Regional Science Inquiry

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December 2022 Volume XIV Number 2

Regional Science Inquiry

THE JOURNAL OF THE
Hellenic Association of Regional Scientists

December 2022
Volume XIV
Number 2

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
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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. XIV, (2), 2022
Editorial Note

In the second semester of 2022, the Regional Science Inquiry Journal (RSIJ), the scientific journal published under the scientific aegis of the Hellenic Association of Regional Scientists, launches the second issue (2) of its fourteenth volume (Vol. XIV) since the first day it was published. 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. So far, it appears fairly serving its purpose, as, according to the Scimago Journal and Country Rank (SJR, 2022), for the year 2021 the RSIJ is ranked in the Q_2 *quartile* in the field *of Sociology and Political Science*, while it improved its ranking in all the other three related fields being under evaluation (*Development*; *Economics and Econometrics*; *Geography, Planning, and Development*), compared to the previous year. To this end, this issue (RSIJ, Vol. XIV, (2), 2022) 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 timely and interesting topics of Regional Science research, such as regional employment, institutions and innovation, Keynesian income multipliers, sustainability in production, tourism competitiveness and seasonality, gender balance and regional resilience, logistics and regional development; and human capital and intellectual capital. These papers mainly build on empirical and analytic approaches, although one study also employs theoretical scenarios.

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.

In brief, the first paper, entitled "*EMPLOYMENT IMPACT OF FIRMS' INNOVATION: WHAT IS THE ROLE OF REGIONAL INSTITUTIONS? EVIDENCE FROM ITALY*", authored by Luca VOTA, studies the impact of private firms' research and development (R&D) spending, institutional quality, and their interaction on the employment rate of the Italian regions, by proposing two dynamic panel models build on Ordinary Least Squares (OLS), Fixed effects (FE), and System Generalized Moments Method (GMM-SYS) approaches. The results illustrate a negative impact of firms' innovation on regional employment, while the ability of the regional institutions to attract, support, and cooperate with the innovative companies and the R&D investment programs jointly financed by regional governments and private firms positively affect the employment rate. The paper concludes with appropriate policy implications based on the analysis.

The second paper, entitled "*A NETWORK-BASED ALGORITHM FOR COMPUTING KEYNESIAN INCOME MULTIPLIERS IN MULTIREGIONAL SYSTEMS*", authored by Dimitrios TSIOTAS, investigates revisits the established regional economic model of the Keynesian "multiplier effect", by proposing an algorithm for computing Keynesian income multipliers in multiregional systems. Building on network connectivity, estimations of the regional shares of imports, marginal propensity to consume, and changes in demand, the proposed algorithm provides a framework for standardizing computations of the multiplier effect in multiregional systems. The algorithm is implemented in two theoretical scenarios, contributing to a deeper conceptualization of the computation of the Keynesian income multipliers, and an empirical case of the land interregional commuting network in Greece, providing insights into the developmental dynamics of the labor market (demand for employment) in Greece. The analysis highlights the symbiotic relationship between the multiplier effect and network structure in regional markets, promotes multidisciplinary thinking in regional science and economics, and provides a code of this network-based algorithm to support further research.

The third paper, entitled "*A THEORETICAL ANALYSIS OF COSTS, WASTE TREATMENT, POLLUTION IN THE GANGES, AND LEATHER PRODUCTION BY TANNERIES IN KANPUR, INDIA*", authored by Amitrajeet A. BATABYAL, and Seung Jick YOO, examines the interaction between two representatives and real tanneries (leather

production) located on the same bank of the Ganges River in Kanpur, India. Both tanneries are spatially interrelated in a chemical waste context, as the leather production of the first adversely affects the leather-producing cost of the second one. In this setting, the paper: determines the amount of chemical waste and the leather produced by both tanneries in a competitive equilibrium; explains why this competitive equilibrium is inefficient from a societal standpoint; ascertains the socially optimal amount of leather produced by the two tanneries; and illustrates the applicability of the theoretical model with a real-world example.

The fourth paper, entitled "*DRAWING AN INDICATOR OF TOURISM COMPETITIVENESS AND EXAMINING ITS RELATIONSHIP WITH TOURISM SEASONALITY FOR THE GREEK PREFECTURES*", authored by Thomas KRABOKOUKIS and Serafeim POLYZOS, proposes a conceptual framework to classify the Greek prefectures according to their tourism competitiveness and examines the relationship between tourism competitiveness and tourism seasonality, based on a tourism competitiveness index and a dataset of 66 variables. The analysis reveals four groups according to tourism competitiveness and seasonality in the case of the Greek tourism market, provides a joint quantitative consideration between tourism competitiveness and seasonality, highlights the effectiveness of a competitiveness index in measuring tourism competitiveness, and proposes a tool for tourism management and regional policy.

The fifth paper, entitled "*ARE THE REGIONS WITH MORE GENDER EQUALITY THE MORE RESILIENT ONES? AN ANALYSIS OF THE ITALIAN REGIONS*", authored by Barbara MARTINI and Marco PLATANIA, investigates the relationship between gender imbalance and regional resilience, a relationship that is currently not being studied in a comprehensive context. The analysis captures employment distribution in terms of a dissimilarity index emerging as a consequence of regional specialization, which in turn, is expected to have an impact on resilience. The results reveal a relationship between gender segregation and regional specialization, observing higher dissimilarity in cases of high regional specialization with low females share; detect a positive relationship between resilience and gender equality, from 2008 to 2013, implying that the more gender equality regions are also the more resilient ones; and discuss on the potential of configuring better policies towards enhancing the welfare and social dimensions and breaking gender stereotypes.

The sixth paper, entitled "*THE LOGISTIC DRIVERS AS A POWERFUL PERFORMANCE INDICATOR IN THE DEVELOPMENT OF REGIONAL COMPANIES OF KOSOVO*", authored by Filipos RUXHO and Christos Ap. LADIAS, investigates whether the management of logistics' supply chain drivers can serve as a formal predictor and driver of the development of regional companies in Kosovo. The study aims to help Kosovo's regional companies, formally and independently, to integrate with supply chains, increasing their performance and development amid the difficult economic conditions in which they operate. To do so, it builds on a quantitative survey conducted among 103 regional companies of Kosovo and uses descriptive statistics and hypothesis testing. The results provide interesting insights into the relationship between the logistics' supply chain drivers and their importance to increase the performance of regional companies and can support policymakers and institutions in the design of development initiatives for regional infrastructure, economic zones, and locations.

The seventh paper, entitled "*INTERRELATIONSHIPS BETWEEN HUMAN CAPITAL AND INTELLECTUAL CAPITAL: EVIDENCE FROM THE PANEL OF HIGH-INCOME AND LOW AND MIDDLE-INCOME GROUPS OF THE WORLD*", authored by Imran HUSSAIN, Ramesh CHANDRA DAS, and Aloka NAYAK, examines the long-term relationship between intellectual capital and human capital formation (HCF) in case of some countries from the high-income group (HIG) and low and middle-income group (LMIG), from 1998 to 2018, by employing panel unit root, panel co-integration, and panel causality techniques. 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, while the short-run causal interplay works in a high-income group only where the human capital formation is

making a cause to the intellectual capital formation. The analysis estimates the elasticity between HCF and intellectual capital in the high-income group and proceeds to appropriate policy suggestions.

All these interesting works are available on the next pages of the RSIJ intending to promote the academic dialogue in Regional Science.

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

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Articles

EMPLOYMENT IMPACT OF FIRMS' INNOVATION: WHAT IS THE ROLE OF REGIONAL INSTITUTIONS? EVIDENCE FROM ITALY

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Abstract

Employment effect of firms' innovation is a widely studied topic at both cross-country and national level, while still few contributions deals with the local dimension. Moreover, the role of the institutional factors is still unexplored. In this manuscript, the author estimates the impact of private firms' R&D spending, institutional quality and their interaction on the employment rate of the Italian regions. To accomplish his task, the author proposes two dynamic panel models and computes them through the Ordinary Least Squares (OLS), Fixed effects (FE) and System Generalized Method of Moments (GMM-SYS) regression tecniques. The obtained results suggest that the employment impact of firms' innovation is negative, while the ability of the regional institutions to attract, support and cooperate with the innovative companies and the R&D investment programs jointly financed by regional governments and private firms positively affect the employment rate. The author has deduced appropriate policy implications from the provided evidence.

Keywords: *Employment impact of firms' innovation, R&D activity, Regional Economics*
JEL classification: O30, R10, R11

1. Introduction

Employment impact of firms' innovation is important for both economists and policy makers who are concerned about the so-colled "fourth industrial revolution". In fact, the debate on the economic consequences of innovation is deadlocked over the questions "How does firms' innovation affect the employment rate?" and "What are the best strategies to maximize the positive externalities of firms'innovation on labour market and to minimize the negative ones?". In the past centuries, many primary economic thinkers focused on the relationship between technological innovation and labour market. For example, according to Adam Smith, innovation contributes to the economic growth of nations through division of labour. David Ricardo, instead, pointed out that the introduction in the production process of new machineries can be detrimental for workers, but it is better to support technological innovation because contrasting it can induce firms to move abroad with even worse aftermath on national labour market. Finally, Schumpeter highlighted that entrepreneurs exploit innovation to allocate the production factors in more and more efficient ways. His main insight is that innovation is responsible for job destruction just as a result of this constant riallocation process of existing resources. However, from an historical point of view and in particular looking at the three global industrial revolutions, it seems that innovation generally leds to a drop in employment in the short-run, but to a permanent increase in the long-run (Kapeliushnikov, 2019).

Today, the academic community is divided between those ones who believe that technological innovation does not reduce the employment rate and those ones claiming that innovation implies "technological unemployment" ("this means unemployment due to our discovery of means of economising the use of labour outrunning the pace at which we can find new uses for labour" (Keynes, 1931)). However, it is a very challanging debate as the evidence on the technological unamployment are mixed for two main reasons. The first one is the fact that this phenomenon is shaped by an eterogeneous and complex set of microeconomic and macroeconomic variables (such as labour and physical capital marginal productivity, stock of human capital, companies' functional specialization, companies' settlment structure, systemic shocks and so on) changing country by country. The second one is the existence of many different kinds of innovation. General guidelines for both researchers and practitioners on the measurement of scientific, technological and innovation activities

have been provided by the Organization for Economic Cooperation and Development (OECD) only starting from 2005 through the well-known Oslo Manual. The fourth and last editon of this handbook (Oslo Manual 2018) defines business innovation as:

"[…] *a new or improved product process (or combination thereof) that differs significantly from firms' previous products or business processes and that has been introduced on the market or brought into use by the firm*"

and lists 8 types of business innovation activities: *i*) R&D activities; *ii*) engigneering, design and other creative work activities; *iii*) marketing and brand equity activities; *iv*) intellectual property (IP) related activities; *v*) employee training activities; *vi*) software development and database activities; *vii*) activities relating to acquisition or lease of tangible assets; *viii*) innovation management activities. Further, business innovation is split into two broad categories: product innovation, namely goods or services providing significant improvements compared to goods and services previously introduced into the market, and business process innovation, i.e. a new business process for one or more business function differing from the firms' previous business processes and that has been brought into use in the firm.

2. Research aims

Currently, there are two ways in which it is possible to contribute to the literature on the employment impact of firms' innovation. The first one consists in widening the local, and in particular regional, dimension of the phenomenon. In fact, actually most of the contributions on the link between firms' innovation and employment rate provide evidence at national or cross-national level (more precisely on the "Triad": USA, Europe and Japan), while those ones analyzing sub-national economies are still few. The second way, is focusing on a factor to which little attention has been paid in this literature until now, namely institutional quality. In fact, it would be fundamental to assess the role played by institutions, given that today innovation is considered a complex process coming from the interaction between public bodies and private firms (van Waarden, 2001; Coriat and Weinstein, 2002) and that regional government R&D spending itself have proved to be insufficient to stimulate employment growth in the advanced economies (Moutinho et al., 2015). Many cases of Regional Systems of Innovation (Cooke et al., 1997; Doloreux, 2002), joint initiatives between institutions and private companies (Korres and Kokkinou, 2011; Kafouros et al., 2015; Hussen and Çokgezen, 2022), R&D by candidate entrepreneurs (Batabyal and Jick Yoo, 2018) and R&D policy schemes on the innovation activities of firms (Almus and Czarnitzki, 2003) have been documented and studied in order to understand whether they are able to favour economic growth and absolute and relative convergence process among regions, but their impact on employment remains almost entirely unexplored. This manuscript aims at filling these two gaps by providing new evidence on the effect of companies' innovation on the employment rates of the twenty Italian regions taking into account the regional institutional quality. More in particular, this paper tries to provide an answer to the following question: "Is the employment effect of firms' innovation shaped by the local institutional quality? Are good quality regional institutions able to attract, support and cooperate with private innovative companies in such a way to mitigate (magnify) the negative (positive) effects of their activities on employment? Have the investment programs in innovation jointly financed by private firms and regional institutions a positive impact on employment rate?"

Here, the terms *institutions* refers to both formal and informal institutions. More in particular, the first ones include public institutions such as regions, provinces, municipalities, branches of public administration operaring at regional and sub-regional level and judicial authorities (police, courts, magistrature and anti-corruption bodies and so on), while the second ones comprise tertiary sector (non-profit organizations, associations, foundations and so on). Innovation, instead, has been measured through firms' R&D spending, a kind of business innovation activity according to the classification of the latest version of the Oslo Manual.

To accomplish his task, the author carried out a multivariate analysis on the twenty Italian regions: Aosta Valley, Piedmont, Trentino Alto-Adige, Friuli Venezia-Giulia, Lombardy, Veneto, Liguria, Emilia Romagna, Marche, Umbria, Tuscany, Latium, Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria, Sicily and Sardinia. The author has employed as proxy of institutional quality of the Italian regions the Institutional Quality Index (IQI) calculated by Nifo and Vecchione (2014). This is a popular measure among the scholars of regional economics dealing with the Italian regions because it captures different qualitative aspects of the formal and informal institutions listed above. More precisely, it is articulated into five pillars:

1) *Control of corruption*, a summary of the crimes committed against the public administration;
2) *Government effectiveness*, accounting for the endowment of social and economic structures in Italian provinces and the administrative capacity of provincial and regional governments in relation to policies concerning health, waste management and the environment;
3) *Regulatory quality*, comprising the degree of openess of the economy, business environment and the capability of the local institutions to attract and support businesses;
4) *Rule of law*, a summary of data on crime against persons or property, on magistrate productivity, trial times, the degree of tax evasion and the shadow economy;
5) *Voice and Accountability*, including electoral participation, number of associations, number of social cooperatives and proxies of cultural liveliness.

Another good motive for considering this particular measure of institutional quality in this manuscript is that, in a recent contribution of them, D'Ingiullo and Evangelista (2020) have demonstrated that it represents a social filter that can foster the innovation across the Italian provinces. Then, in the Italian case, the IQI seems to be very suitable for the economic researches on the nexus between innovation and institutional quality at local level.

The reason for the choice of the Italian regions as territorial units, instead, is that Italy presents large regional gaps in employment rate, institutional quality and private companies' R&D spending. These differences are due to the economic backwordness of Southern regions compared to the Center-Northern ones. a well-known and widely studied issue (the so-colled *Mezzogiorno Question*) puzzling both economists and policy makers since 1880s. Consequently, it could be interesting to assess whether part of the variability in the employment rate of the Italian regions can be explained by both firms' R&D expenditure and the interaction between local institutions and firms' R&D activity, namely the ability of the institutions to attract, support and cooperate with private innovative firms. If so, increasing the institutional quality of the lagging regions and improving the way in which they interact with the innovative firms could be a good strategy for the Italian policy makers to contrast the technological unemployment and boost the employment rates at local level.

3. Literature review

As hinted in the previous paragraph, literature provides many evidence on the relationship between firms' innovation and employment rate and they are mixed, also because of the the fact that many different measures of innovation exist (Vivarelli, 2014; Calvino and Virgilito, 2016). However, the most common one among them is the firm level R&D capital stock. Of course, scholars pay greatest attention to the employment effect of innovation at cross-national level (Hall and Heffernan, 1985; Brouwer et al., 1993; Antonucci and Pianta, 2002; Mastrostefano and Pianta, 2009; Bogliacino and Pianta, 2010; Lucchese and Pianta, 2012; Bogliacino, 2014; Harrison et al., 2014). Among the contributions at international level, very significant is that one by Aldieri and Vinci (2017), as it considers 879 international corporations located in the so-colled "Triad" (USA, Japan and Europe) between 2002-2010, distinguishing between technological level of firms. The selected sample period allows the authors to capture the reallocation process of the labour factor among high-tech and low-tech industries due to the recession of 2008. They proxy innovation through R&D capital stock of firms. Their results indicate that the own innovation generally has a negative destruction rate, but some relevant differences from the baseline result rises looking at the the external

spillover. In fact, the latter one negatively affected the employment rate before the beginning of the crisis and positively after 2006. These findings are similar to those ones presented in Agovino et al. (2016), who also consider USA, Japan and Europe. Other recent evidences at international level are presented by Matuzeviciute et al. (2017). They look for effect of firms' innovation on employment and unemployment rate using panel data relating to 25 European countries between 2000 and 2012 and triadic patent families per million inhabitants as measure of innovation. They find that firms' innovation has no predictive effect neither on employment rate nor on unemployment rate. Feldmann (2013), instead, studies 21 industrial countries using the same proxy of innovation of Matuzeviciute and his co-authors and discrovers that in the short-run (three years) the introduction of new patents boosts unemployment rate, while, in the long run, any negative effect disappears. In other words, technological unemployment is only a temporary consequence of a transition process. Postel-Vinay (2002) writes down a theoretical model of frictional unemployment that arrives at the opposit conclusions of the Feldmann's estimations, namely that, in the short term, technological change has a positive impact on employment but, in the long term, the equilibrium level of employment goes down because of job obsolescence. Even if all the evidences above are quite different, overall they seems to confirm the schumpeterian theory of creative distruction. Other authors have studied the nexus between innovation and employment at national level, again with heterogeneous results (Vivarelli et al., 1996; Klette and Førre, 1998; Greenhalgh et al., 2001; Piva and Vivarelli, 2005; Lachenmaier and Rottmann, 2011; Coad and Rao, 2011; Mitra and Jha, 2015; Van Reenen, 2015; Ciriaci and Moncada-Paterno-Castello, 2016). Instead, among manuscripts treating the argument under scrutiny at regional level, the manuscripts Capello and Lenzi (2013) and by Aldieri et al. (2019) deserves attention. The first one consists in an empirical contribution on the nexus between process and product innovation and employment growth in the regions of 27 European countries (Nomenclature of Territorial Units for Statistics- NUTS2). Its authors show that the effect of these kinds of innovation on employment depend mainly on the regional structural characteristics, or better on the regions' functional specialization and settlment structure: in the regions having larger presence of production functions, product innovations have an average positive effect, while the effect of process innovation is negative in metropolitan areas. In the third one, instead, the authors are interested to understand how the R&D expenditure (measure of technological innovation) and the knowledge spillover shape the employment rate of the Finnish regions differentiating the effects on the basis of the skill level of the workers. Their outcomes suggest the existence of positive effects of both innovation and spillover for high-skilled employees at local level between 2000 and 2013, while only innovative activities have a significant (and negative) effect for the low-skilled ones in the same sample period. Finally, as concerns the nexus among employment rate, firms' innovation and institutional quality, the only contribution on this argument is that one by Goos et al. (2015), which proves that, over the past decades, high-tech employment have increased across the European regions during the period 2005-2015 mainly thanks to the local job multipliers generated by the high-tech companies, altough many institutional obstacles related to innovation impede a proper convergence process between developed and lagging regions.

4. Employment, institutional quality and firms' R&D: a descriptive analysis

In this section, the author provides a simple descriptive analysis of the employment rate, firms' R&D spending and Institutional Quality Index (IQI) and shows their territorial distribution. The data relating to the IQI come from Nifo and Vecchione (2014), while the data on the other two variables have been collected from the public available database of the Italian Statistical Office (ISTAT)[1]. The summary statistics for these three variables in the year 2018 are reported in Table 2 below:

[1] http://dati.istat.it/

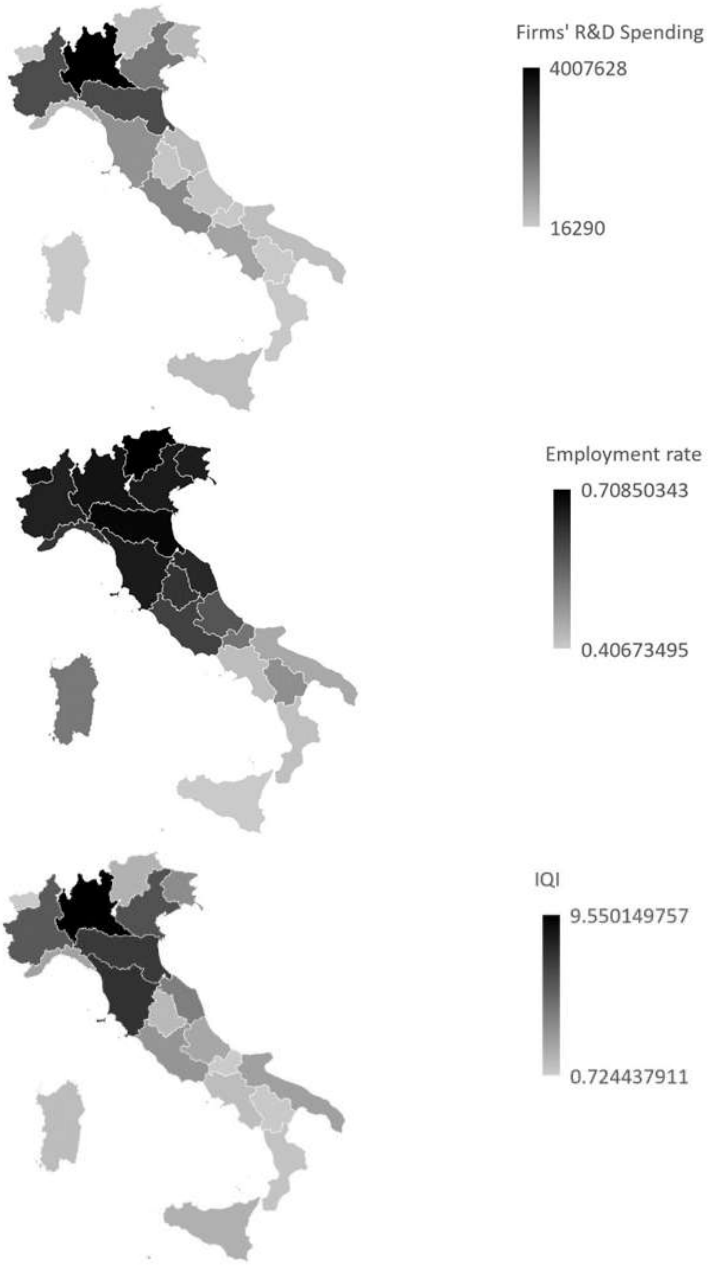
Table 1: Summary statistics for Employment rate, Firms' R&D spending and IQI

Variable	Mean	Median	Standard deviation	Min.	Max.
Employment rate	57.12	62.07	9.891	38.91	70.85
Firms' R&D spending	66200000.00	25860000.00	90760000.00	3181	400800000.00
IQI	3.226	2.378	2.545	0.3621	9.897

Source: author's elaboration

Both the standard deviation and the range (the difference between the maximum and the minimum value) indicate a high variance in the employment rate, IQI and firms' R&D spending. This high variability is due to the gap between the Center-Northern regions and the Southern ones. In fact, as highlighted in the Figure 1 below, in 2018 the Center-Northern regions present higher employment rates and institutional quality than the Southern ones. At the same time, the firms'R&D expenditure is mainly concentrated in few Center-Northern regions, i.e. Lombardy, Piedmont, Emilia Romagna, Veneto and Latium:

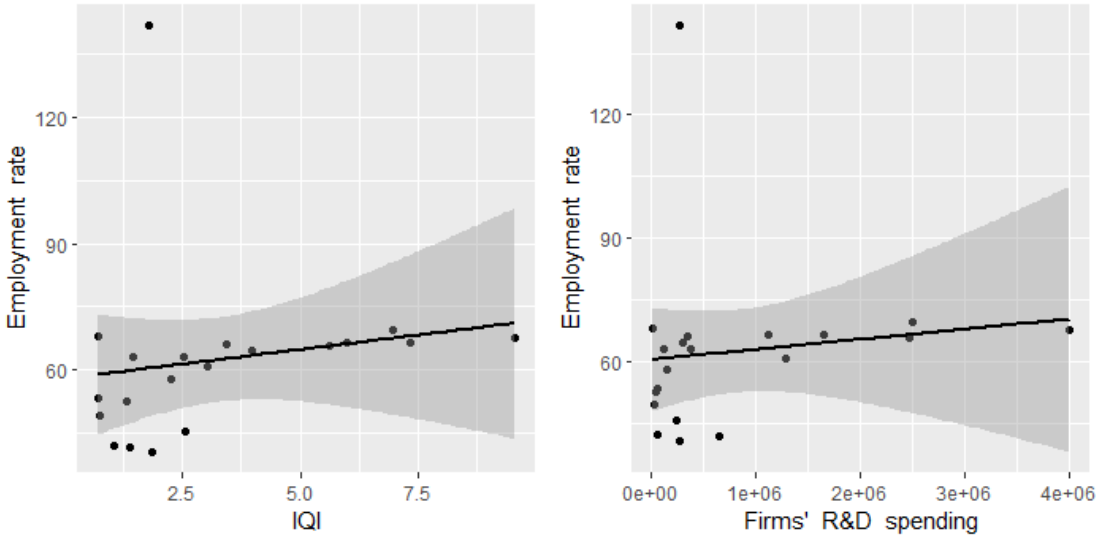
Figure 1: Territorial distribution of Firms' R&D spending, employment rate and IQI



Source: author's elaboration

Finally, the author has plotted both the IQI and the firms' R&D spending towards the employment rate and calculated the Pearson's correlation index between both employment rate and firms'R&D spending and employment rate and IQI in the year 2018 (the last of the considered sample period). The two scatterplot are reported in Figure 2 below:

Figure 2: Territorial distribution of Firms' R&D spending, employment rate and IQI



Source: author's elaboration

As can be noted fromthe graph above, there is a positive and very significant linear correlation between the employment rate and the IQI and between the employment rate and the Firmsì R&D spending. In fact, the correlation indexes between the Employment rate and between the employment rate and the firms' R&D spending are, respectively, equal to 0.55 and 0.43. Then, it is appropriate to carry out a multivariate regression analysis in order to search for the existence of the relating causal relationships.

5. Research methods

In order to assess the impact on the employment rate of the firms' R&D spending, institutional quality and their interaction, the author, following Lachenmaier and Rottmann (2011), has written down the two dynamic panel models below:

$$n_{i,t} = \sum_{i=1}^{2} \beta_i n_{i,t-i} + \sum_{i=3}^{5} \beta_i s_{i,t-i+3} + \beta_6 IQI_{i,t} + \beta_7 (IQI_{i,t} * s_{i,t}) + \gamma X' + \eta_i + \varepsilon_{i,t} \quad (1)$$

and:

$$n_{i,t} = \sum_{i=1}^{2} \beta_i n_{i,t-i} + \sum_{i=3}^{5} \beta_i s_{i,t-i+3} + \beta_6 IQI_{i,t} + \beta_7 (IQI_{i,t} * s_{i,t} * U_{i,t}) + \gamma X' + \eta_i + \varepsilon_{i,t} \quad (2)$$

where:

$n_{i,t}$ is the employment rate of people aged 15-64;

$s_{i,t}$ is the firms' R&D spending;

$IQI_{i,t}$ is the institutional quality index;

$U_{i,t}$ is the regional governments spending;

X is a vector of additional control variables containing GDP per capita, forms' gross fixed investment, labour income; resident population; value added per employee, regional governments tax revenue and human capital (for a complete description of the controls see the Appendix);

η_i is an unobserved region-specific time-invariant effect that can be correlated with the independet variable;

$\varepsilon_{i,t} \sim iid(0, \sigma_\varepsilon^2)$ is an error term;

γ and β_i are sets of parameters to be estimated;

i and t indicate, respectively, the i-th territorial unit (Italian region) and the t-th time unit.

The two coefficients β_1 and β_2 capture the dynamic adjustment of the employment rate over time, while β_3, β_4 and β_5 account for the effect of contemporaneous and delayed effects of the firms' R&D spending on the current employment rate. All these lagged variables reflect the short-run dynamics due to adjustment costs (i.e. the costs borne by firms to change their level of output), expectations formation and decision process of firms. For example, when firms face high hiring and firing costs (just as in the Italian case), the actual employment will deviate from the equilibrium level and so a dynamic estimation equation is better than a static one.

Indeed, specifications like the two ones above are very common in manuscripts dealing with the topic under scrutiny and employing panel data. The novelty here compared to the previous contributions are two. The first one is the coefficient β_6 that estimates the impact of the regional institutional quality on the employment rate. The second one, instead, is given by the interaction term and the double interaction term present, respectively, in the equation (1) and in the equation (2). More in particular, the interaction term in the equation (1) represents the effect on the actual employment rate of the ability of the regional institutions of attracting, supporting and cooperating with the private innovative firms, while the double interaction term in the equation (2) indicates the effect on the current employment rate of the R&D programs jointly financed by the innovative companies and the regional governments, taking into account the administrative quality of the latter ones.

Estimating the equation (1) and the equation (2) poses two significant endogeneity problems. The first one comes from the correlation between the lagged values of the dependent variables (employment rate) and the the cross-section specific effect. The second one, is due to the fact that, probably, firms choose their labour stock and R&D investment at the same time and then the simultaneous causality issue arises. Consequently the Ordinary Least Squares (OLS) estimator is biased and inconsistent. Currenlty, two alternatve estimators are used in this literature to compute models like those ones considered by the author: the GMM-difference proposed by Holtz-Eakin et al. (1988) and Arellano and Bond (1998) that, as suggested by its name, employs first-differenced variables, and the GMM system (GMM-SYS) developed by Blundell and Bond (1998), that can be run either on first-differenced or in level variables. More in particular, the GMM-difference uses all (or most of the) level values of the dependent variables as instruments for the relating lagged variables, while the instrument matrix of the GMM-SYS includes first-differences. Using the GMM-SYS instead of the GMM-difference is highly recommended with short sample period and high persistence of variables over time. In fact, Blundell and Bond (1998) have demonstrated that the GMM-difference estimated coefficients are biased downwards, namely in the same direction of the within group estimator. Here, the author has estimated his two dynamic panel models through an OLS regression with heteroskedasticity and autocorrelation consistent standard errors (HAC), a Fixed effects linar regression with time dummies (a method able to account for all those factors varying over time and constant among units and vice versa) and a GMM-SYS on the variables in level with time dummies. In this context, the time dummies capture the macroeconomic and financial shocks common to all the Italian regions and the economic policy decisions taken from the central Italian government and the European institutions during the considered sample period.

The author preferred the GMM-SYS to the GMM-difference just because both the employment rate and the firms' R&D spending exhibit high serial correlation and his sample period is quite short, as consists of only 6 years (2012-2018). Finally, the author has carried out a Ramsey RESET test on his OLS regression to assess the suitability of the linear specification of his two models and a Sargan test on his GMM-SYS in order to assess the exogeneity of the instruments.

The data on the IQI, as previously hinted, come from Nifo and Vecchione (2014), while the data relating to all the other variables entering the model have been collected from the

public available database of the Italian statistical office (ISTAT)[2]. The author's panel dataset comprises six years only because the ISTAT database includes statistics on the firms' R&D innovation only in the period 2012-2018.

6. Estimation output with a techinical comment

The estimation outcomes of the equation (1) obtained through the three estimators indicated in the previous section (OLS, Fixed effects regression and GMM-SYS) are reported in Table 4 below. All the variables entering the two theoretical model (except the employment rate and the IQI) are in natural logarithm (lin-log):

Table 4: Estimation output of the equation (1)

Control variables	OLS	FE regression	GMM-SYS
$Const$	-	-750.853*** (239.132)	-
$Employment\ rate_{i,t-1}$	0.708494*** (0.129326)	0.116275 (0.0746085)	0.679152 (0.116342)
$Employment\ rate_{i,t-2}$	0.178771 (0.127251)	-0.398698* (0.203407)	0.0509181 (0.0863360)
ln $(GDP\ per\ capita_{i,t})$	-2.21694 (2.16468)	7.32403 (7.51497)	-1.02606 (2.77682)
ln $(Firms'fixed\ investment_{i,t})$	0.663887 (1.44305)	-6.35619*** (2.03463)	-0.706123 (0.885241)
ln $(Labour\ income_{i,t})$	4.76742 (5.43914)	16.3182 (10.5569)	4.09051 (4.93626)
ln $(Human\ capital_{i,t})$	2.20619*** (0.762165)	6.40979*** (2.03750)	3.33608*** (1.17811)
ln $(Reg.gov.spending_{i,t})$	-0.579167 (1.07003)	5.54531 (3.82124)	-0.433485 (1.04359)
ln $(Reg.tax\ revenue_{i,t})$	-0.188970 (0.242083)	0.487948 (4.19932)	-0.217613 (0.216701)
$IQI_{i,t}$	0.00659705 (0.0996435)	-1.81107** (0.701557)	0.00314823 (0.0924068)
ln $(IQI_{i,t}$ $* Firms'R\&D\ spending_{i,t})$	0.708494*** (0.129326)	1.61187 (1.87359)	1.57221** (0.717833)
ln $(Res.pop._{i,t})$	-3.55360 (2.56153)	26.6747 (15.5014)	-6.62479* (3.49254)
ln $(Value\ added_{i,t})$	0.970327 (1.10018)	9.32778** (4.29196)	3.60267** (1.72367)
ln $(Firms'R\&D\ spending_{i,t})$	-0.957997* (0.463278)	-1.30640 (2.23337)	-1.81977** (0.861726)
ln $(Firms'R\&D\ spending_{i,t-1})$	-0.351041 (0.692994)	0.138699 (0.524387)	-0.0774210 (0.372706)
ln $(Firms'R\&D\ spending_{i,t-2})$	0.218288 (0.660917)	0.269937 (0.662955)	0.0405291 (0.328436)
Adjusted R-squared:	0.995119	-	-
Ramsey RESET test:	0.083978 [0.92]	-	-

[2] http://dati.istat.it/

Control variables	OLS	FE regression	GMM-SYS
Sargan test	-	-	17.198 [0.2093]
Time dummies	YES	YES	YES

Robust standard errors (HC3) in round brackets.
p-values associated to the statistical test in squared brackets.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: author's elaboration

Here, some technical considerations can be useful. First of all, it is important to note that the two estimated coefficients associated to the lagged employment rate change greatly among the three considered estimators, both in dimension and standard errors. For example, the estimated coefficient relating to the one-year lagged employment rate is very significant in the OLS regression, while it becomes not statistically different from zero in the FE regression and in the GMM-SYS. This is due to the endogeneity problems previously discussed, namely reverse causality and correlation of the lagged dependent variables with the unobserved region-specific time-invariant factors. Also the other estimated coefficients vary a lot among the three estimators, because of the other endogeneity problems affecting panel data.

Consequently, only the GMM-SYS estimates can be considered reliable, as the other two estimators are unable to rule out the endogeneity issues proper of the dynamic panel models.

As concerns the regression diagnostic, the adjusted R-squared and the Ramsey RESET test sugges that, respectively, the variables included into the equation (1) explain almost all the variability in the employment rate and that a linear specification fits better the data than a polynomial one with squares and cubes. Further, the Sargan test indicates that the instruments exploited by the GMM-SYS satisfy the exogeneity property.

The estimation results relating to the equation (2) have been put in the following Table 5:

Table 5: Estimation output of the equation (2)

Control variables	OLS	FE regression	GMM-SYS
$Constant$	-	-750,853*** (239,132)	-
$Employment\ rate_{i,t-1}$	0,708494*** (0,129326)	0,116275 (0,0746085)	0,679152*** (0,116342)
$Employment\ rate_{i,t-2}$	0,178771 (0,127251)	-0,398698* (0,203407)	0,0509153 (0,0863364)
ln $(GDP\ per\ capita_{i,t})$	-2,21694 (2,16468)	7,32403 (7,51497)	-1,02610 (2,77683)
ln $(Fixed\ investment_{i,t})$	0,663887 (1,44305)	-6,35619*** (2,03463)	-0,706109 (0,885245)
ln $(Labour\ income_{i,t})$	4,76742 (5,43914)	16,3182 (10,5569)	4,09022 (4,93628)
ln $(Human\ capital_{i,t})$	2,20619*** (0,762165)	6,40979*** (2,03750)	3,33613*** (1,17812)
ln $(Reg.gov.spending_{i,t})$	-1,46984 (1,29181)	3,93344 (5,00885)	-2,00565 (1,25104)
ln $(Reg.tax\ revenue_{i,t})$	-0,188970 (0,242083)	0,487948 (4,19932)	-0,217600 (0,216702)
$IQI_{i,t}$	0,00659705 (0,0996435)	-1,81107 (0,701557)	0,00315114 (0,0924073)

Control variables	OLS	FE regression	GMM-SYS
ln ($IQI_{i,t}$ $* Firms' R\&D\ spending_{i,t}$ $* Reg.gov.spending_{i,t}$)	0,890674** (0,296423)	1,61187 (1,87359)	1,57224*** (0,717836)
ln ($Res.pop._{i,t}$)	-3,55360 (2,56153)	26,6747 (15,5014)	-6,62508* (3,49255)
ln ($Value\ added_{i,t}$)	0,970327 (1,10018)	9,32778** (4,29196)	3,60278** (1,72368)
ln ($Firms' R\&D\ spending_{i,t}$)	-0,957997* (0,463278)	-1,30640 (2,23337)	-1,81980** 0,861730
ln ($Firms' R\&D\ spending_{i,t-1}$)	-0,351041 (0,692994)	0,138699 (0,524387)	-0,0774201 (0,372708)
ln ($Firms' R\&D\ spending_{i,t-2}$)	0,218288 (0,660917)	0,269937 (0,662955)	0,0405357 (0,328438)
Adjusted R-squared:	0,995119	-	-
Ramsey RESET test:	0,083978 [0,919561]	-	-
Sargan test	-	-	17,1978 [0,2458]
Time dummies	YES	YES	YES

Robust standard errors (HC3) in round brackets.
p-values associated to the statistical test in squared brackets.
$^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$
Source: author's elaboration

Here, technical comments very similar to those ones above could be made. The author skips them to avoid lengthening this section unnecessarily. The estimated coefficients and the standard errors in the two estimated equations are very near each other. In other words the author's dynamic panel models are robust: changing the interaction term does not imply relevant variations in the estimation output.

