with the draft law on Regional Development, which foresees that there will be several regions at the NUTS III level, and therefore, several regional development organizations that determine the principles of management. regional development, inclusiveness of financial instruments and rules for balanced regional development. As well as to create the institutional framework for the management of EU funds, which will further strengthen the capacities and resources for the management of EU IPA financial assistance.

This will provide the necessary financial resources for the government of Kosovo in the implementation of a strategy to increase income per capita in a medium-term period until 2025 through the approval of an Action Plan for Regional Development that provides a level of income per capita as the average of the emerging economies and in a long-term period until 2030 the income per capita to reach the level of the global income per capita as per table 2. Taking into account the long-term goal for membership in the European Union, the above-mentioned development policies will have to ensure that before the membership in the EU, the per capita income of the citizens of Kosovo has reached at least the level of the lowest income of a member EU state.

The global goals of sustainable development, and specifically SDG8, are a guide and full policy framework necessary to ensure economic development and decent work. Taking into account that the government of Kosovo has recently voted the new wage law, it will be necessary to enrich and adapt it, until the income per capita reaches the above-mentioned levels and ensures decent employment and living of its citizens.

It is recommended that Kosovar policymakers study in detail the Palma Ratio inequality indicator at the level of seven regions as well as at the national level, in order to draw up regional and national development policies that can reduce these inequalities and ensure economic stability. It is understood that regional and national policies for increasing per capita income will also contribute to the reduction of unemployment, aiming to reach the single-digit level in the long term.

Conflicts of Interest

The authors declare no conflict of interest.

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RENEWABLE ENERGY PROJECT APPRAISAL USING THE REAL OPTIONS METHODOLOGY

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Abstract

Renewable energy sources (RES) are characterized as clean forms of energy and come directly or indirectly from the impact of solar energy on the environment. The overall process of planning, designing, constructing, and operating renewable energy projects involves complex uncertainties and risks, which are difficult to analyze and evaluate effectively through traditional investment appraisal methods. Each RES project presents different types of uncertainties, which are categorized as external and internal. The Real Options (RO) theory for evaluating investments in RES projects can provide additional investment options at different stages of the projects, enhancing flexibility and improving the decision-making ability of a company's management.

This paper summarizes the specifics governing RES projects, the main characteristics of the RO methodology, and an overall framework for its application to RES projects. This framework is used to evaluate an investment in a 500kWp photovoltaic (PV) park in Greece. The uncertainties selected for the analysis of the RO methodology are the electricity sales price and the production from the specific PV project. In addition, the options/rights of the investor that are considered, are to continue or abandon the investment in each phase of the project implementation. The results, based on the current data and have included the possible fluctuation in the values of the two aforementioned uncertainties, show that investing in a PV project of similar size and technology in Greece is advantageous and worth undertaking. The intention to finance a large proportion of the investment by the banks plays an important role in this.

Keywords: project appraisal methods, real options theory, renewable energy projects, risk and uncertainty analysis, construction project management

JEL classification: R3, R5, R38,

1. Introduction

In recent times, the developments taking place in the energy sector have been rapid, and energy has always been one of the most important factors for the socioeconomic development of various communities (Ongoma, 2017). At the same time, factors such as global warming and the need to reduce carbon dioxide emissions make are necessary to use cleaner forms of energy, such as Renewable Energy Sources (RES) (Chang, et al., 2013). Renewable energy projects, unlike conventional power plants, present complex uncertainties (Stratigea et al., 2011; Liu, et al., 2019), which can be categorized into internal (e.g. wind speed) and external (e.g. electricity sales price), and affect each renewable energy project differently (Papadaki, 2012; Cesena, et al., 2013). As a result, the use of traditional methods for evaluating investments in RES projects, such as Net Present Value (NPV), is not appropriate and does not include the changes that may occur in the regulatory frameworks governing these projects (Trigeorgis, 1993; Herath and Park, 2007). The Real Options (RO) method is recognized to enhance the value of projects under uncertainty and can provide investment options at the

individual stages of projects during a) planning, b) design, and c) commissioning (Cesena, et al., 2013). In addition, it provides a company's management with considerable flexibility and the ability to adapt to changes in the surrounding technology and market (Yeo and Qiu, 2003).

In this paper, the theory of RO and its application for the evaluation of an investment in a 500kWp photovoltaic (PV) project that can be built in Greece is presented. The influence of two main uncertainties prevalent in renewable energy projects, namely the selling price of electricity and the variation in the production of electricity from the PV park in question, is examined. Finally, two options that an investor has, through the RO methodology, for continuing or abandoning the project, in each of its implementation phases, are analyzed.

The remainder of this paper is structured as follows: In section 2 a brief reference is made to the main characteristics of RES projects and the methodologies for evaluating investments. Then, the main concepts of RO methodology and the most important techniques for its exploitation are analyzed. In the third section, the most recent applications of RO theory to RES projects are listed from the existing literature, taking into account the main uncertainties arising from the various environmental and policy regulations, which have been widely implemented in many countries. Then, a concrete framework for the application of RO theory that has been implemented in a hydropower project in Indonesia is presented. The fourth section includes the case study, where the RO methodology is applied to evaluate an investment in a 500kWp PV power plant in Greece. Finally, in the fifth section, the conclusion is given.

2. Literature review

Project appraisal is a key element of investment planning, both at the national and regional level (Alexiadis and Ladias, 2011; Myakshin and Petrov, 2019; Pnevmatikos et al, 2019; Polyzos and Sofios, 2008, Polyzos, 2019). It has a major significance for projects related to solving the energy problem, the size of which is constantly increasing. The origin of RES is mainly based on solar energy, which is directly or indirectly harnessed to create various forms of renewable energy (Perdios, 2011). Renewable energy includes bioenergy, solar, wind, ocean, geothermal, and hydropower (Owusu and Sarkodie, 2016). RES projects include three features: Firstly, the viability of each project relies to a significant extent on the sale price of the energy produced, an uncertainty that is not in the full control of the investor. Secondly, the use of natural resources for energy production is subject to considerable risk, as their supply is not stable and varies throughout the life of the project. Thirdly, due to the particular expertise required to complete the construction of renewable energy projects, it is usual to conclude single contracts between investors and contractors, which together comprise (a) engineering study, (b) procurement of equipment and materials, and (c) construction of the project (EPC). All of the above characteristics shape the risk profile of RES projects and need to be carefully analyzed when making financial and investment decisions (Mun, 2002; Chang, 2013).

Every business needs to realize successful investments, since on the one hand, they include any benefits, costs, or sacrifices, and on the other hand, they are a milestone for its sustainability and future course (Nijkamp, 2011; Polyzos, 2018; Polyzos, 2019; Arkhipova, 2020). Businesses usually apply static indicators and methodologies for the financial evaluation of projects, using discounted cash flows and realizing calculations such as NPV and internal rate of return (IRR). In these types of approaches, there is an assumption that revenues, costs, and taxes are not subject to change, and a specific project schedule and budget is followed from the beginning to the end of the investment (De Abreu and Neto, 2008). For the most part, the investments of any company involve risks, so their basic evaluation is mainly carried out under conditions of uncertainty (Polyzos, 2018). Although many managers consider uncertainty as a problem that should be avoided in business, instead, uncertainty creates value and can lead a firm to market leadership (Amram and Kulatilaka, 1999). Utilizing investment appraisal through RO, the value of learning and additional information acquisition is recognized. Consequently, the decision on the total investment need not be made immediately, but instead, the opportunity is given to wait for the investment to be completed until the uncertainty at hand is resolved (Leslie and Michaels, 1997). RO theory is based on the same principles that underlie financial options and includes the ownership of real and existing assets (Frayer and Uludere, 2001). An option is the right, but not the obligation, to take action in the future and is characterized by nonlinear returns that are appropriate in

complex and sophisticated environments (Amram and Kulatilaka, 1999; Kogut and Kulatilaka, 2001). Seven different types of options can be exploited (Trigeorgis, 1996):

- The option to delay investment.
- The option of staging, where an investment or a large project can be divided into sub-phases.
- The option to grade an investment, retaining the flexibility to expand or shrink a project during its design or operation.
- The option to abandon an investment, preserving the ability to obtain salvage value.
- The option to change the use of a project.
- The option to terminate and restart a project.
- The option to develop an investment, where a variety of possibilities for future opportunities are created.

The main types of options include the American and the European options: The American option can be exercised at any time until expiration, while the European option is only exercised at expiration (Cox and Rubinstein, 1985). Actual projects are closer to American options as they can be expanded, delayed, or stopped if conditions are not favorable and their value is not optimized (De Abreu and Neto, 2008). Three main techniques are available for the evaluation of options: (a) partial differential equations; (b) simulations; and (c) lattices. The methodologies included in the partial differential equations (Miyata, 2012) are the Black-Scholes model, numerical methods (such as finite differences), and analytical approaches. Simulations (Shibusawa and Miyata, 2011) include a Monte Carlo approach, and the lattices (Tsiotas, 2017, Tsiotas and Polyzos, 2018; Tsiotas, 2019, 2021) can have a binomial, trinomial, or polynomial structure (Kodukula and Papudesu, 2006).

3. . The Real Options method in renewable energy projects

The main studies on investment in RES projects started in the early twenty-first century and differ from each other depending on the emphasis on the analysis of the value and time of investment and the impact of uncertainty factors (Liu et al., 2019). In the existing literature, the application of the RO method to RES projects has focused more on hydropower, wind, and PV projects. For hydropower projects, the most recent publications include applications of RO, examining as main uncertainties the certified emission reduction price, the generation and sale price of electricity, and the project's operation and maintenance costs (Kim et al., 2017b; Lee et al., 2013; Zavodov, 2012; Khryseva et al., 2018). For wind projects, the most recent applications of RO analyze as main uncertainties the generation and sale price of electricity (Stratigea and Grammatikogiannis, 2012; Boomsma et al., 2012; Reuter et al., 2012; Abadie and Chamorro, 2014; Kroniger and Madlener, 2014). For PV projects, the main uncertainties studied in recent articles include electricity generation and sale price, the borrowing rate, and the risk-free rate (Kim et al., 2016; Jeon et al., 2015; Martinez-Cesena et al., 2012). In addition, several studies have analyzed the application of ROs to renewable energy projects, examining the impact of environmental regulations and government support frameworks to promote investments. The main factors of environmental regulations that have been considered are the fuel price with its corresponding demand and supply, the influence of the carbon price, the initial investment capital, the available technologies, and the market structure (Venetsanos et al., 2002; Herve-Mignucci, 2010). The most important determinants of the supporting regulations that have been analyzed are the fixed electricity sales price, the consumer price index, the total investment costs, and the general market situation (Yu et al., 2006; Reuter et al., 2012; Monjas-Barroso and Balibrea-Iniesta, 2013).

Kim et al. (2017a) proposed a framework for the application of RO, regarding the evaluation of an investment for the construction of a hydropower project in developing countries. This implementation framework consists of four main steps, as illustrated below.

Step 1: At the beginning, the project financing scenario is recorded, where the individual phases (such as planning, design, construction, and operation) are separated by their respective implementation periods, depending on the defined time of realization of the cash outputs by the investor.

Step 2: Calculate the project's financial flows and select the main uncertainties that can significantly affect the total investment. Then, the future financial flows of the project are estimated.

Step 3: Calculate the volatility of the project value through the three-point estimation method (pessimistic, most likely, and optimistic scenario estimation). More specifically, the authors used the market asset disclaimer (MAD) approach in combination with the three-point estimation method to calculate the value of the project through the present value of the most likely scenario of financial flows. The most likely scenario lies between the worst (pessimistic) and the best (optimistic) possible scenario. All three of these scenarios are derived from the respective combination (worst, moderate, best) of uncertainties that may occur over the lifetime of the project. Consequently, the volatility in the value of the project can be calculated from the following equation, assuming that the cash flows follow a log-normal distribution.

$$\sigma = \frac{\ln(\frac{S_{opt}}{S_{pes}})}{4\sqrt{t}} \quad (1)$$

Where:

S_{opt} and S_{pes} are the values of the project for the optimistic and pessimistic scenarios respectively, and t is the operation period of the project. Subsequently, the parameters of the options are calculated from the binomial structure of a lattice, for each phase of investment implementation.

$$u = e^{\sigma\sqrt{\Delta t}} \quad (2)$$

Where u is the up movement;

$$d = e^{-s\sqrt{\Delta t}} = \frac{1}{u} \quad (3)$$

Where d is the down movement;

$$q = \frac{e^{rt} - d}{u - d} \quad (4)$$

Where q is the risk-neutral probability and r is the risk-free interest rate or risk-adjusted discount rate;

$$C = e^{rt}[qC_u + (1-q)C_d] \quad (5)$$

Where C is the value of the option; and C_u and C_d are the values of the option associated with the upward and downward movements respectively.