7. Economic discussion of the econometric results

Based on the technical comments of the previous Section, the economic interpretation of the author's results has to be carried out taking into account the estimated coefficients of the GMM-SYS, while those ones of the OLS and FE regression can be neglected. The estimated coefficients associated to the lagged values of the employment rate indicate that the year-on-year firms' adjustment costs, expectations formation and decision processes affect the actual employment rate, while the two-year dynamics plays no role. The estimated coefficients relating to the current and lagged values of the firms' R&D spending, instead, point out that the actual companies' innovation activity reduces the current employment rate (an increase in the firms' R&D expenditure causes an average decrease of the employment rate of 0.189%), whil there are not delayed effects of innovation spending. This result is in line with that stream of literature claiming a negative impact of innovation on employment rate discused in Section 3, but, unfortunately, the lack of contributions focusing on the economic consequences of R&D expenditure on the employment rate of the Italian regions makes it impossible to operate an appropriate comparison with similar evidence and better contextualize this outcome. However, from the microeconomic point of view, it can be deduced that the firms' labour stock is a production factor substitutable with R&D capital. In other words, the marginal rate of substitution between R&D capital and labour force of the firms operating at regional level in Italy is negative. The estimation of the equation 1 seems to suggest that also the marginal rate of substitution between physical capital and labour stock is negative.

It is interesting to note that the institutional quality itself has no predictive power, as this evidence is in contrast with the previous literature on the roots of the *Mezzogiorno Question*

according to which the labour market participation in the Italian regions is shaped by this variable (Agovino, 2019).

The interaction term between the firms' R&D spending and the institutional quality and the interaction term among the firms' R&D spending, the institutional quality and the regional governments' expenditure are highly significant and positive: an increase in this variable implies an average increase in the employment rate equal to 0.157%. This result represents the novelty of this manuscript and it means that the ability of the regional institutions to attact, support and cooperate with innovative firms as well as the R&D investment programs jointly financed by regional governments and private companies give a positive contribution to the local employment rates. Put differently, the involvment of the regional institutions in the firms' R&D activity can make positive the negative firms' innovation impact on employment and help the lagging Italian regions to contrast the phenomenon of long-run low employment puzzling them. The relating policy implication is that implementing forms of cooperation in innovation between private innovative firms and regional governments can be a good strategy for the Italian policy makers to boost the regional employment rates.

The positive and highly significant value associated to the human capital can appear intuitive, but it is not in the case of the Italian regions. In fact, Di Liberto (2008) and Odoardi and Muratore (2019) find out that the Italian regions do not benefit from the accumulation of human capital due to the difficulties to employee the high-skilled workers at territorial level.

8. Concluding remarks

In this manuscript, the author has studied the employment impact of firms'innovation in the Italian regions taking into account an element neglected in the previous literature on this topic, namely the institutional quality. More in particular, he has estimated the impact of firms' R&D spending, institutional quality and their interaction on the actual employment rate. The research method used by the author, namely a multivariate regression analysis on panel data, complies with the literature on the subject under scrutiny and seems to be able to address the endogeneity concerns posed by the estimation of dynamic panel models.

The obtained results prove that the firms' R&D spending has a negative impact on the regional employment, but it becomes positive when the innovative companies interact with the regional institutions. In other words, the ability of the regional institutions to attract, support and cooperate with the firms investing in research and development fosters the local employment rates. The policy implication arising from this evidence is that the regional governments can overcome the issue of technological unemployment and foster the employment growth in their territories by undertaking R&D activities with the innovative private companies.

A natural cue for future research on the topic treated in this paper can be identifying the transmission mechanism of institutional quality to employment rate, namely what are the components of the institutional quality (of the IQI, in the author's case) affecting the regional employment rates. Another possible development could be considering alternative types of firms' innovation listed in the Oslo 2018 manual, such as process and product innovation.

Altough it focuses on the regions of a single country (Italy), the author hopes that his manuscript can rise the interest also of non-Italian scholars, as technological unemployment is expected to become increasingly worrying over time and good solutions for this problem have not been proposed yet.

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Appendix

Table 2: Description of the variables[3]

Variable name	Source	Description
Employment rate	ISTAT	Employment rate of people aged 15 to 64.
GDP per capita	ISTAT	Nominal GDP per capita.
Gross fixed investments	ISTAT	Gross fixed capital formation. It accounts for firms' investments.
Resident population	ISTAT	Number of residents of the region on 01/01/2018. It accounts for demographic factors.
Human capital	ISTAT	Percentage of inhabitants with higher education (degree or more). It is a measure of human capital.
Labour income	ISTAT	Nominal compensation per employee. Wage is used as control also by Lachenmaier and Rottmann (2011).
Regional government spending	Conti Pubblici Territoriali	Nominal tax expenditure of the regions.
Regional tax revenue	Conti Pubblici Territoriali	Nominal tax revenues of the regions, including fiscal transfers from the central government.
Value added per employee	ISTAT	Nominal value added of firms per employee. This variable often is used as a control for labour productivity[4] (Boglianico and Pianta, 2010).
IQI	Nifo and Vecchione (2014).	Composite index of regional institutional quality.

Source: ISTAT and Conti Pubblici Territoriali

[3] Here, all the variables are taken at current prices because there are no available data on the Consumer Price Index (CPI) or GDP implicit deflator allowing to turn the data in real terms

[4] https://www.oecd-ilibrary.org/sites/5f7b09d6-en/index.html?itemId=/content/component/5f7b09d6-en

A NETWORK-BASED ALGORITHM FOR COMPUTING KEYNESIAN INCOME MULTIPLIERS IN MULTIREGIONAL SYSTEMS

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Abstract

In the context of the Keynesian "multiplier effect" approach, regional economic growth and development are conceived as the result of changes in demand stimulating an iterative process of returns of income. Aiming to revisit this established regional economic model, promote multidisciplinary thinking, enjoy better supervision of computations and intuitive interpretation of the results, broaden the applicability of the model, and serve educational purposes in regional economics and development, this paper proposes an algorithm for computing Keynesian income multipliers in multiregional systems. Building on network connectivity, estimations of the regional shares of imports, marginal propensity to consume, and changes in demand, the proposed algorithm provides a framework for standardizing computations of the multiplier effect in multiregional systems. The algorithm is implemented in two theoretical scenarios, contributing to a deeper conceptualization of the computation of the Keynesian income multipliers, and an empirical case of the land interregional commuting network in Greece, providing insights into the developmental dynamics of the labor market (demand for employment) in Greece. Overall, the analysis highlights the symbiotic relationship between the multiplier effect and network structure in regional markets, promotes multidisciplinary thinking in regional science and economics, and provides a code of this network-based algorithm to motivate further research.

Keywords: regional markets, multiplier effect; export-base model; demand for employment; interregional commuting

JEL classification: R11, R15, R23, R41

1. Introduction

Economic growth and development are major concerns in the context of economic and social sciences (Karras, 2010; Acemoglu, 2012; De Dominicis, 2014; López-Bazo et al., 2014), as they are ruled by a high level of complexity (Kuznets, 1967; Tsiotas and Polyzos, 2018; Basile et al., 2021) and relate to the natural property of evolution, as well as to the immanent property of humanity to seek progress and welfare through optimum exploitation (or management) of the available resources (and production coefficients). Although the concepts of economic growth and development were diachronically drivers of human and social behavior (Polyzos, 2019; Polyzos and Tsiotas, 2020), their place in the economic agenda has become prominent during the last century (Acemoglu, 2012), when global, national, and regional economies faced major historical challenges and rapid transformations (Elhorst, 2010; Nijkamp, 2011; Rodrigue et al., 2013; Constantin, 2021; Trusova et al., 2021). A prime milestone in the economic history of the last century can undoubtedly be found in the year 1936, in the work of John Maynard Keynes titled "*The General Theory of Employment, Interest, and Money*" (Keynes, 1937), abbreviated as "*The General Theory*" and ever since has become a seminal work in macroeconomics and economics policy (Capello, 2016; Polyzos, 2019). Getting his inspiration from the Great Depression of the '30s, Keynes conceived that the main flaw (and consequently the determinant of recessions and depressions) of the recession in that period was the insufficient aggregate demand, contrary to the classical economic approaches interpreting that the supply suffices to produce intrinsic demand and thus to shift the supply-demand relationship (Zeenat Fouzia et al., 2020) into new states of equilibrium (Lagos, 2007; Polyzos, 2019). Within this context, Keynes proposed that any form of government spending can contribute to the increase of aggregate demand, which successively increases consumption, which in turn subsequently increases the demand, and so

forth, stimulating, therefore, a circular (demand-consumption-demand-…) process contributing to the overall increase of income and GDP (Capello, 2016; Polyzos, 2019). For instance, changes in one of the components of aggregate demand (such as increases in local consumption, investments, public spending, or exports) generate an increase in income, which in turn increases the aggregate demand through the increase in consumption, stimulating successively further cycles of increase in demand and income, proportionally to the marginal propensity to consume (Capello, 2016). In other words, Keynes conceived that economic growth is indifferent to the structural setting and dynamics of supply (which is by default adaptable to the market requirements) and it rather depends on the increasing demand for goods (products and services), stimulating an income multiplier effect through the subsequent changes in the consumption and employment (Capello, 2016). This iterative economic process of the endless cycles of economic prosperity is known as the "multiplier effect" (Lagos, 2007; Hamm, 2010; Capello, 2016; Polyzos, 2019), which is expressed by a coefficient that is by definition greater than one (in the context that no intermediate or external diffusion of demand is applicable) and measures the change in output (income, GDP, etc.) caused by a unit change ($\Delta D=1$) in an aspect of the aggregate demand (Capello, 2016).

By interpreting demand as the engine of growth and development (Capello, 2016), the Keynesian multiplier effect has conceptually driven the first-generation theories of regional and economic development in the 1950s (Capello, 2016; Polyzos, 2019) and generally changed the road of the modern economic thinking. For instance, considerable influences of this Keynesian macroeconomics approach can be found in all versions of the export-base model of Charles Tiebout and Douglass North (North, 1955; Tiebout, 1956, 1960), which interpret regional development in terms of interregional trade transactions of a small economic system. Provided that assumptions of self-sufficiency and equivalence in production are acceptable for a spatial economic system, the export-base model conceives exports as the prime driver of aggregate demand (while intrinsic investments are considered as a minor driver) that stimulate the engine of regional development through the multiplier effects' process (Lagos, 2007; Capello, 2016; Polyzos, 2019). This is done by measuring the change in aggregate demand in the base industry of a regional economy and afterward estimating the income multiplier. As Capello (2016) notes, one method for computing regional multipliers through direct estimation of the local propensity to purchase goods was proposed by Archibald (1967). The method builds on aggregating the local shares of the national-known household consumption attributes (which are more likely to be locally purchased), for a sufficient period to generate a time series of local spending, on which the marginal propensity to consume (MPC) can be estimated when regressed. Another method for computing regional multipliers was proposed by K.J. Allen (Allen, 1969), according to which the regional multiplier is approximated by the inverse of a region's GDP diffusion quantities (leakages). Once four types of leakages from the multiplier effect on income are known (savings; interregional imports; imports from abroad; and direct and indirect taxes) and their shares of income are consequently computed, their inverse can yield the multiplier's value (Capello, 2016).

Also, considerable influences of the Keynesian multiplier can be found in the Harrod-Domar model (Harrod, 1939; Domar, 1946), which was developed to interpret the dynamics of regional economic systems by assuming that regional development depends on the imports originating from other regions. In particular, interregional imports are considered a major driver of the growth rates of a local economy, which are capable of setting the equilibrium growth conditions less restrictive and more easily sustainable, compared to the case of a national economy closed to foreign trade (Capello, 2016). In this context, while the export-base theory of Tiebout and North points out the importance of external demand as the engine of development, the Harrod–Domar model highlights that the developmental dynamics of a region may also be intrigued by investments (Alexiadis and Ladias, 2011; Polyzos, 2019; Mirzaei et al., 2021) originating from other regions. However, according to the Harrod–Domar model, when a region grows, at certain returns of scale, it undertakes the double risk of either exploding (due to the continuous growth) or meeting a point of recession (to reset its growth). This approach also builds on the engine of the multiplier effect to interpret regional growth, which however this time is stimulated by changes in demand due to the increase in investments due to external demand instead of consumption (Capello, 2016).

A strand in regional economic research that goes beyond the conceptualization of the Keynesian multiplier can be found in Leontief's Input-Output (IO) model (Leontief, 1966), which generally studies the interdependence of production sectors in an economy. The holder of the Nobel Prize in Economics for the development of this model, Wassily Leontief (1905-1999), conceived a systemic approach expressing intersectional transactions, between buyer and seller sectors (or industries) of an economic system, expressed by linear algebra equations (Miller and Blair 2009). By inverting the matrix of the technical coefficients, which expresses the amounts of commodities per unit commodity by each sector, we obtain the so-called "inverse Leontief matrix" (also called the "multiplier matrix") expressing the output by each sector produced by unit changes in the aggregate demand addressed to each sector. According to Capello (2016), "*whereas in export-base theory the Keynesian multiplier is synthesized into a single value, in the input-output analysis is disaggregated into an n×n set of multipliers relative to every sector or good demanded*". Within this context, Leontief's IO model allows estimating the outcome due to changes in demand in economic sectors, by inverting the matrix of technical coefficients (Polyzos, 2006; Polyzos and Sofios, 2008; Miller and Blair, 2009). Although Leontief's IO model is submitted to the limitation of constant returns in production and lack of technical progress (Capello, 2016), it promoted modern economic thinking.

In the last decade, the newly established discipline of network science (Barabasi, 2016) that uses the network paradigm (Tsiotas and Polyzos, 2018) to model systems of interaction into graphs (Barthelemy, 2011; Ladias, 2011; Tsiotas and Polyzos, 2018; Tsiotas and Ducruet, 2021), has contributed in the study of IO economic systems at the global and national level. In particular, by representing a square matrix configuration, an IO table can be seen as a complex network of inter-sectorial connectivity (Dominguez et al., 2021), where complex network analysis (Barthelemy, 2011; Fortunato, 2010; Tsiotas, 2019) may apply to unveil topological properties in the IO structures (Cerina et al., 2015; Dominguez et al., 2021; Costa et al., 2022). Despite its modern emergence, network analysis has already promoted the relevant research in IO economic systems, providing insights into the evolution over time of the worldwide IO model (Cerina et al., 2015; Rio-Chanona et al., 2017); the properties of the European production network (Giammetti et al., 2020); the Japanese IO economic structure (Dominguez and Mendez, 2019; Dominguez et al., 2021); the transmission mechanisms of domestic and foreign shocks across the Italian IO business system (Costa et al., 2022); the Greek IO economic structure (Garcia-Muniz and Ramos-Carvajal, 2015); and more. Within this framework, this paper gets its inspiration from (*i*) the potential to represent multiregional systems as network structures; and (*ii*) the already fruitful contribution of using the network paradigm in the IO economic systems research; and developing a network-based algorithm for computing Keynesian income multipliers in multiregional systems, as conceived in the context of the export-base (North, 1955; Tiebout, 1956, 1960), the Harrod-Domar (Harrod, 1939; Domar, 1946), and relevant models. Although relevant research on Keynesian income multipliers has gotten much ahead, and the IO-based computational approaches prevailed in the regional economics' literature, this paper can claim a place of contribution to the relevant literature as: (*i*) it revisits established (first generation) regional economic models, using a modern computational approach, thus promoting multidisciplinary thinking; (*ii*) it inherits the merit of the export-base theory to deal with Keynesian income multipliers in single values, thus allowing better supervision of computations and an intuitive interpretation of the results, compared to the IO-based models; (*iii*) applies to large multiregional systems composed of many regions, where corresponding IO approaches are counter-intuitive; (*iv*) by supporting supervision and intuitive interpretation, it also serves educational purposes in regional economics and development, where there is still a long way to go.

The remainder of this paper is structured as follows; Section 2 provides the essential and describes the steps of the proposed algorithm for computing Keynesian income multipliers in multiregional systems. Section 3 applies the proposed algorithm (*i*) to a pair of scenarios (examples) of multiregional systems and (*ii*) to an empirical case, of interregional commuting in Greece; and, finally, in Section 4 conclusions are given.

2. Methodology and Data

2.1. Terminology and notations

In the context of the export-base theory (North, 1955; Tiebout, 1956), when the sizes of the base sector and the total sector are known, we can obtain the value of the Keynesian income multiplier according to the formula (Capello, 2016; Polyzos, 2019):

$$m_{Y/X} = \frac{1}{1 - c + m} \quad \textbf{(1)}$$

where $m_{Y/X}$ is the income multiplier, c is the marginal propensity to consume, and m is the marginal propensity to import. Equation (1) originates from the Keynesian formula of income Y (Polyzos, 2019):

$$Y = C + I + G + \left(X - M \right) \quad \textbf{(2)}$$

where C stands for consumption; I for investments; G for government spending; and (X–M) for the trade balance (X exports, M imports). In particular, we can get equation (1): (*i*) by considering the variables of consumption (C) and imports (M) as functions of income $C=c_o+cY$ and $M=m_o+mY$ (Polyzos, 2019), where c_o, m_o are the autonomous consumption and imports and replacing their equivalents in equation (2); and (*ii*) by obtaining the partial derivative from the converted equation (2) in respect to the exports variable (X), namely $m_{Y/X} = \frac{\partial Y}{\partial X}$.

Although equation (1) can become much more complex whether assumptions of (*i*) intermediate demand ($X \rightarrow X–m_XX$); (*ii*) diffusion of demand abroad ($X \rightarrow X–m_XX–m_F(X–m_XX)$); (*iii*) tax payments ($T=t_o–tY$); (*iv*) and government expenses ($G=g_o–gY$); may apply in the model (Polyzos, 2019), the essence behind the computation of the Keynesian income multiplier is that equals to the slope of the variable submitted to changes in demand ($\Delta D \rightarrow \Delta X$). For instance, in the context of the export-base theory, changes in demand for imports (interpreted as consumption due to foreign production: $\Delta\bar{C}$) may be seen as a stimulus for the multiplier effect, according to the relation:

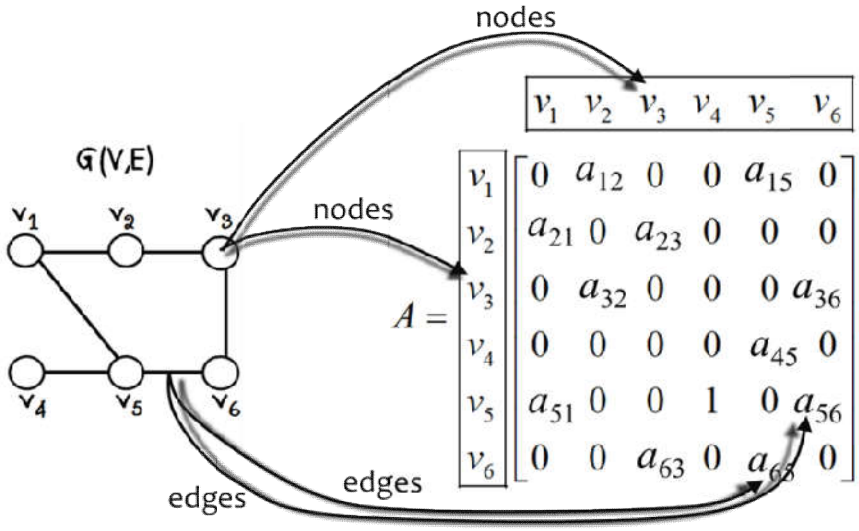
$$\Delta Y = m_{Y/X=\bar{C}} \cdot \Delta D = m_{Y/\bar{C}} \cdot \Delta\bar{C} \quad \textbf{(3)}$$

while, in the context of the Harrod-Domar theory, changes in demand for investments coming from abroad (Capello, 2016) ($\Delta\bar{I}$), may suggest a stimulus for the multiplier effect, according to the relation:

$$\Delta Y = m_{Y/X=\bar{I}} \cdot \Delta D = m_{Y/\bar{I}} \cdot \Delta\bar{I} \quad \textbf{(4)}$$

Therefore, no matter how complex is, the Keynesian income multiplier is computed based on equation (1) and provides changes in income based on equations (3) and (4). However, when a multiregional system is considered, the concept of "abroad" (referring to a region's external environment) has a network structure, and thus changes captured in one region's demand are distributed throughout the other regions, by the structure of the multiregional system. This is the point where the network paradigm may contribute, toward standardizing the procedure of distributing such changes in demand (Polyzos, 2019), which currently lacks a network-based approach. Within this context, based on the network paradigm, a multiregional system can represent a network model (Tsiotas and Polyzos, 2018), which is a graph model (Barabasi, 2016; Barthelemy, 2011) defining a pair-set $G(V, E)$ of n in number nodes (V) and m in number edges/links (E). In algebraic terms, the simplest form of a graph model $G(V,E)$ is expressed by a (square) connectivity ($n \times n$) matrix of binary weights, which is called adjacency matrix $A=\{a_{ij}\}$. In an adjacency matrix, both rows and columns express nodes (Fig.1), whereas the matrix elements (a_{ij}) express the edges (the state of connectivity). In particular, when nodes (row=) i and (column=) j are connected, the corresponding element in the adjacency equals one ($a_{ij}=1$) and zero ($a_{ij}=0$) in cases of no connectivity.

Fig.1. A graph $G(V,E)$ and its Adjacency Matrix $A=\{a_{ij}\}$



By converting a multiregional system into a network model, further computations of distributing the changes in demand for computing the Keynesian income multipliers may apply. Such computations are easy to standardize by moving within the adjacency instead of drawing diverse paths. For doing so, the proposed algorithm is briefly described in the next section.

2.1. Description of the proposed network-based algorithm for computing Keynesian income multipliers in multiregional systems

The algorithm for computing Keynesian income multipliers in multiregional systems is described as follows:

```
Start
Part 1: INPUT arguments configuration
[Step#1] Configure the Adjacency matrix (n×n) of the multiregional system
[Step#2] Configure a vector (n×1) including the change(s) in demand (ΔD=D1-
     Do) observed for one or more regions.
[Step#3] Configure a vector with the imports coefficients, namely with the
     proportions of demand that a prefecture satisfies through imports.
[Step#4] Configure the vector of Marginal Propensities to Consume (MPC), per
     region.
Part 2: COMPUTATIONS
[Step#5] Compute the complementary coefficients (of intrinsic satisfaction
     of demand), by subtracting the vector of the imports coefficients from
     one.
[Step#6] Find the regions that have no sellers and set their imports
     coefficients equal to 1.
[Step#7] Find the number of seller regions.
[Step#8] Compute the shares of imports per region, evenly distributed into
     their seller regions.
[Step#9] Calculate the changes in demand per region, by their trade
     connectivity and imports shares.
[Step#10] Compute the income multipliers according to the relation m=1/(1-
     MPC).
[Step#11] Compute the income changes according to the relation ΔP=m·ΔD
End
```

In particular, in the first part of the algorithm, the researcher configures the required arguments for inputs. In the first step (Step#1), we (Step#1) we create the Adjacency matrix of the interregional system, which represents a directed and connected network, as it is shown in Fig.1. Next (Step#2) the researcher configures a node vector $\Delta D=\{d_i\}$ that includes the change(s) in demand ($d_i= \Delta D_i(t_1)-\Delta D_i(t_o)$) observed for one or more regions $i=1, 2, \ldots, n$. This vector has a length of n elements (equal to the number of nodes or regions), where a non-zero

entry $d_i \neq 0$ in the i-th place of this vector expresses a change in demand for the region (node) i. Next (Step#3), the researcher configures a vector $I=\{m\}$ with the imports coefficients, which also has a length of n and expresses the proportions of demand that a prefecture satisfies through imports. For instance, a non-zero entry $m_i \neq 0$ in the i-th place of this vector expresses that region i satisfies $m_i \cdot 100\%$ of its demand through imports and $(1-m_i)\cdot 100\%$ through intrinsic production. Next (Step#4), the researcher configures the vector of Marginal Propensities to Consume (MPC), per region, based on the methods (Archibald, 1967; Allen, 1969) previously described (Capello, 2016). After configuring the input arguments, in Step#5 the algorithm computes the complementary coefficients of vector I, expressing the intrinsic satisfaction of demand, namely the proportions (shares) of demand covered per region by their intrinsic production ($(1-m_i)\cdot 100\%$). Next (Step#6), the algorithm finds the regions that have no sellers and sets their imports coefficients equal to 1. In the next step (Step#7), the algorithm finds the number of seller regions; to which, afterward (Step#7), it evenly distributes the imports' demand per region, according to the relation:

$$D_{ij} = \frac{m_j \cdot 100\%}{k(-)_j} \tag{5}$$

where $k(-)_j$ is the incoming node degree (number of seller regions) of region j. Here, possible future upgrades may include uneven distribution of the imports' demand. In the next step (Step#9), the algorithm computes the changes in demand per region, by their trade connectivity and imports shares. After converting the Adjacency matrix into a $n \times n$ demand distribution matrix, the algorithm computes (Step#10) the income multipliers according to equation (1). This step can also enjoy future upgrades. Finally, in the last step (Step#11) the algorithm computes the income changes according to equations (4) and (5). The implementation of the algorithm is shown, in detail, in the next section's examples.

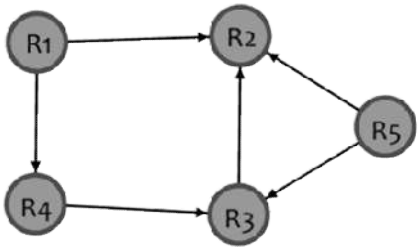
3. Results and Discussion

The proposed network-based algorithm is implemented on two examples, which are available in the textbook of Polyzos (2019) entitled *Regional Development* (language: Greek). The first example regards a five-region multiregional system experiencing changes in demand in one of its prefectures, while the second one regards a four-region multiregional system experiencing changes in demand in two of its prefectures. The step-by-step computational process of estimating the Keynesian income multipliers is shown in the following sub-sections. Although implemented for certain examples, the proposed algorithm is not restricted and applies to complex multiregional systems (composed of n in number regions) enjoying changes in demand in multiple ($k \leq n$) regions. For implementation purposes and the sake of further research, the proposed algorithm is provided in a MATLAB *m*-function format, at the end of this paper (see Appendix).

3.1. Running the proposed algorithm for a five-region system, with changes in demand in one prefecture.

In the first example, the proposed algorithm runs for a five-region system, as it is shown in Fig.2. In this multiregional context, we assume that: (*i*) Region 3 (R_3) experiences a 10-unit change in its demand for investments ($\Delta I=10$); (*ii*) the marginal propensity to consume (MPC) in regions R_1 and R_2 is 60% ($MPC_{R_1,R_2} = 0.60$), while for the other regions (R_3, R_4, and R_5) is 70% ($MPC_{R_3:R_5} = 0.70$); and (γ) each region satisfies 40% of its demand through imports, equally distributed along its seller regions (and thus satisfies 60% of its demand from intrinsic production). Based on these assumptions, we calculate the multiplier effect on the regional income as follows:

Fig.2. The five-region system of trade transactions, where the proposed algorithm applies



First, we create the adjacency matrix of the five-node (five-region) multiregional system, according to the graph structure shown in Fig.3a. As it can be observed, the adjacency of the multiregional system configures a 5×5 matrix of a directed binary graph, where rows represent seller and columns buyer regions. When region R_i is a seller of region R_j, we assign one in the concordant adjacency's element a_{ij} =1. For instance, a non-zero value in cell a_{32} =1 interprets that region R_2 is a buyer of region R_3, but the opposite is not true (thus suggesting that there is no edge a_{23}=0 in the adjacency matrix). Given that each region satisfies 40% of its demand through imports, we compute the complementary shares (100 – 40 =) 60%, representing the demand satisfied by a region's intrinsic production. These values are respectively assigned to the diagonal elements of the adjacency matrix, as it is shown in Fig.3b. As it can be observed, regions with no sellers have their diagonal elements equal to one (namely a_{11}=1 and a_{55}=1), since the "40-60" given rule is not applicable in their cases as all of their demand is satisfied through intrinsic production (no imports are applicable). By replacing the adjacency's diagonal elements with the shares of demand satisfied through intrinsic production, we start converting the adjacency matrix into a distribution matrix of demand coefficients throughout the network structure. Currently (Fig.3b), only the diagonal elements represent shares of demand and thus the process should move on to fill in the total matrix.

Fig.3. (left) The adjacency matrix of the 5-node multiregional system of Fig.2 (colored diagonal elements) (right) The shares of demand satisfied by intrinsic production are assigned to the elements of the main diagonal

(a)

Seller Regions \ Buyer Regions	R1	R2	R3	R4	R5
R1	1	1		1	
R2		1			
R3		1	1		
R4			1	1	
R5		1	1		1

(b)

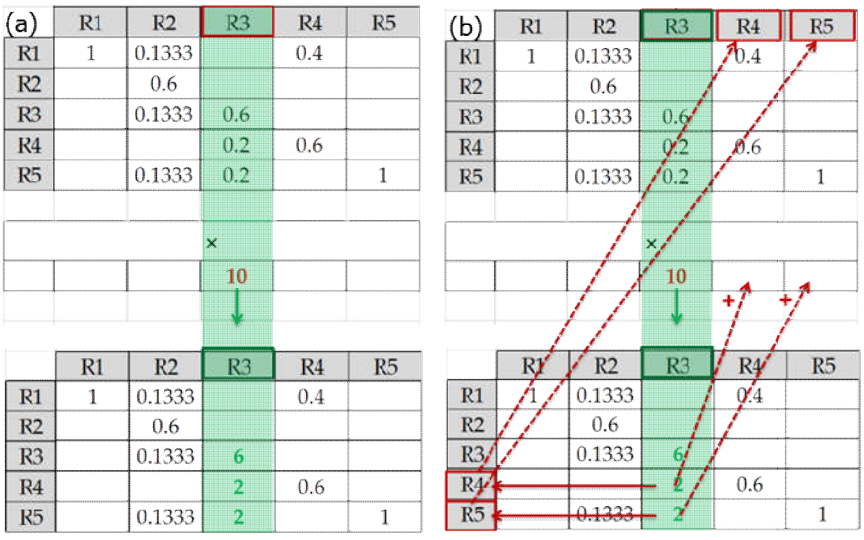
Seller Regions \ Buyer Regions	R1	R2	R3	R4	R5
R1	1	1		1	
R2		0.6			
R3		1	0.6		
R4			1	0.6	
R5		1	1		1

In the next step, we equally distribute the shares of imports into the seller regions per node (region). To do so, for each buyer region R_j, we (column-wisely) divide the import shares (40%) to their incoming degree $k(-)$ (number of sellers), according to equation (5). For our example, the stepwise computational procedure is shown in Fig.4a:c and the results of the share of imports' distribution are shown in Fig.4d. In particular, we can read the results as follows: (*i*) region R_1 satisfies all of its demand through its intrinsic production; (*ii*) region R_2 satisfies 60% of its demand through its intrinsic production, whereas each of its sellers contributes to the region's demand at an amount of 13.33%; (*iii*) region R_3 satisfies 60% of its demand through its intrinsic production, whereas each of its sellers contributes to the region's demand at an amount of 20%; (*iv*) region R_4 satisfies 60% of its demand through its intrinsic production and 40% of its seller region (R_1); and (*v*) region R_5 satisfies all of its demand through its intrinsic production. If the computations are correct, the column-wise summands in the table of Fig.4d should yield ones expressing 1·100% satisfaction with a region's demand. The final matrix shown in Fig.4d represents the regional coefficients of shares in demand of our multiregional system.

Fig.4. (a:c) The stepwise procedure of distributing a region's satisfaction of demand through imports into the seller regions; (d) The final coefficients matrix of shares in demand of the multiregional system

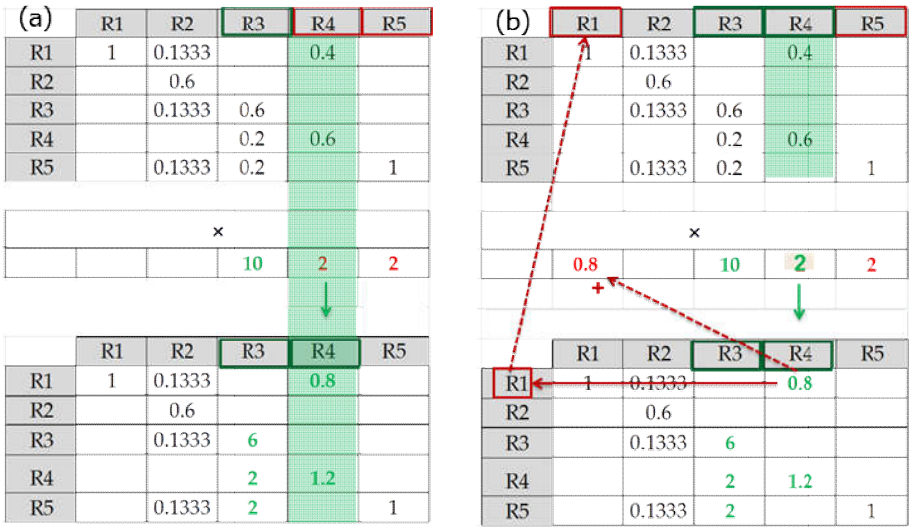
By computing the matrix of shares in demand of our multiregional system (Fig.4d), we afterward distribute the change in demand experienced by region R_3 throughout the multiregional system. First, we start by distributing the 10-unit change in demand (ΔI=10) experienced by region R_3 throughout its neighborhood. To do so, we multiply column 3 (corresponding to the buyer region R_3) with the 10-unit change in demand, as it is shown in Fig.5a. This multiplication yields a distribution of odds 6 (R_3): 2(R_4): 2(R_5), implying that 6 units from the 10-unit change in demand experienced by region R_3 are satisfied by the region's intrinsic production, whereas 2 (out of ten) units are satisfied through imports from region R_4 and another 2 units are satisfied through imports from region R_5. However, in the Keynesian multipliers context, the 2-unit changes in demand satisfied by regions R_4 and R_5 will cause secondary distribution of demand, according to the certain configuration of the multiregional network structure. This is because regions R_4 και R_5 are not closed, but open, economies, depending on other regions. Therefore, these 2-unit changes in demand are expected to initiate further rounds of computation. To facilitate the computations according to the proposed algorithm, we assign these 2-unit changes in demand to the respective places in the row with the initial changes in demand, as it is shown in Fig.5b.

Fig.5. (a) The stepwise procedure of distributing the change in demand experienced by region R_3 throughout its neighborhood (b) According to the R_3 region's trade structure, secondary changes in demand should be also distributed to the sellers of region R_3



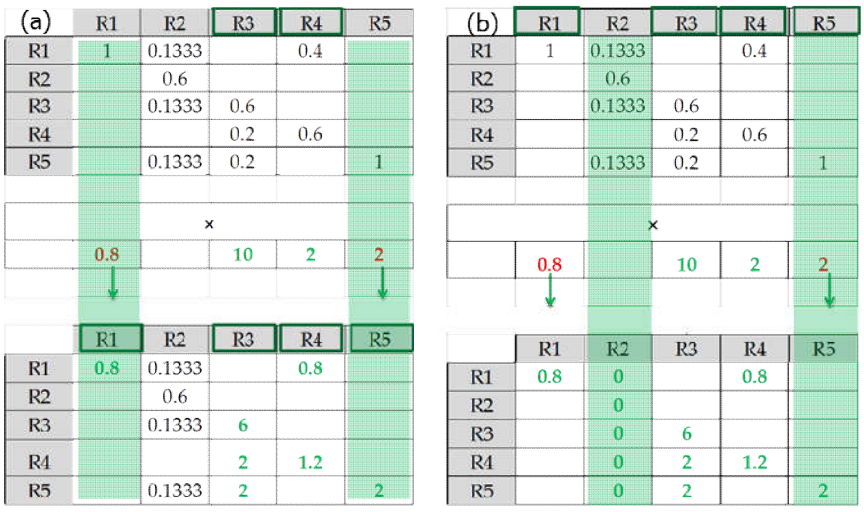
To initiate the round of computing the secondary changes in demand, we multiply column 4 (this time corresponding to the buyer region R_4) with the 2-unit change in demand (that region R_4 experiences due to its trade connectivity with region R_3), as it is shown in Fig.6a. This multiplication yields a distribution of odds 0.8:1.2, implying that 0.8 units from the 2-unit change in demand experienced by region R_4 are satisfied by imports (originating from region R_1), whereas the other 1.2 units of demand are satisfied from the intrinsic production of region R_4 (Fig.6b).

Fig.6. (a) The stepwise procedure of distributing the change in demand experienced by region R_4 throughout its neighborhood (b) The 0.8-unit secondary change in demand satisfied through imports from region R_1 initiates in turn another round of computations, this time for region R_1



Given that 0.8 units of the R_4 region's demand are satisfied through imports from region R_1, the algorithm in turn proceeds to another round of computing the distribution of secondary demands, this time for the case of region R_1 (Fig.7a). This step yields a trivial result since region R_1 is only a seller region, thus interpreting that region R_1 will satisfy all 0.8 units of change in demand through its intrinsic production. Similarly, as region R_5 is only a seller region, it will satisfy all its 2-unit change in demand through its intrinsic production (Fig.7a). Finally, as region R_2 is an only-buyer region, the initial 10-unit change in demand in region R_3 will not the demand of region R_2, thus we assign zeros at all entries of the demand distribution matrix (Fig.7b).

Fig.7. (a) The stepwise procedure of distributing the secondary changes in demand into the only-seller regions R_1 and R_5 (b) Stepwise procedure of distributing the secondary changes in demand into the only-buyer region R_2, yielding a null distribution.



Overall, based on the previous process, the demand distribution matrix is finalized and shown in Fig.8. As it can be observed from the main diagonal of the final demand distribution matrix, the initial 10-unit change in demand experienced by region R_3 is expected to cause a distribution of odds in demand throughout the multiregional system's regions as follows: 0.8 (R_1): 0 (R_2): 6 (R_3): 1.2 (R_4): 2 (R_5). These values are extracted from the main diagonal and should sum to the initial change in demand (0.8+0+6+1.2+2=10) if all computations were done correctly.