Step 4: The above results are evaluated and a decision is made on whether or not to proceed with the investment for each separate phase of the project. The specific RO application framework will be used in the case study of the next chapter, for the evaluation of an investment in a 500kWp PV project that can be built and operated in Greece.

4. Application of the Real Options method to a 500kWp photovoltaic project

4.1. Basic characteristics of the implementation of the Photovoltaic park

This PV project of 500kWp is to be built in the area of Nea Magnesia, Regional Unit of Fthiotida, Greece, and connected to the local network of the Hellenic Electricity Distribution Network Operator (HEDNO). The available technologies for the construction of a PV station

are mainly based on the support system of the PV panels and the type of PV panels to be used. More specifically, there are the fixed support systems and the uniaxial or biaxial tracker, while the type of PV panels includes monofacial or bifacial, which generate energy from one or both sides respectively. In the case study, the fixed mounting system and the bifacial PV panel have been selected. The individual phases of the project implementation are presented in Table 1 and include the planning and preliminary design for the request for an offer of grid connection conditions from the HEDNO, the final design and implementation study of the project (in case the request for an offer of grid connection conditions is accepted by the HEDNO), the construction and operation of the project.

Table 1 Completion Time of the Individual Phases of the 500kWp PV Plant

Planning Period	1 Year
Implementation Study Period	1 Year
Construction period	1 Year
Operational period	20 Years

The most important uncertainties that occur in similar projects in Greece have been identified to be the borrowing rate, the risk-free interest rate, the inflation, the bid price of the terms of connection to the HEDNO network, the fluctuation in energy production, the selling price of electricity, the cost of supply of PV panels and the total cost of construction of the project.

4.2. Application of the Proposed Real Options Methodology

In this case study, the uncertainties about the annual electricity production and its selling price are analyzed. The reason why these two variables were chosen is that power generation is one of the main factors for the choice of design and technology of renewable energy projects, while the selling price for similar-sized PV parks can be secured through various options. These options for an investor are to contract for (a) a fixed and predetermined price, (b) a fixed price determined through a tender for all RES projects, and (c) a variable price resulting from participation in the wholesale electricity market model (target model).

Table 2 lists the values that the two variables can take for the three scenarios (worst, medium, best). Regarding the annual production, the values have been selected based on relevant studies and empirical data for similar projects, while the variation in the sales price has been modeled according to the data that have been valid in the Greek market in recent years and are constantly changing. In more detail, the most probable initial annual production for the 500kWp PV park with the specific equipment, materials, and geographical area of installation and operation is estimated to be 820,000 kWh. The optimistic scenario includes a 10% increase in annual production, while the pessimistic scenario includes a 10% decrease. The fixed and default electricity sales price for PV projects of similar installed capacity is 0.065 €/kWh at present. Its range of variation is estimated at a 30% increase and decrease for the positive and negative scenarios respectively, depending on the type of contract concluded.

Table 2 Selected Values of the Main Uncertainties for the Three Scenarios

Main Uncertainties	Optimistic Scenario	Moderate Scenario	Pessimistic Scenario
Annual Electricity Production (kWh)	902,000	820,000	738,000
Electricity Sales Price (€/kWh)	0.0845	0.065	0.0455

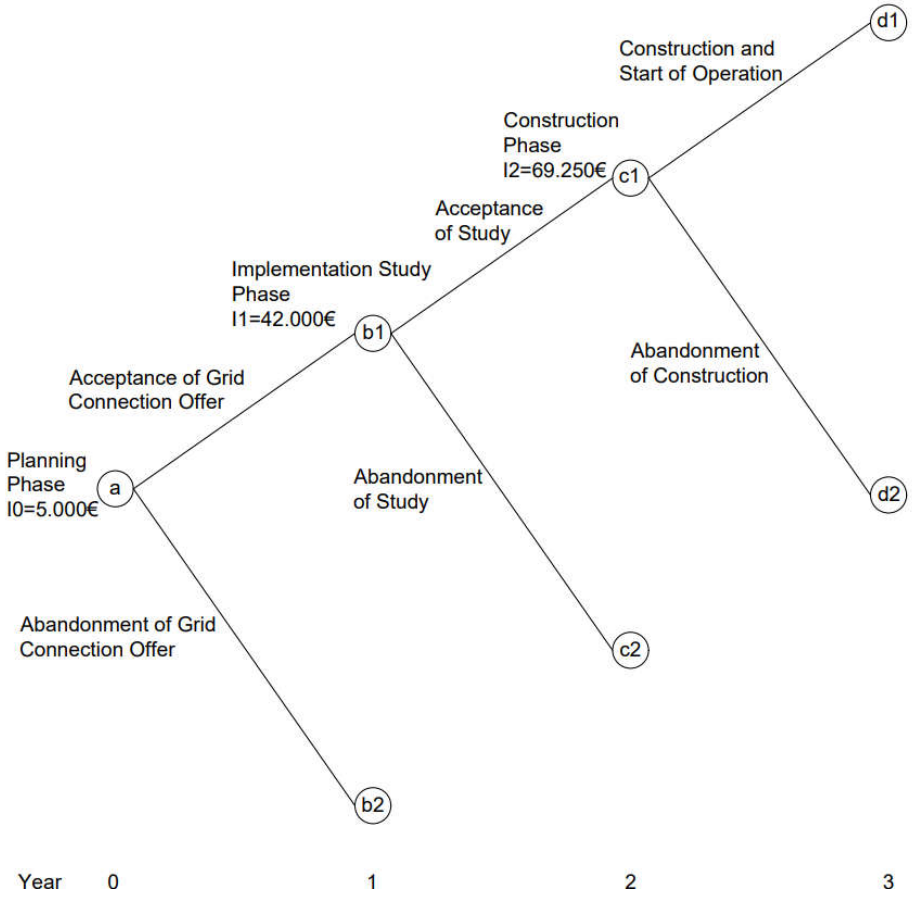
Table 3 lists the data regarding the estimated costs for the planning, design, and construction of the project. The bid price for the terms of connection to the HEDNO network has been assumed to be 40,000.00€.

Table 3 Planning, Implementation Study, and Construction Costs of the 500kWp PV Plant

Planning	Preliminary Design and Examination of the HEDNO Application File for Grid Connection Conditions	3,000.00 €
	Initial Company Management Expenses	2,000.00 €
	Terms and Conditions of Grid Connection with HEDNO	40.000,00 €
Implementation Study	Final Design and Study	2,000.00 €
Construction	Support System	32,000.00 €
	Photovoltaic Panels	148,000.00 €
	Production Substation and Inverters	45,000.00 €
	Cables and Other Electrical Materials	17,000.00 €
	Transport of Materials	5,000.00 €
	Construction and Cargo Insurance	1,500.00 €
	Earthworks and Civil Engineering Works	9,000.00 €
	Electromechanical Works	17,000.00 €
	General Site Expenses	3,000.00 €
	Inspections and Tests for Operation	1,000.00 €
	Interconnection Works	500.00 €
	Contingency Costs	4,000.00 €
	Total Construction Cost	285,000.00 €
	Grand Total Cost of PV Plant 500kWp	330,000.00 €

Figure 1 illustrates the composite options model for the investment in the 500kWp PV plant. The investor, at the beginning of each phase, can choose whether to proceed to the next phase by paying the corresponding amount or whether to abandon the investment altogether, influenced by the resolution or not of each considered uncertainty at the given moment. The planning phase includes the collection of the initial construction drawings and relevant documents for the submission of the application file to the HEDNO as well as the costs of starting and managing the company. The implementation study period can commence if the above costs are paid and the offer price of the grid connection terms is accepted. Similarly, the construction period can start if the costs for the grid connection terms and the implementation study are paid. Finally, the project can be put into operation and electricity generation if the investor decides to complete the total costs for its construction.

Fig.1. The Composite Options Model for the 500kWp PV Plant Investment



Considering the calculation of the financial flows, it should be mentioned that for the construction of PV projects in Greece during this period, banks often provide loans for a significant part of the total construction costs. Usually, the total loan repayment time is 10 years from the start of the project operation and the interest rate of the loan reaches 4.40%, while the bank's participation in the total investment cost of construction is close to 75%. In addition, the average tax rate for the annual revenue from the operation of the project has been estimated to be 30%. The rate for the capital cost of the investment has been estimated to be 6%. Finally, for the calculation of the annual energy production from the PV panels, an aging factor of 0.80% per year has been retained, which is usually given by the panel manufacturers and is due to the deterioration of the construction elements of the panels. All of the above assumptions have been made to obtain the baseline data for calculating the financial flows over the 20 years of the project's operation. Table 4 shows in detail and on an annual basis the individual revenues and costs for the most likely scenario of electricity production and sales price.

Table 4 Financial Analysis of a 500kWp PV Plant for 20 Years of Operation

Year of Operation	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Production (kWh)	820,000	813,440	806,932	800,477	794,073	787,721	781,419	775,168	768,966	762,814
Revenue from Sales (€)	53,300	52,874	52,451	52,031	51,615	51,202	50,792	50,386	49,983	49,583
Part of Installments for Capital (€)	26,616	26,616	26,616	26,616	26,616	26,616	26,616	26,616	26,616	26,616
Project Operation & Maintenance Costs (€)	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500
Total Expenses (€)	31,116	31,116	31,116	31,116	31,116	31,116	31,116	31,116	31,116	31,116
Profit (excluding equity) (€)	22,184	21,757	21,334	20,915	20,498	20,085	19,676	19,269	18,866	18,466
Profit after Tax (excluding equity) (€)	15,528	15,230	14,934	14,640	14,349	14,060	13,773	13,489	13,206	12,927

Year of Operation	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Production (kWh)	756,712	750,658	744,653	738,696	732,786	726,924	721,108	715,340	709,617	703,940
Revenue from Sales (€)	49,186	48,793	48,402	48,015	47,631	47,250	46,872	46,497	46,125	45,756
Part of Installments for Capital (€)	0	0	0	0	0	0	0	0	0	0
Project Operation & Maintenance Costs (€)	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500
Total Expenses (€)	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500	4,500
Profit (excluding equity) (€)	44,686	44,293	43,902	43,515	43,131	42,750	42,372	41,997	41,625	41,256
Profit after Tax (excluding equity) (€)	31,280	31,005	30,732	30,461	30,192	29,925	29,660	29,398	29,138	28,879

The annual costs for the operation and maintenance of the PV park are valued at 4,500€ and include the cleaning of the PV panels and the deforestation of the field every year, the maintenance of the internet account, and the monitoring of the project's proper operation. Also included in the same amount are the company's administration and accounting support costs, the use of closed-circuit television (CCTV), and the project's insurance in case of damage that may be caused by vandalism, fire, or natural disasters. The loan installments for the first 10 years are calculated using the bank's participation rate and applying equations (6) and (7) to obtain the capital recovery factor (CRF) (Polyzos, 2018):

$$CRF = \left(\frac{i(1+i)^n}{(1+i)^n - 1}\right) \quad \textbf{(6)}$$

Where i is the borrowing rate; and n is the years of repayment of the loan.

$$R = CRF * P) \quad \textbf{(7)}$$

Where R is the annual installments; and P is the present value of the loan.