Fig.8. The final conversion of the demand shares matrix to the demand distribution matrix

	R1	R2	R3	R4	R5
R1	1	0.1333		0.4	
R2		0.6			
R3		0.1333	0.6		
R4			0.2	0.6	
R5		0.1333	0.2		1

×

	0.8	0	10	2	2

	R1	R2	R3	R4	R5
R1	**0.8**	0		0.8	
R2		**0**			
R3		0	**6**		
R4		0	2	**1.2**	
R5		0	2		**2**

In the final step of the algorithm, we calculate the expected changes in the regional income due to the Keynesian multiplier effect, according to equations (1) and (3), (4). After replacements and computations, we construct Table 1 with the final results.

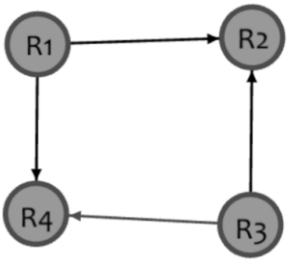
Table 1. Final results of the Keynesian regional income multipliers for the 5-node multiregional system

Region	Change in Demand	MPC	m	Change in Income
R_1	0.80	0.60	2.50	2.00
R_2	0.00	0.60	2.50	0.00
R_3	6.00	0.70	3.33	19.98
R_4	1.20	0.70	3.33	3.99
R_5	2.00	0.70	3.33	6.66
Total	10.00			32.63

3.2. Running the algorithm to a four-region system, with changes in demand in two prefectures

In the second example, the proposed algorithm runs for a four-region system, as it is shown in Fig.9. In this multiregional context, we assume that: (*i*) Region R_2 experiences a 10-unit change in its demand for investments (ΔI_2=10), while region R_3 experiences a 20-units change in its demand for investments (ΔI_3=20); (*ii*) the MPC in regions R_1 and R_2 is 60% ($MPC_{R_1,R_2} = 0.60$), while in regions R_3 and R_4 is 70% ($MPC_{R_3,R_4} = 0.70$); and (γ) each region satisfies 50% of its demand through imports, equally distributed along its seller regions (and thus satisfies 50% of its demand from intrinsic production). Based on these assumptions, we calculate the multiplier effect on the regional income as follows:

Fig.9. The four-region multiregional system of trade transactions, where the proposed algorithm applies.



First, we create the adjacency matrix of the 4-node (4-region) multiregional system, according to the graph structure shown in Fig.10a. The adjacency of the multiregional system configures a 4×4 matrix of a directed binary graph. Given that each region satisfies 50% of its demand through imports, we compute the complementary shares (100 – 50 =) 50%, which represent the demand satisfied by intrinsic production. We afterward assign these values to the diagonal elements of the adjacency matrix, as it is shown in Fig.10b. In this case, regions R_1 and R_4 are only-seller regions (and thus they have their diagonal elements equal to one), whereas R_2 and R_3 are only-buyer regions. Therefore, we start converting the adjacency matrix into a distribution matrix of demand coefficients throughout the network structure. As it can be observed, we obtain a distribution of odds in the shares of intrinsic demand satisfaction, as follows: 1 (R_1): 0.5 (R_2): 0.5 (R_3): 1 (R_4).

Fig.10. (left) The adjacency matrix of the 4-node multiregional system of Fig.9 (right) The shares of demand satisfied by intrinsic production are assigned to the elements of the main diagonal

(a)	R1	R2	R3	R4
R1	1	1	1	
R2		1		
R3			1	
R4		1	1	1

(b)	R1	R2	R3	R4
R1	1	1	1	
R2		0.5		
R3			0.5	
R4		1	1	1

In the next step, we equally distribute the shares of imports into the seller regions per region, as it is shown in Fig.11. As can be observed in columns 2 and 3, regions R_2 and R_3 have the same two sellers, thus they equivalently (25%-25%) satisfy their demand through imports amongst their sellers.

Fig.11. (a,b) The stepwise procedure of distributing a region's satisfaction of demand through imports into the seller regions

(a)	R1	R2	R3	R4
R1	1	1	1	
R2		0.5		
R3			0.5	
R4		1	1	1
		+2		

(b)	R1	R2	R3	R4
R1	1	1	1	
R2		0.5		
R3			0.5	
R4		1	1	1
			+2	

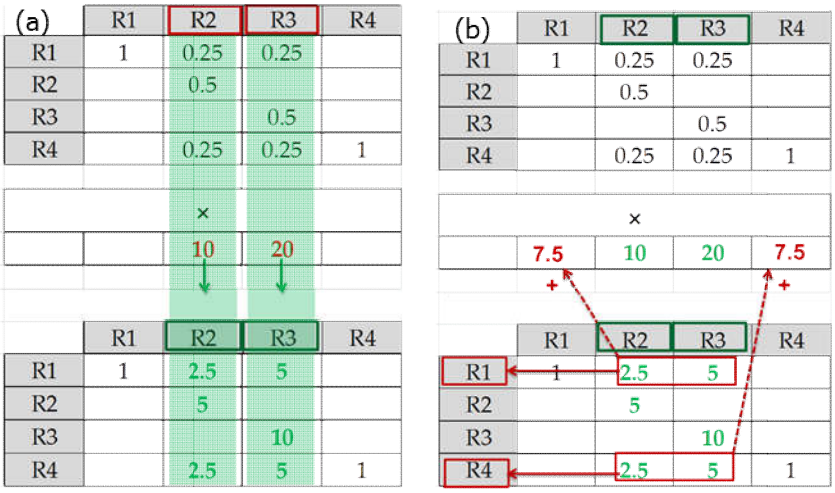
The results of the demand share distributions are shown in Fig.12, where we can read: (*i*) regions R_1 and R_4 satisfy all of their demand through their intrinsic production; and (*ii*) regions R_2 and R_1 satisfies 50% of their demand through its intrinsic production, whereas each of its sellers contributes to the region's demand at an amount of 25%. If the computations are correct, the column-wise summands in the table of Fig.12 should yield ones expressing 1·100% satisfaction of a region's demand.

Fig.12. The final coefficients matrix of shares in demand of the multiregional system

	R1	R2	R3	R4
R1	1	0.25	0.25	
R2		0.5		
R3			0.5	
R4		0.25	0.25	1
	1	1	1	1

By computing the matrix of shares in demand of our multiregional system (Fig.4d), we afterward distribute the change in demand experienced by region R_3 throughout the multiregional system. First, we start by distributing the 10-unit change in demand (ΔI_2=10) experienced by region R_2 throughout its neighborhood, along with the 20-unit change in demand (ΔI_3=20) experienced by region R_3 throughout its neighborhood. To do so, we multiply column 2 (corresponding to the buyer region R_2) with the 10-unit change in demand, and column 3 (corresponding to the buyer region R_3) with the 20-unit change in demand, as it is shown in Fig.13a. For region R_2, this multiplication yields a distribution of odds 2.5(R_1): 5(R_2): 2.5(R_4), implying that 5 units from the 10-unit change in demand experienced by region R_2 are satisfied by the region's intrinsic production, whereas 2.5 (out of 10) units are satisfied through imports from regions R_1 and R_4 respectively. For region R_3, this multiplication yields a distribution of odds 5(R_1): 10(R_2): 5(R_4), implying that 5 units from the 20-unit change in demand experienced by region R_3 are satisfied by the region's intrinsic production, whereas 5 (out of 20) units are satisfied through imports from regions R_1 and R_4 respectively. Since region R_2 imports 2.5 units from region R_1 to satisfy its change in demand and region R_2 imports 5 units from region R_1 to satisfy its concordant change in demand, the overall secondary change in demand for region R_1 is the summand 2.5+5=7.5 units. Similarly, the overall secondary change in demand for region R_4 is also 2.5+5=7.5 units, as it is shown in Fig.13b.

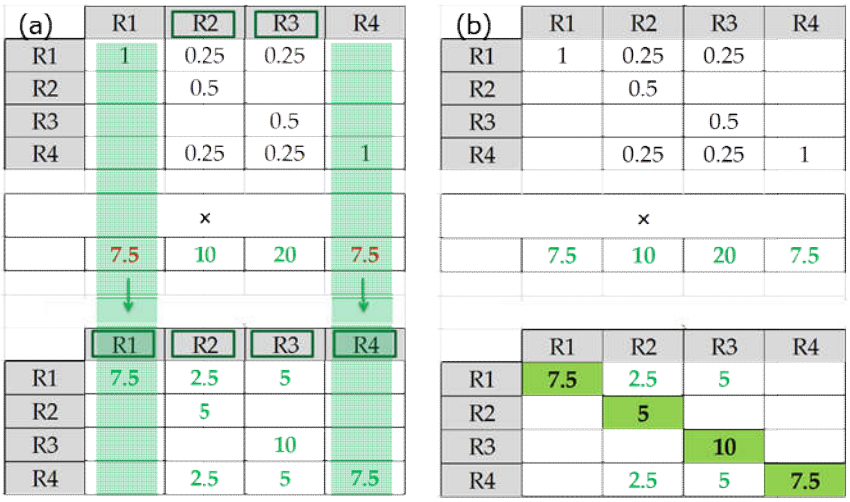
Fig.13. (a) The stepwise procedure of distributing the change in demand experienced by regions R_2 and R_3 throughout their neighborhoods (b) According to the multiregional trade network structure, secondary changes in demand should be also distributed to the sellers of regions R_2 and R_3



Therefore, we proceed and calculate how these 7.5-unit secondary changes in demand are distributed throughout the neighbors of regions R_1 and R_4 respectively, as it is shown in Fig.14a,b. As regions R_1 and R_4 are seller-only regions, these changes in demand are trivial and will be satisfied by the intrinsic production of these regions. Overall, based on the previous process, the demand distribution matrix is finalized as it is shown in Fig.14b. As it can be observed from the main diagonal of the final demand distribution matrix, the initial 10-unit change in demand experienced by region R_2 and the 10-unit change in demand experienced by region R_3 are expected to cause a distribution of odds in demand throughout

the multiregional system's regions as follows: 7.5 (R_1): 5 (R_2): 10 (R_3): 7.5 (R_4). These values are extracted from the main diagonal and should sum to the initial change in demand (7.5+5+10+7.5=(10+20=)30) if all computations were done correctly.

Fig.14. (a) The stepwise procedure of distributing the changes in demand experienced by regions R_1 and R_4 throughout their neighborhoods (b) The 7.5-unit secondary changes in demand satisfied through imports from regions R_1 and R_4 initiates a secondary round of computations, this time for regions R_1 and R_4



In the final step of the algorithm, we calculate the expected changes in the regional income due to the Keynesian multiplier effect, according to equations (1) and (3), (4). After replacements and computations, we construct Table 2 with the final results.

Table 2. Final results of the Keynesian regional income multipliers for the 4-node multiregional system

Region	Change in Demand	MPC	m	Change in Income
R_1	7.50	0.60	2.50	18.75
R_2	5.00	0.60	2.50	12.50
R_3	10.00	0.70	3.33	33.30
R_4	7.50	0.70	3.33	24.98
Total	30.00			89.53

3.3. Estimating the Keynesian income multipliers based on the interregional commuting network in Greece

In the final step of the analysis, we compute the Keynesian income multipliers for the land interregional commuting network in Greece (LGCN), based on the proposed network-based algorithm. The LGCN is a one-layer graph model $G(39;121)$ with commuting weights (Fig.15), composed of (*i*) n=39 nodes expressing the land (non-insular) capital cities of the Greek prefectures and (*ii*) m=121 edges expressing the number of commuters moving daily from a node (city) i=1,2,…,39 to node j=1,2,…,39 ($i \neq j$) for work. Nodes in the LGCN are geo-referenced at the coordinates of the city centers (WGS Web Mercator). Data for the construction of the node-set were extracted from the Google Digital Mapping Services (Google Maps, 2019), whereas commuting data concern employed persons with residence in the area by place of work, extracted from the 2011 national census of Greece (Hellenic Statistical Service – ELSTAT, 2011). To set computations of the Keynesian income multipliers for the LGCN reasonable, we conceptualize commuting as an aspect of labor demand in the interregional market of Greece (Polyzos, 2019; Tsiotas and Polyzos, 2021; Tsiotas et al., 2018, 2022). In particular, we can conceive the number of incoming commuters as an aspect of imports satisfying the labor demand in a regional economy, and inversely the number of incoming commuters as an expression of labor exports. Within this framework, we

can approximate a region's share of labor imports (impC_i) by the ratio of the number of incoming commuters to the employed labor force, according to the formula:

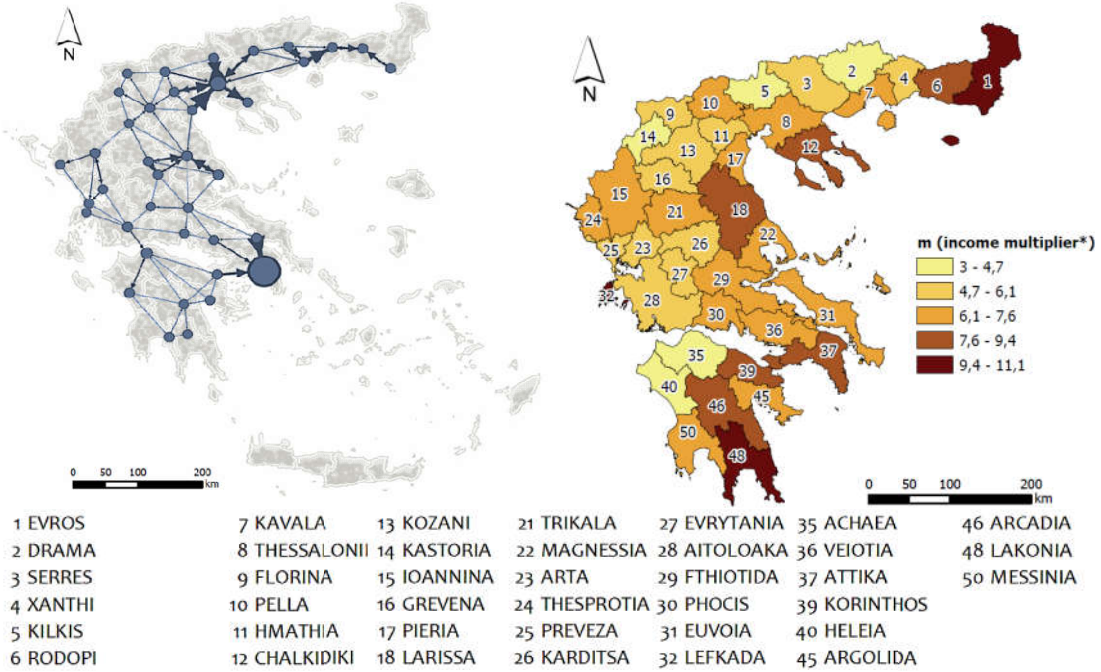
$$\text{imp}C_i = \frac{s_i(-)}{L_i - L_i^{unemp}} = \frac{s_i(-)}{L_i^{emp}} \quad \textbf{(6)}$$

where $s_i(+)$ is the number of incoming commuters of region i; L_i is a region's total labor force, computed by the sum of the employed L_i^{emp} and unemployed L_i^{unemp} labor force. Further, we can approximate a region's marginal propensity to consume "employment" or "labor" (MPC) by the ratio of the employed to the total labor force, according to the formula:

$$MPC_i = \frac{L_i^{emp}}{L_i} = \frac{L_i - L_i^{unemp}}{L_i} \quad \textbf{(7)}$$

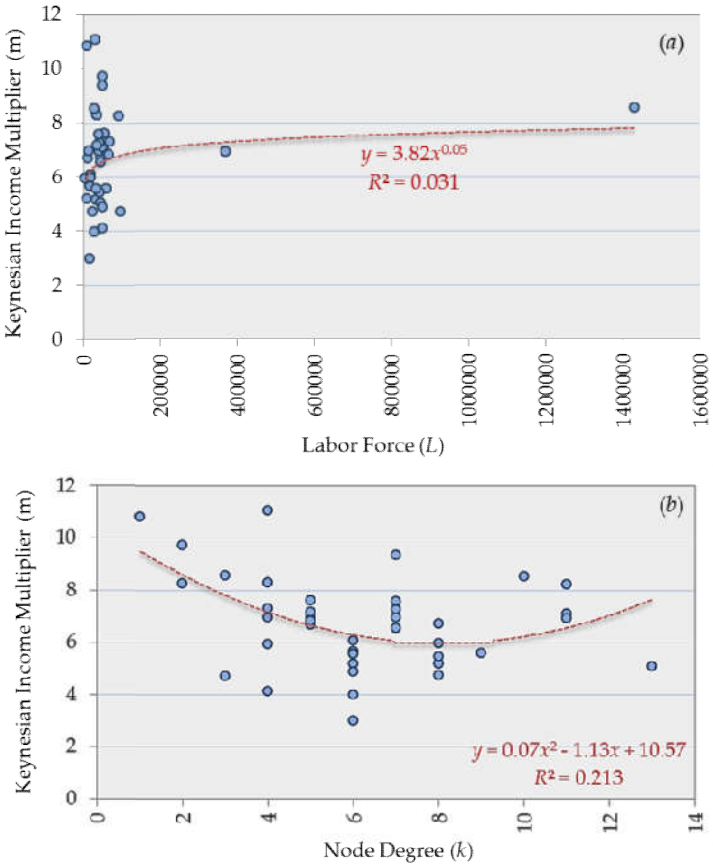
Based on the previous assumptions and after configuring the connectivity (commuting weights) matrix of the LGCN, we can compute the Keynesian income multipliers by applying the proposed algorithm (its code is available in an *m*-function format in the Appendix). Here, instead of using the adjacency matrix, we use the weights connectivity matrix of the LGCN, as the proposed algorithm is written to operate over the trade balances, namely to keep only one link (this with the positive difference w_{ij}–w_{ji}) between two network nodes i,j. Within this context, we estimate the Keynesian income multipliers for the LGCN and the results are shown in Fig.15. As it can be observed, in the context of the Greek market of labor demand, regions with the highest income multipliers are allocated along an "S"-type direction, which coincides with the major pattern describing regional development over time in Greece (Polyzos, 2019; Tsiotas, 2021). The cases with the highest income multipliers are the edge regions (Polyzos, 2015; 2019) Evros (1) and Lakonia (48), an observation that highlights the vitality of employment in edge regions and the importance of regional policies supporting the periphery (Xanthos et al., 2012; Alexiadis et al., 2013; Goula et al., 2015; Tsiotas and Tselios, 2022), addressing avenues of further research. Further, amongst the highest income multipliers we can find: (*i*) the metropolitan prefecture of Attika (37); (*ii*) Larissa (18), which is a region of great intermediacy in the land transport network in Greece (Tsiotas, 2021); and (*iii*) Chalkidiki (12), which is a neighbor and tourism destination of the metropolitan region of Thessaloniki (8).

Fig.15. (left) The land interregional commuting network in Greece (LGCN) (right) Spatial distribution of employment-based* income multipliers computed on the LGCN



To further examine the implementation results of the proposed algorithm, we construct the scatter plots shown in Fig.16. The first scatter plot illustrates the correlation between the labor force of the LGCN (horizontal axis) and the Keynesian income multipliers (vertical axis), and the second scatter plot the correlation between the LGCN's node degree (horizontal axis) and the income multipliers (vertical axis) computed on the LGCN's demand for employment. As it can be observed, the income multipliers appear uncorrelated to the labor market size (Fig.16a), whereas there are indications that they correlate (with 8.8% 2-tailed significance) to the network structure (connectivity). Moreover, the "U"-shaped correlation pattern, implies that nodes of medium connectivity tend on average to be subject to lower multiplier effects than both highly and not-highly connected nodes. This observation impressively interprets that either the states of isolation or high connectivity are network structures stimulating higher multiplier effects. Of course, these indications address avenues of further research on the relationship between network structure and the Keynesian multiplier effect and should be studied in more detail.

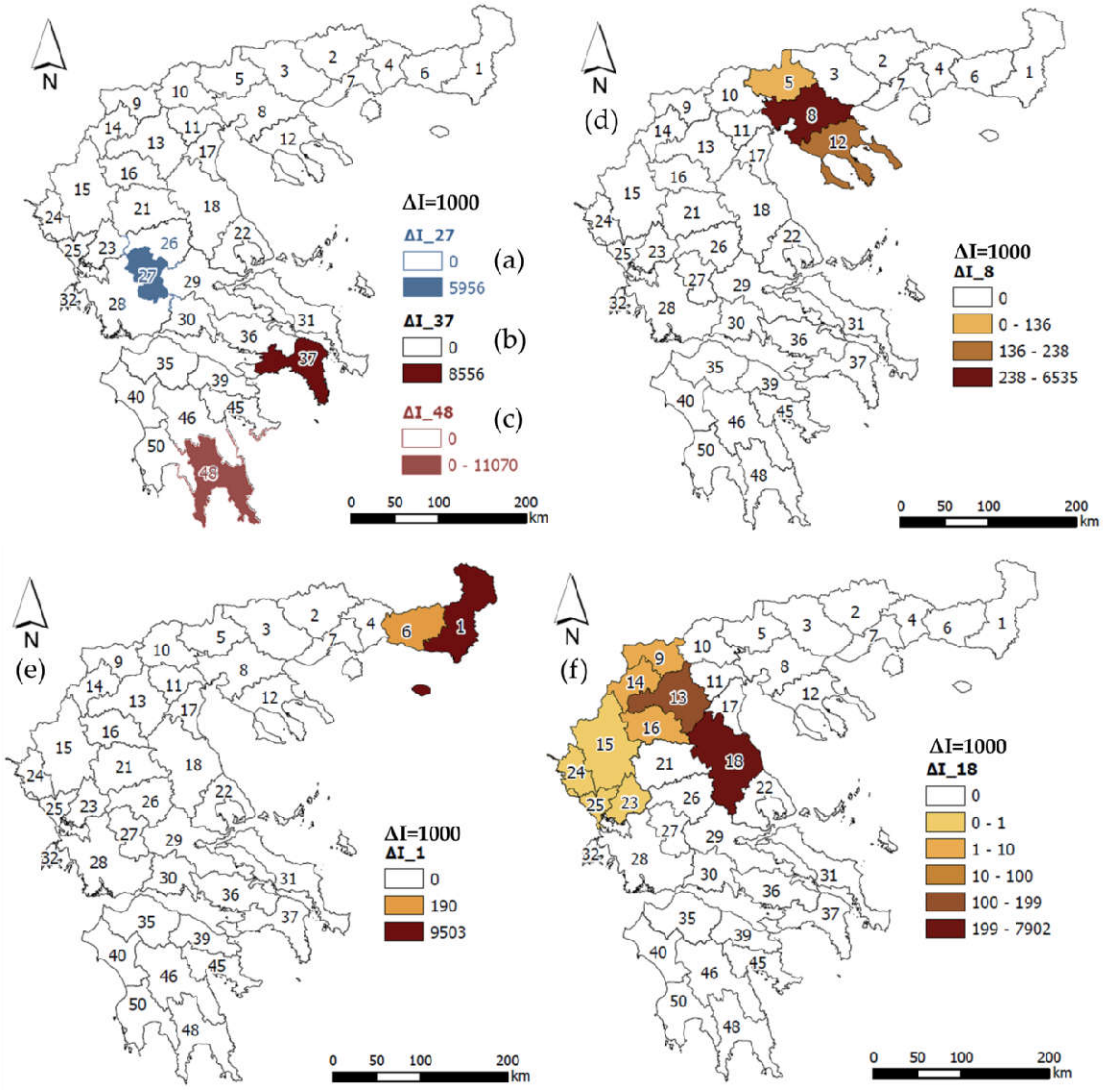
Fig.16. Scatter plots illustrating the correlation between the labor force of the LGCN and the Keynesian income multipliers (computed on the LGCN's demand for employment) and (b) the network degree of the LGCN and the Keynesian income multipliers (computed on the LGCN's demand for employment)



Finally, we examine some scenarios of change in labor demand in the prefectures of Athens (37), Thessaloniki (12), Eurytania (27), Evros (1), Lakonia (48), and Larissa (18). Regions (37) and (37) are metropolitan in the Greek labor market; Evros (1) and Lakonia (48) are edge regions, as it is observed in Fig.15; Eurytania (27) is the least populated region in Greece, and Larissa (18) is a central region in the LGCN (Fig.15). By assuming, in all cases, a change in demand for employment equal to $\Delta I=1000$ workers, the results of the multiplier effect are shown in Fig.17. As it can be observed, for the prefectures Eurytania (27) (Fig.17a), Athens (37) (Fig.17b), and Lakonia (48) (Fig.17c), a $\Delta I=1000$ change in demand for employment will cause an isolated multiplier effect applicable to each prefecture. On the other hand, for the cases of Thessaloniki (8) (Fig.17d), Evros (1) (Fig.17e), and Larissa (18) (Fig.17f) a $\Delta I=1000$ change in demand for employment will also cause spillover (Giovanni

and Francesco, 2008; Andersson, 2012) multiplier effects, which for the prefecture of Larissa (18) are more extensive (spread throughout 8 prefectures).

Fig.17. Results of implementing the proposed algorithm on six scenarios of change in labor demand ΔI=1000 in the prefectures of (a) Eurytania (27); (b) Athens (37); (c) Lakonia (48); (d) Thessaloniki (8); (e) Evros (1); and (f) Larissa (18)



4. Conclusions

The Keynesian macroeconomics approach of the "multiplier effect" influenced the way the 1st generation theories in regional science have perceived and described the engine of regional economic growth and regional development. In the context of this approach, regional economic growth and development are conceived as the result of changes in demand stimulating an iterative process of returns of income. Despite the constraints due to modeling assumptions, in epistemological terms, the evolution of theories and models building on the Keynesian multiplier effect has proven that this approach has been subjected to a multiplier effect itself, as it stimulated succeeding theories and perceptions (e.g. the export-base model of Tiebout and North, the Harrod-Domar's model, the Leontief's IO model, and many other similar approaches), enjoyed voluminous and multidisciplinary research and promoted the way of economic thinking. Today, in the era of complexity and connectivity ruling all aspects of scientific research and life, economic growth and development are revisited in the context of the network paradigm supporting the description of complex systems. By getting its inspiration from its multidisciplinary-friendly configuration, the potential to represent multiregional systems as network structures, and the fruitful contribution of network science in the IO economic systems research, this paper developed a network-based algorithm for computing Keynesian income multipliers in multiregional systems. Aiming to (*i*) revisit an

established regional economic model through a modern computational approach; (*ii*) promote multidisciplinary thinking; (*iii*) retrieve the Keynesian income multipliers' benefits of better supervision of computations, mono-variable (one good) consideration, and intuitive interpretation of the results; (*iv*) broaden the applicability of the model; and also (*v*) serve educational purposes in regional economics and development; the proposed algorithm built on inputs of a network connectivity (adjacency) matrix and estimations of the regional shares of imports, marginal propensity to consume, and changes in demand, and provided a framework for standardizing computations of the multiplier effect in multiregional systems, regardless their size and the level of their complexity. The algorithm consists of steps distributing the shares and volumes in demand throughout the adjacency (connectivity) matrix of the multiregional system and afterward estimating the multiplier coefficients and the changes in income per region (node). After its description, the proposed network-based algorithm was implemented in two theoretical scenarios, which are available in the textbook Polyzos (2019), and in an empirical case of the land interregional commuting network in Greece, where nodes represented land (non-insular) capital cities of the Greek prefectures and the edges the number of commuters moving between regions for work. The theoretical scenarios contributed to a deeper conceptualization of the computation of the Keynesian income multipliers, whereas the empirical scenario revealed patterns providing insights into the developmental dynamics of the labor market (demand for employment) in Greece. In particular, the analysis revealed that regions with the highest income multipliers are allocated along an "S"-type direction, coinciding with the major pattern of regional development in Greece, and edge regions enjoy the highest regional multipliers. Also, it revealed a "U"-shaped correlation pattern between the node degree and the income multipliers, implying that either the states of isolation or high connectivity are network structures stimulating higher multiplier effects. Finally, this paper examined scenarios of 1000-unit change in labor demand in the Greek commuting network and revealed that network intermediacy and less the regional population is a stimulus for spillover multiplier effects. Overall, the analysis revealed the symbiotic relationship between the multiplier effect and network structure in regional markets, promoted multidisciplinary thinking in regional science and economics, and provided a network-based algorithm for computing Keynesian income multipliers to motivate further research.

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Appendix

The income multipliers *m*-function in MATLAB
(it can be used whether copied and pasted to a MATLAB's function format)

```
--------------------------------------------------------------------------
function [ T DSM DVM ] = multipliers_multireg( W, dD, impC, MPC)
%MULTIPLIERS_MULTIREG_SYSTEM This function computes the regional income multipliers
and the income changes due to changes in the demand captured in a multiregional
system.
%
% Ref (1). Tsiotas, D., (2022) "A network-based algorithm for computing keynesian
income multipliers in multiregional systems", Regional Science Inquiry, 14(2).
% Ref (2). Polyzos, S., (2019) Regional Development, Athens: Kritiki Publications [in
Greek]
%
%   INPUTS
%   W:      Adjacency matrix, a binary matrix including ones in locations ij if
%           regions Ri and Rj are connected. If a weighted connectivity matrix is
%           imported, it is converted to its adjacency
%   dD:     Change in demand, vector including the change(s) in demand
%           dD(i) = D1(i)-Do(i) in one (or more, i=1,2,... =<n) region(s) Ri.
%           that a prefecture satisfies through imports.
%   impC:   Imports coefficients, vector with the proportions of demand
%           that a prefecture satisfies through imports. If not entered,
%           is randomized, impC = [rand() rand() ... rand()]. Note: it
%           should be assigned in normalized form [0,1].
%   MPC:    Vector of Marginal Propensity to Consume per region
%
%   OUTPUTS
%   T:      Tabulation matrix with the results [1:Region 2:ΔD 3:MPC 4:m 5:ΔP],
%   where
%   m:      Income multipliers vector, including the income multipliers of regions due
to the increase of demand
%   ΔD:     Change in Demand in all regions
%   ΔP:     Income increase vector, including the income increase in regions due
%           to the increase of demand
%   DSM:    Demand Shares Matrix, matrix including the proportions (shares) at
%           which a region satisfies its demand through intrinsic production (at
%           the main diagonal) and imports.
%   DVM:    Demand Shares Matrix, matrix including the
%           volume of intrinsic satisfaction of demand and through imports.
%
%   Developed by Dimitrios Tsiotas, Ph.D., Assistant Professor, on 26/6/2022

tic
W(isnan(W))=0;  % removes NaNs from connectivity matrix
% Check (#0) of vertically aligned arguments
sdD=size(dD);
simpC=size(impC);
sMPC=size(MPC);
if sdD(1)<sdD(2)
    dD=dD';
end
if simpC(1)<simpC(2)
    impC=impC';
end
if sMPC(1)<sMPC(2)
    MPC=MPC';
end
% end of Check#0
% Check (#1) of square structure
s=size(W);
if s(1)~=s(2)
    n=min(s(1),s(2));
    W=W(1:n,1:n);        % keeps only the nxn table
else
    n=s(1);
end
% end of Check#1
% Conversion (#2) of non-symmetric adjacency
Adj_temp=W>0;
if sum(sum(W))~=sum(sum(Adj_temp))
   W=W-W';
   W(W<0)=0;   % removes negative entries
   Adj=eye(n)+W; % fills the main diagonal with ones
   Adj(Adj>1)=1;    % non-symmetric adjacency (to make the structure reasonable for
one-product trade balance)
end
if sum(sum(W))==sum(sum(Adj_temp))
```

```
   Adj=W;
end
% end of conversion #2
% Check (#3) of MPC argument
if nargin<4
    MCP=ones(1,n); % MPC is set to one for all regions
end
% end of Check#3
% Check (#4) of impC argument
if nargin<3
    impC=rand(1,n);
end
% end of Check#4
% Check (#5) of dD argument
if nargin<2
    temp=rand(1,n);
    tM=max(temp);
    dD=(temp==tM);
    dD=dD.*temp;
end
% end of Check#5
% Check (#6) coefficient form of impC (should be <=1)
if impC>1
    if min(impC)<=100;
        impC=impC/100;
    else
    cm=min(impC);
    cM=max(impC);
    for i=1:n;
    impC(i)=impC(i)/(cM-cm); % normalizes values
    end
    end
end
% end of Check#6
intrC=1-impC;        %finds the complementary coefficients, of intrinsic production
AC=Adj-eye(n);      % keep from Adj only connections with seller regions
sellers=sum(AC)';   % finds the number of seller regions per node
so=(sellers==0); % finds regions that have no sellers due to the network structure
% Check#7, regions with no sellers are set impC=1
intrC=intrC.*(abs(1-so));
intrC=intrC+so;      % sets fully intrinsic regions with no sellers
% end of Check#7
AintrC=diag(intrC); % intrC set to diagonal form
imporpo=impC./sellers;   % proportions satisfied by imports per region
imporpo(isinf(imporpo))=0;   % replaces inf with zeros
% Loop#8, calculation of demand coefficients matrix
for i=1:n
    DSM(:,i)=AC(:,i)*imporpo(i);
end
DSM=DSM+AintrC;
% end of Loop#8
DVM=eye(n);
% Loop#9, calculation of demand volumes
for i=1:n
    DVM(:,i)=DSM(:,i)*dD(i);
end
dvms=zeros(n,1);
% end of Loop#9
% Loop#10, calculation of secondary demand volumes
for j=1:n
    if sum(sum(DVM)==0)<n
dvms=dvms+(dvms==0).*sum(DVM,2); % finds the shared demand volume
dv2=(abs(1-dD>0)); % index of secondary demand, finds regions who secondarily
increased their demand
dvm2 = dvms.*dv2;    % finds the shared demand volumes
for i=1:n
    DVM2(:,i)=DSM(:,i)*dvm2(i);
end
DVM=DVM+DVM2.*(DVM==0);
end
end
% end of Loop#10
indemandchange=sum(DVM.*eye(n))'; % the demand that each regions satisfies
% Loop#11, calculation of regional multipliers
for i=1:n
m(i)=1/(1-MPC(i));
end
m=m';
% end of Loop#11
```

```
T=[(1:n)' indemandchange MPC m indemandchange.*m];
toc
display('***********************************************')
display('LABELS in Tabulation Matrix:')
display('1st column: Region')
display('2nd column: ΔD - Change in Demand')
display('3rd column: MPC - Marginal Propensity to Consume')
display('4th column: m - Regional Income Multiplier')
display('5th column: ΔP - Change in Product/Income')
display('***********************************************')

end
--------------------------------------------------------------------------------
```

A THEORETICAL ANALYSIS OF COSTS, WASTE TREATMENT, POLLUTION IN THE GANGES, AND LEATHER PRODUCTION BY TANNERIES IN KANPUR, INDIA

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Abstract

We theoretically analyze the interaction between two representative and real tanneries, denoted by A and B, that are located on the same bank of the Ganges River in Kanpur, India. Tannery A is situated upstream from tannery B. Both tanneries produce leather and leather production by tannery A also gives rise to chemical waste that adversely affects the cost incurred by tannery B in producing leather. In this setting, we perform four tasks. First, we determine the amount of chemical waste and the leather produced by tanneries A and B in a competitive equilibrium. Second, we explain why this competitive equilibrium is inefficient from a societal standpoint. Third, we ascertain the socially optimal amount of leather produced by the two tanneries. Finally, we illustrate the working of our theoretical model with a specific example in which we use explicit functional forms and numbers.

Keywords: Ganges River, Leather Production, Tannery, Waste Treatment, Water Pollution

JEL classification: R11, R22, R32, Q52, Q53

1. Introduction

There is general agreement on the point that the Ganges (Ganga in Hindi) is the longest and the most prominent river in India. This notwithstanding, Black (2016) has rightly pointed out that in contemporary times, more than a billion gallons of waste are deposited into the Ganges every day. Even though the problem of waste deposition into the Ganges occurs at several points along the river, the prior work of Gallagher (2014), Black (2016), and Jain and Singh (2020) tells us that as far as the flow of water and pollution in the Ganges are concerned, three issues deserve to be highlighted.

The first issue concerns the phenomenon of climate change and the concern here is that this phenomenon is diminishing water flows in the Ganges and, *inter alia*, this factor has, almost certainly, diminished the river's natural capacity to absorb waste that is deposited into it. The second issue is water pollution from the tannery industry which is centered in the city---see Figure 1---of Kanpur. The salience of the tannery industry in Kanpur explains why this city is sometimes referred to as India's "leather city" (go to https://mahileather.com/blogs/news/the-world-s-most-famous-leather-markets for a more detailed discussion of this point; accessed on 18 August 2022). The third issue is waste deposited into the Ganges in the city of Varanasi which is, as shown in Figure 1, situated to the south-east of and roughly two hundred miles downstream from Kanpur.

The question of how climate change affects the Ganges and water pollution caused by tanneries in Kanpur has recently been studied by Batabyal *et al*. (2022a). Similarly, the issue of cleaning up pollution in the Ganges at Varanasi has been analyzed from a variety of standpoints by Batabyal and Beladi (2017, 2019, 2020) and by Xing and Batabyal (2019). In this regard, the particular question of how best to manage polluting tanneries in Kanpur when the water pollution they cause negatively impacts small farmers has been analyzed by Batabyal *et al.* (2022b). Finally and more generally, pollution in the Ganges stemming from the activities of tanneries in Kanpur has been examined by Batabyal (2022).

Figure 1: Path of the Ganges River and the Location of Kanpur

In Batabyal (2022) and in Batabyal *et al*. (2022a), water pollution in the Ganges caused by an upstream tannery negatively influences the downstream tannery's ability to *produce* leather. Even so, what these two studies do *not* take into account is the fact that the negative externality imposed by the upstream tannery on the downstream tannery also affects the downstream tannery's *cost* of producing leather. Second, the two studies mentioned above also do *not* account for the fact that polluting tanneries in Kanpur are frequently required to take one or more actions to *diminish* the environmental damage stemming from their production of leather[1].

To the best of our knowledge, the extant literature has *not* analyzed the two points mentioned in the preceding paragraph. Given this lacuna in the literature, we extend the analyses in Batabyal (2022) and Batabyal *et al*. (2022a) by constructing and analyzing a theoretical model that explicitly accounts for the above-mentioned two points about water pollution in the Ganges that results from the production of leather by tanneries in Kanpur. The problem we study has broader implications for the sustainability of urban life as studied by Nijkamp (2011). We emphasize that the theoretical model we construct and analyze is our own and therefore this model and our subsequent analysis represent new knowledge in the literature.