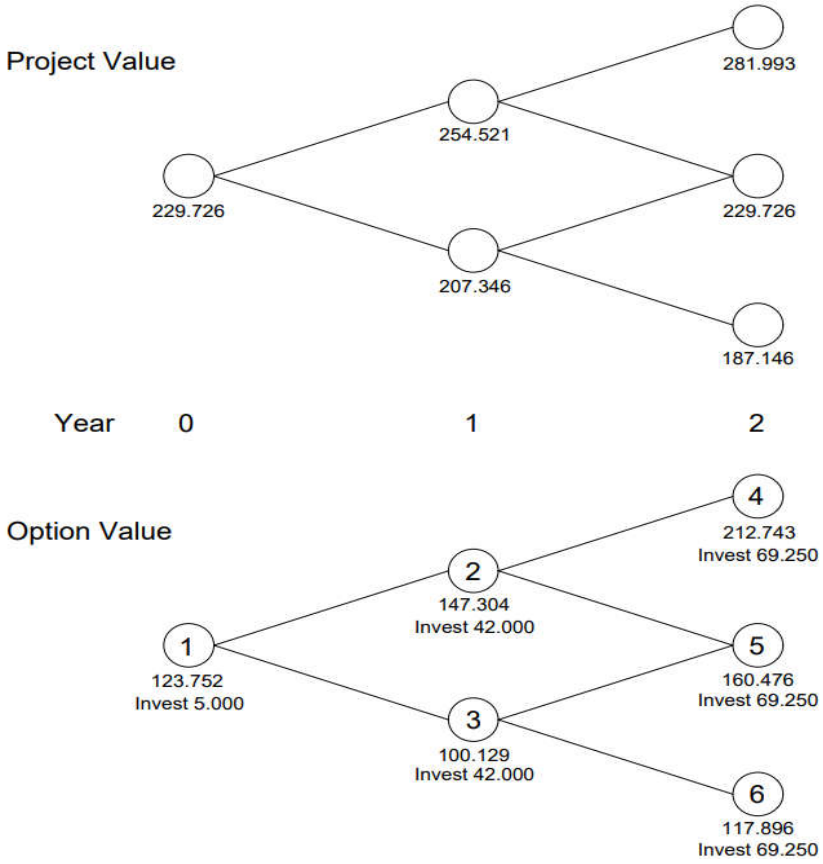
Next, the annual profit is calculated excluding the amount of the investor's equity and after the upcoming 30% tax, followed by the NPV of the project. For the most likely cash flow scenario, the project value has been calculated to be 229,726.00€ and the NPV 113,476.00€. Similarly, for the optimistic scenario, the NPV is 286,759.00€. For the pessimistic scenario, the NPV is -35,629.00€, which when considered in isolation is a deterrent to undertaking this investment. Table 5 lists the most important results for the evaluation of the investment in 20 years of the project's operation, taking into account all three different cases.

Table 5 Aggregate Investment Evaluation Data for the Three Scenarios

Key Investment Characteristics	Optimistic Scenario	Moderate Scenario	Pessimistic Scenario
Total Equity (€)			116,250
Total Gross Revenue (€)	1,413,904	988,744	622,909
Total Expenses (€)			356,165
Total Net Profit (€)	1,057,739	632,579	266,744
Total Net Profit Less Equity (€)	941,489	516,329	150,494
Net Present Value (€)	286,759	113,476	-35,629

Following the proposed methodology, the volatility in project performance has been calculated by equation (1) to be 10.25%. Through equations (2) and (3), the upward and downward movements of the binomial lattice have been obtained at 1.1079 and 0.9026 respectively. Moreover, the risk-neutral probability is calculated by equation (4) to be 0.7755. Using the binomial lattice structure and equation (5), the value of the project's option or the strategic NPV (SNPV) is 123,752.00€. The option premium is equal to 10,276.00€ and can be obtained by subtracting from the SNPV, the NPV calculated for the most likely scenario. Figure 2 illustrates the RO analysis of the project investment.

Fig.2. The RO Model for the 500kWp PV Plant Investment



4.3. Discussion on the Applicability of the Real Options Methodology

According to the RO model, in nodes where the cost of the investment is higher than the value of the option and the uncertainty is not yet resolved, it is recommended that the investor should abandon the continuation of the project financing. In the current situation (year 0), the cost of 5,000.00€ for the investment in the planning phase is less than the option value of 123,752.00€ and therefore the investment is worth making. In nodes 2 and 3, the total investment cost for the payment of the grid connection conditions with the HEDNO and the completion of the implementation study is less than the values of the options of 147,304.00€ and 100,129.00€ respectively. Therefore, the investment is worthwhile to be implemented also at this stage, creating the next option for the construction of the project. Looking at nodes 4, 5, and 6, it can be seen that the investment cost of 69,250.00€ to complete the construction is also less than the values of the options in all 3 of these nodes so the investment is worth completing until the construction is completed and the project is operational.

These results lead to two main conclusions. The first is that through the presented methodology of RO theory, investment is recommended to be carried out in all phases of the PV project implementation, even when the two uncertainties considered are not fully resolved. This is in stark contrast to the decision that would have to be taken by the investor if only the NPV in the worst case scenario was analyzed and taken into account, which is -35,629.00€, and therefore the investment should be rejected from the beginning. The second conclusion that follows from the application of RO theory in this application study is that because a large part of the investment (75%) is financed by the bank and completed during the construction period, the cost of the investor's participation in the construction phase is proportionally low (69,250.00€) and lower than the value of the option in all 3 nodes of the binomial lattice. Therefore, overall investment is encouraged in all phases of the project implementation.

5. Conclusion

In this paper, a presentation and application of the RO theory to a RES project were made. In the beginning, the main characteristics that affect the construction and operation of RES projects are listed. Then, a brief reference is made to the investment appraisal methodologies and RO theory. Referring to the different application models available for the RO evaluation, a specific methodology that has been proposed for the valuation of an investment in a hydropower project in Indonesia is discussed. Subsequently, this methodology is applied to a 500kWp PV project that can be constructed in Greece.

The results and contribution of this study can be summarized in three points. Firstly, the process and the cost of the individual services and materials required for the implementation of a PV project in Greece are presented. In this way, a potential investor can be assisted in the construction of a PV power plant of similar installed capacity, knowing from the outset the uncertainties, approximate costs, and the set of actions that need to be carried out in all the separate phases of the project. Secondly, the application of the RO methodology gives an investor the ability and flexibility to exercise his options (to continue the investment or to abandon it, for this case study) in each phase of the PV project and taking into account the possibility of occurrence or resolution of uncertainty. The specific methodology followed is simple, without the need for advanced mathematical or economic knowledge, so that it can be easily used by investors or the management of a company. Thirdly, since a large part of the financing (close to 75%) for similar PV projects in Greece is usually provided by banks, the investment based on the current data turns out to be advantageous, as reflected by the results of this article.

On the other hand, the uncertainties that have been considered in the case study include the variation in the electricity selling price and the production performance of the PV plant. However, other uncertainties such as the consumer price index, the borrowing rate, the bid price of the grid connection conditions, and those variables generally associated with the prevailing socio-economic situation in Greece, have not been taken into account. In addition, the costs for the construction of the project have been assumed to be constant, without considering any revaluation of materials and delays in all phases of the project, which may further increase the total cost of the investment. Nevertheless, this article can be an important basis for understanding the main processes surrounding PV projects and the potential uncertainties that can occur and dramatically affect the overall investment. Finally, the investment appraisal methodology used can be applied not only to PV projects, but also to other RES projects, both in Greece and in other countries, always taking into account the respective political and environmental regulations that can create various uncertainties.

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HOW AND HOW MUCH DIGITALIZATION AFFECTED ENTERPRISE PERFORMANCE DURING COVID-19 PANDEMIC

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Abstract

This paper focuses on the analyses of digitalization of enterprises and its performance impact in Albania. Using World Bank Enterprise Survey of 2019 merged with the ES follow-up on Covid-19 for Albania we investigate on the overall performance of enterprises during Covid-19 pandemic and the role of digitalization. The objective of the survey is to better understand the firm's experience in the private sector. Collected data are based on firms' experiences and perception of the environment in which they operate.

The paper uses these specific questions to study digitalization prior to and during Covid-19 pandemic. ES questionnaires focus on the following questions: (1) Does the establishment have its own website? (2) Started or increased business activity online? (3) Started or increased remote work arrangement for its workforce? The dependent variable is performance of the enterprises measured in terms of sales growth, employment growth, closure, and production adjustment. While the vector of independent variables is composed by enterprise characteristics such as firm size, ownership structure, legal status, region, etc. Moreover, dummy variables are used to capture access to formal banking service, and gender ownership.

Keywords: Firm Performance, Entrepreneurship, Digitalization, General Regional Economics

JEL classification: L25, L26, L86, R15

1. Introduction

Digitalization can speed up progress towards building flexible infrastructure, promoting sustainable industrialization, and encouraging innovation. Moreover, the engagement in the digital economy can foster economic competitiveness and well-being (Kraus et al., 2018).

Digitalization brings with it a variety of risks and opportunities for various sectors of society (Aceto et al. 2018). The role of digitalization has become crucial during the challenges of the pandemic Covid-19. The expansion of digital developments has the potential to help enterprises survive and find new and innovative ways of doing business. Much research attention has been dedicated to the developed countries and still is needed to be done in emerging economies such as Albania (Kalybekova et al., 2021).

Traditionally, enterprises in developing countries such as Albania have encountered higher barriers in connecting and in obtaining access to information from markets (Curraj, 2017; Abedini & Hani, 2017; Balla, 2020). The use of the internet (Clarke & Wallsten, 2006; Clarke, 2008; Ferro, 2011) plays an important role in lowering communication costs and barriers to entering new markets. Empirical evidence shows that increased digitalization contributes to total trade through websites that facilitate communication and trading relationships (Bharadwaj et al., 2013; Giones & Brem, 2017; Nambisan et al., 2019; Ruxho & Ladias, 2022). Therefore, it is important to study the microeconomic relationship between an enterprise's internet use and economic performance.

The global pandemic crises of Covid-19 have acted as a catalysator for enterprises to face the pressure of the outbreak. Government measures in response to the pandemic affected enterprises activity by decreasing the production capacity, disrupting flows of exports and imports, and seriously pressuring the service sector operation. In this context digitalization

may help firms to overcome obstacles and find new opportunities for doing business (Papadopoulos et al., 2020; Ratten, 2021).

According to the findings, although not explicitly during COVID-19, it appears that some research has been done on the digitalization of enterprises in Albania. As a result, it is possible to conclude that there is a broad research gap that should be addressed. In this regard, research might investigate into how COVID-19 has affected the digitalization of business enterprises in Albania, including any obstacles they might have faced, such as limited access to digital infrastructure or new regulations, and the kinds of strategies they used to get past them. This study examines the digitalization of Albanian enterprises during COVID-19, as well as the potential effects associated with it, during the epidemic.

The rest of the paper is organized as follows. The next section presents a literature review while the third section frames the general environment of Albanian enterprises. The link between digitalization and performance is presented in the third section. Conclusions and discussions are summarized in the last section of the study.

2. Literature Review

This study contributes to the rapidly growing literature of the economic impact of Covid-19 to the enterprise's performance with a specific focus on the role of digitalization. There are few studies that investigate on the role of digitalization in Albanian enterprises and its impact to their economic performance. Research is mainly focused on the tourism sector (Kushi & Caca, 2010; Vicky, 2011; Noti & Tartaraj, 2016; Kordha, et al., 2019; Pano & Gjika, 2020) and financial service sector (Tolica et al., 2015; Balla, 2020) and analyzing the level of digitalization rather than its contribution in enterprises' economic performance.

According to Curraj (2017) shows that size, age, and location of the enterprises affect performance of Albanian enterprises and are related to business digitalization more than strategy. Moreover, the level of enterprise digitalization is determined by entrepreneurial characteristics. His research gives evidence that there is growing interest in ICT, digitalization of enterprises, but innovation is still low due to the lack of financial and human resources.

Using Enterprise Survey for 2019 for Albania, Kalaj & Merko, (2021) show that digitalization affects enterprise labor productivity. The positive result does not hold when it comes to the digitalization impact on sales growth. In their paper digitalization is measured in terms of adoption of high-speed internet and website use by enterprises.

Gërguri et al. (2017) investigate the impact of (ICT) and innovation activities on firm performance. They used Enterprise Survey firm-level data in the three rounds (2002, 2005, and 2008) for nine CEE countries investigating the impact of (ICT) and innovation activities on firm performance. The Probit model results show a significant effect of some of the innovation activities determinants, indicating that larger firms in transition economies tend to carry out more innovation activities than smaller ones.

Analyzing data from 518 Chinese small and medium enterprises Guo et al., (2020), give an empirical frame on the relationship between digitalization and the response of SMEs. Their results show that digitalization not only helped enterprises to effectively respond to the Covid-19 shock but also helped improve their performance. However, their study lacks in describing the ways toward successful digitalization strategies.

From the macroeconomic perspective Myovella et al. (2020) analyses the impact of digitalization to economic growth in Sub Saharan Africa (SSA). This analysis relies in a panel data of 41 SSA and 33 OECD countries. Using GMM estimators they find positive effects in both group of countries. Nevertheless, due to the lower telecommunication infrastructure in SSA the effect is lower in comparison to OECD countries.

Amankwah-Amoah et al., (2021) observe digitalization during COVID-19 pandemic crises focusing on the internal and people dimension. In their study they offer a conceptual model linking the different influences for and against digitalization. They bring an insightful explanation about the so called "psychological dividend" or "nostalgia" of COVID-19 as a powerful barrier in the adoption of new technologies related to the distribution of work.

Besides recent literature about the positive effect of digitalization economy either in micro or macro level, the use of digital techniques from enterprises brings challenges and contradictions related to the organization strategies and management of personal information (Botsaris & Vamvaka, 2012; Papadopoulos et al., 2020; Vasyltsiv, et al., 2021). In this frame

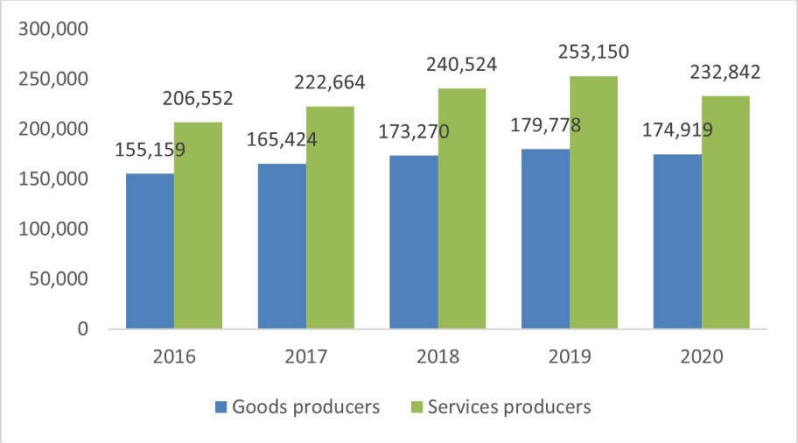
further investigation is needed to better understand the level of digitalization of enterprises in Albania and how much this digitalization affects their performance.

3. Background of Albanian Enterprises

Enterprises in Albania cope with obstacles and challenges in their endeavor. According to the World Bank (2021) the rank of Albania declined to 82 in 2019 from 63 in 2018. Most problematic factors affecting the business environment in Albania are corruption, fiscal policy issues, lack of trained workforce, access to finance, and government bureaucracy (IDRA, 2017; Kalaj & Merko, 2020; Valbona et al., 2021; Kalaj et al., 2022).

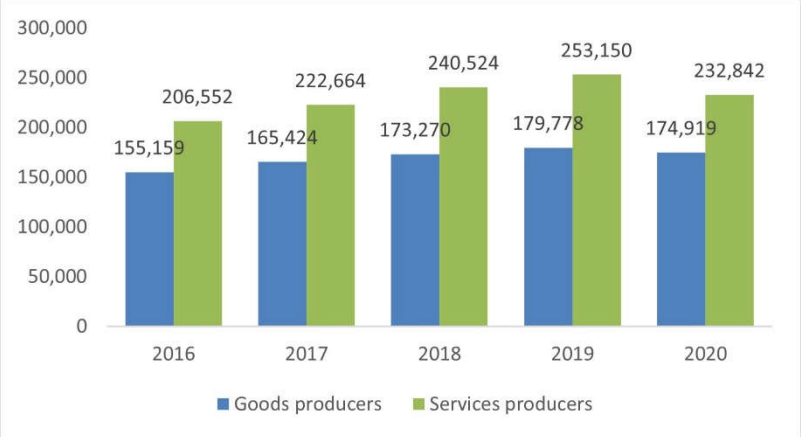
According to the Institute of Statistics of Albania (2022) th number of active enterpises declined by 1.5 percent in comparison to 2019, the time trends are represented in Figure 1. While the number of average employees devided by sectors is shown in Figure 2. In 2020 there has been a decrease of 5.1 percent in the number of average employees compared to 2019. In the service sector are employed 63.2 percent, and in the goods sectors are employey 36.8 percent.

Figure 1. Number of enterprises



Source: INSTAT, 2022

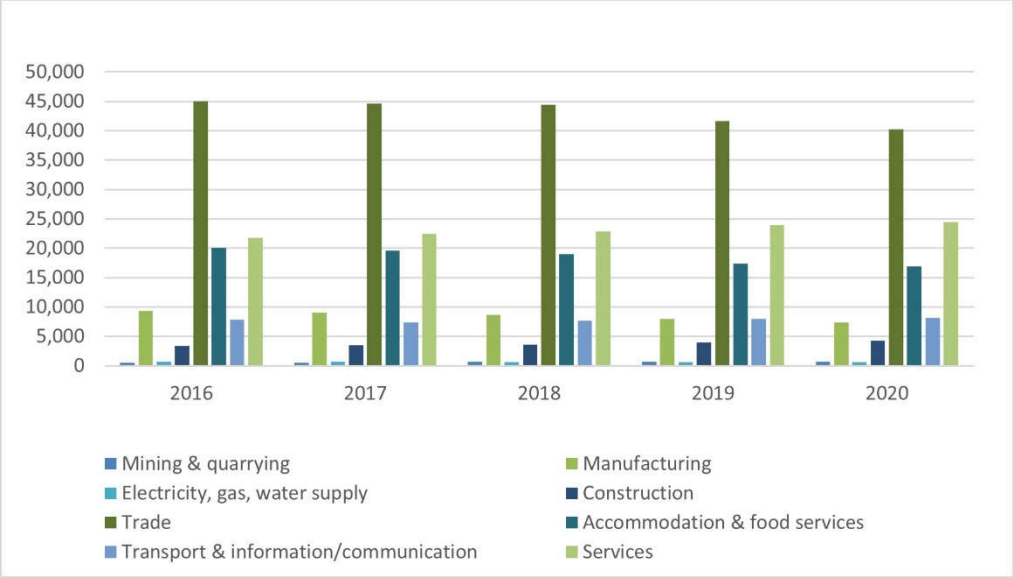
Figure 2. Annual average number of employees



Source: INSTAT, 2022

In Figure 3 we represent the distribution of enterprises by economic activity. The main economic activity in Albania as shown is trade. However, the number of registered enterprises in trade is decreasing by 0.9 percent if compared to 2019. During the same period there is a lower growth in the number of enterprises offering services.

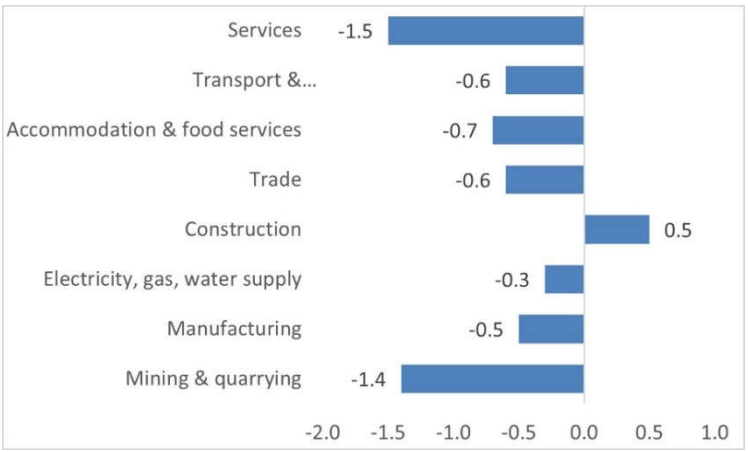
Figure 3. Number of enterprises by economic activity



Source: INSTAT, 2022

During the period 2019 to 2020 due to the global pandemic lockdown of Covid-19 there is a decrease of 5.1 percent in 2020 in comparison to 2019, see Figure 4. The only sector representing a positive turnover growth by 0.5 percent is the construction sector (INSTAT, 2022). The primary characteristics of the pandemic influence on the construction sector include working style and behavioral changes, problems and hazards, and new directions for the sector in the post-pandemic future.

Figure 4. Contribution in the annual turnover growth, 2019-2020



Source: INSTAT, 2022

The main indicators in terms of number, employed, and investments divided by enterprise size are given in Table 1. According to INSTAT (2022), the largest number of enterprises are concentrated in the central part of the country, more precisely the municipality of Tirana, while the lowest number of enterprises is registered in the municipality of Pustec. Female-owned enterprises are 25.5 percent, with women leading mainly micro enterprises (1-4 employed). Most of foreign partners around 77.8 percent are from Greece and Italy in the foreign and joint enterprises.

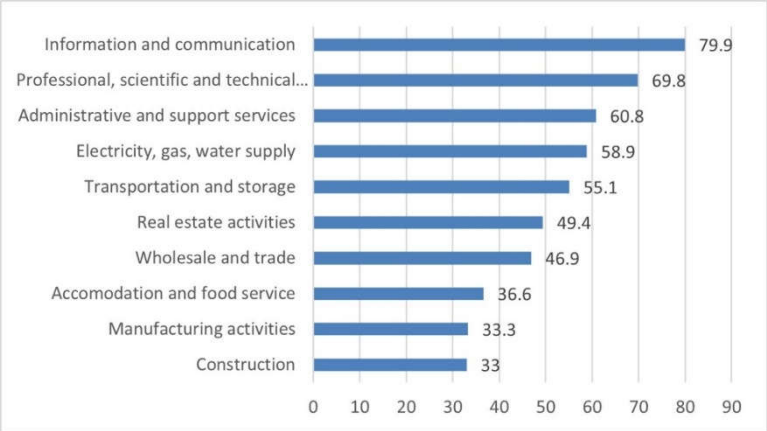
Table 1: Enterprises by main indicators, 2020

Enterprises size class	Enterprises		Employed		Investments (mln ALL)	
	no.	%	no.	%	no.	%
TOTAL	**102,574**	**100**	**530,853**	**100**	**193,880**	**100**
1-4 employed	88,082	85.9	139,154	27.6	12,372	6.4
5-9 employed	7,476	7.3	47,245	9.4	13,443	6.9
10-49 employed	5,674	5.5	111,347	22.1	62,475	32.2
50+ employed	1,342	1.3	206,239	40.9	105,589	54.5

Source: INSTAT, 2022

Digitalization has been increasing within Albanian enterprises. During 2021 around 45 percent of enterprises have a website and use it generally to publish the catalog of products and services, but only 38.3 percent use it to receive orders and online booking (INSTAT, 2021). Moreover, 24.8 percent use customer relationship management software (CRM) to handle their clients.

Figure 5. Share of enterprises having a website by economic activity, 2021



Source: INSTAT, 2021

4. Data and methodology

In this paper we use two different sources of data the World Bank Enterprise Survey of 2019 merged with the ES follow-up on Covid-19 for Albania. These short surveys follow the baseline ES of 2019 that contains 377 interviews conducted from January to May 2019 (WB, 2019). This dataset is designed to provide information on the impact and adjustments that pandemic has brought for the re-interviewed enterprises. The data are collected in the period between June 5 – June 26, 2020. The target group is all registered establishments with five or more employees that are engaged in the following activities: manufacturing, construction sector, service sector, transport, storage, and communication sector, and information technology. The response rate is 92 percent, 344 enterprises.