The remainder of this paper is organized as follows: Section 2 describes our theoretical model of the interaction between two representative tanneries, A and B, that are located on the same bank of the Ganges river in Kanpur, India. Tannery A is situated upstream from tannery B. Both tanneries produce leather and leather production by tannery A negatively impacts the cost incurred by tannery B in producing leather. Section 3 determines the amount of chemical waste and the leather produced by tanneries A and B in a competitive equilibrium. Section 4 explains why this competitive equilibrium is inefficient from a societal standpoint. Section 5 ascertains the socially optimal amount of leather produced by the two tanneries. Section 6

[1] The interested reader may visit https://www.unido.org/news/kanpur-tanneries-win-awards-innovations-reduce-environmental-impact, to https://www.stahl.com/strategy/sustainable-development/partnership-cleaning-ganges, and see Gupta *et al*. (2007) and Singh and Gundimeda (2021) for additional details on this point; accessed on 18 August 2022

provides an example to demonstrate the working of our theoretical model. Section 7 concludes and then suggests three ways in which the research delineated in this paper might be extended.

2. The Theoretical Framework

Consider two real and representative tanneries, denoted by A and B, that are situated on the same bank of the Ganges in Jajmau, an industrial suburb of Kanpur. It makes sense to concentrate on Jajmau because a relatively large number of the tanneries in Kanpur are located in this suburb (go to https://www.incredibleindia.org/content/incredible-india-v2/en/destinations/kanpur/jajmau.html for additional details on Jajmau; accessed on 18 August 2022). The two tanneries under study produce leather and the production of leather requires the use of chemicals that are toxic to humans. Tannery A is situated upstream from tannery B.

Tannery A sells the leather it produces at price $p_A > 0$ per square feet. Its cost of producing leather q_A is given by the function $C_A(q_A)$ and we assume that $C_A'(\cdot) > 0$ and that $C_A''(\cdot) > 0$. For each square feet of leather produced, tannery A also generates one kilogram of chemical waste. The tannery is supposed to treat this chemical waste before it is deposited into the Ganges but enforcement of existing regulations is poor and therefore tanneries can often get away with not complying with existing regulations requiring tanneries to treat the chemical waste they generate.

Let w_{Ae} denote the amount of chemical waste that tannery A deposits into the Ganges *without* first treating it. This action results in *no* cost to the tannery. In contrast, if this tannery first treats the chemical waste it produces before depositing it into the Ganges then it bears a cost given by the function $C_{AT}(w_{At})$ where w_{At} is the amount of waste treated and it is understood that $C_{AT}'(\cdot) > 0$ and that $C_{AT}''(\cdot) > 0$.

Tannery B is located downstream from tannery A on the same bank of the Ganges. Its cost of producing leather q_B is given by the function $C_B(q_B)$, where $C_B'(\cdot) > 0$ and $C_B''(\cdot) > 0$. The untreated chemical waste deposited into the Ganges by tannery A increases tannery $B's$ cost of producing leather. Let us denote this *additional* cost with the function $C_{Be}(w_{Ae})$, where we suppose that $C_{Be}'(\cdot) > 0$ and that $C_{Be}''(\cdot) > 0$. The *spatial* element in the upstream-downstream interaction between the two tanneries that we are studying is accounted for by the *magnitude* of the untreated chemical waste w_{Ae} that tannery A deposits into the Ganges. In other words, assuming a constant flow of the water in the Ganges river and *ceteris paribus,* as the distance between the two tanneries A and B increases, the magnitude of this waste amount w_{Ae} also increases and so does tannery $B's$ cost of producing leather. Finally, tannery B sells the leather it produces at price $p_B > 0$ per square feet. With this description of the theoretical framework in place, we are now in a position to solve for the amount of chemical waste generated by tannery A and the leather produced by these two tanneries in a competitive equilibrium.

3. The Competitive Equilibrium

The profit function of tannery A or Π_A can be written as

$$\Pi_A = p_A q_A - C_A(q_A) - C_{AT}(w_{At}) \tag{1}$$

and the profit function of tannery B or Π_B is given by

$$\Pi_B = p_B q_B - C_B(q_B) - C_{Be}(w_{Ae}). \tag{2}$$

In a competitive equilibrium, both tanneries maximize their profit Π_A and Π_B. Specifically, tannery A chooses the amount of leather to produce or q_A and the amount of chemical waste to treat or w_{At}. The two first-order necessary conditions for a maximum are (the second-order sufficiency conditions are satisfied)

$$\frac{\partial \Pi_A}{\partial q_A} = p_A - C_A'(q_A) = 0 \tag{3}$$

and

$$\frac{\partial \Pi_A}{\partial w_{At}} = -C'_{AT}(w_{At}) < 0. \quad (4)$$

From (3) and (4), we deduce that the optimal solution for tannery A---denoted with a star (*)---is given by $q_A^* = \{C'_A\}^{-1}(p_A)$ and $w_{At}^* = 0$.

For tannery B, the first-order necessary condition for a maximum is given by (the second-order sufficiency condition is satisfied)

$$\frac{\partial \Pi_B}{\partial q_B} = p_B - C'_B(q_B) = 0. \quad (5)$$

Manipulating equation (5), the optimal solution for tannery B---denoted with a star (*)---can be expressed as $q_B^* = \{C'_B\}^{-1}(p_B)$. Now, writing the three solutions that arise in a competitive equilibrium together, we obtain

$$q_A^* = \{C'_A\}^{-1}(p_A), w_{At}^* = 0, and\ q_B^* = \{C'_B\}^{-1}(p_B). \quad (6)$$

Let us now explain why the competitive equilibrium that we have just solved for is inefficient from a societal standpoint.

4. The Inefficiency

The competitive equilibrium described in section 3 is inefficient because of the presence of a production externality. Put differently, leather production by the upstream tannery A *reduces* the profit of the downstream tannery B because of the presence of the cost term $C_{Be}(w_{Ae})$ in this tannery's profit function given by equation (2). In addition, the relevant externality is an external *diseconomy* and therefore, in general, leather production by tannery A is inefficiently *high*. In other words, tannery $A's$ production of leather is higher than the socially optimal level of leather production. Our next task is to compute, *inter alia*, the socially optimal amount of leather produced by the two tanneries.

5. The Socially Optimal Level of Leather Production

To determine the socially optimal level of leather production by the two tanneries and the optimal amount of chemical waste to treat by tannery A, we need to maximize the *sum* of the profits earned by these two tanneries. In other words, we need to solve

$$max_{\{q_A, q_B, w_{At}\}} \Pi = \Pi_A + \Pi_B. \quad (7)$$

Substituting for the two profit functions Π_A and Π_B from equations (1) and (2) into equation (7), the maximization problem of interest can be rewritten as

$$max_{\{q_A, q_B, w_{At}\}} p_A q_A - C_A(q_A) - C_{AT}(w_{At}) + p_B q_B - C_B(q_B) - C_{Be}(q_A - w_{At}). \quad (8)$$

The reader will note that we have used the fact that $w_{Ae} = q_A - w_{At}$ to substitute for w_{Ae} in the last cost expression in equation (8).

The three first-order necessary conditions that together delineate the social optimum are given by (the second-order sufficiency conditions are satisfied)

$$\frac{\partial \Pi}{\partial q_A} = p_A - C'_A(q_A) - C'_{Be}(q_A - w_{At}) = 0, \quad (9)$$

$$\frac{\partial \Pi}{\partial w_{At}} = -C'_{AT}(w_{At}) + C'_{Be}(q_A - w_{At}) = 0, \quad (10)$$

and

$$\frac{\partial \Pi}{\partial q_B} = p_B - C'_B(q_B) = 0. \quad (11)$$

Let us denote the socially optimal levels of the three choice variables q_A, w_{At}, and q_B with the superscript O. Then, from equation (11), we infer that $p_B = C'_B(q_B)$. Therefore, the socially optimal output of leather produced by tannery B or $q_B^O = \{C'_B\}^{-1}(p_B)$. Moving on, equations (10) and (9) tell us that $C'_{AT}(w_{AT}) = C'_{Be}(q_A - w_{At})$ and that $p_A - C'_A(q_A) = C'_{Be}(q_A - w_{At})$. Equating the right-hand-sides (RHSs) of the two preceding equations and then simplifying the resulting expression, we obtain the socially optimal output of leather produced by tannery A. This output is given by $q_A^O = \{C'_A\}^{-1}[p_A - \{C'_{AT}\}^{-1}(w_{At})]$. The optimal amount of chemical waste or w_{At}^O that is treated by tannery A is given implicitly by equation (10). Once this value of w_{At}^O is known, we can determine the optimal amount of untreated chemical waste that is deposited into the Ganges by tannery A or w_{Ae}^O by using the relationship $w_{Ae}^O = q_A^O - w_{At}^O$.

Let us now compare leather production by the two tanneries in a competitive equilibrium with that produced in the social optimum. We begin with tannery A. The two outputs to compare are q_A^* with q_A^O. In this regard, observe first that $p_A - \{C'_{AT}\}^{-1}(\cdot) < p_A$. Second, recall that tannery $A's$ marginal cost of producing leather function or $C'_A(\cdot)$ is strictly increasing. Since the inverse function of a strictly increasing function is also strictly increasing, it follows that $q_A^* > q_A^O$. In words, determining the socially optimal output of leather produced by tannery A is equivalent to tannery A *internalizing* the negative impact that its discharge of untreated chemical waste into the Ganges has on tannery $B's$ ability to produce leather. When this internalization takes place, it is optimal for tannery A to *reduce* its optimal output of leather.

What about the output of leather produced by the downstream tannery B? To compare the output of leather produced by tannery B in the competitive equilibrium with that produced in the social optimum, we need to relate q_B^* from equation (6) with q_B^O from the paragraph right after equation (11). This comparison clearly shows that $q_B^* = q_B^O = \{C'_B\}^{-1}(p_B)$. This last result tells us that the downstream tannery $B's$ optimal production of leather is the same in both the competitive equilibrium and in the social optimum. Our last task in this paper is to illustrate the working of our theoretical model with an example in which we use explicit functional forms and numbers.

6. A Specific Example with Numbers

Suppose the two leather output prices are $p_A = US\$10$ per square feet and $p_B = US\$5$ per square feet. Using an exchange rate of Rupees $75 = US\$1$, the US$ prices translate to $p_A = 750$ rupees per square feet and $p_B = 375$ rupees per square meter. These are reasonable ranges for the price of finished leather in Kanpur, India (go to https://www.exportersindia.com/kanpur/raw-leather.htm for more details; accessed on 18 August 2022). That said, we stress that the above choices for the two prices are meant to illustrate how our model can be applied in a *variety* of different settings. As such, one could use *any real price* for the two leather outputs and this would allow us to conduct an analysis that is very similar to that conducted in this section.

The two cost functions for producing leather are quadratic and given by $C_A(q_A) = 0.5q_A^2$ and $C_B(q_B) = 0.5q_B^2$. The extra cost borne by tannery B as a result of the discharge of untreated waste into the Ganges by tannery A is also quadratic and given by $C_{Be}(w_{Ae}) = 0.5w_{Ae}^2$. Finally, the linear cost of treating chemical waste by tannery A is $C_{AT}(w_{At}) = 2w_{At}$.

Let us first determine the competitive equilibrium. To do this, we need to set up the equivalents of equations (3), (4), and (5). Doing this, we get

$$\frac{\partial \Pi_A}{\partial q_A} = 10 - q_A = 0, \quad (12)$$

$$\frac{\partial \Pi_A}{\partial w_{At}} = -2 < 0, \quad (13)$$

and

$$\frac{\partial \Pi_B}{\partial q_B} = 5 - q_B = 0. \tag{14}$$

Solving (12)-(14) for the choice variables of interest, we get $q_A^* = 10, q_B^* = 5$, and $w_{At}^* = 0$. Also, because $w_{Ae}^* = q_A^* - w_{At}^* = 10 - 0 = 10$, the Ganges water pollution cost imposed on tannery B by tannery A is $0.5(10)^2 = 50$.

Moving on to ascertain the social optimum, we now need to set up the equivalents of equations (9), (10), and (11). Doing this, we obtain

$$\frac{\partial \Pi}{\partial q_A} = 10 - 2q_A + w_{At} = 0, \tag{15}$$

$$\frac{\partial \Pi}{\partial w_{At}} = q_A - 2 - w_{At} = 0, \tag{16}$$

and

$$\frac{\partial \Pi}{\partial q_B} = 5 - q_B = 0. \tag{17}$$

Simplifying equations (15)-(17), we obtain the values of the pertinent decision variables in the social optimum. Specifically, we get $q_A^O = 8, q_B^O = 5, w_{At}^O = 6$, and $w_{Ae}^O = 2$. Three results are now worth emphasizing. First, because $q_A^* = 10 > 8 = q_A^O$, this example confirms our previous general finding in section 5 that tannery A produces an inefficiently *high* amount of leather in the competitive equilibrium and that social optimality requires this tannery to produce *less* leather. Second, since $w_{At}^O = 6 > 0 = w_{At}^*$, this example confirms that it is socially *suboptimal* to treat no chemical waste, as tannery A does in the competitive equilibrium. Instead, it is socially optimal for this tannery to treat 6 units of chemical waste and this action results in a cleaner Ganges. Finally, because tannery A *internalizes* the negative impact of the chemical waste it generates on tannery B in the social optimum, the corresponding water pollution cost now equals $0.5(2)^2 = 2$ and this number is obviously far *lower* than the corresponding cost in the competitive equilibrium which equals is $0.5(10)^2 = 50$. This completes our theoretical analysis of costs, waste treatment, pollution in the Ganges, and leather production by tanneries in Kanpur, India.

7. Conclusions

Given the lacuna in the existing literature identified in section 1, we theoretically examined the interaction between two representative and real tanneries, A and B, that were located on the same bank of the Ganges River in Kanpur, India. Our analysis led us to first ascertain the socially optimal amount of leather produced by the two tanneries and to then demonstrate the working of our theoretical model with an example in which we used overt functional forms and realistic numbers for prices.

Here are three suggestions for extending the research described in this paper. First, it would be useful to determine the scope of fiscal policy (see Karras (2015)) in determining the location choices (see Cao (2021)) of tanneries and in alleviating the Ganges water pollution problem in Kanpur. Second, it would be useful to analyze the interaction between tanneries A and B when the cost of enforcing the requirement to treat chemical waste before it is deposited into the Ganges is explicitly modeled in the underlying analysis. Such an interaction could be studied as a problem of implementing the right regional development policies (see Lincaru *et al.* (2010), Stilianos and Ladias (2011), Goula *et al.* (2015), and Mitsopoulos and Pelagidis (2021)) or as a Principal-Agent game, potentially repeated over time, in which the regulator is the principal and the two tanneries are the two agents. Third, it would also be helpful to study the interaction between tanneries A and B when, potentially because of the natural cleansing capacity of the Ganges, the impact of not treating chemical waste before it is deposited into the Ganges is stochastic and not deterministic. Studies of the prevention of water pollution caused by tanneries in Kanpur that incorporate these facets of the problem into the analysis will provide new perspectives on the ways in which tanneries can avoid a threat to their continued existence and, simultaneously, the environmental damage done to the

Ganges and to humans living in the neighborhood of these tanneries is assuaged to the extent possible.

8. Acknowledgments

We thank the Academic Editor Dimitrios Tsiotas and two anonymous reviewers for their helpful comments on a previous version of this paper. In addition, Batabyal acknowledges financial support from the Gosnell endowment at RIT. The usual disclaimer applies.

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DRAWING AN INDICATOR OF TOURISM COMPETITIVENESS AND EXAMINING ITS RELATIONSHIP WITH TOURISM SEASONALITY FOR THE GREEK PREFECTURES

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Abstract

Within the context that tourism competitiveness is a complex concept, this article proposes a conceptual framework and uses Pena's P_2 distance synthetic index (DP_2) to classify the Greek prefectures according to their competitiveness. This paper aims to define the potentials of Greek prefectures through the tourism competitiveness index. Additionally, examines the relationship between tourism competitiveness and tourism seasonality which is a significant phenomenon that affects tourism every destination globally. The study utilizes a total of 66 variables, and the data were processed using the Package 'p2distance' in R Studio. The analysis reveals four groups according to their values in the tourism competitiveness index (DP_2) and tourism seasonality (RSI). In these four groups, tourism carrying capacity and tourism saturation indexes from previous studies are also presented in the last section. Overall, the analysis supports multidisciplinary and synthetic research in the modeling of tourism research and promotes the DP_2 synthetic index in the study of tourism competitiveness. The overall analysis can propose a tool for tourism management and regional policy, as these are complex concepts. The proposed approach advances the DP_2 index as a quantitative measure for tourism competitiveness and compares the results with tourism seasonality

Keywords: tourism competitiveness, tourism attractiveness, tourism seasonality, regional and tourism development, DP_2 synthetic index

JEL classification: R10, R11, R58, C43, Z32

1. Introduction

The unequal spatial development of tourist destinations affects the economy, society, and the environment and is an important factor for development strategies in a sustainable framework (Andrei et al., 2015; Romao et al., 2017; Polyzos, 2019). The study of these inequalities is highly complex, and interdisciplinary approaches have been developed in the international literature (Tsiotas et al., 2021). Because tourism is an important economic sector for many countries worldwide (Hall, 2022), and the attractiveness of destinations from emerging economies is over time increasing (Ritchie and Crouch, 2003), concepts such as tourism competitiveness and tourist attractiveness have long attracted the interest of researchers seeking to define and quantify these concepts (Gomezelj and Mihalic, 2008; Cracolici and Nijkamp, 2009). Destinations globally attempt to procced in more sustainable tourism policies (Morgan et al., 2011; Cucculelli and Goffi, 2016) looking for more resilient economies in the post-Covid-19 era (Kim et al., 2022), with more solutions and more rational planning, especially for times of crisis (Farzanegan et al., 2020), and seek to include the concepts of competitiveness and attractiveness on their policymaking (Morgan et al., 2011).

Trying to separate these two concepts, tourism attractiveness usually is limited to specific tourism characteristics of the destination and depends on subjective factors that are often associated with the emotional criteria of the visitors (Cracolici and Nijkamp, 2009; Reitsamer and Brunner-Sperdin 2017). On the other hand, tourism competitiveness is a more complex

and integrated framework that does not focus exclusively on aspects of tourism, having a more holistic approach (Shaw and Williams, 2004; Cracolici and Nijkamp, 2009). Tourism competitiveness concerns the degree which a destination can maintain its natural and cultural resources, can increase the long-term prosperity of its inhabitants, and provide unique experiences, more attractive than the experiences of other destinations (Ritchie and Crouch, 2003; Bahar and Kozak, 2007).

This approach even includes hidden cause-effects assumptions within a sustainability context it appears to be a system of definitional (Medina-Munoz et al., 2013). Nevertheless, the definition of tourism competitiveness, its measurement, and the indicators examined in such studies have not been commonly accepted (Mira et al., 2016; Abreu-Novais et al., 2018). As a result, competitiveness is also influenced by subjective factors (Cracolici and Nijkamp, 2009; Abreu-Novais et al., 2018; Vasyltsiv et al., 2021), leading to an even greater ambiguity of concept (Claver-Cortes et al., 2007). This effect of subjective factors on the assessment of tourism competitiveness is also related to the fact that the destinations in question may target different tourism markets. The destination factors are different or have a different weight on the overall competitiveness of the destination for each market (Morgan et al., 2011; Medina-Munoz et al., 2013).

In attempting to deconstruct tourism competitiveness and the different conceptual frameworks that have been developed, it appears that the concept includes two dimensions. On the one hand includes internal attributes and abilities of the residents, such as the improvement of their health and level of education, aiming at the enhancement of the quality of life, prosperity, and human development (Sharpley, 2010; Croes et al., 2020). On the other hand, includes the external environment and connects tourism with market position, comparing, for example, the tourist arrivals or overnight stays with the competing destinations (Croes et al., 2020). Many times, these two different environments (internal and external) can come into conflict.

As it turns out, the concepts of tourism competitiveness and tourism attractiveness are very complex (Medina-Munoz et al., 2013), and studies have tried to prioritize and weigh their most critical factors (Crouch and Ritchie, 2005; Zehrer et al., 2016). Most studies use a set of objective (hard data and long-term) and subjective (soft data and short-term) indicators (Cucculelli and Goffi; 2016; Usyal and Sirgy, 2019; Croes et al., 2020) to approach the concepts. It is useful, in addition to the number of visitors, the market share of a destination, or the level of price competitiveness (Seetaram et al., 2016), in the quantification of tourism competitiveness to take into account the concepts of sustainability, tourism carrying capacity, prosperity, and human development, the investment opportunities, provided services, and to include the social and cultural variables of destination (Mira et al., 2016; Romao et al., 2017; Croes et al., 2020). As a result of the complexity of the concepts, studies attempted to approach them using different techniques such as multicriteria decision analysis (Cracolici and Nijkamp, 2009), shift-share analysis (Constantino et al., 2020), multiple linear regression, phenomenographic approach (Abreu-Novais et al., 2018), fuzzy approach (Fu and Chen, 2019).

The majority of studies approach the complex concepts by examining them at a country or group of countries level (Bahar and Kozak, 2007; Gomezelj and Mihalic, 2008; Croes et al., 2020). However, some studies approach tourism competitiveness and attractiveness in smaller destinations such as islands (Mechinda et al., 2010), large cities (Minghetti and Montaguti, 2010), specific types of destinations (Lee and King, 2006), well-known holiday destinations, and provinces (NUTS3) (Cracolici and Nijkamp, 2009). Very few studies examine tourism competitiveness comparing all the administrative spatial groups of a country (NUTS3) despite the uneven spatial development within many countries (Cucculelli and Goffi, 2016), which leads to the regional issue.

Aiming to serve the demand for quantifying the tourism competitiveness in the small administrative spatial groups (NUTS3), this paper quantifies the concept for each Greek prefecture using a synthetic index. In order to construct the synthetic index, in the beginning, a conceptual framework for the study of the concept of tourism competitiveness is proposed. To approach the concept at a lower administrative level, some main factors such as the political and legal factors, technology (Ritchie and Crouch, 2003), business environment, destination management (Cocculeli and Goffi, 2016), or global economic impacts (Ritchie

and Crouch, 2010) that referred in international literature, are difficult to be included. There aren't significant differences and data among the prefectures of a country, and in this light, it is usefull to set the framework within which the tourism competitiveness will be analyzed.

For the quantitative analysis will be constructed a synthetic index based on the method of P_2 distance (DP_2), following the approach of other similar studies (Salinas Fernandez et al., 2020). While the study of Salinas Fernandez et al. (2020) designed a synthetic index to rank 80 countries using variables from the 2017 Travel & Tourism Competitiveness Index, this study attempts to apply the approach in Greece's small administrative spatial groups after first defining the conceptual framework within which, the concept, will be analyzed. The international literature analyzed the properties that make the application of the synthetic index DP_2 particularly prevalent in different issues by replacing or supplementing methodologies such as Principal Component Analysis and Data Envelopment Analysis (Somarriba and Pena, 2009; Salinas Fernandez et al., 2020). The main advantage of this synthetic index is the quantitation of the index and at the same time the ability to calculate the weight of each variable to be used (Somarriba and Pena, 2009). Since many variables affect competitiveness, this feature is useful for the determination of the weight of each variable in the final calculation of the index.

At the second level, the study examines the relationship between tourism competitiveness and tourism seasonality. The phenomenon of tourism seasonality is the unequal distribution of demand throughout the year. The phenomenon is complex, globally, with temporal, spatial, and socio-economic dimensions, that presents differences, both between countries and within countries (Tsiotas et al., 2021). As a result, tourism seasonality is affected by various factors such as the type of the tourism product (Cuccia και Rizzo, 2011), the climate (Fang and Yin, 2015), the social configuration (Almeida and Kastenholz, 2019), the political regime (Fernandez-Morales et al., 2016), and other factors (Lee et al., 2008). A fundamental issue in quantitative studies is the quantification of tourism seasonality, which is implemented by using a specific variable within a certain period (e.g., monthly), regardless of their patterns (Ferrante et al., 2018). The most common variables for measuring tourism seasonality are the number of visitors, arrivals, and overnight stays, while, in terms of economic impacts, income-defined variables are also used. For the measurement of tourism seasonality, this study applies the Relative Seasonal Index - RSI (Lo Magno et al. 2017), which is a more suitable index than Gini, which is also a widespread index for the measuring of the phenomenon (Ferrante et al. 2018).

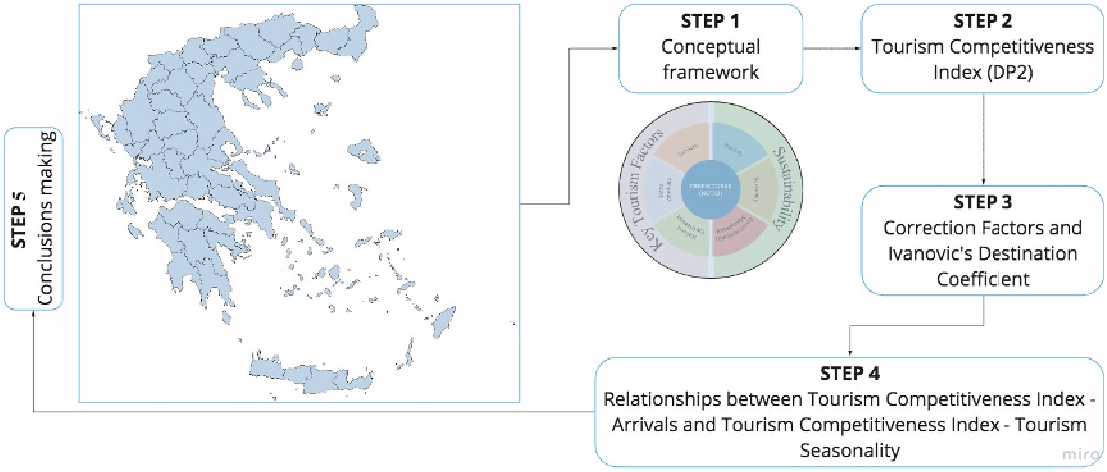
The study focuses on the case of Greece, which is a coastal country with a mixed mountainous, land, coastal, and insular morphology (Tsiotas, 2017). Tourism is a significant sector in the Greek economy as, for the year 2019 accounted for 20,8% of national GDP and 21,7% of total employment (SETE, 2021). In the country, there is high uneven spatial development among the prefectures (Polyzos, 2019), and some of them have high tourism seasonality (Tsiotas et al., 2021), tourism carrying capacity (Krabokoukis and Polyzos, 2020), and saturation indexes (Krabokoukis et al., 2021). Within this context, the study offers a quantitative tool for measuring and classifying the dynamics of the Greek prefectures by their competitiveness. This consideration can provide insights that may contribute to the configuration of more effective and more sustainable tourism development strategies.

The remainder of this paper is organized as follows: Section 1 is a brief literature review discussing mainly the concept of tourism competitiveness, and secondarily the concept of tourism seasonality. Section 2 describes the methodological framework of the study, the available data, and the variables participating in the analysis. Section 3 presents the results and discusses them within the context of regional science and tourism development. Finally, in section 4, conclusions are given.

2. Methodological framework

The study aims to quantity the tourism competitiveness of Greek prefectures and examines the relationship with tourism seasonality. The further purpose of the study is to determine the dynamics of each prefecture in Greece. The study is based on the DP_2 index (Croes et al., 2020), which can calculate the weight of each variable to be used (Somarriba and Pena, 2009). The methodological framework consists of five steps, as is shown in Fig.1.

Figure 1. The conceptual diagram illustrating the methodological framework of the study.



At the first step is proposed the conceptual framework of tourism competitiveness for the study of Greek prefectures. To approach the concept at a lower administrative level, certain main factors such as the political and legal factors, technology (Ritchie and Crouch, 2003), business environment, destination management (Cocculeli and Goffi, 2016), or global economic impacts (Ritchie and Crouch, 2010), are general and thus affect almost all areas of a country. As a result, it is difficult to find useful data to apply well-known models for tourism competitiveness at this administrative level and thus is particularly useful an adjustment of the factors involved in assessing tourism competitiveness.

Figure 2. The conceptual framework diagram illustrating the tourism competitiveness as proposes for the studying of Greek prefectures (NUTS3)

From the literature review arising three main dimensions of tourism competitiveness which are the ability to attract international visitors, the ability to satisfy them, and the ability to enhance the well-being of destination residents (Sharpley, 2010; Medina-Munoz et al., 2013), which are involved in the proposed conceptual framework. Figure 2 presents the proposed conceptual framework for assessing tourism competitiveness at the level of Greek prefectures, based on key points from previous studies. It is proposed to examine tourism competitiveness in six main interacting frameworks, which form the two main pillars.

Following the approach of Usyal and Sirgy (2019), we separate as "Input" the main factors of tourism divided into three frameworks, "Output" the sustainability in its three frameworks. The balance of these two main pillars is crucial for any destination, as there isn't any competitive tourist destination if the conditions for its development do not exist or if they operate to the detriment of its viability. Since Greek tourism is based mainly on its natural characteristics (Krabokoukis et al., 2021), which do not have the expected positive impacts on competitiveness as often related to low value-added for the host communities and mass tourism (Romao et al., 2017), the proposed model includes the concept of attractiveness (natural resources), and visitor satisfaction (infrastructure and services). The concept of the well-being of the inhabitants is contained in both main pillars (key tourism factors, sustainability), as these points affect the inhabitants' daily life.

The natural environment as part of the key tourism factors (Inputs) includes indicators and variables related to climate, location, coastline, biodiversity, mountain range, particular geomorphological features, etc. These factors often shape the tourism model developed in a destination and are usually the most popular points of interest for visitors (Polyzos, 2019). The infrastructure framework includes indicators and variables related to accessibility, health, safety, local market, culture, and history. Such factors shape the first image and the first experience of each visitor to the destination. If this experience is not successful, it is difficult for the overall experience to be positive. Accordingly, the framework of the services includes intangible elements and is more related to the experience emotions and the creation of unique memories to visitors who demands authenticity and meaningful interactions with locals (Paulauskaite et al., 2017). It includes indicators and variables related to research and development, visitor satisfaction, local events, entertainment, sports, and other activities, the quality of services provided, the recognition of the destination, and the actions for its promotion. These factors shape the entire tourist experience provided by the visitor to a destination.

The pillar of sustainability, having as its framework its three dimensions, includes the results (consequences) of the tourist activity of the destination (Outputs), but at the same time the characteristics that contribute more indirectly to the improvement of the level of the tourism competitiveness. The context related to society includes elements such as human development, social prosperity, social carrying capacity, and the level of dependence on tourism. A prosperous society contributes positively to tourism competitiveness (Ritchie and Crouch, 2003; Cucculelli and Goffi, 2016; Usyal and Sirgy, 2019). The economy includes dimensions related to economic prosperity, the economic benefits of tourism, the level of wages and average household income, and investments made in the destination. Finally, the framework of environmental management is related to factors such as the protection of natural resources, the use of renewable energy sources, water management, wastewater treatment, and air pollution.

To remains a competitive destination, both the input pillar (key tourism factors) and the output pillar (sustainability) need to be improved. Destinations, for example, that focus on increasing the tourism activity without, at the same time, focusing on the destination's sustainability are likely to lead to situations of tourism saturation, over-tourism, and consequently a reduction in their overall tourist attractiveness and competitiveness. Respectively, destinations that focus on the pillar of sustainability to increase their tourism competitiveness are called upon to develop at the same time the other three points of the "inputs" pillar. The importance of each pillar depends on a variety of factors, such as the main tourism markets of each destination, the situation of each destination, and the main comparative advantages of each destination. In conclusion, linking socio-economic benefits to the local economy and sustainable local resource management is vital to tourism competitiveness (Romao et al., 2017), although tourism development in one area affects tourism in another area through a spatial spillover effect (Ma et al., 2015).

In the second step, the calculation of the synthetic index DP_2 is done by equation 1, using in total 66 components based on the conceptual framework.

$$DP_2 = \sum_{i=1}^{n} \left\{ \left(\frac{d_{ij}}{\sigma_i} \right) \left(1 - R^2_{i,i-1,i-2,\ldots,1} \right) \right\} \quad (1)$$

where n is the number of components (variables), $d_{ij}=\left|x_{ij}-x_{*i}\right|; i=1,2,\dots n,; j=1,2,\dots,m$ is the absolute value of the difference between the value obtained by the component i in prefecture j (x_{ij}) and the minimum value of the variable i in all prefectures (x_{*i}), σ_i is the standard deviation of the variable i, $R^2_{i,i-1,i-2,\dots,1}$ is the determination coefficient of regression of x_i to x_{i-1}, x_{i-2}, …, x_1.

At the third step, to estimate the discriminant power of each variable, applying Ivanovic's Discrimination Coefficient (DC) using equation 2. The index takes values in the closed space 0 and 2. When all the values of Xi are equal, the weight of the variable is 0. When only Xi takes non-zero value in a prefecture and the remaining m-1 values are zero, the determinant coefficient takes the value 2 (Salinas Fernandez et al., 2020). It is an improvement in theoretical depth as parade information for the weight of each variable (Mazanec et al., 2007).

$$DC_i = \frac{2}{m(m-1)} \sum_{j,l>j}^{k_i} m_{ji}\, m_{li} \left| \frac{x_{ji} - x_{li}}{\bar{X}_\iota} \right| \tag{2}$$

where m is the number of Greek prefectures, x_{ji} is the value of X_i in prefecture j, and x_{li} is the minimum value taken by variable X_i in prefecture j, m_{ji} is the number of Greek prefectures where the value of X_i is x_{li}, X_{im} is the average of X_i and k_i is the number of different values taken by the X_i.

To find the total information provided by the components used to estimate the synthetic tourism competitiveness index, defined the Ivanovic-Pena Global Information Coefficient as a measurement that combines the Ivanovic Discrimination Coefficient and the Pena's correction factor (Coefficient Ivanovic Pena - CIP), as proposed by (Salinas Fernandez et al., 2020). The calculation of this index is derived from relation 3.

$$CIP = \sum_{i=1}^{n} DC_i \left(1 - R^2_{i,i-1,i-2,\dots,1}\right) \tag{3}$$

where n is the number of components, DC_i is the Ivanovic's Discrimination Coefficient, and $1 - R^2_{i,i-1,i-2,\dots,1}$ is the Pena's correction factor.

To estimate the effect of each component, each component is classified using the individual relative information coefficient, as defined in equation 4 by Zarzosa (Salinas Fernandez et al., 2020). This index takes values between 0 and 1, showing the relevance of each variable when measuring the tourism competitiveness of each prefecture.

$$a_\iota = \frac{DC_i\left(1 - R^2_{i,i-1,i-2,\dots,1}\right)}{CIP} \tag{4}$$

At the fourth step, the results of the tourism competitiveness index of each prefecture are compared with the arrivals of visitors and with the tourist seasonality of each prefecture. For the estimation of the tourist seasonality the RSI index was used, to find out that is a more suitable index related to Gini (Ferrante et al. 2018). This index was defined within the context of the transportation problem, formulated as the problem of minimizing the cost of eliminating seasonality by transferring units from high to low season periods (Lo Magno et al., 2017), and the mathematical expression is described as follows:

$$S_R\left(\mu, C\right) = \frac{\sum_{i\in A}\sum_{j\in B} c_{ij} x_{ij}}{\mu \cdot max_{i\in M}\left\{\sum_{j\in M} c_{ij}\right\}} \tag{5}$$

where x_i is the *i*-th observation of variable *x*, μ is the average value of the available observations, *c* is the total cost for eliminating seasonality, *A* is the set of high-season time periods, *B* is the set of low-season time periods, and *M* is the set of all possible observed time-patterns.

The results of the analysis and the overall approach are discussed at the sixth step of the study. This approach develops a tourism competitiveness index for each prefecture and the overall approach is expected to provide a tool of quantitative analysis useful for the regional policy and tourism management.

3. Results and discussion

For calculation of the indicators, given the difficulty for measuring the indexes, especially for the relation 2, due to its iteration, this study used the programming language R and the Package 'p2distance' in R Studio. Table A, in Appendix, shows 45 of the total 66 components (variables) examined, as these components have correction factors greater than 0%. The other 21 examined components have correction factors equal to 0% means that their information does not contribute to the synthetic index of tourism competitiveness. Additionally, this Table shows the individual relative information coefficient indicator "a", as used by Salinas Fernandez et al. (2020). From this indicator resulted that these 45 components represent 70% of the total information for the tourism competitiveness indicator.

Table 1 shows the significant correction factors, with values above 10%, which represent the new information that each variable contributes when integrated into the final tourism competitiveness index.

Table 1. The variables of the synthetic tourism competitiveness index with the highest values greater than 10% in the correction factors.

Variables	Absolute Correlation Coefficient - DP_2	Correction Factors
Monthly Average of visitors per sq. km.	0.8940	1.000
Restaurants per sq. km.	0.8702	0.189
Museums per 100 sq. km.	0.8164	0.331
Road Network Density	0.7563	0.184
Per Capita GDP	0.7230	0.479
Ports and Airports per sq. km.	0.7220	0.101
Archaeological Sites per sq.km.	0.6682	0.215
Education Index	0.6408	0.160
Sum of Cultural Resources Indices	0.6226	0.192
Prosperity Index	0.6036	0.212
Length of Sandy Beaches	0.5387	0.124
Dependent Reason	0.4951	0.108
Gross Fertility Rate	0.4494	0.150

The component "Monthly Average of visitors per sq. km." has the highest absolute correlation coefficient, and 100% of the information brought from this component is incorporated into the synthetic index of tourism competitiveness. This result is logical given that competitive destinations can attract more visitors. The components "Restaurants per sq. km.", "Museums per 100 sq. km.", "Road Network Density", "Ports and Airports per sq. km.", "Archaeological Sites per sq.km.", "Sum of Cultural Resources Indices", and "Length of Sandy Beaches" relate to the infrastructures of the destination. Even though they have a high absolute correlation coefficient, only the component "Museums per 100 sq. km." has a high correction factor as contributes 33,1% of new information not collected by previous variables. These results are following the results of similar studies in Greece (Tsiotas et al., 2021). The component "Per Capita GDP" has a high absolute correlation coefficient and correction factor greater than 47% showing that it's new information not collected by previous variables. It is a significant component that shows the economic situation of each destination. The last components, "Education Index", "Prosperity Index", "Dependent Reason", and "Gross Fertility Rate", show the social situation of the destination. As a result, infrastructure components, and economic and social components shape to a large extent the tourism competitiveness index for the Greek Prefectures.

Table 2 shows the discriminant power of components resulted from Table 1, using Ivanovic's discrimination coefficient, ranging from 0 to 2. The variables with the greatest discriminant power are related to the number of visitors, infrastructures, cultural and natural resources. The component "Monthly Average of visitors per sq. km." has the highest Ivanovic's discriminant coefficient (1.390), indicating that tourism is distributed unequally

among the Greek prefectures. This result is in line with other studies (Tsiotas et al., 2021). The components "Restaurants per sq. km.", "Museums per 100 sq. km.", "Ports and Airports per sq. km.", "Archaeological Sites per sq.km.", "Sum of Cultural Resources Indices" refers to general infrastructures and cultural resources of the destination having also high Ivanovic's discriminant coefficient (1.320, 1.000, 1.340, 1.090, 0.930).

Table 2. Ivanovic's discriminant coefficient and the contribution of individual relative information coefficient to the tourism competitiveness index.

Variables	Ivanovic's discriminant coefficient (DC)	Individual relative information coefficient (a)
Monthly Average of visitors per sq. km.	1.390	0.0207
Ports and Airports per sq. km.	1.340	0.0200
Restaurants per sq. km.	1.320	0.0197
Archaeological Sites per sq.km.	1.090	0.0163
Length of Sandy Beaches	1.040	0.0155
Museums per 100 sq. km.	1.000	0.0149
Sum of Cultural Resources Indices	0.930	0.0139
Prosperity Index	0.470	0.0070
Road Network Density	0.390	0.0058
Dependent Reason	0.280	0.0042
Per Capita GDP	0.220	0.0033
Gross Fertility Rate	0.170	0.0025
Education Index	0.160	0.0023

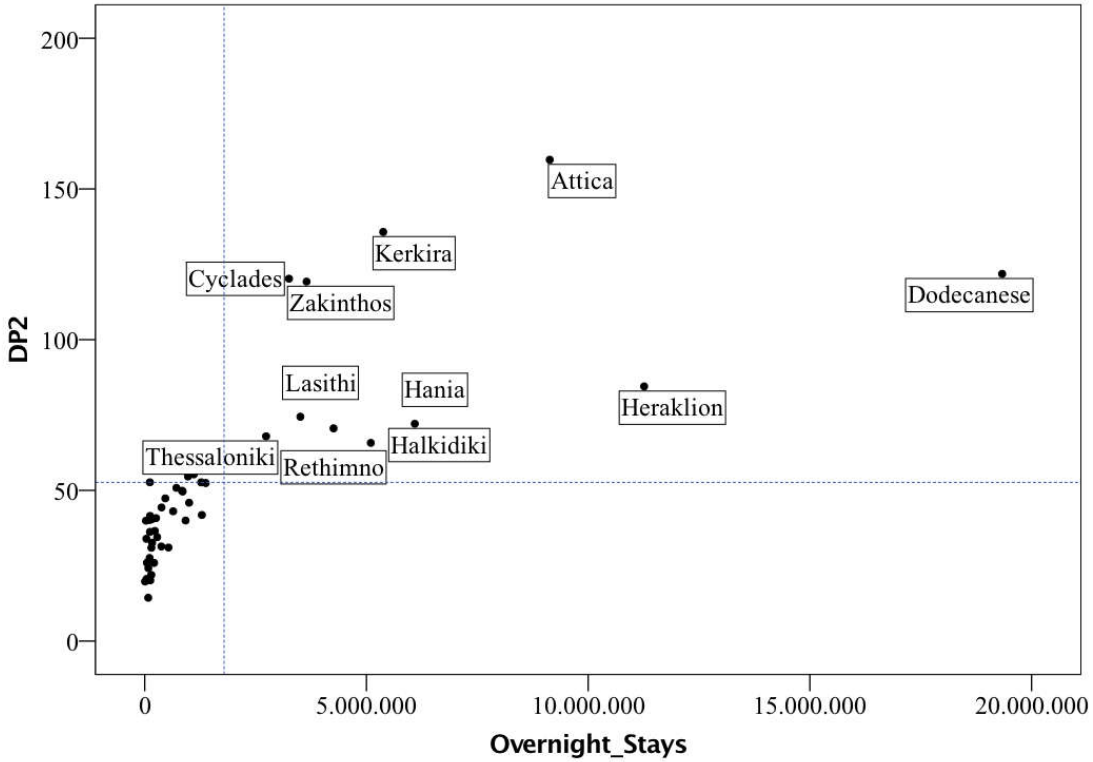
The component "Length of Sandy Beaches" represents the natural environment of the destination and has also a high value in Ivanovic's discriminant coefficient (1.040), showing the unequal distribution of Greek tourism in general. Sea is a major factor influencing tourism development in the country, given that the most representative tourism model is based on 3s (Polyzos, 2019). The other components "Road Network Density" (infrastructures), "Per Capita GDP" (economy), "Education index" (society), "Prosperity index" (society), "Dependent ratio" (society), and "Gross Fertility rate" (society), have significand values Ivanovic's discriminant coefficient (0.390, 0.220, 0.160, 0.470, 0.280 and 0.170), but lower than the other components.

The correction factors (Table 1, column 3) and Ivanovic's discriminant coefficient (Table 2, column 2) result in the significant information contributed from each component to the tourism competitiveness index. Table 2, column 3, shows this relative information coefficient indicator "a", which combines this information measuring the contribution in relative terms made by each component. In total, 13 components represent only 15% of the total information for the tourism competitiveness indicator. This result shows that despite the significance of these components, the rest of the components examined in this study include significant information. The components shown in Table A of the Appendix represent 70% of the total information for the tourism competitiveness indicator.

Table B of the Appendix shows the Greek prefectures sorted in descending order according to their tourism competitiveness index (DP_2), corresponding tourism seasonality indexes (RSI), and their total overnight stays for both categories of visitors (domestic and foreign). More specifically, the tourism competitiveness index (DP_2) shows the distance of a prefecture from a hypothetical prefecture in which all components have the minimum price and is not a tourism competitive prefecture (DP_2=0). The most tourism competitive prefecture is Attica (on which belongs the capital of Greece, Athens), followed by island prefectures (Kerkira, Dodecanese, Cyclades, Zakynthos, Heraklion, Lasithi, Hania, and Rethimno). These nine prefectures represent 72% of total overnight stays for the year 2018. As resulted from Figure 3, these prefectures additionally to the prefectures Thessaloniki and Halkidiki are the only prefectures with higher values than the average values, in both the tourism competitiveness index and the total overnight stays, for the year 2018. Most of the Greek

prefectures are in the first quadrant, where the values in the tourism competitiveness index and the total overnight stays for the year 2018 are lower than the national average.

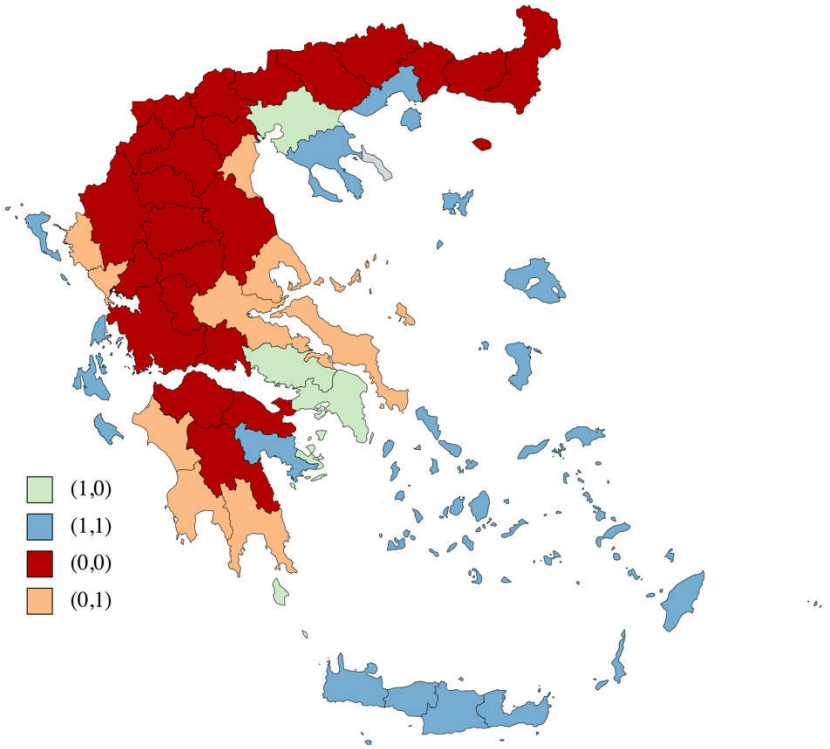
Figure 3. The prefectures with higher than the average values in tourism competitiveness index and total overnight stays, for the year of 2018.



As arises from Figure 3, there isn't a linear relationship between the tourism competitiveness index and overnight stays. A similar conclusion also emerged from the study of Perles-Ribas, et al. (2014), who used rank correlation to analyze the relationship among these variables. This observation is particularly important as it highlights that a destination with a higher tourist demand than another destination, is not necessarily a more competitive one. In Figure3, there is a group of the destinations of Lasithi, Hania, Thessaloniki, Rethimno, and Halkidiki, that even, in general lines, have a similar number of overnight stays with the group of the destinations of Kerkyra, Cyclades, and Zakinthos, their tourism competitiveness indexes are lower. The explanation arises from the variables that are applied for the quantification of tourism competitiveness., which, as shown in table A in the Appendix, are in an analog context (e.x. per sq. km., per 100 inhabitants).

Figure 4 shows the prefectures classified in four quadrants according to their values in the tourism competitiveness index (DP_2) and tourism seasonality (RSI) for the year 2018. The first group of prefectures (1,0) includes the prefectures that have higher than the average values in the tourism competitiveness index (DP_2) and lower than the country's average tourism seasonality (RSI) for the year 2018, showing that there is tourism potential. These prefectures are Attica, Thessaloniki, which includes the most populated cities of the country, and the prefecture of Voiotia. According to other studies, these prefectures have a high tourism saturation index (Krabokoukis et al., 2021), and except for Voiotia, they have a high tourism carrying capacity index (Krabokoukis and Polyzos, 2020).

Figure 4. The classified prefectures in four quarters according to their values in the tourism competitiveness index (DP_2) and tourism seasonality index (RSI), for the year 2018.



The second group (1,1) includes the most touristic destinations. They have higher than the average values in the tourism competitiveness index (DP_2) and higher tourism seasonality (RSI), for the year 2018. These prefectures are all the island prefectures (Kerkira, Dodecanese, Cyclades, Zakynthos, Heraklion, Lasithi, Hania, Rethimno, Kefalonia, Lefkada, Chios, Lesvos, Samos), while are also included three mainland prefectures (Halkidiki, Argolida, Kavala). These prefectures except Lefkada, and Chios, have high values in tourism saturation (Krabokoukis et al., 2021), and except Chios, Lesvos, and Kavala high values in tourism carrying capacity (Krabokoukis and Polyzos, 2020). As a result, there is a need for a different approach to the development policies of the prefectures of this category.

The third group (0,0) includes the prefectures with lower values than the average values in the tourism competitiveness index (DP_2) and tourism seasonality (RSI) for the year 2018. Most of them are in mainland Greece without instant access to the sea, which is the main factor for the tourism development in the country (Ioannina, Kozani, Florina, Imathia, Trikala, Kastoria, Kilkis, Karditsa, Grevena, Pella, Drama, Evritania), but there are also coastal prefectures in this group (Achaia, Korinthia, Arkadia, Larisa, Aitoloakarnania, Evros, Xanthi, Fokida, Arta, Rodopi, Serres). The fact that almost 45% of the Greek prefectures have lower than the average tourism competitiveness index, shows the great unequal tourism development of the country. Additionally, these prefectures have a low tourism carrying capacity index (Krabokoukis and Polyzos, 2020), and except the prefectures of Ioannina, Achaia, and Korinthia, have a low tourism saturation index (Krabokoukis et al., 2021).

The last category (0,1) shows the prefectures with lower values than the average values in the tourism competitiveness index (DP_2) and higher in tourism seasonality (RSI) for the year 2018. These prefectures are all coastal (Magnesia, Messinia, Lakonia, Evia, Preveza, Pieria, Thesprotia, Ilia, Fthiotida), but they are not tourism. These prefectures have also low tourism carrying capacity (Krabokoukis and Polyzos, 2020), and except Lakonia Preveza, Thesprotia have also high values in the tourism saturation index (Krabokoukis et al., 2021). As a result, showing that there is a need for the development of new tourism policies to become more competitive in the context of sustainability.

4. Conclusions

This paper provided a conceptual framework for the tourism competitiveness in Greek prefectures and the quantity of the concept. The proposed approach builds on the DP_2 index

with which it was possible to identify the components that participated most in the calculation of the index. As shown, components related to infostructures, economy, and society, shape to some extent the tourism competitiveness index for the Greek Prefectures. The analysis resulted in four groups according to their values in the tourism competitiveness index (DP_2), and tourism seasonality (RSI). In particular, the first group (1,0), including the most populated prefectures (Attica and Thessaloniki), and the prefecture of Voiotia which borders the prefecture of Attica, had higher than the average values in the tourism competitiveness index (DP_2), and lower in tourism seasonality (RSI), showing a dynamic. Additionally, these groups have high indexes in tourism saturation and tourism carrying capacity, showing that despite their tourism competitiveness new tourism models are needed to be applied. The second group (1,1) includes the most touristic destinations. These prefectures have higher than the average values in both examined variables (DP_2 and RSI), but additionally in variables tourism saturation and tourism carrying capacity. To continue to be tourism competitive prefecture new tourism approaches, more sustainable, are needed. The third group (0,0) has lower than the average values in both examined variables (DP_2 and RSI), and additionally in tourism saturation and tourism carrying capacity. Includes the 45% of the Greek prefectures, showed the unequal tourism development of the country, and the difficulties to develop tourism models away from the sea. The last group (0,1) includes coastal mainland prefectures that are not so competitive in the tourism sector but have high values in tourism seasonality. Additionally, they have high values in tourism saturation and low values in tourism carrying capacity. The overall analysis can propose a useful tool for tourism management and regional policy, as these are complex concepts, and points out that a destination with a higher tourism demand than another destination, is not necessarily more tourism competitive. The proposed method advances the DP_2 index to be used as a quantitative measure of tourism competitiveness and compares the results with tourism seasonality.

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6. Appendix

Table A. The 45 of total 66 used variables, sorted in descending order according to their correction factor index and their corresponding values in the Individual relative information coefficient (a)

Components	Correction Factors	a	Source
Monthly Average Visitors per sq. km.	1.0000	0.0207	Hellenic Statistical Authority
Per Capita GDP	0.4790	0.0033	Hellenic Statistical Authority
Museums per 100 sq. km.	0.3309	0.0149	Hellenic Statistical Authority
Archaeological Sites per sq. km.	0.2147	0.0163	Hellenic Statistical Authority

Components	Correction Factors	a	Source
Prosperity Index	0.2120	0.0070	Polyzos, 2019
Sum of Cultural Resources Indices	0.1918	0.0139	Polyzos, 2019
Restaurants per sq. km.	0.1892	0.0197	Hellenic Statistical Authority
Road Network Density	0.1841	0.0058	Hellenic Statistical Authority
Education Index	0.1597	0.0023	Polyzos, 2019
Gross Fertility Rate	0.1503	0.0025	own elaboration
Length of Sandy Beaches	0.1237	0.0155	Hellenic Statistical Authority
Dependent Ratio	0.1083	0.0042	own elaboration
Ports and Airports per sq. km.	0.1006	0.0200	Institute of SETE-INSETE
Average of all Location Quotients Indicators	0.0942	0.0017	own elaboration
Ancient Monuments	0.0926	0.0134	Hellenic Statistical Authority
Visitors per inhabitant	0.0824	0.0174	Hellenic Statistical Authority
Number of Organized Beaches	0.0810	0.0198	Hellenic Statistical Authority
Ski resorts	0.0768	0.0218	Hellenic Statistical Authority
5-star Hotel Beds per inhabitant	0.0684	0.0244	Institute of SETE-INSETE
Productive Dynamics Index	0.0679	0.0052	Polyzos, 2019
Tourism Industry Specialization Index (sector 4)	0.0613	0.0071	own elaboration
Listed Restaurants on Tripadvisor per sq. km.	0.0505	0.0194	TripAdvisor
Listed Activities on Tripadvisor per sq. km.	0.0503	0.0218	TripAdvisor
Occupancy Rate	0.0448	0.0059	Hellenic Statistical Authority
Labor Productivity of the Tourism Sector	0.0401	0.0048	own elaboration
Accommodation and Catering companies per sq. km.	0.0365	0.0160	Institute of SETE-INSETE
Woodland	0.0335	0.0122	Hellenic Statistical Authority
Average Annual Tourist Employment Index	0.0314	0.0085	own elaboration
Attractiveness Index	0.0286	0.0209	Krabokoukis and Polyzos, 2020
Indirect Potential	0.0282	0.0066	Polyzos, 2019
Hotel Beds per sq. km.	0.0258	0.0216	Institute of SETE-INSETE
Number of Blue Flags	0.0232	0.0194	Blue Flag
Camping places per sq. km.	0.0195	0.0245	Institute of SETE-INSETE
Hotel Beds per 100 inhabitants	0.0178	0.0191	Institute of SETE-INSETE
Indigenous Tourist Penetration Index	0.0162	0.0109	own elaboration
Tourist Intensity Index	0.0156	0.0167	own elaboration
Visitors per sq. km during the high season	0.0150	0.0216	own elaboration
Wholesale and Retail Trade Companies per sq. km.	0.0121	0.0151	Hellenic Statistical Authority
Length of Coasts	0.0112	0.0189	Hellenic Statistical Authority
Human resources	0.0100	0.0176	Polyzos, 2019
Foreigners Tourist Penetration Index	0.0092	0.0229	own elaboration
Total Beds per sq. km.	0.0067	0.0214	Institute of SETE-INSETE
5-star Hotel Beds per sq. km.	0.0051	0.0235	Institute of SETE-INSETE
Hospital Beds per 100 sq. km.	0.0033	0.0169	Institute of SETE-INSETE

Components	Correction Factors	a	Source
Overnight Index	0.0032	0.0209	own elaboration
Total Beds per 100 inhabitants	0.0007	0.0194	Institute of SETE-INSETE
Doctors per 1000 inhabitants	0.0003	0.0056	Hellenic Statistical Authority
UNESCO Monuments	0.0000	0.0244	Hellenic Statistical Authority
Tourist Accommodation Potential Index	0.0000	0.0214	own elaboration
National Parks	0.0000	0.0254	Hellenic Statistical Authority
Water Resources	0.0000	0.0151	Hellenic Statistical Authority
Number of Blue Flags per Organized Beach	0.0000	0.0292	own elaboration
Beds in Rooms to Let per 100 inhabitants	0.0000	0.0210	Institute of SETE-INSETE
Beds in Rooms to Let per sq. km.	0.0000	0.0220	Institute of SETE-INSETE
Camping places per 100 inhabitants	0.0000	0.0206	Institute of SETE-INSETE
Mountain activities	0.0000	0.0157	Hellenic Statistical Authority
Mountain Routes	0.0000	0.0168	Hellenic Statistical Authority
Rafting points	0.0000	0.0262	TripAdvisor
Canyoning points	0.0000	0.0251	Hellenic Statistical Authority
Length of skiing routes	0.0000	0.0244	Hellenic Statistical Authority
Saturation Index	0.0000	0.0008	Krabokoukis et al., 2021
Tourism Operation Index	0.0000	0.0193	own elaboration
Visitors per sq. km during the low season	0.0000	0.0186	own elaboration
Total Potential	0.0000	0.0081	Polyzos, 2019
Exports to GDP	0.0000	0.0157	Polyzos, 2019
Exports to Imports	0.0000	0.0151	Polyzos, 2019

Table B. Greek prefectures sorted in descending order according to their tourism competitiveness index (DP_2) and corresponding tourism seasonality indexes (RSI) and total overnight stays, for both categories of visitors (domestic and foreign).

Prefecture	DP_2	Total RSI 2018	Total Overnight stays 2018
Attica	159.683	0.1815	9,132,778
Kerkira	135.734	0.5635	5,378,036
Dodecanese	121.819	0.5499	19,335,953
Cyclades	120.239	0.5807	3,253,224
Zakynthos	119.259	0.5990	3,649,380
Heraklion	84.482	0.5062	11,262,869
Lasithi	74.425	0.5393	3,509,508
Hania	72.100	0.5258	6,089,434
Rethimno	70.588	0.4925	4,258,102
Thessaloniki	67.945	0.0942	2,736,541
Halkidiki	65.747	0.5913	5,098,659
Kefalonia	63.740	0.6166	945,669
Lefkada	62.928	0.6255	364,363
Hios	58.801	0.3454	156,246
Lesvos	56.948	0.5336	706,798

Prefecture	DP_2	Total RSI 2018	Total Overnight stays 2018
Argolida	55.296	0.4533	1,108,308
Samos	54.622	0.5562	974,165
Voiotia	52.666	0.0531	115,137
Kavala	52.664	0.5607	1,271,909
Magnesia	52.440	0.4465	1,375,651
Achaia	50.832	0.2766	713,425
Korinthia	49.872	0.3193	842,066
Messinia	49.632	0.4727	854,151
Lakonia	47.338	0.4440	464,096
Evia	45.892	0.4768	1,001,323
Preveza	44.336	0.5753	378,484
Ioannina	43.056	0.0461	640,467
Pieria	41.836	0.5630	1,287,624
Arkadia	41.542	0.1405	121,529
Larisa	40.795	0.1288	255,116
Thesprotia	40.417	0.5202	157,383
Kozani	40.183	0.0483	107,167
Ilia	39.998	0.4973	921,843
Florina	39.953	0.0543	27,484
Fthiotida	36.528	0.3260	228,048
Imathia	36.218	0.1060	115,797
Aitoloakarnania	34.479	0.2194	280,272
Evros	33.937	0.2732	368,12
Xanthi	32.632	0.0592	167,553
Fokida	31.397	0.2623	374,649
Trikala	31.044	0.1099	535,133
Kastoria	30.947	0.0908	149,828
Pella	27.569	0.0933	110,072
Arta	25.984	0.1408	48,579
Rodopi	25.929	0.2058	212,404
Drama	24.175	0.1530	81,822
Serres	21.950	0.0473	148,052
Kilkis	20.608	0.1458	41,964
Karditsa	20.142	0.0524	124,821
Grevena	19.762	0.1214	8,772
Evritania	14.367	0.1411	78,663

ARE THE REGIONS WITH MORE GENDER EQUALITY THE MORE RESILIENT ONES? AN ANALYSIS OF THE ITALIAN REGIONS

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Abstract

The paper aims to investigate the relationship between gender equality and regional resilience. Literature, primarily regional literature, has shown limited interest in gender. Nevertheless, females and males are employed in different industries, so when a shock hits, it can have a different employment impact in terms of gender and, consequently, in terms of resilience. Regions are specialized in some industries. Regional specialization results from historical, cultural, natural endowments, and social elements. Also, the uneven distribution between females and males within industries involves social, cultural, and economic components. As a result, regional specialization determines an employment distribution that can be unequal regarding gender. This employment distribution is captured by the Dissimilarity Index, which measures the sum of the absolute difference in females' and males' distribution over occupations. Therefore, the dissimilarity index emerges as a consequence of regional specialization. This dissimilarity, in turn, could have an impact on resilience. Our results put several significant results forwards. First, there is a relationship between gender segregation and regional specialization. The higher the regional specialization in sectors where the females' share is low, the higher the dissimilarity. Second, there was a positive relationship between resilience and gender equality from 2008 to 2013. The more gender equality regions are also the more resilient ones. Taking a sectoral occupation is not easy, including social values, cultural components, welfare, education, and soft skill. Policies should also address their efforts to enhance the welfare and social dimensions and break gender stereotypes.

Keywords: Gender, Regional specialization, Dissimilarity, Resilience, Italy
JEL classification: R10, R11, R19, O18

1. Introduction

Resilience is a keyword in European economic policy. Nevertheless, resilience is not a new concept: it summarizes the capacity of a territory to be shock-absorber and to trigger a phase of fast recovery after the shock. Starting from the pioneering Holling's contribution (1973), it has received a growing interest in various fields and has become a buzzword after the 2007 economic shock, especially in the Evolutionary Economic Geography (EEG) field. This approach rejects neo-classical inspired notions of adjustment mechanisms towards any notion of equilibrium. Instead, they understand the economic landscape as a complex adaptive system that can never be in equilibrium (Dawley et al., 2010). This rejection of equilibrium in the EEG approach is based on the economy's ability to *self-transform from within* (Witt, as cited in Boschma & Martin, 2010).

Following Martin (2012), regional economic resilience can be defined as "the capacity of a regional economy to reconfigure, that is adapt, its structure (firms, industries, technologies, and institutions) to maintain an acceptable growth path in output, employment, and wealth over time" (Martin 2012 p.14). The adaptive capacity of a region's economy will depend on the region's pre-existing industrial tissue, regional resources, skills, and capabilities. In this context, resilience emerges as a conceptual framework in which the observation unit (community, city, region, and nation) can be represented dynamically and holistically in

which social-ecological and economic components are interrelated. Starting from the Cambridge Journal contributions (2010) and Martin's contribution, a growing body of literature in EEG explores the regional resilience determinants using the Martin resilience index as the dependent variable. Most of the contributions focalized attention on the resilience regional determinants highlighting that sectoral composition and human and social capital are essential for resilience (Cuadrado-Roura and Maroto, 2016; Di Caro, 2015; Di Caro, 2017; Diodato and Weterings, 2015).

Hence, the critical variables in such an approach are sectoral composition and human capital, as they are responsible for knowledge diffusion in the global and local economies. The measurement of industrial composition in literature exploits several approaches, from measures of industrial concentration (as the Hirfendal index used by van Egeraat et al. (2018), Dauth et al. (2018), Neffke et al. (2011)) to more refined measures of composition, like the Local Quotient index (Fan and Scott, 2003; Martini, 2020; Davies and Maré, 2021), and the measures or related and unrelated variety (Frenken et al., 2007, Castaldi et al., 2015; Fritsch and Kublina, 2018). However, a red thread links these contributions: investigating which form of industrial composition fosters knowledge diffusion through externalities effects (from the MAR to the Jacob spillover). The latter remains the engine of a territory's resilience and recovery capacity, and, in this light, the interrelationship between industrial composition and human capital must be seen (Alexiadis, 2020). Firms are not islands, and ideas can not be confined: the local and cognitive proximity of firms and workers in a territory produces a continuous exchange of ideas, organizations, skills, and capabilities.

Moreover, the literature shows that these external effects are stronger when firms and workers share a certain degree of relatedness in production. Nevertheless, the literature treats workers as a homogenous and anonymous body, irrespective of their cultural, social, and economic background and, for our scope, gender. However, the literature shows that gender matters in the cognitive process (Sastre, 2015; Østergaard et al., 2011; Jackson et al., 1995; O'Reilly and Spee, 1997; Xie et al., 2020; Williams and O'Relly, 1988), and workers cannot be treated as an anonymous body. The focus on the gender dimension opens new questions that we want to fill. If the industrial composition matters for knowledge diffusion and if the latter is affected by a gender question, then we have to add these dimensions to the question.

There is extensive literature on the low female participation in the workforce; for several reasons, spanning from a cultural and social context (even inside firms) to female's human capital choice until to the welfare policies helping female workers take care of offspring.

In this paper, we want to investigate these dimensions affecting knowledge transmission, hence the territory's resilience. We focus on Italy for several reasons: in Italy, female workers are confined to a few sectors (gender discrimination), their social and cultural background is particularly binding, and there is a general lack of a welfare system. What is intriguing is that such determinants are not homogenous and are not evenly distributed in the Italian territories: in southern regions, the social, cultural, and productive structure context is particularly discouraging. Moreover, for historical reasons, in northern regions, female workers are more confined to a few industry sectors (textile, wholesale and retail trade, low human capital activities), while female workers are more concentrated in the education sector in the southern regions. Furthermore, the complexity of the gender gap makes an international comparison very hard, as cultural, social, and institutional contexts matter and are very heterogeneous. For example, in Scandinavian countries caring for children, the disabled, and the elderly has been taken over by the public sector, while in some other countries, such as Italy, those activities represent unpaid women's jobs. Those social dimensions can have an impact on the regional resilience process.

Few studies consider gender-related or associated with economic resilience (Renschler et al., 2010; Augustine et al., 2013; Chacon-Hurtado et al. 2020; Wang and Wei, 2021). Despite this, the relationship between gender equality and resilience is still unexplored, particularly with its relationship with industrial composition and knowledge diffusion.

We base our contribution on the conceptual framework of Evolutionary Economic Geography. EEG aims to understand why industries concentrate in space, how networks evolve in space and why some regions grow more than others (Frenken and Boschma, 2015). Proximities play a central role in understanding interactive learning and innovation (Boschma

2005). These proximities influence the diffusion of knowledge and, consequently, innovation and growth.

Gender differences can impact skill-relatedness connectivity, proximities, the diffusion process of knowledge, and consequently, the territory's capacity to be resilient and recover a growth path after a shock. However, these relationships are still neglected in the literature.

As previously discussed, several approaches in the literature measure regional specialization. However, these theories are developed by hypothesizing that social and cultural beliefs are unimportant. Regional specialization is not only the result of productivity and endowments but also depends on regional-specific components such as history, traditions, cultural beliefs, and social values. Following this, the regional sector specialization can be considered the result of several interrelated components influencing each other. Regions with the same productivity and endowments can have different regional specializations. The index summarizing local specialization is the Location Quotient (LQ) -the ratio between the share of regional employment in one sector and the share of employment in that same sector in the reference economy (https://ec.europa.eu/eurostat)-.

The idea that gender matters for growth is not new by itself. The literature dating back to Boserup (1970) has emphasized the positive effects of gender equality on development (Cubers and Teignier, 2014). Nevertheless, a small body of literature finds positive aspects of having a sizeable gender gap (Seguino, 2000). All those studies do not consider the role played by regional specialization. Different industries have different gender compositions. In Italy, gender differences are evident between various industries and regions in the same industry. This uneven distribution can be due to education, cultural components, social values, welfare systems, and beliefs. Substantial reductions in gender segregation will require more extensive measures, including changes in the content and organization of work in traditionally male -and female-dominated areas and changes in young women's and men's choice of education very early in life. Regional sectoral composition emerges from regional productivity, regional endowments, and regional-specific components. We do not explain how these cultural and social dimensions affect regional specialization (it is out of our aim). Considering regional specialization as given and inherited from the past, the relationship between dissimilarity index -ID- (Ducan and Ducan 1955) and regional specialization will be analyzed to investigate if and how the latter impacts on the dissimilarity using several stylized facts emerging from the data investigation.

Our contribution aims to answer the following research question: Does a more gender-equal regional specialization make territories more resilient? Our analysis will focus on Italian regions. Italian regions share the same national roles in terms of welfare but strongly differ in history, cultural beliefs, social values, and regional sectoral composition. Those differences are particularly evident between the Northern and the Southern regions, and a by-product of our analysis is to provide some new clues to the old debate about the North-South divide in Italy.

Concerning results, the analysis of LQ decomposed by gender shows a relationship between gender distribution (segregation) and regional specialization. It leads to an expected result: the higher the regional specialization in sectors where the females' share is low, the higher the gender gap is measured by the dissimilarity index. Therefore, a ri-equilibrium in gender between sectors is desirable to reduce the dissimilarity; we wonder if such rebalancing fosters the resilience of territories. We find that there is a positive relationship between resilience and gender equality. The more gender equality regions are also the more resilient ones. Creating a resilient place means also creating more inclusive sites and vice versa.

We structure our contribution as follows. Section 2 will present the literature review to delimitate our theoretical background and address the research questions. Section 3 shows the stylized facts emerging from the data investigation. Section 3.1 underlines the relationship between the actual regional specialization and the gender distribution among territories and sub-groups (industries), while section 3.2 is the relationship between gender and resilience. Section 4 provides the empirical investigation to section 3; it presents two empirical models; the first is devoted to analyzing if and how regional specialization affects gender segregation (measured by the dissimilarity index ID). The second one uses the fitted value of the previous model (to depurate the ID from the component explained by the regional specialization) as a

covariate of a probit model whose dependence is the probability of being resilient or not. Finally, conclusions, discuss policies and research implications related to our findings.

2. Literature review

Following the definition provided by the World Health Organization, gender is used to describe the characteristics of women and men that are socially constructed. At the same time, sex refers to those that are biologically determined. For example, people are born female or male but learn to be girls and boys who grow into women and men. This learned behaviour makes up gender identity and determines gender roles (https://www.euro.who.int/en/health-topics). Following this definition, gender is a cultural category related to the complex social construction of sexual identities, hierarchies, and interactions (Becchio, 2018).

The analysis's first economic contributions included gender (Aigner and Cain, 1977; Becker, 1985) focused on the different participation rates in the labor market for females and males and the gender pay gap (Abbot and Beach 1994; Altonji and Blank 1999). The first micro-founded model was developed by Hakim (2000), in which the author uses the preference to explain females' behavior and choices between employment and family work. At the outset of this pioneering contribution, a growing body of economic literature aims to investigate the different behavior of females and males in the job market and their consequences on gender segregation (Eige (https://eige.europa.eu) defines gender segregation as "Differences in patterns of representation of women and men in the labor market, public and political life, unpaid domestic work and caring, and young women's and men's choice of education"). Gender segregation, actual dominance of one sex in a particular occupation or the higher share of one sex relative to the expected share, can be horizontal such as vertical. However, the first is generally pictured as women and men's disparate concentration across industries and occupations (Duran, 2019, Lyberaki et al., 2017).

In contrast, the second refers to gender disparities in positions and roles with different statuses or potential employment advancement. The unequal distribution of females and males between industries means that an increase of females in the labor market will not be equally distributed between industries. As a result, females are more likely to fall in some industries than others. Employment segregation significantly affects economic growth, household welfare, firm performance, and intergenerational social mobility. Efforts to reduce employment segregation can create a virtuous cycle in which increased female participation in high-return occupations creates more extensive networks of women and changes social norms (Das and Kotikula; 2018). Female participation in the job market is conditioned by national institutions such as welfare regimes, social policies, employment protection legislation (Hall et al., 2019), and cultural norms (Alesina et al., 2011). The evolution of production structure, the de-specialization process taking place in Italy since 1995 (Martini 2020), has increased the service share and, consequently, the females' employment in service sectors (Olivetti and Petrongolo 2016; Petrongolo and Ronchi 2020). Addressing employment segregation is central to reducing the gender wage gap, improving job quality and earnings, and increasing female labor force participation. Policies aim to increase female participation in the labor market, and those aimed at re-skilling the workforce play a central role in responding to crises and contributing to the country's growth process.

2.1. From regional specialization to gender segregation

Although gender acquired an increasing interest in economic literature, the theme is still neglected in regional science, and the contributions are limited (Hirschler 2010; Pavlyuk 2011; Noback et al., 2013; Ray et al., 2017; Martini 2021; Correia and Alves, 2017). In particular the role played by regional specialization. As discussed during the introduction, regional specialization is not only the result of productivity and endowments but also depends on regional-specific components such as history, traditions, cultural beliefs, and social values. The stylized fact analysis highlighted that men and women are not employed in the same sub-groups. This uneven distribution is also due to cultural, historical, social, and welfare components. Among them, women receive different education, for instance, they prefer more humanistic topics rather than being involved in STEM fields.

Furthermore, in Italy, especially in the Southern regions, there are still some gender stereotypes and culturally biased regarding which women should be preferably employed in education rather than industry. Moreover, women are still involved in unpaid work, such as caring for children, the disabled, and the elderly. Those social components influence regional specialization. The latter can impact, in turn, gender segregation.

We aim to investigate if and how regional specialization affects gender segregation by merging three strands of literature. The first one regards regional specialization, the second concerning gender segregation, and the third about resilience. To our knowledge, this is the first contribution to exploring this topic. The relationship between regional specialization and resilience has been explored, among the others, by Martini (2020), who highlighted that do not exist a mix of specialization and regional-specific factors able to ensure resilience. The ability to resist the shock or recover after the shock- known in literature with the term resilience- will depend on a mix of regional attributes that vary from shock to shock. The relationship between gender and resilience has been neglected by literature. The few available studies (McKay et al. 2013; Duvvury and Finn 2014) have highlighted that male workers suffered the most significant impact in terms of job losses in the initial phases of the recession in the UK.

Nevertheless, immediately after the initial phase, the situation reversed. This difference finds its roots in how the Government faced the crisis. To reduce the deficit, Governments decided to cut welfare and public services. However, due to the unequal distribution of care between females and males, these cuts have inevitably penalized females (Seguino, 2009). Similar results are found by Ray et al., (2017) for Canada, which analyzed the resilience in terms of gender, highlighting that females and males experienced a different degree of resilience after the 2007 economic shock. This phenomenon, known as *mancession* - unemployment trends in the early stages of the recession seem to affect males more than females- can be due to a gender effect, but it can be imputable to the different shares of females and males between industries (Banerjee, 2010). Boshma (2005) pointed out that regional resilience depends on the sectoral composition. If the shock hits a sector where the females' share is higher than the males', more females will lose their job. The "mancession" incurred during the 2007 economic shock is contrasted by a *shecession* experienced after the Covid-19 shock, during which the hours worked by females' decreased while the males' hours worked remained unchanged (Alon et al., 2021). This phenomenon is also related to sectors, welfare and care. During the Covid-19 shock, many workers accomplished working at home. However, females found more difficulties working at home due to the time spent in care and house duties. Furthermore, schools were closed, and children were at home. As a result, females were less productive than males (Lyttelton et al., 2020).

Scholars do not pay much attention to the relationship between regional specialization and gender. However, the relationship between labor growth and specialization has been explored by Martini (2021), highlighting that increasing females' employment in sectors where females are already segregated is less effective than increasing females' employment in sectors where females are less segregated. Furthermore, the results of Mussida and Pastore (2015) for Italy highlighted that the regional gap in turnover rate is mainly due to differences in the gender of the workforce because females have more temporary jobs (Polavieja 2012).