Table 2: Description of variables

Dependent Variable	Source	Description
Sales growth	Covid-19 follow-up	Change in enterprises sales for the last completed month with the same month in 2019
Employment growth		Change in enterprises employment for the last completed month with the same month in 2019
Closure		Equal to 1 if a firm was confirmed permanently closed
Production adjustment		Equal to 1 if enterprises adjusted or converted, partially or fully, its production or the services it offers in response to the COVID-19
Digital		Equal to 1 if enterprises started or increased business activity online, and started or increased delivery or carry-out of goods or services
Remote activity		Equal to 1 if enterprises started or increased remote work arrangement for its workforce

Explanatory variables		Description
Age	WBG ES 2019	Number of years that the establishment has been in operations.
Size		Number of full-time employees
Manufacturing		Equals to 1 if establishment is in the manufacturing sector.
Retail		Equals to 1 if establishment is in the retail sector.
Services		Equals to 1 if establishment is in the service sector.
Exporter		Equals to 1 if establishment directly exporting at least 10 percent of annual sales
Foreign ownership		Equals to 1 if establishment has at least 10 percent of foreign ownership
Female ownership		Equals to 1 if establishment's top manager is a woman
Website		Equals to 1 if establishment uses website for business related activities
Finance		Equals to 1 if establishment using bank loans to finance working capital
Location		Equals to 1 if establishment is in the capital

Our paper uses these specific questions to study digitalization of enterprises. ES questionnaires focus on the following questions: (1) Does the establishment have its own website? (2) Started or increased business activity online? (3) Started or increased remote work arrangement for its workforce? To investigate the impact of digitalization and give answer to our research questions we use the following model:

$$Y_i = \beta_0 + \beta_1 Digital_i + \beta_2 Website_i + \beta_3 Remote_i + \gamma X_i + \mu_i \quad (1)$$

where:

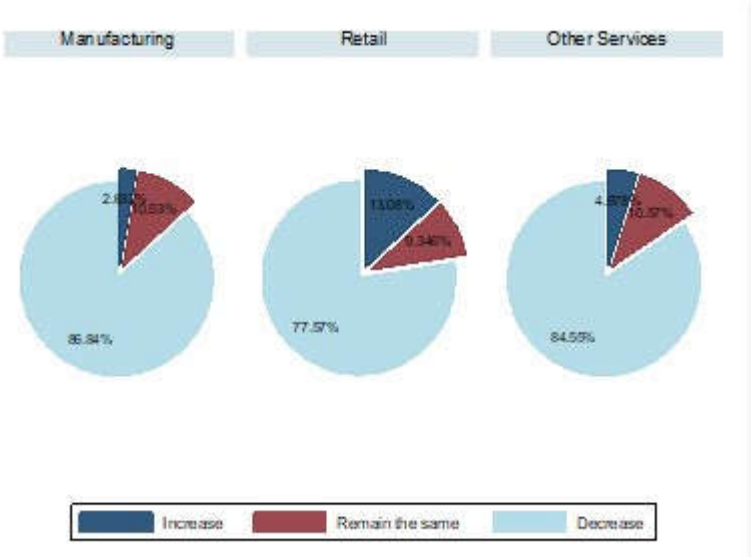
Yi is one of the components of performance of the firms measured in terms of sales growth, employment growth, closure, and production adjustment.

Digital, *Website* and *Remote* are dummy variables to indicate the adoption of Internet or the usage of websites by enterprises,

Xi is vector of variables including: the size, age, status, foreign ownership, location, exporter, and female-ownership etc.

To compute the dependent variable sales growth, we follow Clarke et. al (2015) and Gosavi (2017). To have a broader picture of the enterprise's response during Covid-19 public crises we present some summary statistics.

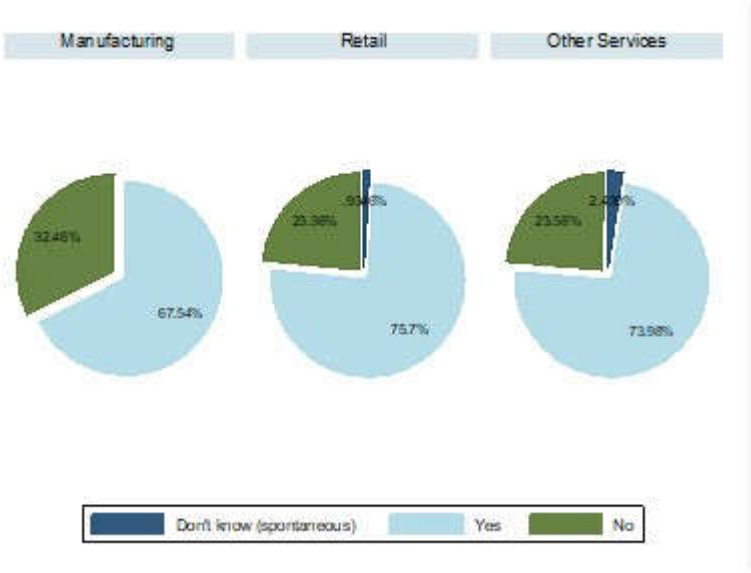
Figure 6: Sales changes by industry during Covid-19



Source: Authors' calculations

Following the responses from 344 enterprises for the Covid-19 follow-up survey we notice that the establishments experiencing sales growth are quite low. The highest percentage of sales growth is around 10 percent for the sector of services, this result in quite comprehensive.

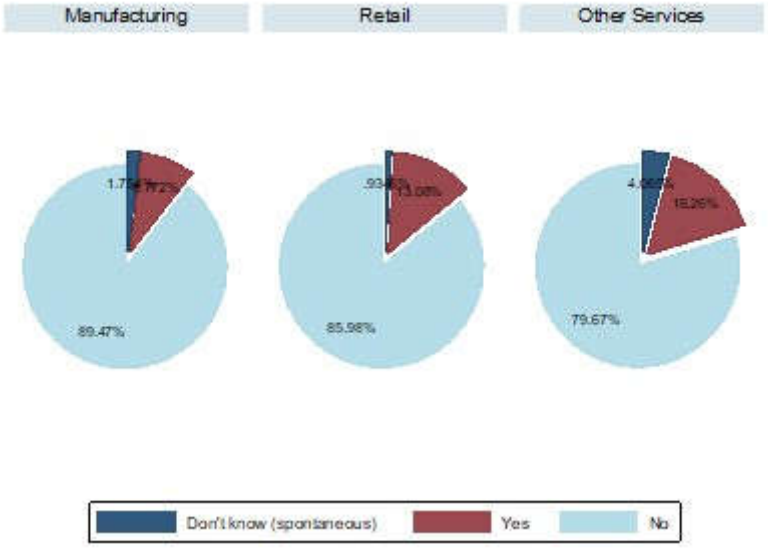
Figure 7: Converted production/service in response of Covid-19



Source: Authors' calculations

Most enterprises converted their production/service activities in response to the pandemic crises of Covid-19. This reflects an evident propensity toward changes or flexibility of enterprises due to exogenous shocks. However, when it comes to the online work arrangements of the working force (Figure 8) and in general business activity online the percentage cannot be considered high, see Figure 9.

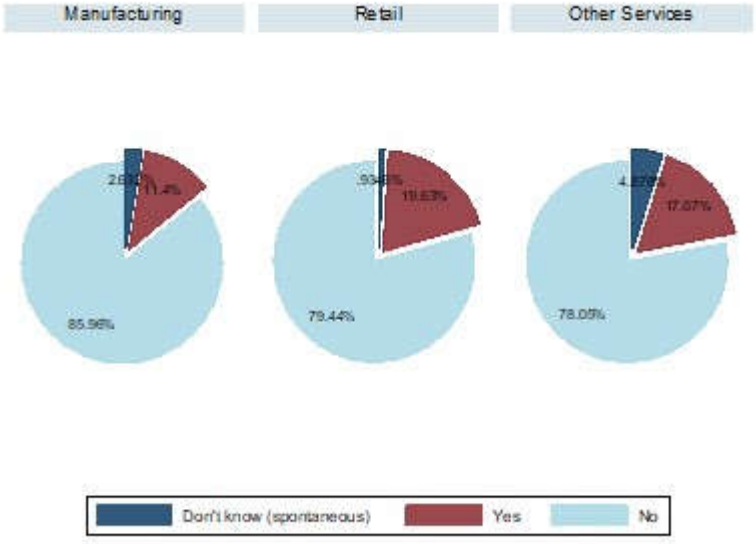
Figure 8: Remote work arrangement of working force during Covid-19



Source: Authors' calculations

As we can notice from Figure 9 manufacturing sector represents the lower percentage of business activity online. Since the survey does not contain questions on reasons related to the low level of digitalization of enterprises we have to further investigate to better understand. Additionally, the lack of digitalization, complicated cash flow, the prevalence of labor-intensive methods, imported materials, and equipment may be considered as the primary causes for the weak resilience of the economy.

Figure 9: Started or increased business activity online



Source: Authors' calculations

If we refer to INSTAT (2020) the share of employees using the computer for work purposes in general can be considered low since it is only 27.2 percent, and this figure is lower if compared to the previous year. The lowest share of employees using the computer during their business activity is in manufacturing activities with only 8.0 percent and construction activity with 16.2 percent. On the other side, computers are used to a greater level by employees of enterprises that perform in information and communication sectors by 75.5 percent, repair of computers and communication equipment by 73.7 percent and professional, scientific, and technical activities by 64.9 percent.

5. Empirical results

Depending on the descriptive data on enterprises response during pandemic of Covid-19, we can notice a low level of digitalization. To realize if enterprises that included digitalization in their production/service activity obtained benefits in terms of performance, we run OLS regressions for discreet variables and Logit regressions for the dummy dependent variables.

The econometric results of the regression for employment growth are shown in Table 3. As we can notice from the coefficients, the only statistically significant are digitalization and remote activity. We can conclude that those enterprises that started or increased their business activity online, increased delivery of goods and services, experienced employments growth. Furthermore, websites have a positive but not statistically significant effect on employment growth. This may be related to the effectiveness of websites of enterprises and the way they reflect production/service activity. There is a positive relationship with the following variables: retail sector, exporter enterprises, female ownership, foreign ownership, and the access to finance.

Table 3: Estimation of regression results on employment growth

Employment Growth	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Digital	1.037	.508	2.04	.041	.042	2.032	**
Website	.381	.39	0.98	.328	-.383	1.146	
Remote activity	1.32	.563	2.35	.019	.217	2.423	**
Age	-.007	.022	-0.32	.751	-.051	.036	
Retail	.604	.434	1.39	.164	-.247	1.456	
Manufacturing	-.245	.502	-0.49	.626	-1.23	.739	
Small	-.222	.496	-0.45	.654	-1.195	.751	
Medium	-.203	.498	-0.41	.683	-1.179	.773	
Exporter	.257	.464	0.55	.579	-.652	1.167	
Female ownership	.068	.453	0.15	.881	-.819	.955	
Foreign ownership	.812	.555	1.46	.143	-.276	1.9	
Finance access	.082	.381	0.22	.829	-.665	.83	
Constant	-2.342	.669	-3.50	0	-3.653	-1.031	***

Mean dependent var	1.035	SD dependent var	5.125
Pseudo r-squared	0.29	Number of obs	344
Chi-square	14.139	Prob > chi2	0.292
Akaike crit. (AIC)	250.932	Bayesian crit. (BIC)	300.860

*** p<.01, ** p<.05, * p<.1

In table 4 we represent Logit regression results on the probability to have sales growth during pandemic crises Covid-19. Yet digitalization positively affects sales growth, but the results do not persist when it comes to remote activity of the work force and existence of website. The coefficient is high meaning that enterprises starting or increasing their business activity online enhance the probability of having higher sales by around 1.23 percent. Foreign ownership is positively related to sales growth during pandemic crises. Sales growth is negatively affected by websites, remote activity, age, manufacturing sector, small and medium enterprises, exporter enterprises.

Table 4: Estimation of regression results on sales growth

Sales Growth	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Digital	1.23	.336	3.66	0	.571	1.89	***
Website	-.051	.314	-0.16	.871	-.666	.564	
Remote activity	-.484	.472	-1.03	.305	-1.408	.441	
Age	-.002	.019	-0.08	.937	-.039	.036	
Retail	.386	.369	1.05	.296	-.338	1.109	
Manufacturing	-.263	.417	-0.63	.529	-1.081	.555	
Small	-.264	.405	-0.65	.515	-1.057	.53	
Medium	-.5	.421	-1.19	.235	-1.325	.326	
Exporter	-.351	.416	-0.85	.398	-1.166	.463	
Female ownership	.053	.396	0.13	.893	-.723	.83	
Foreign ownership	.905	.499	1.81	.07	-.072	1.882	*
Finance access	.089	.324	0.27	.784	-.546	.724	
Constant	-1.901	.569	-3.34	.001	-3.017	-.785	***

Mean dependent var	0.151	SD dependent var	0.359
Pseudo r-squared	0.27	Number of obs	344
Chi-square	21.402	Prob > chi2	0.045
Akaike crit. (AIC)	324.877	Bayesian crit. (BIC)	375.996

*** p<.01, ** p<.05, * p<.1

According to the regression results of Table 5 we notice the positive effect of digitalization on the production adjustments. This variable is a dummy that takes value 1 if the enterprise adjusted or converted production/service activity during Covid-19. In this case, website has a positive effect but not statistically significant.

Table 5: Estimation of regression results on production adjustments

Production Adjustments	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Digital	1.354	.336	4.03	0	.695	2.013	***
Website	.167	.236	0.71	.478	-.295	.629	
Remote activity	-.462	.444	-1.04	.298	-1.331	.408	
Age	-.007	.014	-0.48	.631	-.033	.02	
Retail	-.08	.295	-0.27	.785	-.658	.497	
Manufacturing	-.268	.294	-0.91	.363	-.845	.309	
Small	.355	.314	1.13	.257	-.26	.97	
Medium	-.035	.312	-0.11	.912	-.645	.576	
Exporter	.136	.298	0.46	.648	-.448	.72	
Female ownership	.015	.299	0.05	.959	-.57	.6	
Foreign ownership	.262	.413	0.63	.526	-.548	1.072	
Finance access	.017	.244	0.07	.945	-.461	.494	
Constant	.306	.418	0.73	.464	-.512	1.125	

Mean dependent var	0.660	SD dependent var	0.474
Pseudo r-squared	0.22	Number of obs	344
Chi-square	25.132	Prob > chi2	0.014
Akaike crit. (AIC)	483.970	Bayesian crit. (BIC)	535.089

*** p<.01, ** p<.05, * p<.1

According to the regression results only a few coefficients are statistically significant and further research is necessary. Enterprises having websites exhibit higher labor growth than others, and the result is statistically significant, but the magnitude is relatively low. The results are not statistically significant when it comes to sales growth and production adjustments.

Female ownership of enterprises does not mean statistically higher sales or labor growth. However, coefficients have positive signs meaning that there is space for further analyses. These findings are in line with other gender studies in Albania (Kalaj and Merko, 2020). Interesting is the fact that enterprises involved in export activities and foreign ownership increases the propensity to higher economic performance.

6. Conclusion

This paper is focused on the analyses of the role of digitalization of Albanian enterprises during the pandemic crises of Covid-19. Digitalization is measured as a proxy of business activity online, delivery or carry-on of products or services. To give answer to the research questions, the study relies on two different sources of data the World Bank Enterprise Survey of 2019 merged with the ES follow-up on Covid-19 for Albania. These data are collected in the period between June 5 – June 26, 2020.

In our study enterprises' performance is measured in terms of employment growth, sales growth, production adjustments, and permanent closure. Since the percentage of permanently closed enterprises in sample is very low, our empirical interpretations are concentrated in the first three variables. Empirical results show that digitalization affects enterprise performance in a statistically significant way. The effect is positive and statistically significant when it comes to sales growth, employment growth and production adjustments in response to Covid-19 pandemic crises. However, in the study we used three different variables as proxy for enterprises digitalization such as the increased business activity online, website existence, remote work force activity.

Finding show that only the business activity has a significant impact on performance improvements of Albanian enterprises. We cannot conclude on the effect of the other two variables such as website and remote working activity since the coefficients are not statistically significant. If compared to other sectors, manufacturing-sector enterprises are less likely to use digital technology in their business activity if compared to the other sector. The manufacturing sector in Albania will undoubtedly be profoundly impacted by the digital transformation. If Albanian companies in the processing sector have undergone sufficient digitalization and are prepared to fully adopt Industry 4.0 principles in the installation of digital solutions throughout all value-chain creation segments, more research is required.

This study contributes to the recently growing literature of digitalization during the pandemic crises related to the effect it might have on enterprises performance. It provides a useful frame for the policy formulation on how to help enterprises on their way toward digitalization. Still, additional research is needed to better understand what consists of online business activity and if enterprises intend to expand their digitalization process in the future regardless of pandemic shocks.

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Announcements, Conferences, News

ASSA 2023 Annual Meeting
June 14 -17 2023 | New Orleans, USA

Event Overview[1]

The Regional Studies Association's Annual Conference 2023, also known as #RSA23, is a four-day event held in partnership with the School of Economics and Business, at the University of Ljubljana, Slovenia. It will take place from June 14 to 17, 2023, and will feature 500+ presentations, high-profile plenary speakers, several specially convened sessions, workshops, networking sessions, walking tours, and field trips. This four-day conference will bring together academics and policymakers to exchange news, views, and research findings from the fields of regional studies and science, regional and economic development, policy, and planning.

The social program will include the conference dinner and reception, side events, sports activities, exhibitor stalls, and post-conference tours to explore Slovenia.

The conference venue has the technology to facilitate a fully blended conference which will be supported through the "RSA Hub" app which is available to download for free from the app store. It is device-agnostic working on phones, tablets, laptops, and desktops. The RSA Hub App allows delegates to view the most up-to-date program, abstracts, and speakers, select a specific conference schedule, network with other delegates, and participate in the conference. Online participants can also access the app through the desktop version. All participants, whether in the room or taking part virtually, will be able to present, ask questions, and can join the debate. All sessions if possible, will be livestreamed including plenary, roundtable, and workshop sessions.

The conference offers different rates for online participants, members, and non-members and has tiered members' conference fees depending on the country's Band. Signing up as an RSA member will offer a discounted conference rate, so interested participants may consider registering as a member and then registering for the conference.

The draft conference program is structured as follows:

#RSA23 Draft Conference Programme
Side event Monday 12th & Tuesday 13th June 2023
Young Scholars Academy on Regional Studies (free event, separate registration required)
Wednesday, 14th June 2023
[10.00-16.00] Board Meeting (invitation only) [10.00-12.00] City Walking Tour (separate registration necessary) [13.00-17.00] **4th Networking Workshop for Early and Mid-Career Women in Regional Studies and Regional Science** (free event, separate registration necessary) [14.00-16.00] **Technical Tour 1:** Architectural Walking Tour of Ljubljana (separate registration necessary) [14.00-16.00] **Technical Tour 2:** Exploring Urban Culture in Ljubljana - A Discussion on the Move (separate registration necessary) [14.00-16.00] **Technical Tour 3:** The Sustainable Mobility Good Practices Visit (separate registration necessary) [15.00-17.00] Conference Registration open at SEB [18:30-20:30] **Welcome Reception** – Ljubljana Castle

1 Event overview edited by Dimitrios Tsiotas, Assistant Professor, RSI J.

Welcome Speech by Lilijana Madjar, MSc, Director of Regional Development Agency of Ljubljana Urban Region and President of the Western Slovenia Cohesion Region Prof. Dr. Gregor Majdič, Rector of the University of Ljubljana.

Thursday, 15th June 2023

[08.00-17.30] Conference registration
[08.45-09.05] Welcome to the conference
Prof Metka Tekavčič, Dean of the School of Economics and Business, University of Ljubljana, Slovenia
Neil Lee, Chair of RSA
[09.05-10.35] **Opening Plenary – Green Global Value Chains for Sustainable Regional Development**
Speakers:
Oliver Harman, IGC Oxford, UK
Riccardo Crescenzi, London School of Economics, UK
Marco Kamiya, Economist at UNIDO, United Nations
Anna Hammarberg, Business Sweden, Sweden
Chair:
Sandrine Kergroach, Head of Unit, OECD
[09.00-12.00] Finance and Space Editors Meeting (invitation only)
[10.35-11.15] Coffee Break
[11.15-12.45] Parallel Workshop Sessions A
[12.45-14.00] Lunch Break
[12.45-14.00] Territorial Representatives Annual Meeting and Lunch (invitation only) 14.00-15.30 Parallel Workshop Sessions B
[14.00-15.30] **Meet the RSA Editors I**
]15.30-16.00[Coffee Break
[16.00-17.30] Parallel Workshop Sessions C
[17.30-18.30] **New Member's Meet Up**
[17.30-19.00] **Professional Development Session**

Friday, 16th June 2023

[08.30-17.00] Conference registration
[08.45-10.15] **Plenary 2 - Finance and Space: Sustainable Financing and Unsustainable Debt**
Speakers:
Katherine Brickell, King's College London, UK
Vincent Guermond, Royal Holloway London, UK
Daniela Gabor, UWE Bristol, UK
Chair:
Sabine Dörry, Luxembourg Institute of Socio-Economic Research, Luxembourg
[09.00-12.00] Regional Studies Editors Meeting (invitation only)
[10.15-10.45] Coffee Break
[10.45-12.15] Parallel Workshop Sessions D
Meet the RSA Editors II
[12.15-13.15] Lunch Break
[13.15-14.45] **The Regional Studies Plenary 3 – Global Production Networks meets Evolutionary Economic Geography: What Common Ground Can the two Theories Find and what are the Implications for Regional Studies**
Speakers:
Henry Yeung, National University of Singapore, Singapore
Ron Boschma, Utrecht University, The Netherlands
Discussant:
Jessie Poon, University at Buffalo, USA Discussant: Lisa De Propris, University of Birmingham, UK
Chair:
Neil Lee, London School of Economics, UK
[14.50-16.20] Parallel Workshop Sessions E
[16.20-16.50] Coffee Break
[16.50-18.20] Parallel Workshop Sessions F
[16.30-18.00] Technical Tour 4: The Library of Things Visit (separate registration necessary)
[19.30-22.30] Conference Dinner (separate registration necessary)

Saturday, 17th June 2023

[08.30-12.30] Conference registration
[08.45-10.15] Parallel Workshop Sessions G
[10.15-10.45] Coffee Break
[10.45-12.15] **Closing Plenary – Territory Politics Governance Annual Lecture: What Does a more Sustainable Future Require? Strengthening Cooperation, Improving Governance, and Understanding the Politics of Systemic Change**
EC Speaker:
Alexander L. Q. Chen, Roskilde University, Denmark
Speakers:
Janez Potočnik, Co-Chair of UN International Research Panel
Discussant:

Virginie Mamadouh, University of Amsterdam, The Netherlands

Chair:

Klaus Dodds, Royal Holloway, UK

[12.15-12.30] Conference Close
Klaus Dodds, RSA Board Member
[13.30-20:30] Post-Conference Tour: Slovenia: A Land of Bees and Honey (separate registration necessary)
[13.30-20.30] Post-Conference Tour to Lake Bled (separate registration necessary)
[15.00-17.00] Paddle Boarding Tour Ljubljana (separate registration necessary)
[15.00-17.00] Exploring Ljubljana by Bicycle (separate registration necessary)

Sunday, 18th June 2023

[08.30-15.00] Post-Conference Tour to Postojna Cave and Predjama Castle
(separate registration necessary)

For more details, the interested reader can visit the link:
https://www.regionalstudies.org/events/2023rsaannualconf/

Twentieth International Conference on Environmental, Cultural, Economic & Social Sustainability

Pathways to Sustainability Innovation: Perspectives from Civil Society, Government, and Business

January 24 -26 2024 | University of Aveiro, Portugal + Online

Event Overview[2]

The Twentieth International Conference on Environmental, Cultural, Economic & Social Sustainability will take place from January 24-26, 2024, at the University of Aveiro, in the homonymous city of Aveiro, Portugal. The conference is organized by the On Sustainability Research Network Network (https://onsustainability.com), bringing together a common concern for sustainability from a holistic perspective, where environmental, cultural, economic, and social interests intersect. The organization committee of the conference seeks to build an epistemic community where we can make linkages across disciplinary, geographic, and cultural boundaries.