Literature explored the complex relationship between gender and resilience from several points of view. Le Masson and Lovell (2016) explores the relationship between resilience, natural disaster, and climate change, while Bakas (2015) focuses on the relationship between community resilience and entrepreneurship. The journal Gender and Development 2015 made a special issue titled Gender and Resilience. The conclusion is that the concept of resilience needs to take into consideration also gender. Finally, Papageorgiou and Petousi (2018) empirically investigated the relationship between economic resilience and gender after the 2007 economic shock in Greece.

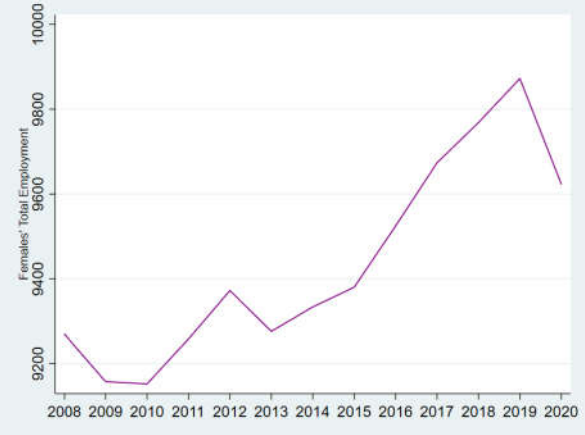
The literature shows a complex relationship between specialization, gender, and resilience that encompasses several cultural and economic dimensions. To address this multi-dimensionality in a single contribution is not feasible. For this reason, we start from the given regional specialization, measured by LQ index decomposed by gender to investigate the effects on the resilience process.

3. 3. Stylised facts

Our analysis focuses on Italian regions for the period 2008-2020 and aims to explore the labor market characteristics in terms of females and males. Data comes from the National Institute for Statistics (Istat); unfortunately, no data are available before 2008. Females and males display differences in employment growth, as depicted in Figure 1.

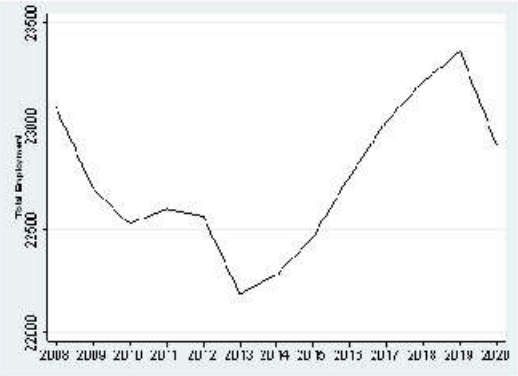
Figure 1: Employment growth Total, Females, and Males at the national level

Females' Total Employment



Males' Total Employment

Total Employment

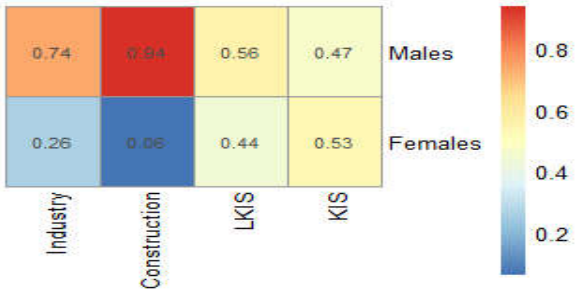


Source: ISTAT

Males' employment decreased during 2008-2013 while females' employment decreased during 2008-2010, followed by recovery during 2010-2012, a new decrease during 2012-2013, and a further recovery starting from 2013. Starting from 2013, females and males display the same employment trend. Consequently, females and males reacted differently to the shock. To investigate the reasons behind this different reaction, we will focus on the distribution of females and males between industries in Italy using data provided by ISTAT for 2008-2020 (the only period available). Due to the data availability, industries will be grouped into four sub-groups: Industry, Construction, Less Knowledge Intensive Services

(LKIS), and Knowledge-Intensive Services (KIS), as shown in Appendix. Figure 2 displays the females/males' share in each sub-group.

Figure 2: Females and Males' share by sub-groups at national level (average 2008-2020)



Source: our elaboration

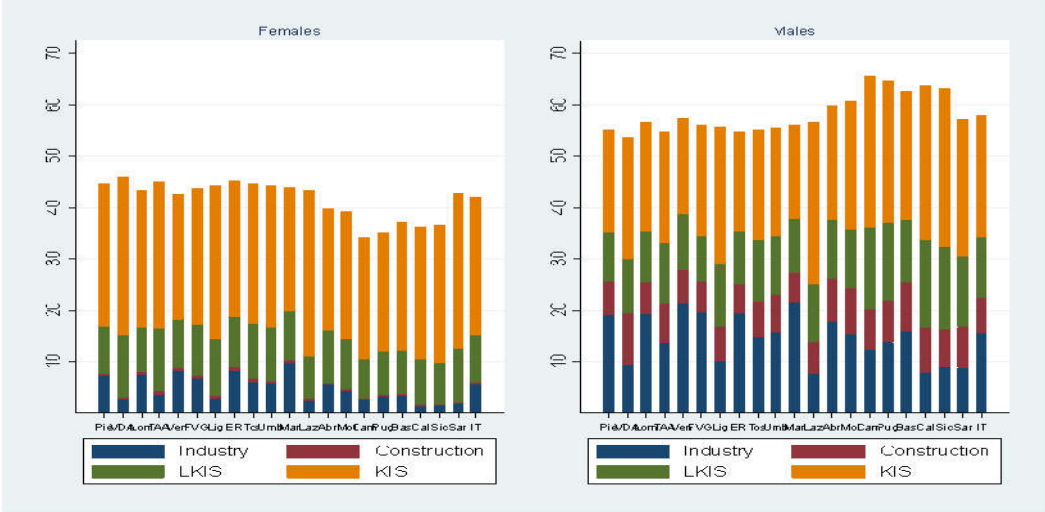
Figure 2 highlights the uneven distribution of females and males between sub-groups. For example, females have the highest share in the KIS sub-group, while the lowest share is construction (6%). It is well known that the 2007 economic shock mainly hit the industry and construction industries where the females' share is low. Consequently, females' employment was less hit by the shock than males' employment.

The uneven distribution between gender is known in the literature as gender segregation. Several indexes capture gender segregation (Emerek et al., 2003). Among them, the index of dissimilarity (ID) proposed by Duncan and Duncan (1955) measures the sum of the absolute difference in females and males' distribution over occupations:

$$ID = \frac{1}{2}\sum_i \left|\frac{M_i}{M} - \frac{F_i}{F}\right| \quad [1]$$

where M represents the total number of males in employment, M_i is the number of males in sub-group *i,* F is the total number of females in employment, F_i is the number of females in sub-group *i*. The ID index is equal to 0 in the case of complete equality (where females' employment is distributed similarly to males across occupations) and is equal to 1 in the case of *complete dissimilarity* (where females and males are in totally different occupational groups). Figure 3 displays the regional share of females/males' employment on the total employment in each sub-group (the regional map is in Appendix, figure A1).

Figure 3: Regional shares by gender. Regional females/males' employment in each sub-groups on the total employment.



Source: our elaboration

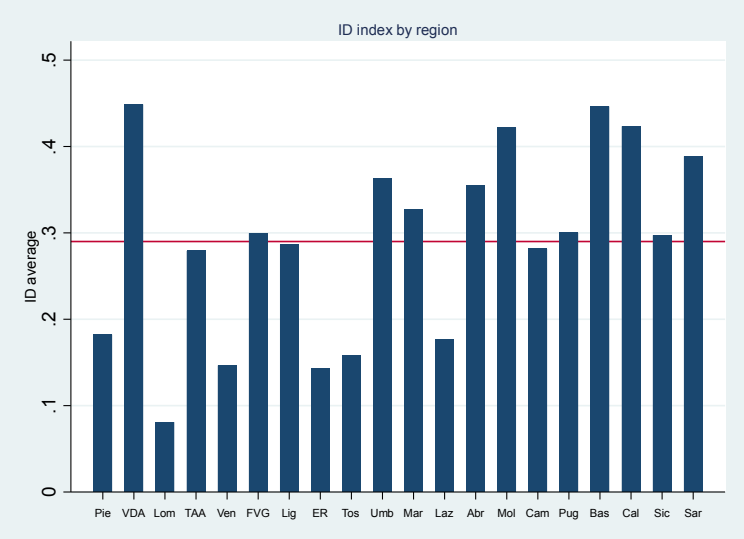
As depicted in Figure 3, females' employment differs between sub-groups and by region. Marche (a well-known district for shoes), for instance, has the highest share of females in the industry (9.73%), while Calabria displays the lowest share (1.32%).

Regional differences are evident, and they cannot be imputable only to the regional structure but also to social and cultural components. The shape of the employment

distribution is the observable part of significant, hidden, and unmeasurable interrelationships among social, historical, and cultural interplay.

Figure 4 displays the ID index as the average of the periods 2008-2020 by region. The red line represents the national ID index obtained as the average of the regional ID index. Figure 4 highlights differences between regions in terms of ID in Italy. Some regions, such as Lombardia, Emilia-Romagna, Veneto, and Toscana, are more gender-equal, while others such as Molise, Basilicata, Calabria, Sardegna, and Valle d'Aosta display greater gender discrimination. Moreover, except for Valle d'Aosta, the unequal regions are localized in the south of Italy (Appendix, figure A1).

Figure 4: ID index as average of the periods 2008-2020 by region



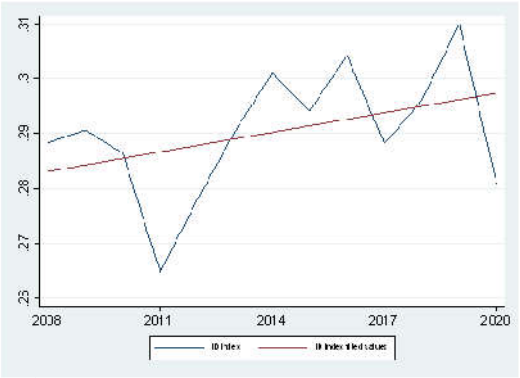
Source: Our elaboration

By comparing Figures 3 and 4, female workers are mainly employed in KIS and LKIS sub-groups but with important regional differences. Once again, southern regions employ a relatively lower share of women in these sectors than the northern ones. Hence, not only the gender gap is a matter of regional specialization but also a geographical one (Cutrini and Valentini, 2017). The well-known North-South divide regards not only the regional GDP, but it is evident also in terms of gender segregation.

Social and historical components drive the results. From the historical point of view, females have been employed in textile, starting from Middle Ages. Furthermore, they were educated in art and literature since Renaissance. Consequently, females are more concentrated in service sectors than industry sector. Moreover, due to the unpaid job (childcare, housecare), typically done by women, they preferred to be involved in work with more flexible hours (such as teaching). Finally, following the patriarchal roles firmly rooted in the southern regions, females typically do not work in the industry and, in general, are characterized by lower labor market participation.

If we look at the time series of the national ID index (Figure 5), we see that it is increasing after the 2007 economic shock. As a result, segregation between gender increased, and consequently, females became more segregated. Nevertheless, two turning points are evident in Figure 5 in 2011 and 2014. From 2008 to 2011, the ID index decreased, while from 2011 to 2014, it increased. From 2014 onwards, the ID index highlights a fluctuating trend.

Figure 5: ID index at the national level during the period 2008-2020



Source: our elaboration

This trend can be explained by looking at the labor growth rate by sub-groups, as depicted in Figure 6, which highlights that females' and males' labor growth during 2008-2013 have different growth rates but the same trend while, after 2013, by contrast, they have different growth rates and trends because females' labor growth rate is countercyclical to males' employment growth rate. Therefore, those other trends reflect in the ID index.

Figure 6: Labour growth by gender and sub-groups

Source: Our elaboration

3.1. From regional specialization to gender segregation

As discussed during the introduction, regional specialization is the result of productivity and endowments and depends on regional-specific components such as history, traditions, cultural beliefs, and social values. The stylized fact analysis highlighted that females and males are not employed in the same sub-groups. Moreover, this uneven distribution differs by region. Therefore, our first aim is to explore the relationship between regional specialization and gender segregation.

To measure regional specialization, we will use the Location Quotient (LQ):

$$LQ_i = \frac{\frac{e_{ij}}{E_j}}{\frac{E_i}{E}} \qquad [2]$$

where i is the sub-group and j the region, e_{ij} represents the employment in sub-group i in region j, E_j is the total employment in region j, E_i is the employment at the national level in sub-group i, and E is the employment at the national level. LQ>1 means that the region is specialized in each sub-group. The Location Quotient does not consider gender. A region can be more specialized than the nation in a given sub-group due to a high number of employees, but those employees can belong all to the same gender. The total LQ in Eq.2 will be decomposed in:

$$LQ_{ij} = \frac{\left(\frac{e_{Fij}}{E_j} + \frac{e_{Mij}}{E_j}\right)}{\frac{E_i}{E}} = \underbrace{\frac{\frac{e_{Fij}}{E_j}}{\frac{E_i}{E}}}_{LQ_{Fij}} + \underbrace{\frac{\frac{e_{Mij}}{E_j}}{\frac{E_i}{E}}}_{LQ_{Mij}} \quad [3]$$

to consider regional specialization and gender in the same index. e_{Fij} is the females' employment in sub-group i in region j, E_i is the national employment in sub-group i, E_j is the regional employment, and E is the national employment. The sum of LQ_{Fij} and LQ_{Mij} is equal to the regional LQ. This decomposition allows us to consider the regional and regional specialization by gender. The LQ values, by regions and gender, are displayed in Appendix (figure A2). As expected LQ differs not only by region but also between gender in the same region. Figure 7 depicts the relationship between LQ for females and males by sub-groups and gender.

Figure 7: LQ relationship between LQ for females and males by sub-groups (*)

(*): R2 industry 0.835, R2 construction 0.006, R2 LKIS 0.126, R2 KIS 0.034)

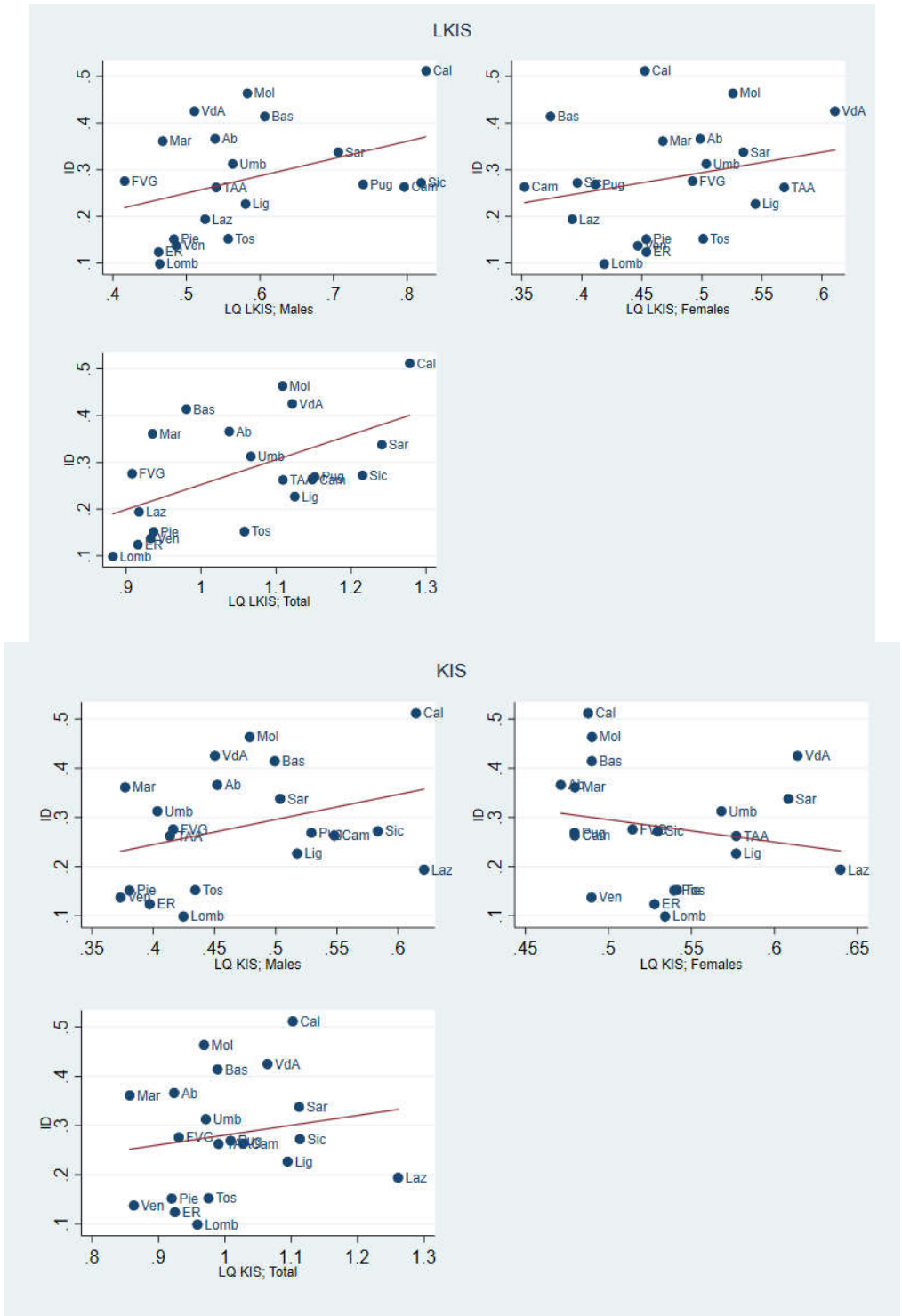
Figure 7 highlights a positive relationship between LQ for females and males in the industry sub-group (LQ in a region is the sum of LQf and LQm. If the sum is above one, the region is more specialized than the national average). Specialization in the industry (Carbonara and Giannoccaro, 2016) is an advantage for females and males. Regions more specialized in industry, such as Veneto, Emilia Romagna, and Lombardia, also display a higher share of females in this sub-sector (as pointed out in Figure 3). If regional specialization in industry increases in these regions, females are more likely to fall in this industry than in the other regions. Consequently, LQ in industry, for females and males, is positively related. Regions specialized in services are mainly localized in the South of Italy.

Furthermore, services sub-groups display an equal distribution between females and males within subgroups (as displayed in Figure 2). Nevertheless, these sub-groups have different behavior. In the LKIS sub-group, the males' share in the southern regions is higher than that of the females. For instance, in Campania, the males' share in LKIS is 15.8%, with 7.33% of the females' share (in Sicily, the females' share is 7.99%, and the males' share is 16.21%). In

Lombardia, by contrast, the females' share is 8.44%, while the males' share is 9.9% (in Piemonte, the females' share 9.55%, and the males' share is 10.82%). Even if southern regions are more specialized in LKIS (due to the higher value of LQ), a sub-group in which the females' share is considerable, in these regions' females have a lower probability of falling into this sub-group than in the other regions. KIS, by contrast, is a sub-group in which females and males are equally distributed, and there are no differences between regions. This sub-group displays the same behavior as the industry sub-group.

The previous analysis highlighted that some regions perform better than others in balancing male and female workers. We want to analyze how the result affects the segregation index. Figure 8 displays the relationship between ID index and Location Quotient by gender and by sub-groups.

Figure 8: Relationship between ID index and LQ; LQ total and by gender (*)



(*): R2 industry Total 0.175 R2 industry Female 0.238 R2 industry Males 0.134,
R2 construction Total 0.134, R2 construction Female 0.163 R2 construction Males 0.477
R2 LKIS Total 0.18 R2 LKIS Females 0.025 R2 LKIS Males 0.10
R2 KIS Total 0.04 R2 KIS Females 0.02 R2 KIS Males 0.09
Source: our elaboration

As depicted in Figure 8, the relationship between Location Quotient ad ID varies within sub-groups. For example, the industry and ID index displays a negative relationship. Regions more specialized in industry foster an equal distribution of workers. The result was largely expected because Figure 7 shows that females and males are, in some sense, complements. By contrast, the relationship between LQ and ID index in the LKIS sub-group is positive: the higher the regional specialization, the higher the regional dissimilarity.

3.2. Gender segregation and Resilience index

So far, we have explored the relationship between regional specialization and dissimilarity. Our second research question aims to explore the relationship between dissimilarity and resilience.

There are several ways to measure resilience. The mainstream EEG uses the Martin approach (Martin et al., 2016). Resilience is composed of two different components: resistance and recoverability. Resistance represents the region's ability to resist after the shock, while recovery represents the ability to recover after the shock. In Martin et al., (2016) approach, followed in our contribution, the resistance/recovery periods are calculated pick to pick with respect to the national economy. In this approach, the national economy is used as the expected growth path of the regional ones, with the idea that the latter adjusts to the national path. The Martin index is hence built by looking at the difference between the actual and the expected regional growth rate (measured by the national one) to measure the regional performance. In this sense, regions can lead or lag the national path, depending on if they are growing more or less than the national economy. In other approaches, as Han and Goetz (2015), the regional expected growth rate is measured locally by smoothing the time series over a window of ± 2 years.

Consequently, using Figure 1 in our contribution, we consider as resistance period of the recessionary downturn 2008-2010 for females, followed by a recovery period 2010-2012, a new resistance period 2012-2013, a recovery period between 2013-2019 and a new resistance period between 2019-2020. For males, the resistance period is 2008-2013, followed by a recovery period between 2013-2019 and a new resistance period between 2019-2020. Unfortunately, data by gender and sectors are not available before 2008. Consequently, it is impossible to explore and understand if the negative trend between 2008-2010 in women's total employment in Figure 1 of our contribution were already in progress before 2008. Martin et al., (2016) calculates the resilience index by comparing the movement of national employment (in contraction and expansion phases) concerning expected falls and increases in the region concerned. The expectation is that each region's employment would contract (in recession) and expand (in recovery) at the same rate as nationally. The expected change in employment in region *r* during recession or recovery of duration *k* periods would be given as:

$$\left(\Delta E_r^{t+k}\right)^e = \sum_i g_N^{t+k} E_{ir}^t \quad [4]$$

where g_N^{t+k} is the rate of contraction (in recession) or expansion (in recovery) of national employment; and E_{ir}^t is the employment in the industry *i* in region *r* in starting time *t*. The starting time *t* represents the turning point into recession or recovery. The measure of regional resistance can be expressed as:

$$Resistance_r = \frac{\left(\Delta E_r^{Contraction}\right) - \left(\Delta E_r^{Contraction}\right)^{expected}}{\left|\left(\Delta E_r^{Contraction}\right)^{expected}\right|} \quad [5]$$

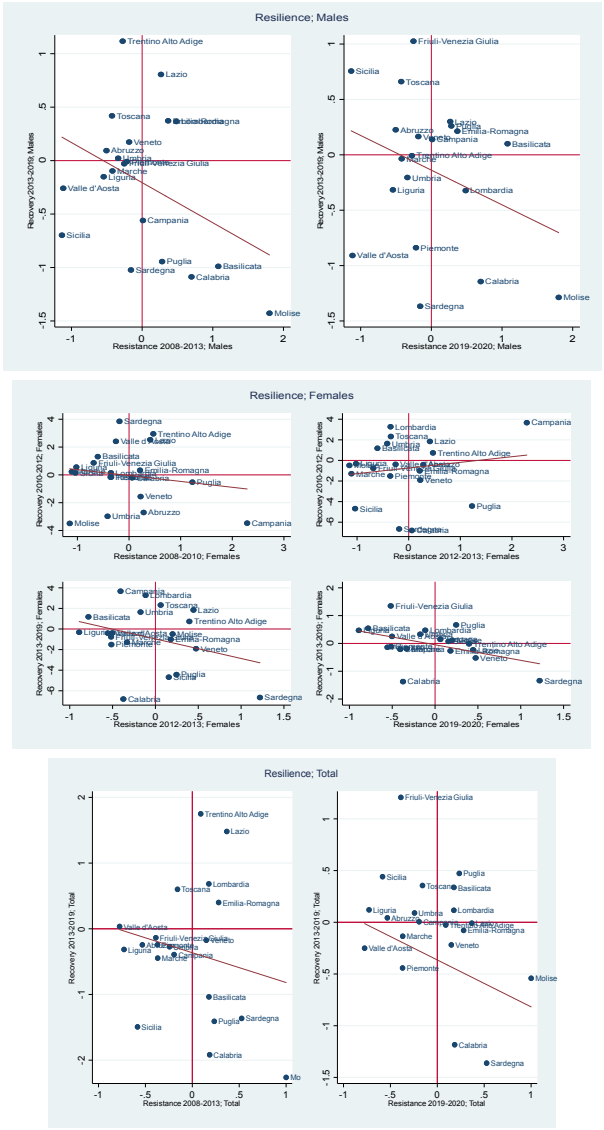
And the recoverability is given by:

$$Recovery_r = \frac{\left(\Delta E_r^{Recovery}\right) - \left(\Delta E_r^{Recovery}\right)^{expected}}{\left|\left(\Delta E_r^{Recovery}\right)^{expected}\right|} \quad [6]$$

The two measures of resistance and recovery are concentrated around zero. Thus, an R greater than zero indicates that a region is more resistant to recession or abler to recover more than the national economy.

Females' employment differs from males' employment during 2008-2013, attesting those females react differently to males to the 2007 economic shock. The relationship between resistance index and recovery index is depicted in Figure 9.

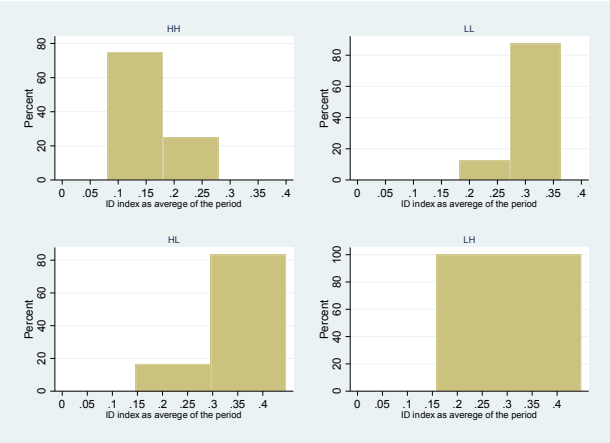
Figure 9: Regional resistance and recoverability for Males, Females and the whole economy



Source: our elaboration

The resilience index varies from shock to shock. Moreover, if gender is considered, resistance and recovery will be different. The resilience during the resistance and recovery period for males is similar to the whole economy, while resilience differs for females. According to the resilience index calculated on the whole economy, Regions can be divided into four different groups. The first group experienced a high resistance and recoverability (H;H). The second group experienced a high level of resistance and a low level of recoverability (H;L). A third one experienced a low level of resistance and high level of recoverability (L;H), and a fourth was composed of regions with low resistance and low recoverability (L;L). The relation between recovery, resistance and ID index is depicted in Figure 10. As shown in Figure, regions with high resistance and recoverability also exhibit a low dissimilarity index. Conversely, a higher dissimilarity index is associated with low resistance and recovery regions.

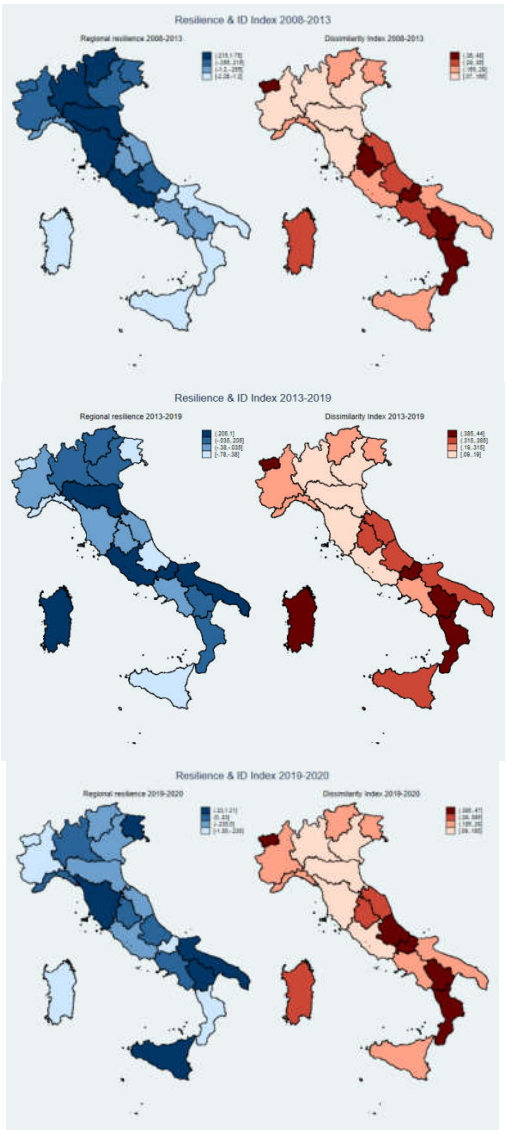
Figure 10: Relationship between resistance/recoverability and dissimilarity index (ID)



Source: our elaboration

The stylized facts highlighted that females and males are employed in different sub-groups. An index, the segregation index, captures this uneven distribution. Furthermore, regional specialization can differ by gender. Finally, the resilience index is different when gender is taken into account. Figure 11 maps the regional resilience and the ID index as period average.

Figure 11: Relationship between resistance/recoverability and dissimilarity index (ID) at the regional level



The maps highlight a negative relationship between regional resilience and ID index during the 2008-2013 i.e. the higher the resilience, the lower the dissimilarity. However, the relationship no longer holds during the recovery period 2013-2019 and the following resistance period (2019-2020). The following section of the paper aims to develop an empirical investigation to explore the relationship between regional specialization, dissimilarity index, and resilience.

4. Methodology and empirical investigation

The paper investigates a relationship between gender segregation and regional specialization and whether the more gender-equal are also more resilient. Our analysis will be developed in two steps. The first will consider the impact of specialization, captured by LQ by gender on the index of dissimilarity ID. The second one will explore the relationship between ID and resilience.

To explore the relationship between dissimilarity index and regional specialization, we will use the Location Quotient dived by gender obtained in equation [3]. Due to the collinearity, the LQ impact on ID will be estimated considering regional specialization in industry (*I*) and construction (*C*) for females and males. In this case, the Variance Inflation Factor (VIF) is less than 5, ensuring the absence of collinearity among covariates. The equation to be estimated is the following:

$$ID_{it} = \alpha_i + \beta_1 LQ_{FI} + \beta_2 LQ_{FC} + \beta_3 LQ_{MI} + \beta_4 LQ_{MC} + \varepsilon_{it} \quad [7]$$

To estimate equation [7] we will use a panel model with fixed effects. The results are depicted in Table 1.

Table 1: estimation results

Location Quotient	Coefficient
LQ_{FI}	-0.193**
	(0.0706)
LQ_{FC}	-2.016***
	(0.0940)
LQ_{MI}	0.0571
	(0.0446)
LQ_{MC}	0.0683***
	(0.0190)
Cons	0.350***
	(0.0405)
N	260
Standard errors in parentheses	
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$	

Source: our elaboration

ID is equal to 0 in the case of complete equality (where females' employment is distributed similarly to males across occupations). The results highlight that increases in females' regional specialization in sub-groups industry and construction, in which the females' share is low, decrease the dissimilarity index, while an increase in males' regional specialization in sub-group construction will cause an increase in the ID index. Furthermore, increasing employment in sub-groups where females' share is lower than males will decrease the ID index. Therefore, regions become more egalitarian in terms of gender.

To answer our research question: Does a more gender-equal regional specialization make territories more resilient? We will use the following estimation strategy. Indicating the fitted values of equation [7] as $\widehat{ID}_{it}$, a probit model will be used to explore the relationship between the resilience index at the regional level and the dissimilarity index. We use the fitted values $\widehat{ID}_{it}$ calculated as the regional average.

Our resilience index will be measured by a binary variable which will take a value of 1 if regions are resilient and 0 if they are not. Our regressions will be the following:

$$Pr(res_{08-13} = 1|\widehat{ID}_{i2008-2013}) = \phi(\beta_0 + \beta_1 \widehat{ID}_{i2008-2013}) \quad [8.1]$$

$$Pr(rec_{13-19} = 1|\widehat{ID}_{i2013-2019}) = \phi(\beta_0 + \beta_1 \widehat{ID}_{i2013-2019}) \quad [8.2]$$

$$Pr(rec_{19-20} = 1|\widehat{ID}_{i2019-2020}) = \phi(\beta_0 + \beta_1 \widehat{ID}_{i2019-2020}) \quad [8.3]$$

The results are depicted in Tables 2, 3, and 4. The results obtained using a probit model can be interpreted as how much the (conditional) probability of the outcome variable changes when the value of a covariate changes.

The results highlight that a more gender-equal region has more chance of being resistant than a less gender-equal one. However, this result holds only for the first resistance period (2008-2013), not for the remaining one. As previously highlighted, 2013 represents, in Italy, a turning point. Since 2013, the segregation index does not impact resilience. Therefore, regarding our second research question Q2, the results do not allow us to give an unambiguous answer.

Table 2: Estimation result; period 2008-2013

Resistance 2008-2013			
	Total Economy	Males	Females
$\widehat{ID}_{i2008-2013}$	-24.31*	-19.69*	-0.621
	(12.09)	(9.014)	(6.212)
cons	6.315	5.419*	-0.202
	(3.312)	(2.571)	(1.851)
N	20	20	20
Standard errors in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$			
McFadden's R^2: 0.530			
Maximum Likelihood R^2: 0.476			

Source: our elaboration

Table 3: Estimation result; period 2013-2019

Recovery 2013-2019			
	Total Economy	Males	Females
$\widehat{ID}_{i2013-2019}$	2.664	7.058	-0.571
	(6.218)	(6.277)	(6.178)
cons	-0.770	-2.303	0.0395
	(1.817)	(1.846)	(1.809)
N	20	20	20
Standard errors in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$			
McFadden's R^2: 0.32			
Maximum Likelihood R^2: 0.26			

Source: our elaboration

Table 4: Estimation result; period 2019-2020

Resistance 2019-2020			
	Total Economy	Males	Females
$\widehat{ID}_{i2019-2020}$	1.897	1.831	-2.170
	(5.072)	(5.041)	(5.064)
cons	-0.531	-0.512	0.607
	(1.447)	(1.437)	(1.444)
N	20	20	20
Standard errors in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$			
McFadden's R^2: 0.31			
Maximum Likelihood R^2: 0.21			

Source: our elaboration

5. Discussion and conclusion

The paper aimed to merge three strands of literature, regional specialization, gender segregation, and resilience, to investigate the relationship between regional specialization and segregation index and between segregation index and resilience. Our contribution underlines the importance of including gender in the analysis. Females and males are not equally distributed between industries. Moreover, this uneven distribution varies from region to region. The empirical investigation confirms this result and enhances the idea that considering gender in the analysis is essential in terms of policy implications. Increasing employment is always a desirable aim.

Nevertheless, some policies can be effective only for some regions and sub-groups. Consequently, policies should consider the national dimension and the regional ones. Borrowman and Klasen (2020) have pointed out that tackling sectoral occupation is not easy. It requires the analysis of constraints that prevent females from moving from one sub-group to another, including social and welfare elements such as childcare and home duties. Furthermore, formal and informal barriers to accessing specific jobs need a deeper investigation.

Moreover, the social and mental barriers which induce females to choose some education fields instead of STEM fields need a deeper analysis. The National Recovery and Resilience Plan (PNRR) focuses on digitization, innovation, and ecological transition. Human capital is essential to operationalize the PNRR. Therefore, females must acquire technological competencies to compete in the job market. However, performing those policies is complex, and gender segregation remains pervasive.

Second, the analysis highlighted that the ID index could play a role in enhancing regional resistance. Creating more gender-equal regions can protect them from external shocks. This result holds only during the period 2008-2013. From 2013 onwards, there is no relationship between resilience and dissimilarity. This result can be imputable to the structural change that interested Italy starting from 1993 and exacerbated by the 2007 economic shock (Martini 2020). From 1993 Italy experienced a de-specialisation process switching from industry to the services sector. The latter represents an advantage for females. Nevertheless, as Kushi and MacManus (2021: 381) pointed out, whereas "labor market segregation in the early years of the crisis effectively sheltered women's employment and wages, long-term economic decline and fiscal consolidation, particularly cuts to public sector employment and social spending, have exposed women to greater labor market instability". Consequently, the relationship between resilience and dissimilarity did not hold anymore. Resilience literature highlighted that resilience is a process and it depends on several interrelated dimensions. To develop resilient regions decreasing gender segregation should remain an aim. Less segregated regions it is more protected by shock under the social dimension. Our analysis does not take into consideration temporary jobs, for instance.

Nevertheless, it is well known that the temporary position is mainly available in service sectors and is mainly filled in by females. This situation makes one gender more exposed to the external shock with economic and social consequences. In conclusion, gender is an important topic involving social and economic components. This topic cannot be ignored by policymakers.

Finally, a word on the North-South divide. Our analysis shows that regions behave in different ways: while some have a minor role in driving the gender composition, others show a remarkable negative impact on the ID. This is particularly true for Southern regions, even in sub-groups where we should expect higher female participation. As we argue, the reasons are mainly cultural, social, and historical and this makes the North-South divide in Italy still on the policymaker's agenda, not only as a question of "growth gap" but also of gender one.

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7. Appendix

Table A. Sectoral definition NACE2_Rev

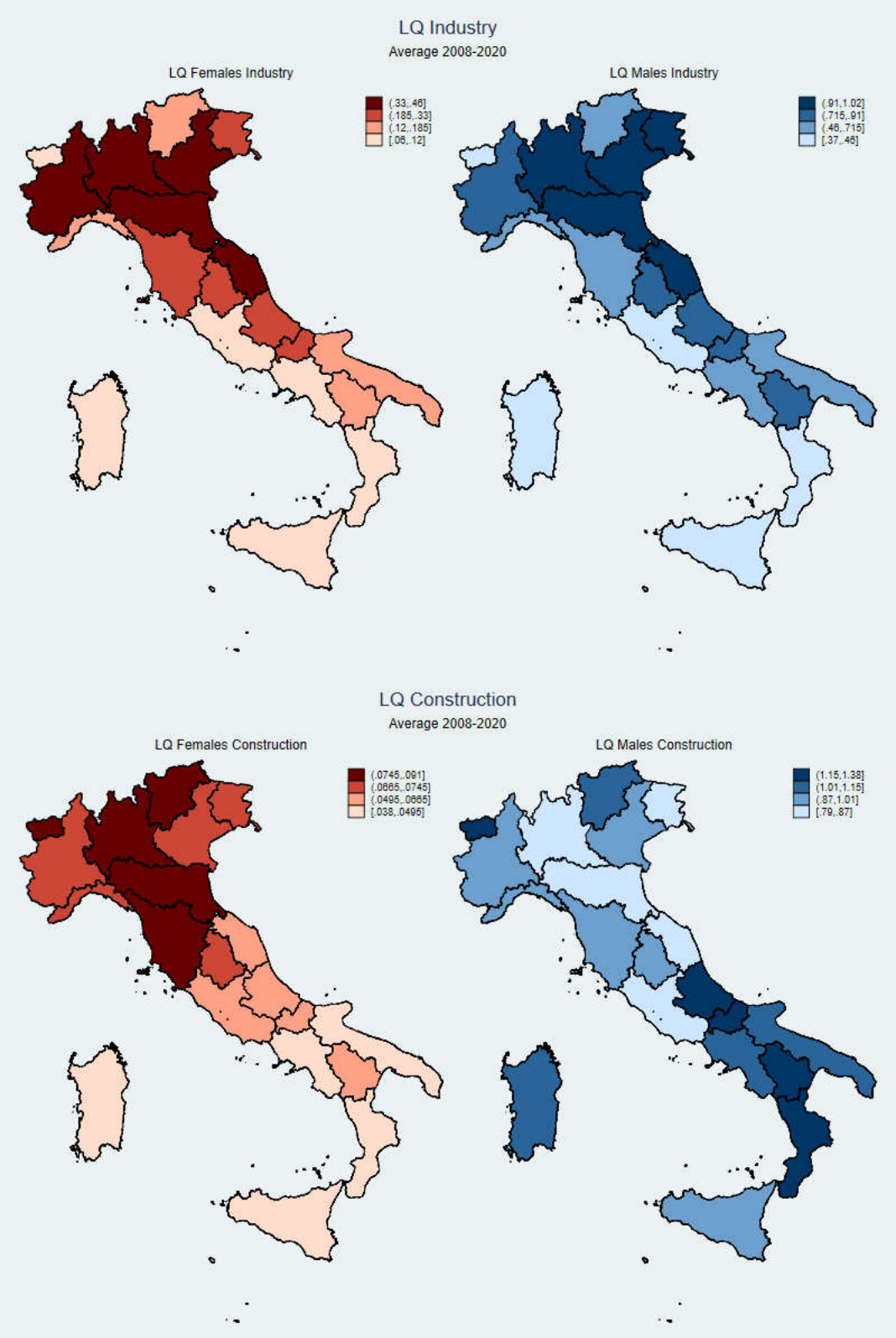
Group 1: Industry (I)	**B**	**Mining and quarrying**
Group 1: Industry (I)	C	Manufacturing
Group 1: Industry (I)	D	Electricity, gas, steam and air conditioning supply
Group 1: Industry (I)	E	Water supply; sewerage, waste management and remediation activities
Group 2: Construction (C)	F	Construction
Group3: Less Knowledge Intensive Services (LKIS)	G	Wholesale and retail trade; repair of motor vehicles and motorcycles
Group3: Less Knowledge Intensive Services (LKIS)	H	Transportation and storage
Group3: Less Knowledge Intensive Services (LKIS)	I	Accommodation and food service activities
Group4: Knowledge Intensive Services (KIS)	J	Information and communication
Group4: Knowledge	K	Financial and insurance activities

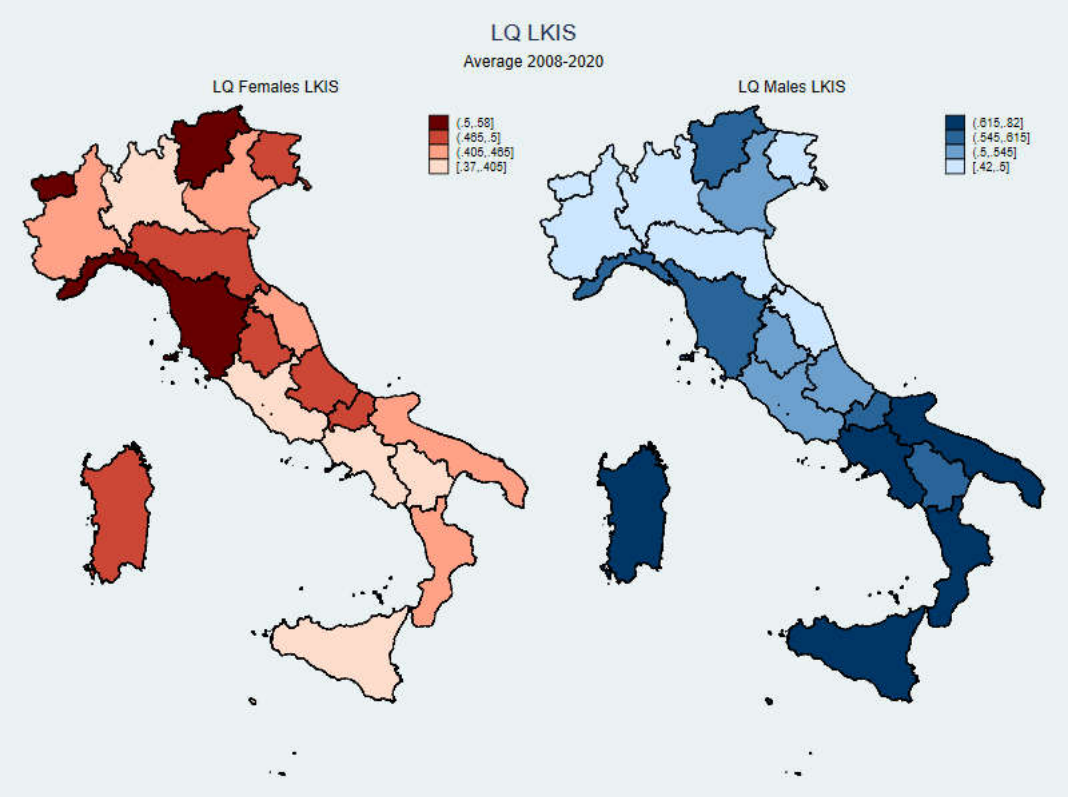
Intensive Services (KIS)			
Group4:	Knowledge	L	Real estate activities
Intensive Services (KIS)			
Group4:	Knowledge	M	Professional, scientific, and technical activities
Intensive Services (KIS)			
Group4:	Knowledge	N	Administrative and support service activities
Intensive Services (KIS)			
Group4:	Knowledge	P	Education
Intensive Services (KIS)			
Group4:	Knowledge	Q	Human health and social work activities
Intensive Services (KIS)			
Group4:	Knowledge	R	Arts, entertainment, and recreation
Intensive Services (KIS)			
Group4:	Knowledge	S	Other service activities
Intensive Services (KIS)			

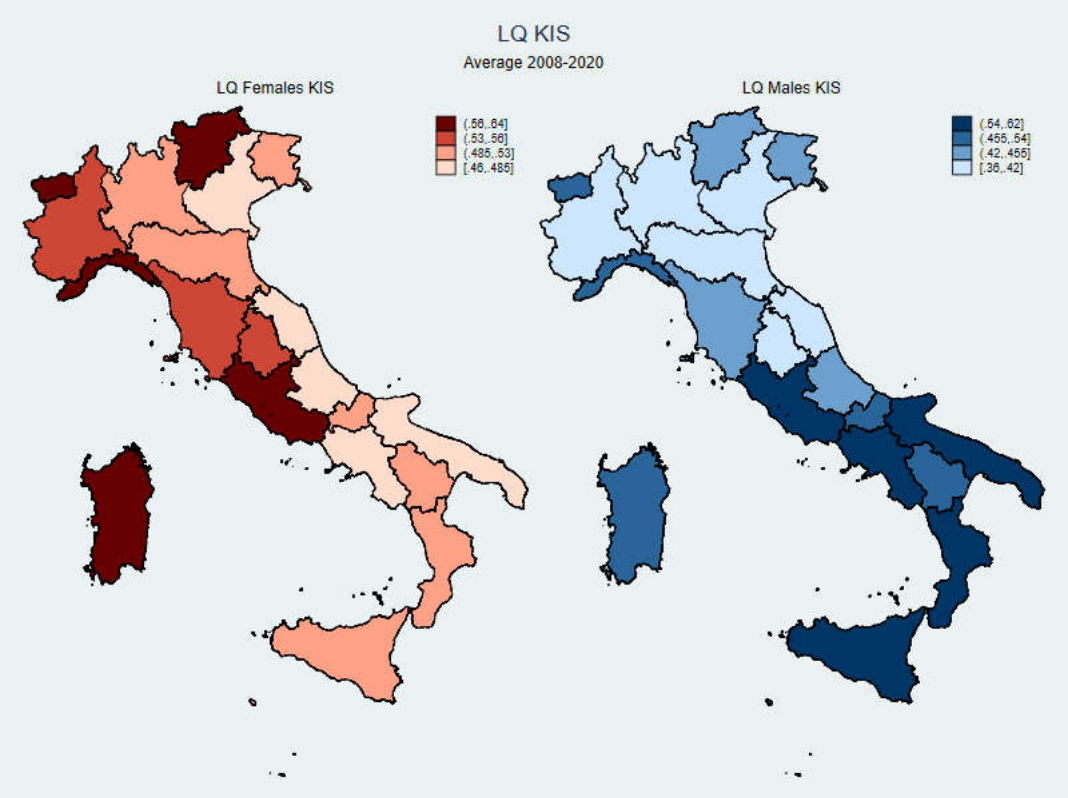
Figure A1: Regional map of Italy (*)

(*): the autonomies provinces of Trento and Bolzano shape Trentino - Alto Adige region

Figure A2: LQ by gender







Source: our elaboration

THE LOGISTIC DRIVERS AS A POWERFUL PERFORMANCE INDICATOR IN THE DEVELOPMENT OF REGIONAL COMPANIES OF KOSOVO

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Abstract

Regional companies in Kosovo operate in challenging economic conditions that hinder their ability to survive and develop. However, the management of logistics supply chain managers can increase their performance and help in their further development. The main purpose of this research is to investigate whether the management of logistics supply chain drivers can serve as a formal predictor and driver of the development of regional companies in Kosovo. The study aims to help Kosovo's regional companies in a formal and independent way to integrate with supply chains, increasing their performance and development amid the difficult economic conditions in which they operate. The research approach and method is based on a quantitative survey conducted among 103 regional companies of Kosovo. Data was analyzed using descriptive statistics and hypotheses are tested using Pearson Correlation Coefficient. The results of the statistical analysis showed that the management of the six logistics drivers of the supply chain affects the increase in the performance of regional companies. It is mainly influenced by the information logistic driver, compared to other drivers, it turns out that over fifty percent of the respondents believe that the information logistic driver is the most important, followed by the next driver with sixteen percent transport, twelve percent facilities, nine percent resources, seven percent inventory and only one percent price. From the analysis of the questionnaire data, the importance and quality of road transport in the performance of regional companies was clearly highlighted. Implications and managerial practices of this research will serve as an aid to policy makers and institutions when designing development initiatives for regional infrastructure, economic zones and locations.

Keywords: logistic drivers, regional development, inventory, transportation, information
JEL classification: R10, R11, R40, R58, M10

1. Introduction

The literature review of this paper is focused on various sources such as statistical data, reports, regulations and research papers. The structure of the composition of this paper includes data from the legal cooperation frameworks of Kosovo's regional cooperation, where various important issues are taken into account in the implementation of supply chain processes, including the responsible institutional bodies and the role of international partners. Moreover, data from various reports and reliable statistical data for the development indicators of different countries are presented in this paper. A variety of research findings and recommendations are elaborated separately to address each of the variables in this survey research method.

Kosovo Economic overview

Kosovo is a lower-middle income economy and one of only four economies in Europe to grow every year since the onset of the global financial crisis in 2008. With a population of 1.8 million, Kosovo is the second smallest economy in the Western Balkans after Montenegro.

The Kosovar economy has maintained consistent growth in recent years (Table 1). Real growth in gross domestic product (GDP) averaged about 3.2% per year[1] over 2013- 17: a noteworthy performance compared to other economies in the region (EC, 2018[1]). Despite recording positive growth rates, however, Kosovo was still the second poorest economy in Europe in 2017, after Moldova, with an average GDP per capita of USD 3 894.

Table 1. Kosovo: Main macroeconomic indicators (2013-18)

Indicator	Unit of measurement	2013	2014	2015	2016	2017	2018
GDP growth	% year-on-year	3.4	1.2	4.1	3.4	4.2	3.8**
Inflation	% average	1.8	0.4	-0.5	0.3	1.5	0.3**
Government balance	% of GDP	-3.1	-2.2	-2.0	-1.2	-0.8	..
Current account balance	% of GDP	-3.4	-6.9	-8.6	-8.3	-6.0	-6.5**
Exports of goods and services[1]	% of GDP	21.9	22.5	21.9	22.2	27.0	27.5**
Imports of goods and services	% of GDP	49.6	51.2	50.4	50.8	53.8	54.8**
Net FDI	% of GDP	5.3	2.7	5.3	3.6	4.5	3.7**
External debt	% of GDP	30.2	31.2	33.3	33.2	32.6	..
Gross internationalreserves	Ratio of 12 months imports of goods moving average	7.4	6.0	5.9	5.0	4.9	4.9**
Unemployment	% of total active population	30.00	35.3	32.9	27.5	30.5	27.9**
National GDP	Billion euros	5.3	5.6	5.8	6.1	6.4	..

Note: *projection; **average of 1st and 2nd quarter.

Sources: EC (2018[2]), "EU candidate countries' and potential candidates' economic quarterly (CCEQ): 3rd quarter 2018", https://ec.europa.eu/info/sites/info/files/economy-finance/tp028_en.pdf; EBRD (2018[3]), Transition Report 2018-2019: Work in Transition, https://2018.tr-ebrd.com/countries/# Eurostat (2018[4]), Eurostat (database), https://ec.europa.eu/eurostat/web/national-accounts/data/database.

Table 2. Number of registered companies in Kosovo by enterprise size and region

		Enterprise size, by employment					
Region	**Year**	**0-9**	**10-49**	**50-249**	**250+**	**Total**	**Share of total number of enterprises**
Gjakova	2018	3,408	162	17	2	3,589	9,40%
Gjilan	2018	3,580	233	20	0	3,833	10,04%
Mitrovica	2018	3,069	146	23	2	3,240	8,49%
Peja	2018	3,189	185	23	2	3,399	8,90%
Prizren	2018	5,625	317	34	3	5,979	15,68%
Prishtina	2018	12,602	1,111	216	47	13,979	36,62%
Ferizaj	2018	3,898	231	28	1	4,158	10,89%
Kosovo	**2018**	**35,374**	**2,385**	**361**	**57**	**38,177**	**100,00%**

Source: Statistical Agency of Kosovo, 2018.

SMEs in the national economy

Kosovo's classification of SMEs is defined by the law on foreign investment which entered into force in 2014. The only criterion is employment size, which is in line with the EU definition (Table 3).

Table 3. Definition of micro, small and medium-sized enterprises in Kosovo

Size	EU definition	Kosovo definition
Micro	< 10 employees, turnover ≤ EURO 2m	< 10 employees
Small	< 50 employees, turnover ≤ EURO 10m	< 50 employees
Medium	< 250 employees, turnover ≤ EURO 50m	< 250 employees

Note: In Kosovo the classification of SMEs is defined by Law No. 04/L-220 on Foreign Investments. The SME categorisation is based on the number of employees (Article 2, paragraph 1.21).

For purposes related to the law on bankruptcy an SME is defined as a business organisation which has an annual turnover of up to EUR 1 million or has up to 25 employees. This definition is only applied in bankruptcy cases.

Source: Republic of Kosovo (2014[23]), Law No. 04/L-220 on Foreign Investment, https://mti.rks-gov.net/desk/inc/media/1916AE1F-48E8-451D-A328-CA350EC4D7D2.pdf.

Conceptual Framework

A supply chain is a network (Tsiotas and Polyzos, 2018) of relationships formed by more than two individuals or associations involved in the upstream or downstream realization of products, services, finance and information from a source to a clent (Mentzer et al., 2001). According to another definition, the supply chain is defined as the cluster that includes suppliers, logistics service providers, manufacturers, distributors and dealers and where information flow takes place between these mentioned stakeholders (Kopczak, 1997). Supply chain management includes internal and external activities by the business to deliver high-value products to customers (Shahzadi et al., 2013). According to another definition, supply chain management is defined as the entire process of handling raw materials, processing raw materials and transforming them into products and delivering them to consumers, as part of the operations and stakeholders that host storage, transport, transport activities (Yavuz & Ersoy, 2013).

Businesses in the supply chain have to make individual or corporate decisions to improve their logistics performance. These decisions are made using the major logistic drivers of the supply chain.

Logistic Drivers of Supply Chain

The impact of supply chain logistics drivers of three factors: facility, inventory, transportation (Polyzos and Tsiotas, 2020); It consists of six sections, three cross-functional as information, sourcing and pricing (Chopra & Meindl, 2016). According to another definition there are six units: inventory, transportation, facility location, information, sourcing and pricing (Doan, 2020; Matthew & Othman, 2017; Shahzadi et al., 2013). According to Hugos, (2018), there are five units: production, inventory, location, transportation, and information. According to another definition, there are seven units: production, inventory, transportation, facility location, information, sourcing and pricing (Googlesir.com, 2021).

1. Facilities

Facilities are the physical locations in the supply chain network where products are produced, stored and assembled. Production and storage facilities are important. Because the location, capacity and flexibility of these facilities directly affect the supply chain (Chopra & Meindl, 2016). The facility has a long-term impact on company finances. In addition, it is of priority importance in product development and distribution (Doan, 2020). Therefore, facility location selection is important for the manufacturer to gain competitive advantage (Matthew & Othman, 2017).

1.1. Production

A driver can set up flexible manufacturing factories to have high capacity and a wide range of products. Thus, they become more responsiveness to demand. In addition, responsiveness can be increased by making production through small factories close to large customer groups. In this way, the delivery time is reduced. If businesses want to achieve efficiency, they can optimize production by producing less variety products in factories with less capacity. In addition, businesses can achieve efficiency by using economies of scale (Polyzos, 2019) in large central factories (Hugos, 2018). The performance of the supply chain is directly dependent on production, such as how and when a product should be produced (Googlesir.com, 2021).

1.2. Location

Opening physical stores close to customers will increase responsiveness. McDonalds uses this strategy to stay responsive to its customers. Here, efficiency can be achieved by centralizing common locations. Dell for efficiency serves large markets from several central geographic locations (Hugos, 2018). In this direction, the first hypothesis of this research is as follows:

H1: Place of company is positively correlated with the importance managers put on facilities of regional companies

2. Inventory

Inventory includes raw materials, processes and finished products in the supply chain. Changing inventory policies increases supply chain efficiency and business responsiveness (Chopra & Meindl, 2016). In supply chain management, inventory is an important factor used in balancing supply and demand (Matthew & Othman, 2017). Inventory plays an important role in the management of relations between customers and suppliers (Doan, 2020). The responsiveness of the inventory can be increased by keeping a wide range of products and a high level of stock. Keeping product stock in a center close to the customer provides additional responsiveness. Ensuring efficiency in the inventory depends on reducing the level of products that are not sold very often in the entire inventory. In addition, economies of scale and cost savings can be benefited from by collecting the inventory in a few designated centers (Hugos, 2018). In addition, reducing inventory will increase efficiency but decrease responsiveness (Googlesir.com, 2021). Hence, it comprises one of the most meaningful variables within this research variable scheme and the second hypothesis is given as in the following:

H2: Safe inventory is interwoven with the level of importance managers put on inventory in general

3. Transportation

The transfer of products from one point to another in the supply chain is called transport. Transport may consist of many modes and combinations of transport. The availability of transportation options affects the responsiveness and efficiency of the supply chain (Chopra & Meindl, 2016). Responsiveness can be increased by using a fast and flexible mode of transport. Many companies can improve responsiveness by using a mode of transport that will deliver their products within 24 hours. Moving products in large batches less frequently can increase efficiency. Also ship, rail, pipeline modes can be more efficient for transport. It will be more efficient if the transportation process is done from a central facility (Hugos, 2018). In addition, which mode of transport a product will be transported from one place to another depends on the trade-off between the buyer and the seller.Therefore, decisions should be evaluated in terms of both economic and customer satisfaction (Googlesir.com, 2021). In addition, outsourcing is the agreement of the manufacturers with a third party or business for the transportation to the customer in order to keep the transportation costs low (Shahzadi et al., 2013). In this regard, the next hypothesis is as follows:

H3: Sources provided by regional companies in supply chain performance impact the level of the importance of transportation in the same chain

4. Information

Information consists of data and analysis about inventory, transportation, costs, prices and customers in the supply chain. Information is the biggest driver in the supply chain as it affects other drivers. Information makes the supply chain more efficient and more responsive (Chopra & Meindl, 2016). The development of information technologies in supply chain management has become increasingly common. In addition, due to its multifaceted nature, supply chain management has forced other organizations to communicate online (Matthew & Othman, 2017). The development of information technologies, their easy accessibility and cheapness increase the importance of this driver day by day. Knowledge is just like money. The 4 previously mentioned (production, inventory, location, transportation) drivers increase the performance of supply chain drivers when used with information. Businesses can have a high level of responsiveness when they collect and share data from these four factors. Information collection and sharing is important for suppliers, distributors, manufacturers and large retail stores (Hugos, 2018).

H4: Information in supply chain performance has the major importance in driving factors of a regional company in Kosovo

5. Sourcing

Sourcing is the determination of who will select factors such as production, storage, transportation and information in the supply chain. This decision determines which resource a company produces itself and which is outsourced. Sourcing affects the responsiveness and

efficiency of the supply chain (Chopra & Meindl, 2016). Sourcing is the activity of supplying the right material at the right time, in the right quantity, at the right quality, at the right price. Purchasing in large batches allows suppliers to benefit from economies of scale, improve capacity and processes, and improve customer service. However, if the business uses only one supplier, it faces inventory risk. Sourcing decisions for businesses consist of own manufacturing and outsourcing, supplier selection and procurement. Even if international sources have the cost and complexity of transportation, storage, etc., the cost advantage can be offset by the low prices offered by global suppliers (Googlesir.com, 2021). In addition, outsourcing is an important factor as it can cause a product to be produced at lower costs (Matthew & Othman, 2017). In order to address the importance of resources in the supply chain process of regional companies in Kosovo, it was vital to create a new hypothesis in this research and measure how it affects the annual turnover performance of companies:

H5: Sources provided by regional companies in supply chain performance impact the annual turnover of the company

6. Pricing

Pricing affects the functioning of supply chain management (Doan, 2020). Pricing is the determination of the price of goods and services offered by a business within its supply chain. Pricing affects the buyer's demand for goods and services. This in turn affects the performance of the supply chain. Different pricing affects responsiveness to buyers. A change in pricing affects revenue and costs on other drivers (Chopra & Meindl, 2016).

The cost of a product or service is an important element in pricing. In addition, manufacturers should know the market conditions in order to apply the right pricing strategy (Matthew & Othman, 2017). Pricing is used to match supply and demand. Sellers can eliminate excess supply by making price reductions or delay demand to the next period to prevent seasonal demand increases. Pricing is an important element in the competitive strategies of businesses. Pricing varies according to the targeted customer segment customers with different needs (Googlesir.com, 2021).

2. METHODOLOGY

The questionnaire is adopted from the previous survey that took place in Kosovo. The targeted regional companies consist of respondents from different regions of the country during the course of survey administration. The targets of this study are regional active business respondents during the time of survey administration. Simple random sampling is used to collect data from 103 respondents.

The questions of the first part of the questionnaire, intend to identify the respondent's region (Place), their annual income (Turnover) and number of the employees (Workers).

Since the aim of this research is to search if there is any correlation between logistic drivers and the performance of the regional businesses of Kosovo, the second part of the survey included statements that are grouped under scale called Differences consisted of 6 variables: Q1: Facilities Q2: Inventory, Q3: Transportation, Q4: Information, Q5: Sourcing and Q6: Pricing. The above-mentioned items are measured and are presented below in the data analysis.

3. DATA ANALYSIS

This study aims to contribute by guiding Kosovo's regional companies on how to successfully manage supply chain logistics drivers in order to increase their performance and the country's economic prosperity. This part covers estimations of six items, number, descriptive statistics, crosstabulation analysis and hypothesis test.

Table 4. Regional companies participating in the study

Region/District	Number	Percentage
Prishtina	39	38%
Ferizaj	33	32%
Prizren	19	18%
Gjilan	10	10%
Mitrovica	1	1%
Peja	1	1%
Total	103	100%

Source: Author's data

Descriptive statistics

Descriptive statistics indicating number, mean and standard deviation of all variables are provided within Table 5. Outputs of means and SD are as follows: place (M=3.0000, SD=1.97534); annual turnover (M=1.8350, SD=.76821), number of employees (M=2.0583, SD=.76473); Q1 facilities (M=3.2816 SD=.69193), Q2 inventory (M=3.3010, SD=.65432), Q3 transportation (M=3.5049, SD=.69837), Q4 information (M=3.5631, SD=.58862), Q5 sources (M=3.2913, SD=.96532), Q6 pricing (M=3.1165, SD=.78342).

Table 5. Descriptive statistics of nine variables

Variables	N	Mean	Std. Deviation
Place	103	3.0000	1.97534
Annual Turnover	103	1.8350	.76821
Number of Employees	103	2.0583	.76473
Facilities	103	3.2816	.69193
Inventory	103	3.3010	.65432
Transportation	103	3.5049	.69837
Information	103	3.5631	.58862
Sources	103	3.2913	.96532
Pricing	103	3.1165	.78342

Source: Author's data

Cross tabulation analysis

In this part is presented a summary of respondent's distribution based on place, annual turnover, number of employees and what are their correlations with the logistics drivers: facilities, inventory, type of inventory, transportation, type of transportation, information, sources and pricing.

The first part of the survey is consisted of three variables: place, annual turnover and number of employees. Therefore, the data from the sample regarding the region where the companies operate show us that 38% are from the region of Prishtina, 32% from the region of Ferizaj, 18% from the region of Prizren, 10% from the region of Gjilan, 1% from the region of Peja and 1% from the region of Mitrovica. Respondents are deliberately divided into two categories: respondents according to the number of employees, which results that 26% of regional companies had 0-9 employees, 42% of regional companies had between 10-49 employees and 32% had over 50- 249 employees and respondents by annual turnover, which results that 39% of the sample includes respondents are regional companies with a turnover of < 2 million Euros, 39% are regional companies with a turnover of < 10 million Euros and 22% are regional companies with a turnover annual < 50 million Euro.

Table 6. Importance of logistic driver "facilities"

Valid	Frequency	Valid Percent
Somewhat	14	14%
Neutral	46	45%
Very much	43	41%
Total	**103**	**100%**

Source: Author's data

In table 6, the result of the first survey on the importance of the logistics driver of the supply chain "objects" in the performance of the regional companies of Kosovo, shows us that 14% of the respondents consider it partially important in their answer, 45% express as neutral and 41% answered that the logistics driver of the supply chain "facilities" play a very important role in the development performance of companies.

Table 7. Importance of logistic driver "inventory"

Valid	Frequency	Valid Percent
None	1	1%
Somewhat	8	8%
Neutral	53	51%
Very much	41	40
Total	**103**	**100%**

Source: Author's data

In table 7, the result of the second survey on the importance of the logistic driver "inventory" shows us that 1% of the respondents consider it not important, 8% consider it partially important in their answer, 51% express themselves as neutral and 41 % answered that the logistic driver of the supply chain "inventory" plays a very important role in the development performance of companies.

Table 8. Importance of logistic driver "transport"

Valid	Frequency	Valid Percent
None	2	2%
Somewhat	6	6%
Neutral	33	32%
Very much	62	60%
Total	**103**	**100%**

Source: Author's data

In table 8, the result of the third survey on the importance of the logistic driver "transport" in the performance of companies, shows us that 2% of respondents consider it not important, 6% consider it partially important in their answer, 32% expressed as neutral and 60% answered that the logistics driver "transport" plays a very important role in the performance of the regional companies.

Table 9. Type of transportation used by regional companies of Kosovo

Valid	Frequency	Valid Percent
Road transport	88	85%
Air transport	8	8%
Intermodal transport	4	4%
See transport	3	3%
Total	**103**	**100%**

Source: Author's data

In table 9, the result of the survey of what type of transport the regional companies of Kosovo mainly use to increase their performance, it turns out that 85% of the respondents use road transport, 8% use air transport, 4% intermodal combined with more than a transport and 3% sea transport.

Table 10. Importance of logistic driver "information"

Valid	Frequency	Valid Percent
None	1	1%
Somewhat	2	2%
Neutral	38	37%
Very much	62	60%
Total	**103**	**100%**

Source: Author's data

In table 10, the result of the fourth survey on the importance of the logistic driver "information" in the performance of regional companies, shows us that 1% of respondents consider it not important, 2% consider it partially important in their answer, 37 % express themselves as neutral and 60% answer that the logistics driver "information" plays a very important role in the performance.

Table 11. Importance of logistic driver "sources"

Valid	Frequency	Valid Percent
Somewhat	13	13%
Neutral	47	45%
Very much	43	42%
Total	**103**	**100%**

Source: Author's data

In table 11, the result of the fifth survey on the importance of the logistic driver "sources" in the performance of the regional companies of Kosovo, shows us that 13% consider it partly important in their answer, 45% express themselves as neutral and 42% answer that the logistic driver "sources" play a very important role in performance.

Table 12. Importance of logistic driver price

Valid	Frequency	Valid Percent
None	2	2%
Somewhat	20	19%
Neutral	45	43%
Very much	36	35%
Total	**103**	**100%**

Source: Author's data

In table 12, the result of the sixth survey on the importance of the logistic driver "price" in the performance of the regional companies of Kosovo, shows us that 2% of the respondents consider it not important, 19% consider it partially important in their answer, 43% express themselves as neutral and 35% answer that the logistic manager "price" plays a very important role in performance.

Table 13. Importance of the logistic drivers

Logistic Drivers of Supply Chain	Frequency	Valid Percent
Information	57	55%
Transport	17	16%
Facilities	12	12%
Sources	9	9%
Inventory	7	7%
Price	1	1%
Total	**103**	**100%**

Source: Author's data

In table 13, the result of the seventh survey on the importance of logistics drivers in the performance of regional companies in Kosovo, shows that 55% of respondents consider "information" very important, 16% consider "transport" important, 12 % say that they consider "objects" important, 9% consider "resources" important, 7% consider "inventory" important and only 1% consider "price" important.

Hypothesis test

Based on the subject studied, the test of hypothesis is conducted using bivariate Pearson Correlation coefficient, *r*, which measures the strength and direction of linear relationships between pairs of continuous variables. The Pearson Correlation evaluates whether there is statistical evidence for a linear relationship among the same pairs of variables in the sample, represented by a correlation coefficient, ρ ("rho"). The degree of coefficient values can range from +1 to -1, where +1 indicates a perfect positive relationship, -1 indicates a perfect negative relationship, and a 0 indicates no relationship exists. According to Ratner, B. (2009) correlation degrees can be interpreted as quoted below:

Perfect: If the value is near ± 1, then it said to be a perfect correlation: as one variable increases, the other variable tends to also increase (if positive) or decrease (if negative).

High degree: If the coefficient value lies between ± 0.50 and ± 1, then it is said to be a strong correlation.

Moderate degree: If the value lies between ± 0.30 and ± 0.49, then it is said to be a medium correlation.

Low degree: When the value lies below ± .29, then it is said to be a small correlation.
No correlation: When the value is zero'.

Table 14 presents each correlation estimation for all five hypotheses, p value and a sample size on which the below correlations are being estimated.

Table 14: Correlations Hypothesis Test

Hypotheses	Correlation Coefficient	Sig. (2-tailed)	Number of respondents	Test
$H_{1:}$	.337**	.000	103	Accepted
$H_{2:}$	.453**	.000	103	Accepted
$H_{3:}$	.306**	.002	103	Accepted
$H_{4:}$	.282**	.004	103	Accepted
$H_{5:}$	.377**	.000	103	Accepted

Source: Author's data

In the first hypothesis, the independent variable is the place and dependent variable satisfaction rate of respondents with the importance of facilities takes value of r = .337, N=103, p value is .000, p<.001which is less than 0.05. The above-mentioned variables were significantly and strongly and positively correlated. The null hypothesis that the correlation is 0 is rejected. It is accepted that there is a strong correlation between place and facilities in the performance of regional companies.

In the second hypothesis, the independent variable safe inventory and dependent variable inventory in general takes value r = .453, N=103, p value is .000, p<.001which is less than 0.05. Two variables were significantly, strongly and positively correlated. The null hypothesis that the correlation is 0 is rejected and it is accepted that there is a strong correlation in the performance of regional companies.

The third hypothesis, consisted of independent variable sources and dependent variable transportation r = .306, N=103, p value is .002, p<.001which is less than 0.05. Two variables were significantly and moderately positively correlated and the null hypothesis that the correlation is 0 is rejected.

The forth hypothesis, consisted of independent variable information and dependent variable annual turnover r = .282, N=103, p value is .004, p<.001which is less than 0.05. Two variables were significantly, strongly and positively correlated. The null hypothesis that the correlation is 0 is rejected and it is accepted that the information in supply chain performance has the major importance in driving factors of a regional company in Kosovo.

The fifth hypothesis, consisted of independent variable sources and dependent variable annual turnover r = .377, N=103, p value is .000, p<.001which is less than 0.05. Two variables were significantly and slightly positively correlated. The null hypothesis that the correlation is 0 is rejected and it is accepted that the sources provided by regional companies in supply chain performance impact the annual turnover of the companies.

4. CONCLUSION

The regional development of Kosovo has been and remains the focus of many policymakers who want to develop initiatives in order to increase the performance of the supply chain of regional companies through the development of economic zones, the creation of infrastructure and the provision of technological services. Despite these initiatives, regional companies in Kosovo are still characterized by low levels of entrepreneurial activity, low survival rate of small companies and lack of business skills by owners and managers of these companies. The World Bank emphasized that these challenges can be addressed through supply chain integration, which involves building capable relationships and processes within and across settlement boundaries. The logistics activity facilitates these relationships between the various role players in their supply chain by managing the six logistics drivers of the supply chain to coordinate the flow of products, services, and information. The purpose of this article was to investigate whether the management of supply chain logistics drivers can increase the chances of regional companies developing further.

Based on the data obtained from 103 regional companies in Kosovo, it was proven that the good management of the logistics drivers affects the increase in the performance of the companies and specifically in the increase in their annual income, and for this a descriptive statistical analysis was developed to identify their influence.

The results of the descriptive statistical analysis showed that the management of six supply chain logistics drivers affects the performance increase of regional companies. From the literature and data analysis, it results that the increase in performance is mainly influenced by the logistic manager of "information" which compared to other drivers in table 13 shows that the regional companies of Kosovo in over 55% of their respondents believe that "information" is the most important logistic driver, followed by the next driver with 16% "transportation", 12% facilities, 9% "resources", 7% "inventory" and only 1% "price". From the analysis of the questionnaire data, the importance of road transport in the performance of regional companies that practice it massively was highlighted.

Referring to the findings of this study, we can come up with some recommendations for the policy makers and institutions of Kosovo to be taken into account in the design of development policies for regional companies. The consideration of “information” as one of the six most important logistic drivers, increases the needs and demands of companies for national investments in technological and informational infrastructure in support of the digitalization of processes which will provide information in real time for effective decision-making. Also, the companies emphasize the need to develop the road infrastructure as a direct influence on the management of the supply chain.

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INTERRELATIONSHIPS BETWEEN HUMAN CAPITAL AND INTELLECTUAL CAPITAL: EVIDENCE FROM THE PANEL OF HIGH-INCOME AND LOW AND MIDDLE-INCOME GROUPS OF THE WORLD

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Abstract

The competitiveness in production sector is increasing significantly due to the openness of the economies in the world. Importance of intellectual capital (IC) thus has been mounting continuously and human capital formation (HCF) is considered as the main source of it. IC, an advanced version of human capital, is formed by the efforts upon research and development (RD) activities. It is a natural question whether HCF helps in the formation of intellectual capital in the countries of different status. Under the backdrop, the study examines the long-term relationship between intellectual capital and HCF 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. It employs panel unit root, panel cointegration and panel causality techniques for examining the long run associations and short run dynamics between human capital and intellectual capital for the two groups of the economies. The findings of the study 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. A one-unit increase in the change of HCF at period t-1 results in a 0.05 unit rise in the change of current year intellectual capital in the high-income group. The governments of the countries are suggested to make more human capital formation via increasing expenditures on both education and health sector to assure more intellectual capital.

Keywords: Human capital, intellectual capital, growth, panel cointegration, panel causality, high and middle income countries

JEL classification: R10, R11, O30, C33

1. Introduction

The historical growth records of the so called developed economies in the phase of the post-world war II has established the role of human as well as intellectual capital in the generation of human resource as well as helping the economies in boosting up their income levels. With the emergence of endogenous growth theory (1980's), the importance of intellectual capital in economic development has been increasing. Intellectual capital had a positive effect on organizational performance (Jardon and Cobas, 2021; Abualoush and Obeidat, 2018). The level of the development of intellectual capital determines the competitiveness of an economy (Dzhioev and Gurieva, 2019). Human capital is one of the most important resources in the economy because it allows people to respond to environmental changes in innovative ways (Kong, 2010). Furthermore, human capital is seen as crucial because it has an impact on an organization's performance (Bolen et al., 2005; Zeghal, Maaloul 2010; Rodrigues, Faria, Cranfield and Morais, 2013). De Pablos (2003) stated that the value of human capital is derived from its ability to improve the efficacy and

efficiency of enterprises, hence gaining a competitive advantage. As a result, human capital is regarded as the most important component of intellectual capital because the firm's existence is dependent on it (Kianto and Ritala, 2010).