The conference features research on four themes: Ecological Realities, Participatory Process, Economic, Social, and Cultural Context, and Education, Assessment, and Policy, with a special focus on examining the questions: How do Ecological Realities Necessarily Frame Our Planetary Existence?; Whose Sustainable Future?; What are the Pressing Demands of Our Time?; and Framing Responsibility to Act?

The conference offers a hybrid (both in-person and online) attendance opportunity, where online-only presenters have access to discussion boards and other online activities. The deadline for proposal submission was up to 24 March 2023 and the Advance Registration Rate is no longer available after April 24th.

The conference provides an opportunity for presenters and audience members to benefit from the content, connect with presenters, and join the discussion on issues related to sustainability.

For more information, please visit the conference's site: https://onsustainability.com/2024-conference

2 Event overview edited by Dimitrios Tsiotas, Assistant Professor, RSI J.

Academic Profiles

Prof. **Teresa Sequeira** is an economist and academic, with a wealth of experience in the fields of regional and sustainable development. She has a degree in Economics (University of Porto) and concluded, in 2006, a Ph.D. also in Economics (University of Trás-os-Montes and Alto Douro – UTAD).

Her professional career began in 1987 at the SONAE group, where she was a senior manager, namely at the sub-holding SONAE Real Estate and Tourism. During this time, she was also a member of the Board of SPIDOURO, SA, where she promoted several structuring projects of Regional Development and private projects in the field of tourism.

Since 1992, Teresa Sequeira has been a professor at UTAD, having published several scientific papers. Her research area is focused on the issues of Regional and Sustainable Development, Investment, European Union, and Social Cohesion. Currently, she is structuring the project National Road 2 Observatory, involving a network of higher education institutions, municipalities, and private agents.

Some recent publications of Teresa Sequeira are:

– Sequeira, T., & Diniz, F. (2022). Entrepreneurship, culture, and social economy in the sustainability of a mountain territory. Revista Brasileira de Gestão e Desenvolvimento Regional.

– Sequeira, T., & Diniz, F. (2020). Portuguese Public Higher Education Institutions Investment in Low-Density Regions – Case study. Economy of Region – Scientific Economic Journal.

– Santos, K., Goncalves, H., Sequeira, T., & Diniz, F. (2019). Development and Solidarity Economy Strategies in Brazil: Case Studies. Regional Science Inquiry, XI (2), 153-265.

– Almeida, Z., Scheuneman, I., Sequeira, T., & Diniz, F. (2018). Challenges of a Sustained and Sustainable Development: a study-case. Regional Science Inquiry, IX (2), 243-250.

Academic Profile by:
Dimitriost TSIOTAS, Assistant Professor, RSI J

References

2023 CETRAD – Centre for Transdisciplinary Development Studies [accessed: 08/ 05/ 2023].

Prof. **J. Paul Elhorst** is a Professor of Spatial Econometrics at the University of Groningen, the Netherlands. He studied econometrics at the University of Amsterdam, from where he holds a Ph.D. in economics. He joined the Faculty of Economics and Business of the University of Groningen in 1992, where he has been teaching and conducting research in this field for over 30 years.

Prof. J. Paul Elhorst is a distinguished expert in the field of spatial econometrics, economics, and regional science. Since September 2015 Prof. J. Paul Elhorst is the Editor-in-Chief of the Regional Studies Association journal titled Spatial Economic Analysis. He is also a member of the Editorial Board of the Journal of Regional Science, Regional Science & Urban Economics, Journal of Geographical Systems, Geographical Analysis, Journal of Spatial Econometrics, and Letters in Spatial and Resource Sciences. Prof. J. Paul Elhorst has published numerous articles in leading academic journals in spatial economics, regional science, and economic geography. He has written more than 100 papers in refereed journals and research interests include (but are not limited to) spatial econometrics, both theoretical and empirical, software, regional labor market analysis, economic growth, research productivity, military spending, contagion, FDI, fiscal policy interaction, and transport economics. According to the Scopus database, his research enjoys so far 4,800 citations and an h-index of 28. Three indicative publications of Prof. J. Paul Elhorst with high impact are Elhorst, J. P., (2014) "Matlab software for spatial panels", *International Regional Science Review*, 37(3), pp.389-405; Elhorst, J. P., (2010) "Applied spatial econometrics: raising the bar", *Spatial Economic Analysis*, *5*(1), 9-28; Elhorst, J. P., (2003) "Specification and estimation of spatial panel data models", *International regional science review*, 26(3), pp.244-268.

Prof. J. Paul Elhorst has been Awarded the Martin Beckmann Prize for the best paper in Papers in Regional Science 2007 by the Jury of the distinguished scholars Masahija Fujita, Jean Paelinck, John Quigley, and Jouke van Dijk. He is also the author of the book *Spatial Econometrics: from cross-sectional data to spatial panels*, which was released in 2014 by Springer, and enjoys a high impact (over 2000 citations, according to the Google Scholar database).Prof. Paul Elhorst has extensive teaching experience both in undergraduate and postgraduate level courses in spatial econometrics, including (but not being exhausted to) courses in Applied Macroeconometrics (Cross-sectional dependence/Spatial Econometrics); Matrix Analysis and Optimization; Empirical Econometrics; and Economics. He has also supervised several Ph.D. students in the field of regional and urban economics and has served as a mentor and advisor to several young researchers in the field.In addition to his academic work, Prof. Paul Elhorst is also an active member of the academic community and is actively involved in promoting spatial econometrics and regional science. He is a Member of the Regional Science Association International, a Fellow of the Spatial Econometrics Association, the Regional Studies Association, and the Groningen Research School (SOM).

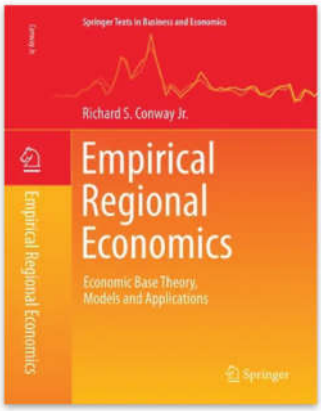
Overall, Prof. J. Paul Elhorst is a highly accomplished and respected scholar, with a significant record of scientific research, teaching, and service to spatial econometrics and regional science.

Academic Profile by:
Dimitrios TSIOTAS, Assistant Professor, RSI J

References

https://www.regionalstudies.org/people/paul-elhorst/ [accessed: 08/05/2023]
https://www.rug.nl/about-ug/latest-news/press-information/scientists-in-focus/pelhorst?lang=en [accessed: 08/05/2023]
https://www.rug.nl/staff/j.p.elhorst/cv?lang=en [accessed: 08/05/2023].

Book Reviews



Empirical Regional Economics, Economic Base Theory, Models and Applications, by Richard S. Conway Jr.

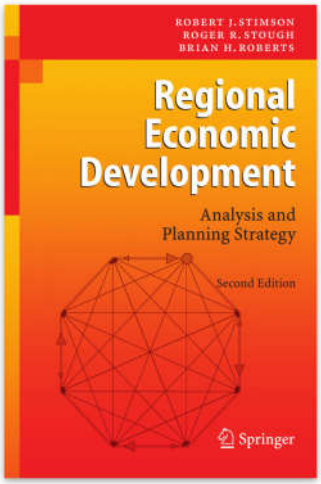
The book Empirical Regional Economics, Economic Base Theory, Models and Applications, by Richard S. Conway Jr., is a textbook introduction to the field of regional economics for juniors, seniors, and graduate students majoring in economics, business, and geography. The book covers a wide range of topics related to regional economics (such as regional economic growth, economic convergence, spatial econometrics, and regional policies and regional development), and is also addressed to anyone in the private or public sector who has an interest in gaining a better understanding of regional economic behavior and the practical methods of regional forecasting and analysis.

As evident by its title, the book emphasizes the use of empirical methods and data to understand regional economic dynamics, with a focus on applied research and practical application, the value of observation and testing, to explain regional economic behavior. One of its key themes regards the importance of understanding the forces that impact the economic growth and development of regions, highlighting the need for a multidisciplinary approach to regional economics. To this end, the active carrier of the author as a private economist in conjunction with his teaching academic experience and service as a board member in leading journals in regional science provided added value.

The book is divided into three parts. The first part, entitled "Regional Economic Base Theory", presents the economic base theory of regional growth and the empirical evidence supporting it. The second part, entitled "Regional Economic Models and Applications", covers the specification and application of four increasingly complex regional economic models: the economic base model, the input-output model, the inter-industry econometric model, and the structural time-series model. Lastly, the third part, entitled "Regional Economic Case Studies", presents numerous regional economic case studies organized under seven thematic topics: U.S. and World Economy; Regional Economic Behavior and Welfare; Urban and Rural Economies; Economic Cycles; Economic Policy; Regional Housing Market; and Regional Forecasting.

The textbook Empirical Regional Economics, Economic Base Theory, Models and Applications may be somewhat technical, for readers without a background in economics or related fields, and perhaps more focused on the case of the United States, for the audience seeking more international examples. Overall, it is a valuable textbook suggested for regional scientists, as it provides a comprehensive empirical overview of regional economics, by (i) emphasizing the use of empirical methods and data towards the understanding of regional economics; (ii) providing insights into the modern aspects of regional economics and their policy implementation; and (iii) highlighting the importance of endogenous characteristics of regions towards economic growth and development.

Book Review by
Dimitrios TSIOTAS, Assistant Professor – RSI J



Regional Economic Development, Analysis, and Planning Strategy, by Robert J. Stimson, Roger R. Stough, and Brian H. Roberts.

The book Regional Economic Development, Analysis, and Planning Strategy, by Robert J. Stimson (Professor of Geographical Sciences and Planning and Convenor, Australian Research Council, Research Network in Spatially Integrated Social Science, University of Queensland), Roger R. Stough (Professor, School of Public Policy, George Mason University), and Brian H. Roberts (Professor, Centre for Developing Cities the University of Canberra), is a comprehensive and informative textbook covering a broad range of topics related to regional economic development.

Being a successor of the original book published in 2001, the Second Edition represents a re-editing and significant rewriting in places, to bring forward to 2006 the original thesis of the book about the need for regions to be prepared to experience increasingly greater shocks and to have increasingly less time to respond in adjusting their economic development to achieve sustainability. Provided that a major concern of regional scientists is the development of a comprehensive tool-kit of methodologies to measure and monitor regional economic characteristics (such as industry sectors, employment, income, the value of production, investment, and the like, using both quantitative and qualitative methods of analysis, and focusing on the both static and dynamic analysis), this book focuses on the analysis of regional economic performance and change, and how analysis integrates with strategies for local and regional economic development policy and planning. To this end, the book is organized into 10 chapters covering a broad range of topics related to this major concern.

In particular, the book is structured as follows:

Chapter 1 provides an introduction to the topic of regional economic development, including key concepts and epistemological perspectives;

Chapter 2 examines the evolution of regional economic development strategies from early to contemporary approaches;

Chapters 3 and 4 describe traditional tools for measuring and evaluating regional economic performance (such as including economic base theory, shift-share analysis, and input-output analysis);

Chapter 5 provides an approach to regional economic development futures through the “path setting” strategic conceptualization;

Chapters 6 and 7 discuss two specific tools for assisting regional economic development strategy formulation, the industry cluster (ICA) and multi-sectoral analysis (MSA), to assess regional competitiveness and risk in the context of regional innovation systems;

Chapter 8 highlights the importance of capacity building, leadership, and institutions, for effective regional economic development;

Chapter 9 discusses GIS-based decision support tools for informing regional economic development analysis and strategy; and

Chapter 10 addresses emerging issues in regional economic development, including the challenges and opportunities posed by globalization, regional integration, and sustainability.

The book Regional Economic Development, Analysis, and Planning Strategy is a wealth of case studies and practical examples to illustrate key concepts and strategies. However, it may be in places somewhat technical or dense for some readers, particularly for those that are new to the field. Overall, the book Regional Economic Development, Analysis, and Planning Strategy constitutes a useful resource and is suggested for the regional science audience, as it provides (i) comprehensive coverage of a range of topics related to regional economic development, from established tools and models to contemporary issues related to globalization and sustainability; (ii) a practical guide including a range of case studies and examples of key concepts and strategies; (iii) a concise introduction to regional economic development for those new to the field, along with a more advanced analysis reference for experienced researchers and practitioners.

Book Review by
Dimitrios TSIOTAS, Assistant Professor – RSI J

GUIDELINES

for the Writers & a format model for the articles submitted to be reviewed & published in the journal

Regional Science Inquiry Journal

(EconLit, Scopus, RSA I) – www.rsijournal.eu

Guidelines for the Writers & a format model for the articles submitted to be reviewed & published in the journal

The Title of the paper must be centered, and the font must be Times New Roman, size 12, in Uppercase, in Bold

For the writers' personal information use the Times New Roman font, size 11, in bold, and centered. Use lowercase for the first name and uppercase for the last name. The line below the name includes the professional title and workplace; use the Times New Roman font, size 10, centered. In the third line write only the contact e-mail address in Times New Roman 10, centered.

Name LAST NAME
Professional Title, Workplace
E-mail Address

Name LAST NAME
Professional Title, Workplace
E-mail Address

Abstract

The abstract consists of a single paragraph, no longer than 250 words. The font must be Times New Roman, size 11. The text must be justified. The title "Abstract" must be aligned left, in Times New Roman, size 11, in bold. A space of one line must be left between the title and the text of the abstract. The abstract must contain sufficient information, be factual, and include the basic data of the paper.

Keywords: Use 3 to 5 keywords, separated by commas

JEL classification: We kindly request that you classify your paper according to the JEL system, which is used to classify articles, dissertations, books, book reviews, and a variety of other applications. The use of the JEL classification is necessary so that your paper be properly indexed in databases such as EconLit. Select the codes that represent your article and separate them by commas. You can find information on the JEL system here: https://www.aeaweb.org/jel/guide/jel.php

1. Introduction

All articles must begin with an introduction, a section which demarcates the theoretical background and the goals of the paper.

The present document provides the necessary information and formatting guidelines for you to write your article. We recommend that you copy this file to your computer and insert your own text in it, keeping the format that has already been set. All the different parts of the article (title, main text, headers, titles, etc.) have already been set, as in the present document-model. The main text must be written in regular Times New Roman font, size 11, justified, with a 0.5 cm indent for the first line of each paragraph.

We recommend that you save this document to your computer as a Word document model. Therefore, it will be easy for you to have your article in the correct format and ready to be submitted. **The only form in which the file will be accepted is MS Word 2003**. If you have a later version of Microsoft Office / Word, you can edit it as follows:

- Once you have finished formatting your text, create a pdf file, and then save your file as a Word "97-2003" (.doc) file.

- Compare the two files – the pdf one and the Word "97-2003" (.doc) one.
- If you do not note any significant differences between the two, then – and only then – you can submit your article to us, **sending both the pdf and the Word "97-2003" (.doc) files** to our e-mail address.

If you use a word processor other than Microsoft Word, we recommend that you follow the same procedure as above, creating a pdf file and using the appropriate add-on in order to save your document in MS Word "97-2003" (.doc) form. Once you compare the two files (and find no significant differences), send us both.

2. General Guidelines on Paper Formatting

2.1. Body

The body of the text consists of different sections which describe the content of the article (for example: Method, Findings, Analysis, Discussion, etc.). You can use up to three levels of sections – sub-sections. For the Body of the text, use the default format style in Word, selecting the Times New Roman font, size 11, justified, with a 0.5 cm indent for the first line of each paragraph (this is further detailed in the section "Paragraphs").

2.2. References

The references included in the paper must be cited at the end of the text. All references used in the body of the paper must be listed alphabetically (this is further detailed in the section "References").

2.3. Appendices

The section "Appendices" follows the section "References".

3. Page formatting

3.1. Page size

The page size must be A4 (21 x 29,7 cm), and its orientation must be "portrait". This stands for all the pages of the paper. "Landscape" orientation is inadmissible.

3.2. Margins

Top margin: 2,54cm
Bottom margin: 1,5cm
Left and right margins: 3,17cm
Gutter margin: 0cm

3.3. Headers and Footers

Go to "Format" → "Page", and select a 1,25cm margin for the header and a 1,25cm margin for the footer. Do not write inside the headers and footers, and do not insert page numbers.

3.4. Footnotes

The use of footnotes or endnotes is expressly prohibited. In case further explanation is deemed necessary, you must integrate it in the body of the paper.

3.5. Abbreviations and Acronyms

Abbreviations and acronyms must be defined in the abstract, as well as the first time each one is used in the body of the text.

3.6. Section headers

We recommend that you use up to three sections – sub-sections. Select a simple numbering for the sections – sub-sections according to the present model.

3.7. First level header format

For the headers of the main sections use the Times New Roman font, size 11, in bold and underlined, and leave a size 12 spacing before the paragraph and a size 6 spacing after the paragraph. The header must be aligned left. Use a capital letter only for the first letter of the header.

3.8. Second level header format

For second level headers, follow this model. Use the Times New Roman font, size 11, in bold, and leave a size 12 spacing before the paragraph and a size 3 spacing after the paragraph. Select a 0.5 cm indent. The header must be aligned left. Use a capital letter only for the first letter of the header.

3.8.1. Third level header

For third level headers, follow this model. Use the Times New Roman font, size 11, in bold and italics, and leave a size 6 spacing before the paragraph and a size 0 spacing after the paragraph. The header must be aligned left, with a left indent of 1 cm. Use a capital letter only for the first letter of the header.

4. Paragraphs

In every paragraph, use the Times New Roman font, size 11, with single line spacing. We recommend you modify the default (normal) format style in Word and use that in your text. For all paragraphs, the spacings before and after the paragraph must be size 0, and the line spacing single. Use a 0,5cm indent only for the first line of each paragraph. Leave no spacings nor lines between paragraphs.

4.1. Lists

In case you need to present data in the form of a list, use the following format:

- Bullet indent: 1,14cm
- Text:
    - Following tab at: 1,5 cm
    - Indent at: 1,5cm

Use the same format (the above values) if you use numbering for your list.

1. Example of numbered list 1
2. Example of numbered list 1

5. Figures, images, and tables

5.1. Figures and images

Insert your figures and images directly after the part where they are mentioned in the body of text. They must be centered, numbered, and have a short descriptive title.

Figures put together "as they are", using Office tools, are absolutely inadmissible. The figures used must have been exclusively inserted as images in Word, in gif, jpg, or png form (with an analysis of at least 200dpi), and in line with the text. The width of an image must not exceed 14,5cm so that it does not exceed the margins set above.

The images, figures, and tables must be inserted "as they are" in the text, in line with it. **Figures and images which have been inserted in a text box are absolutely inadmissible.**

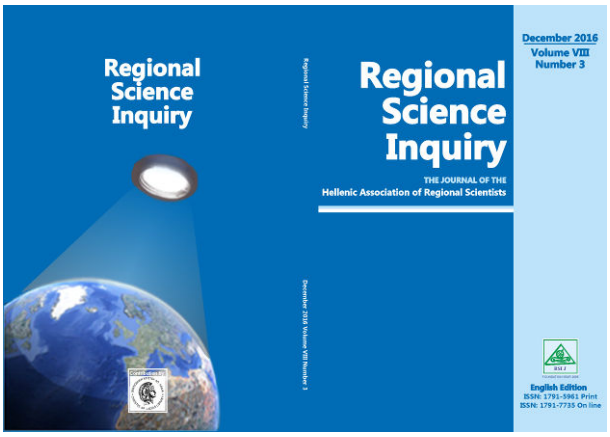
5.1.1. Reference inside the text

Avoid phrases such as "the table above" or the "figure below" when citing figures and images. Use instead "in Table 1", "in Figure 2", etc.

5.1.2. Examples

A model of how to format figures/images follows. For the title, use the Times New Roman font, size 10, in bold. Write the title above the figure, and set a size 6 spacing before the title and a size 0 spacing after it. The line spacing of the title must be 1.5 line. Both the image and its title must be centered.

Image 1: Title



Source: cite the source

Directly below the figure you must cite the source from which you took the image, or any note regarding the figure, written in Times New Roman, size 10. Write it below the figure, leaving a size 0 spacing before and after it, use a line spacing of 1.5 line, and make it centered.

5.2. Tables

For the title, use the Times New Roman font, size 10, in bold. Write the title above the table, and set a size 6 spacing before the title and a size 0 spacing after it. The line spacing of the title must be 1.5 line. Both the table and its title must be centered. The width of the table must not exceed 14,5cm so that it does not exceed the page margins set.

Table 1. Example of how a table must be formatted

Age	Frequency	Percentage %
Under 40	44	32.1
40 - 49	68	49.6
Over 50	25	18.2
Total	**137**	**100.0**

Source: cite the source

If the table needs to continue on the next page, select in the "Table properties" that the first line be repeated as a header in every page, as in the above example of Table 1. **Tables (or figures or images) which are included in pages with a "Landscape" orientation are absolutely inadmissible.**

Every table must have horizontal lines 1 pt. wide at the top and bottom, as shown in the example. The use of vertical lines and color fill at the background of the cells is strictly prohibited.

Directly below the table you must cite the source or any note regarding the table, written in Times New Roman, size 10. Write it below the table, leaving a size 0 spacing before and a size 6 spacing after it, and make it centered.

6. Mathematical formulas

There is a variety of tools in order to insert and process mathematical formulas, such as the "Mathematics", found in the most recent editions of Word, "Math Type", "Fast Math Formula

Editor", "MathCast Equation Editor", "Math Editor". Since it is impossible for us to provide you with compatibility with all these tools in all their editions, **we can only admit your paper if it contains mathematical formulas solely in the form of images.**

Keep a continuous numbering for the mathematical formulas and center them in the page, as shown in the following example:

$$y = ax^2 + bx + c \tag{1}$$

The same stands for formulas or particular mathematical symbols you may have integrated in your text. For instance, if you want to use the term ax^2 in your text, you must insert it as an imaged, in line with the text. The images containing the mathematical formulas must be legible (at least 300dpi).

In the exceptional case of a text which may contain a great number of mathematical formulas, the writer may send it to us in TeX form if they so wish.

7. References

We recommend that you use the Chicago Manual of Style Author-Date system, as it is recommended by the AEA (American Economic Association) for the journals included in the EconLit database, and it is the dominant style of bibliography in the field of Economics. For more information you can go to the following links:

- https://www.aeaweb.org/journals/policies/sample-references
- http://www.chicagomanualofstyle.org/tools_citationguide.html
- http://libguides.williams.edu/citing/chicago-author-date#s-lg-box-12037253

7.1. Online references (internet citations)

Check your links again before sending your file, to confirm that they are active.

Avoid long internet links. Where possible, also cite the title of the website operator-owner. Return the font color to black, and remove the hyperlink. Links such as the following are impractical and distasteful, therefore should be avoided.

Example of an inadmissible hyperlink

https://el.wikipedia.org/wiki/%CE%9F%CE%B9%CE%BA%CE%BF%CE%BD%CE%BF%CE%BC%CE%B9%CE%BA%CE%AC

7.2. References Formatting

For your list of references, use the Times New Roman font, size 10, with single line spacing. The paragraph format must include a size 0 spacing before the paragraph and a size 0 spacing after it, aligned left. Use a 0,5 cm indent only for the first line of each paragraph. Leave no spacings or lines between paragraphs.

7.3. Example of how References must be formatted

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