Education spending, in particular, reflects human capital development because it can aid in advancing educational outcomes. The importance of education in expanding human capital stock has long been recognised, both theoretically and empirically (Scultz, 1960; Becker, 1964; Barro, 1991; Benhabib and Spiegel, 1994). Healthy individuals are more physically and psychologically fit than sick people, and they are expected to contribute more to production, boost productivity, and have a beneficial impact on human capital formation. Increases in health spending allow for increased supply of labour and productivity, which must eventually lead to increased wealth (Bleakley, 2010; Muysken, Yetkiner, and Ziesemer, 2003; Heshmati, 2001; Kurt, 2015; Elmi and Sadeghi, 2012). As a result, the present study focuses on two major drivers of human capital formation (HCF): government spending on education and health sector.

Intellectual capital is constituted by efforts on research and development which means all human capitals are not necessarily intellectual capital (Cohen & Levinthal, 1989). It is thus a natural question whether HCF helps in the formation of intellectual capital in all the countries of the world.

The present study evaluates the long-run relationship between intellectual capital and human capital formation separately taking the panel of some of the countries from the high-income group (HIG) and low and middle-income group (LMIG) for the period of 1998 to 2018 by employing panel cointegration and causality techniques for the groups. Countries belonging to the high-income group are: The Canada, United Kingdom, Ireland, Germany, Austria, Norway, Finland, Spain, Portugal, Hungary, Estonia and Cyprus. And countries belonging to the low and middle-income group are: Argentina, Armenia, Brazil, Azerbaijan, Belarus, Colombia, China, India, Kazakhstan, Mexico, Kyrgyz Republic and South Africa. The countries are selected on the basis of the data availabilities on the selected indicators for the period of the study. Table 1 presents the spatial/geographical identities of the selected countries in the world map.

Table 1. Geographical location of selected countries under HIG and MIG

HIG		LMIG	
Countries	**Geographical Location**	**Countries**	**Geographical Location**
Canada	North America	Argentina	South America
United Kingdom	North-western Europe	Armenia	Western Asia
Ireland	North-western Europe	Brazil	South America
Germany	Western Europe	Azerbaijan	Eastern Europe
Austria	Central Europe	Belarus	Eastern Europe
Norway	Northern Europe	Colombia	South America
Finland	Northern Europe	China	Central Asia
Spain	South-western Europe	India	South Asia
Portugal	South-western Europe	Kazakhstan	Central Asia
Hungary	Central Europe	Mexico	North America
Estonia	Northern Europe	Kyrgyzstan	Central Asia
Cyprus	Western Asia	South Africa	Africa

Note: The countries belong to high income and middle income groups are as per the World Bank.

Source: Prepared by the authors using world map

2. Review of Literature

The extant literature mainly reveals the studies on the impacts of human and intellectual capitals on the income growth and other sectors but studies on the associations between human capital and intellectual capital are too limited. The present study reviews some of the related literatures for the purpose of finding the research gaps.

Rodrigues et al. (2015) investigated the impact of intellectual capital on product and process innovation and concluded that, only human capital was an essential component of intellectual capital which had a direct and positive impact on product and process innovativeness. According to Bontis (1998), there was a large and meaningful causal relationship between several aspects of intellectual capital and corporate performance. These findings ought to make it easier for academics and professionals to comprehend the parts of intellectual capital and offered guidance on fostering and boosting it within a corporation. Dzhioev and Gurieva (2019) studied the impacts of intellectual capital on company's performance in developed and emerging markets and discovered that intellectual capital had a beneficial impact. According to Sullivan (2000), intellectual capital was a valuable resource for many businesses, and a company could profit from the advantages that intellectual capital would provide. He proposed two types of strategies for extracting the value of intellectual capital: tactical (short-term) and strategic (long-term), with strategic value extraction generally concerned with intellectual capital. According to Bukowska (2019), the most influential multinational firms were all aware of the expanding significance of intellectual capital in business of today, which was defined as the activation of cross-border transfers of human capital.

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. The consequences of innovative activities on the process of regional convergence were elucidated by Korres and Kokkinou (2011). 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.

Lu, Kweh, and Huang (2014) attempted to evaluate the R&D efficiency and economic efficiency of the national innovation system (NIS) in 30 nations from 2007 to 2009, and found that the R&D efficiencies of the NIS outperformed the economic efficiencies. It discovered that intellectual capital had substantial impacts on NIS performance. For 328 high-tech enterprises in China, Wang and Wang (2016) investigated the effects of intellectual capital and knowledge management on company performance. They discovered that the more a firm's intellectual capital matches its knowledge management strategy type, the better its operational and financial success.

Todericiu and Serban (2015) investigated the significance of intellectual capital in educational institutions and its relevance and found that educational institutions, such as universities, was the gateway for intellectual capital since human capital was generated there and used to produce high-quality research outcomes. Also Secundo, Lombardi and Dumay (2018) looked at the relevance of intellectual capital in education, arguing that treating educational institutions as investors within a wide variety of platforms could assist to tackle societal concerns.

The best reason to measure intellectual capital is to consider the risks of not measuring it (Konticand Cabrilo, 2009). Labor shortages, skill mismatches, ability avoidance to rivals, and low productivity are just a few of the repercussions of failing to assess intellectual capital indicators. In spite of this, Zeng, Tan, and Liu (2021) discussed the rationale for regional differences in intellectual capital and proposed how economic development could be achieved by dividing intellectual capital into human, structural and relational capital, finding that structural capital had the greatest impact on GDP of all types of capital. They do, however, proposed that human capital should be considered while increasing intellectual capital. In a knowledge-based economy, education is a prerequisite for building human capital on a national, organizational, and individual level. The mechanism that underlies the operation of the contemporary labour market includes accumulated educational capital. It will be challenging for graduates to obtain a satisfying job in their profession if the profile of educational career capital is not tailored to the profile of requirements stated by the labour market (Małajowıcz and Tęcza, 2019).

Lopez et al. (2011) examined whether it was possible to measure development and management of knowledge in a country using indicators of intellectual capital, such as human capital and structural capital, using a cross section series of 2006 for 82 countries, and found

that structural factors were more closely related to a country's wealth, while human capital did not contribute significantly to economic development. On the other hand, Perez et al. (2012) tried to explain the impact of human capital on the innovation capacity of companies where they found human capital, the element of intellectual capital, contributed to the innovation capacity of companies. Beyer and Leonski (2017) studied that, human capital management was difficult since it was difficult to control further because it was not a company's property. Also the study found that, barrier to efficient human capital management might be a lack of infrastructure to facilitate the process of information sharing, and suggested that a proper motivational strategy should be offered by human capital management to promote employee loyalty and job satisfaction. Alfaro et al. (2011) used human capital and structural capital as intangible assets to estimate the worth of a nation's intellectual capital. They found that the relationships between wealth and efficiency in the management of intangibles were always positive, with the case of image, processes, human administration, and R&D having the greatest significance. In the words of Bradley (1997), 'intellectual capital is the capacity to transform knowledge and intangible assets into resources that can be used to create wealth for both organizations and governments'.

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. More attention was paid to the effects of higher education by Bajrami and Leka (2020). 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. Malesevic Perovic 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. Avdi (2013) concentrated on the health insurance system's contribution structure. Little economic development and a challenge that Albania had already started to face are the primary economic factors. One of Albanian politics' biggest issues had been and will continue to be the need for healthcare reform.

Alawamleh et al. (2019) studied how innovation and human capital investment contributed to Jordan's economic development. They argued that a beneficial influence on a country's economy might be done by improving the educational system (by doing more practical things), providing more possibilities for young people, and decreasing power distance. Dias and Tebaldi (2012), on the other hand, used cross-country panel data from 1965 to 2005 to describe the development process of an economy by focusing on the relevance of institutions for human capital accumulation. In general, they discovered that structural institutions had a long-term favorable influence on economic growth, however more gains might be achieved by increasing the pace of human capital growth. There is a list of studies on the interrelationships between R&D activity, a source of knowledge capital, economic growth and innovative capital, and trade liberalizations in worlds leading countries that demonstrate no linkage from R&D to income, etc, and the employment generating factors in the phase of globalization. (Das and Mukherjee, 2019; Das & Ray, 2019; Das, 2020; Das and Chatterjee, 2020; Rahmi & Alliasuddin, 2020; Myzrova et al, 2020).

Todericiu and Serban (2015) investigated the role of intellectual capital and its significance for education institutions. They considered educational institutions like universities to be a linkage of intellectual capital because human capital was generated there in accomplishing high quality research outcomes. Career capital was the subject of study by Yavuz Aksakal (2020), which was conducted with the understanding that it could be treated as a distinct essential factor. Career capital is a stock built up along the path created by individual qualities, whereas a career is a path in which all of a person's traits form and change as a result. Cesen (2014) studied whether the gender gap in intellectual capital was responsible for the limited impact of innovation on productivity, though now-a-days labour market by gender shows high participation rate of woman, high educational involvement and success, but there was a persistent pay gap due to inferior positions in the work hierarchy. Uno and Kobayashi (2012) analysed the relationship between education and economic growth from the view point of human capital among emerging BRIC countries, and human capital considered as the important tool for keeping high productivity. They showed that higher quality of education brought to the positive effect on economic growth in these countries.

3. Rationale and Objective of the Study

According to the available studies, intellectual capital plays a key role in an economy's competitiveness since it has a significant influence on an organization's performance. As the human capital is a primary component of intellectual capital, no study so far was there on analyzing interrelationships between human and intellectual capitals. The present study aims to investigate empirically the existence of long-term interaction between intellectual capital and human capital accumulation for the countries from some of the high-income group (HIG) and low and middle-income group (LMIG), applying the tools of panel cointegration and causality test for the period 1998-2018.

4. Hypotheses of the Study

a. Is there any short-run and long-run relationship between human capital formation and intellectual capital formation in the countries under the panel of high and middle income groups?

b. Does human capital formation make a cause to the intellectual capital formation in the panel of both the high and middle income groups?

5. Theoretical Background

First, we consider the generation function of IC with the help of HCF by the following functional form given the other factors affecting IC.

1. $IC = f(HCF)$ *where* $f' > 0$ *and* $f'' < 0$.

The growth rate of IC ($dIC/dt/IC = (IC)^{\cdot}$) is proportional to the growth rate of HCF ($(HCF)^{\cdot}$). Here a dot in the top of the variables signifies the growth rate over time of that particular variable.

The production function using the Lucas version of endogenous growth with IC is thus-

2. $YIC = AK^{\alpha}L^{\beta}[IC(HCF)]^{1-\alpha-\beta}$

And that for using HCF is-

3. $YHCF = AK^{\alpha}L^{\beta}(HCF)^{1-\alpha-\beta}$

Where, $0 < \alpha, \beta < 1$, making the diminishing returns to each of the single factors. Further, K and L are the units of physical capital and physical labour respectively. In both the production functions, having $0 < 1-\alpha-\beta < 1$, there are increasing returns to scale making the growth of output larger than the production function having no such human capital factors, HCF or IC. Since IC is the advanced form of the HCF, hence the growth of output under HCF will be lesser than that under IC, or, $(YIC)^{\cdot} > (YHCF)^{\cdot}$. Hence it is justifiable why the policy makers should think of IC besides HCF.

6. Variables and their Measurements

Research and Development Expenditure (RD) [% of GDP current US dollar] is selected as the proxy variable of Intellectual Capital as it is the advanced form of human capital. The Human Capital Formation (HCF) is taken by summation of two heads- government expenditure on education, total (% of GDP in current US dollar) and domestic general government health expenditure (% of GDP in current US dollar).

[1] Research and Development Expenditure (RD) includes both capital and current expenditures in the four main sectors: Business enterprise, Government, Higher education and

Private non-profit. RD covers basic research, applied research, and experimental development.

[2] General government expenditure on education (current, capital, and transfers) is expressed as a percentage of GDP. It includes expenditure funded by transfers from international sources to government. General government usually refers to local, regional and central governments.

[3] Public expenditure on health from domestic sources as a share of the economy as measured by the GDP.

7. Data Source

The data regarding the variables under study, GDP current US dollar, Research and Development Expenditure (RD), Government Expenditure on Education and Government Expenditure on Health, are taken from the World Bank Open Data (https://data.worldbank.org).

8. Empirical Methodology

The study uses extensive empirical tools and techniques for the examinations of the above-mentioned objectives. They are briefly outlined below.

8.1. Cross Sectional Dependence Test

Investigating the cross-sectional dependency in the panel data is essential before examining the stationary features of the analysed variables. Without considering it, the cross-sectional dependency in the data may lead to inaccurate findings if the first generation unit root and cointegration techniques are applied. Taking the model as-

4. $(RD)_{it} = \theta_{ij} + \lambda_i (HCF)_{it} + \eta_{it}$

There may be the possibility of cross sectional dependency across states. This study does so by utilising the cross-sectional dependency and Lagrange multiplier (LM) techniques, both of which were proposed by Breusch and Pagan (1980) and Pesaran (2004), respectively.

5. $CD = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=0}^{N-1} \sum_{j=i+1}^{N} r_{ij}$

Where, N indicates the cross-sections (number of states) in the panel, T represents the total time periods and r_ij implies the cross-sectional correlation of residual of equation-1 between i and j. The null hypothesis (H0: r_ij=0 for i ≠j) explains that there does not exists any cross-sectional dependency in the panel. Since the results shows that there is no presence of cross sectional dependency in the panel of both high income group and middle income group, thus the study continues along with first generation methods of panel unit root and causality test.

8.2. Panel Unit Root Test

The result of the panel unit root test is determined by applying Levin, Lin & Chut* statistic; Im, Pesaran and Shin W-statistic; Fisher Chi-square test and finally Hadri Z-statistic to check the stationarity of the variables.

Levin et al. (2002) (LLC) used the ADF equation as-

6. $M\Delta Y_i = \mu_i Me + \rho M Y_{it-1} + \sum_{j=1}^{p_i} \beta_{ij} M \Delta Y_{it-j} + M\varepsilon_i$

Where M is idempotent matrix and the null hypothesis that each individual time series contains a unit root in contradiction of the alternative hypothesis that each time series is stationary, H1: $\rho < 0$. The test statistics is specified as-

7. $t_\rho = \frac{\sum_{i=1}^{N} \hat{\sigma}_i^{-2} \Delta Y_i' MY_{I,-1}}{\sqrt{\sum_{i=1}^{N} \hat{\sigma}_i^{-2} \Delta Y_i' MY_{I,-1}}}$

where $\hat{\sigma}_i^2 = \frac{\Delta Y_i' MY_i}{T-2}$.Using the likelihood technique, Im, Pesaran, and Shin (2003) (IPS) construct a more flexible and computationally simple unit root test for panels. The ADF tests make up the IPS test. The alternative hypotheses used in this test are H_1: $\rho_1 < 0, \rho_2 < 0$, …., $\rho_{N1} < 0$, where $N_1 < N$. The test statistic is $\bar{t} = \frac{1}{N}\sum_{i=1}^{N} t_i$ where t_i is the Dickey–Fuller t-statistic of cross section unit i and is assumed to be i.i.d. with finite mean and variance and $t_i = \frac{\Delta Y_i' MY_{i,-1}}{\hat{\sigma}_i^2 \sqrt{\Delta Y_i' MY_{i,-1}}}$. Individual ADF test statistics can have different levels of significance using the Fisher (1932)-type test. Assume we wish to test the identical hypothesis that was tested in the IPS test H_0: $\rho_i = 0$ for all i = 1, …, N against the alternative hypothesis H_1: $\rho_i < 0$ for i = 1, … N_1 and $\rho_i = 0$ for i = N_1+ 1, …, N, with $0 < N_1 \leq N$. The Fisher-type test statistic in Choi (2001) model is $P = -2 \sum_{i=1}^{N} \log(P_i)$. Breitung (2005) applied the pooled proxy equation as $\Delta Y_{it}^* = \rho Y_{it-1}^* + v_{it}$ where $Y_{it}^* = \tilde{Y}_{it} - \tilde{Y}_{i1} - \frac{t-1}{T-1}(\tilde{Y}_{iT} - \tilde{Y}_{i1})$. Under the null, the ensuing estimator $\rho^*$is asymptotically distributed as a standard normal. It necessitates only a specification of the number of lags used in each cross-section ADF regression, ρ_i, and the exogenous regressors. Hadri (2000) LM test is based on residual. The stationary null hypothesis means the variance of the randomwalk equals zero. Therefore, in Hadri LM test the hypothesis can be stated as H_0: $\lambda = \frac{\sigma_u^2}{\sigma_e^2} = 0$ and H_1: $\lambda > 0$. The LM statistic is-

8. $LM = \frac{1}{\hat{\sigma}_e^2} \frac{1}{NT^2} \left(\sum_{i=1}^{N} \sum_{t=1}^{T} S_{it}^2 \right)$.

Here Levin, Lin & Chu t*; Breitung t-stat and Hadri Z-stat assumes common unit root process and in contrast of these Im, Pesaran and Shin W-stat; ADF-Fisher Chi-square and PP-Fisher Chi-square assumes individual unit root process.

8.3. Panel Cointegration Test

Pedroni (1999, 2004) proposes a set of cointegration tests that account for varied intercepts and trend coefficients across cross-sections. Following the regression-

9. $Y_{it} = a_i + b_i t + \beta_{1i} X_{1i,t} + \beta_{2i} X_{2i,t} + \ldots + \beta_{Zi} X_{Zi,t} + e_{it}$

Where Y denotes investment in research and development (RD), X implies human capital formation (HCF), t = 1,..., T; i = 1,..., N; z = 1,..., Z; Y and X are assumed to be I (1). The parameters $a_i$andb_i, which can be set to zero if desired, regulate individual and trend effects. The residuals e_{it} will be I(1) under the null hypothesis of no cointegration and the auxiliary regression of the residuals are$e_{it} = \rho_i e_{it-1} + \sum_{j=1}^{\rho_i} \phi_{ij} \Delta e_{it-j} + v_{it}$.For each cross-section, Pedroni describes various methods of constructing statistics for testing for null hypothesis of no cointegration ($\rho_i = 1$) against the two alternative hypotheses- homogenous alternative, ($\rho_i = \rho$) < 1 for all i (within-dimension test or panel statistics test)and the heterogeneous alternative, $\rho_i < 1$ for all i (between-dimension or group statistics test).Under the null of no cointegration, Kao shows that following augmented version statistic, for ρ > 0,

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

Fisher (1932) derives a combined test that uses the results of the individual independent tests. If Ω_i is the *p*-value from an individual cointegration test for cross-section, then under the

null hypothesis for the panel is -2 $\sum_{i=1}^{N} \log(\Omega_i) \rightarrow \chi^2 2N$. Based on MacKinnon-Haug-Michelis (1999) p-values, EViews defaults to reporting the χ^2 value for Johansen's cointegration trace test and maximum eigenvalue test.

8.4. Wald Test

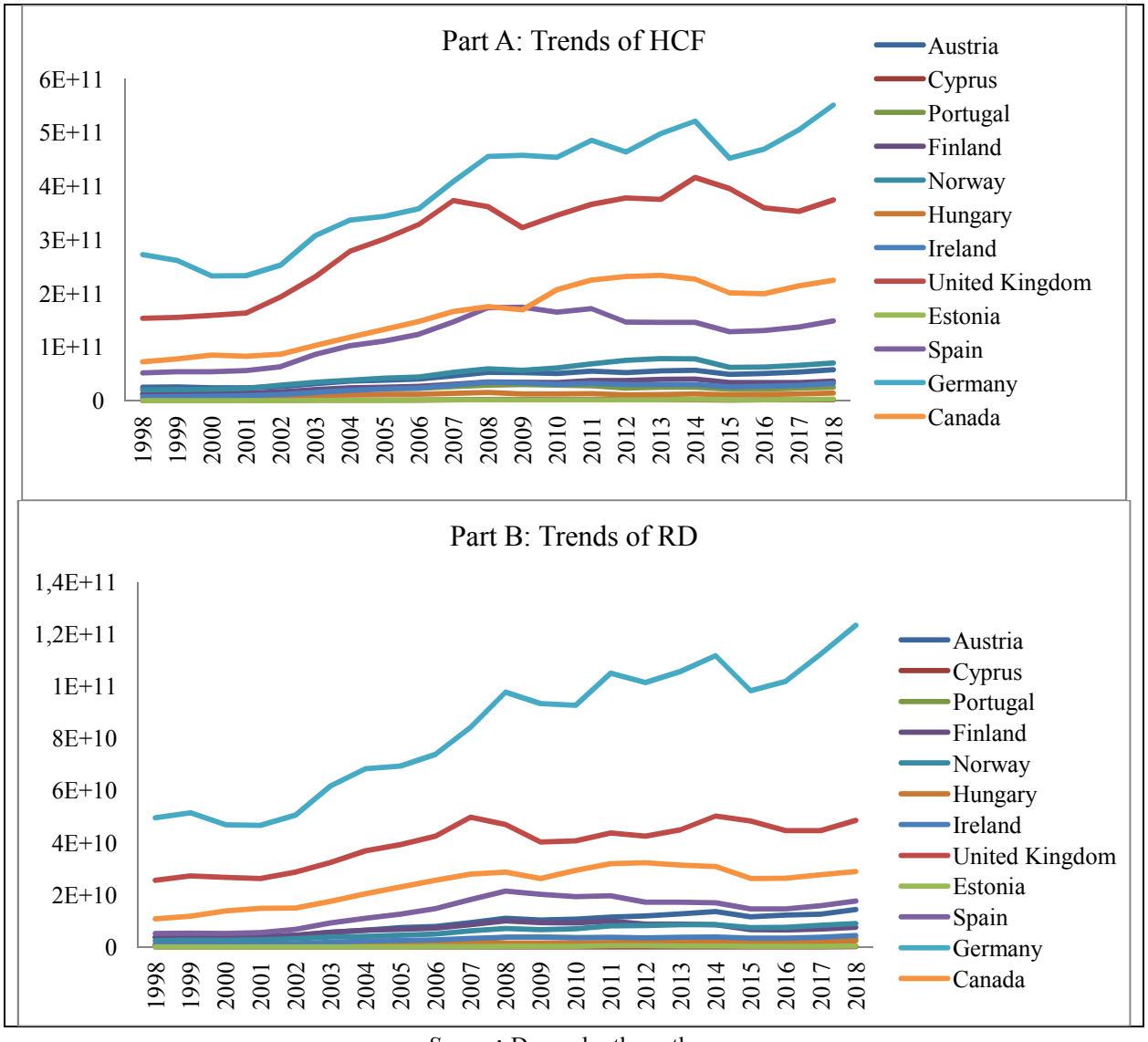
Once the existence of co integration between variables is established, the next step is to develop a vector error correction mechanism to describe dynamic relationships. The Vector Error Correction Model's goal is to show how quickly a system adjusts from short-run equilibrium to long-run equilibrium. Finally, the Wald test is used to demonstrate short-run causality between independent and dependent variables.

9. Empirical Results and Discussion

9.1. Graphical presentation of the variables

The patterns of the series HCF and RD for both high and low and middle income countries, as illustrated in both the parts of Figure 1 and Figure 2, show that the two series move in the upward directions side by side, which may establish meaningful long-term relations between the production of human capital and intellectual capital. Additionally, there are some parallel features between the fluctuations in the two series, which prompts us to look into whether there are causal interactions in the short runs.

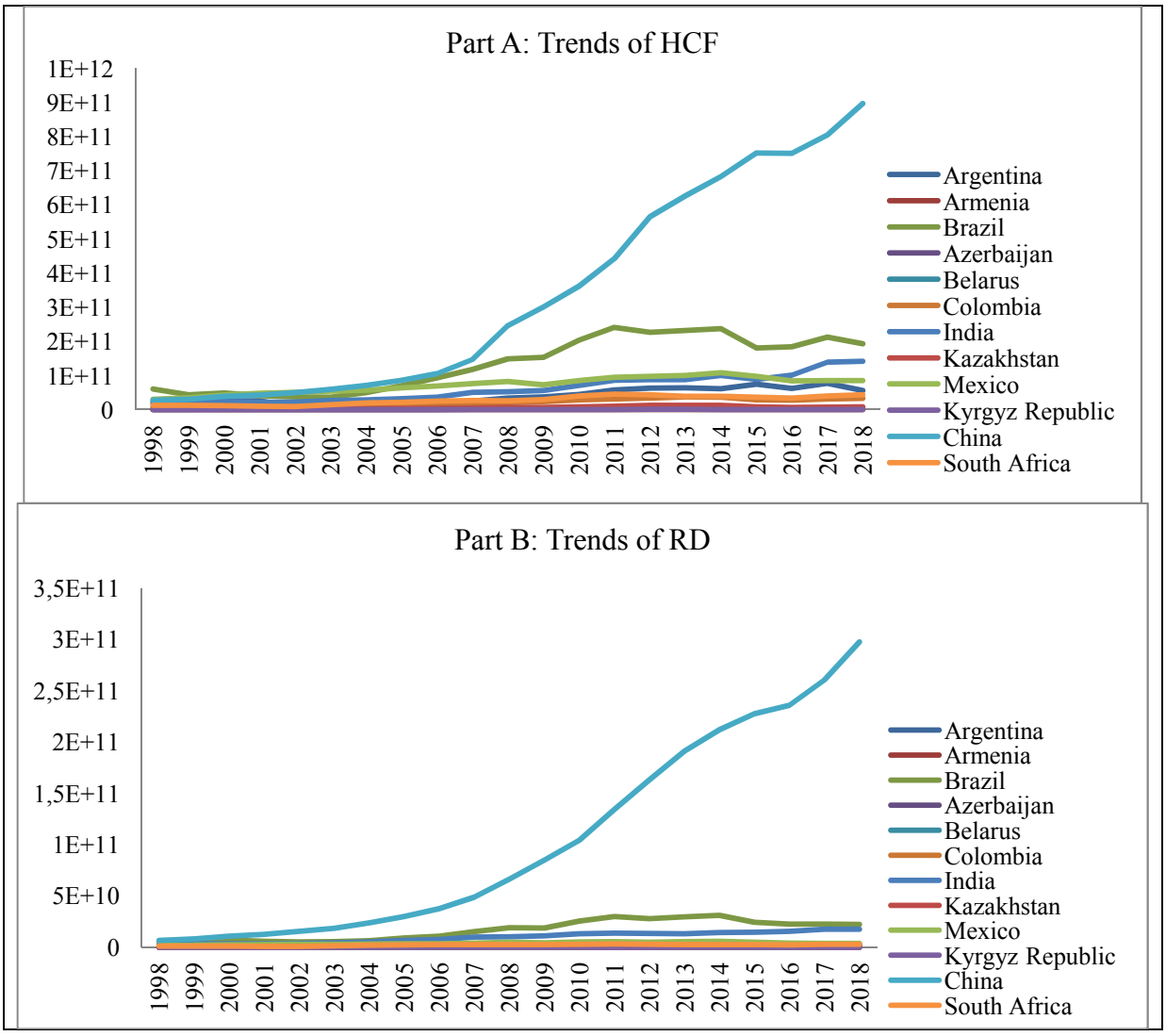
Figure 1. Trends of HCF and RD of high income countries



Source: Drawn by the authors

The levels of both HCF and IC are larger in the countries in the HIG compared to that of the LMIG, although the case of China is different as its level values are greater than Germany, the highest value holders in the HIG. China belongs to the LMIG as because its per capita GDP is far below than the average per capita GDP of the countries from the HIG. The important point is that the countries from the LMIG are progressing at the greater rates in HCF and IC compared to that of the countries from the HIG.

Figure 2. Trends of HCF and RD of low and middle income countries



Source: Drawn by the authors

Out of the countries from the LMIG, Brazil and India follow China in to some extent in respect to the HCF and IC. South Africa stands at the bottom line.

9.2. Cross-sectional dependence test

The findings of the LM tests conducted by Breusch and Pagan (1980) and Pesaran (2004) are shown in Table2. The Pesaran scaled LM and CD test statistics are not significant ($p > 0.10$), while the Breusch-Pagan LM statistic has been shown to be significant ($p < 0.01$).

Table 2. Residual cross section dependence test results

HIG	Statistics	df	Probability
Breusch-Pagan LM	116.5680	45	0.0000
Pesaran scaled LM	05.43895		0.1143
Pesaran CD	0.340253		0.7337
MIG	Statistics	df	Probability
Breusch-Pagan LM	362.7028	45	0.0000
Pesaran scaled LM	05.3321		0.1021
Pesaran CD	03.1423		0.3642

Note: HIG-High-income group; MIG-Middle-income group
Source: Authors' calculations

Thus, taking into account the majority of the findings, the study came to the conclusion that there was no cross-sectional dependence between investment in research and development (RD) and the formation of human capital (HCF) among the countries under study, both for the high income group and the middle income group, in the heterogeneous panel data. Thus the study conducted the first generation panel unit root, cointegration and causality test methods as follows.

9.3. Panel unit root test results

When the variables RD and HCF are considered in their first differences for both the high-income and middle-income groups, the findings reject the unit-root hypothesis (Table3). It means that the series RD and HCF for both the high-income and middle-income groups are stationary in first difference, i.e., they are integrated of order one, I(1).

Table 3. Panel unit root test results for HIG and MIG

Exogenous variables: Individual effects, individual linear trend
Automatic lag selection based on SIC: 0 to 2 for RD and 0 to 1 for HCF (For HIG)
: 0 to 1 for both RD and HCF (For MIG)
Cross-sections: 10

Series D(RD)		HIG		MIG	
Hypotheses	Methods	Statistic	Prob	Statistic	Prob
H_0: Unit root (Assumes common unit root process)	Levin, Lin & Chu t*	-5.41397	0.0000	-5.98761	0.0000
	Breitung t-stat	-3.02525	0.0012	-4.05989	0.0000
H_0: Unit root (Assumes individual unit root process)	Im, Pesaran and Shin W-stat	-4.32971	0.0000	-4.50430	0.0000
	ADF-Fisher Chi-square	51.3669	0.0001	56.7117	0.0000
	PP- Fisher Chi-square	40.3862	0.0045	60.6371	0.0000
H_0: No unit root (Assumes common unit root process)	Hadri Z-stat	6.08393	0.0000	7.15411	0.0000
Series D(HCF)					
Hypotheses	Methods	Statistic	Prob	Statistic	Prob
H_0: Unit root (Assumes common unit root process)	Levin, Lin & Chu t*	-6.78229	0.0000	-6.78229	0.0000
	Breitung t-stat	-4.48721	0.0000	-4.48721	0.0000
H_0: Unit root (Assumes individual unit root process)	Im, Pesaran and Shin W-stat	-3.92892	0.0000	-3.92892	0.0000
	ADF-Fisher Chi-square	46.8619	0.0006	46.8619	0.0006
	PP- Fisher Chi-square	43.9000	0.0016	43.9000	0.0016
H_0: No unit root (Assumes common unit root process)	Hadri Z-stat	2.14612	0.0159	2.14612	0.0159

Note: HIG-High-income group; MIG-Middle-income group
Source: Author's calculations

9.4. Results of lag length selection

The variables RD and HCF are now rendered stationary for both high-income group and middle-income group, the study then test for the existence of a cointegrating relationship between these two variables. The Lag Selection Criteria test is used to determine the lag duration before analysing the cointegration test. Three lag length selection criteria have been

employed in this study to assess the optimum autoregressive (AR) lag length of our variables-Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC) and Hannan-Quinn Information Criterion (HQIC).The results are given in Table4.

Table 4. Results of lag length selection criteria for HIG and MIG

	HIG			MIG		
Lag	AIC	SIC	HQIC	AIC	SIC	HQIC
0	99.26	99.29	99.27	101.67	101.71	101.68
1	92.22	92.33	92.27	93.47	93.58	93.51
2	92.14	92.34	92.22	93.34	93.54	93.42
3	91.68	91.94	91.78	93.36	93.63	93.47
4	91.59	91.94*	91.73*	93.06	93.40*	93.20*
5	91.57*	91.99	91.74	93.04*	93.46	93.21

Note: * implies the criterion's chosen lag order.
HIG-High-income group; *MIG*-Middle-income group; *AIC*: Akaike information criterion; *SIC*: Schwarz information criterion; *HQIC*: Hannan-Quinn information criterion
Source: Author's calculations

It is observed that at lag four, two criteria, SIC and HQIC, yield the lowest values, implying that the four-year-lag factors have a considerable impact on the present period's values of the variables in the panel.

9.5. Panel Cointegration Test Results

The Pedroni and Kao tests, which are based on the Engle Granger residual test and the Fisher Johansen test, are used in this panel cointegration investigation. Individual intercepts are taken into account when performing the Pedroni and Kao tests. The results are given in Table5.

Table 5. Panel cointegration test results for HIG and MIG

		HIG		MIG	
	Methods	Statistic	Probability	Statistic	Probability
Pedroni(Individual intercept)	Panel v-Statistic	3.1570	0.0008	-1.1718	0.8794
	Panel rho-Statistic	-1.2917	0.0982	1.3788	0.9160
	Panel PP-Statistic	-0.9587	0.1688	1.3950	0.9185
	Panel ADF-Statistic	-3.0724	0.0011	-1.8966	0.0289
	Group rho-Statistic	1.9759	0.9759	1.4601	0.9279
	Group PP-Statistic	2.6084	0.9955	1.1786	0.9279
	Group ADF-Statistic	-0.0377	0.4850	-1.0825	0.8807
Kao	ADF- Statistic	-3.4487	0.0003	-2.9886	0.0014
Fisher (Combined Johansen)	Fisher Stat (Trace)	144.8	0.0000	187.2	0.0000
	At most 1	59.18	0.0000	94.67	0.0000
	Fisher Stat (Max. Eigenvalue)	125.5	0.0000	157.0	0.0000
	At most 1	59.18	0.0000	94.67	0.0000

Note: HIG-High-income group; MIG-Middle-income group
Source: Authors' calculations

The majority of statistics in the Pedroni panel cointegration test cannot reject the null hypothesis of no cointegration in both the high-income and middle-income groups. This means that there is no long-term association between the variables HCF and RD for both groups in this test. According to the Kao ADF-Statistic and Fisher combination tests, the null hypothesis of no cointegration is rejected for these two groups at a significance level of less than one percent. There is a long-term relationship between HCF and RD in these two categories, according to these statistics. Considering Pedroni, Kao and Fisher combined test, the last two test results reject the null hypothesis of no cointegration. The study, therefore, concludes that the two unit root variables RD and HCF are cointegrated. In other words, there is a long-run relationship between human capital formation and intellectual capital in the panel of nations belonging to both the high-income and middle-income groups. The increase in expenditure on education and health sector aggravates human capital formation and thus has a permanent effect on the intellectual capital for high income nations as well as middle income nations. The stable relation between human capital formation and intellectual capital

formation supports the argument of extension version of human capital theory by Nerdrum and Erikson (2001).

9.6. Vector error correction model estimation

The VEC model is built in the following procedure to analyse the dynamics of long run associations in the panel of nations for both high-income group and middle-income group, using a four-year lag (as the lag length selection criteria shown in Table4). The model is-

11. $\Delta RD_t = \lambda\hat{\varepsilon}_{t-1} + \pi_1\Delta(RD)_{t-1} + \pi_2\Delta(RD)_{t-2} + \pi_3\Delta(RD)_{t-3} + \pi_4\Delta(RD)_{t-4} + \mu_1\Delta(HCF)_{t-1} + \mu_2\Delta(HCF)_{t-2} + \mu_3\Delta(HCF)_{t-3} + \mu_4\Delta(HCF)_{t-4} + C$

Table 6. The estimated coefficients of VEC model for HIG and MIG

	HIG		MIG	
	Value	Probability	Value	Probability
λ	0.0581	0.2360	0.0122	0.2626
π_1	0.2035	0.2319	0.3990	0.0000
π_2	-0.8498	0.0000	-0.1086	0.1391
π_3	0.2795	0.1735	0.5461	0.0000
π_4	-0.4736	0.0264	-0.4312	0.0002
μ_1	0.0479	0.0558	0.0039	0.6105
μ_2	0.0306	0.2212	-0.0033	0.6866
μ_3	0.0254	0.3316	0.0064	0.4517
μ_4	0.0305	0.2577	-0.0012	0.8897
C	287754860.47	0.0045	137492942.20	0.1010

HIG-High-income group; MIG-Middle-income group

Source: Authors' calculations

The coefficient of $\hat{\varepsilon}_{t-1}$ is positive but not significant both in panel of high-income nations and middle-income nations. The positive coefficient of $\hat{\varepsilon}_{t-1}$ (λ= 0.0581) implies the long-run stable relationship wouldn't be restored (Table6). The coefficient of ΔHCF such as μ_1, μ_2, μ_3 and $\mu_4$corresponding to t-1, t-2, t-3 and t-4 gives the short-run relationship between research and development and human capital formation. Individual coefficients are found to be statistically insignificant, with the exception of μ_1 for the high-income group, indicating the absence of short-run causation from human capital formation to research and development. The current study used the Wald test to assess the short-run causality running from human capital formation to research and development, and the results are shown in Table7.

The null hypothesis and alternative hypothesis for the panel causality test are respectively as-

H_0: No short-run causality running from HCF to RD and H_1: There is short-run causality running from HCF to RD

Table 7. Wald test results

	HIG			MIG		
Test Statistic	Value	df	Probability	Value	df	Probability
Chi-square	15.01803	4	0.0047	0.729095	4	0.9477

HIG-High-income group; MIG-Middle-income group

Source: Authors' calculations

The results in the table clearly show that there is short term causal interplay in the direction from human capital formation to intellectual capital of the panel of nations for high-income group as because the p-value is at the less than 1% level of significance. It is insignificant for the middle-income group. The coefficient of the lag terms of HCF, μ_1, is shown to be positive and significant for the high-income group, indicating the positive degree of influence of human capital formation on intellectual capital formation of panel of nations. A one-unit increase in the change of HCF at t-1 lag period results in a 0.05unit increase in the change of current-year intellectual capital in the high-income group. Hence, it is reasonable to conclude that human capital formed in high-income countries is one of the causes of increases in the intellectual capital formation. The huge growth history of the so called developed economies could thus be explained with the generation of large intellectual capital formation. The medium and low income countries will thus have to go for continuous investment on human capital formation and converting them into intellectual capitals to make them at par with the world's high income countries.

10. Conclusion and Policy Recommendations

Intellectual capital has been increasingly essential in the production process in recent years, since it drives market innovation. Human capital formation is thought to be the primary source of intellectual capital growth. As a result, the current panel analysis presents empirical evidence on the inter-relationship between human capital investment and intellectual capital for a panel of high-income and middle-income countries from 1998 to 2018. In this regard, the study employed the panel cointegration approach to establish long-run relationship, followed by the Wald test to prove short-run causality between intellectual capital and human capital. Both high-income and middle-income groups exhibit a long-run relationship between intellectual capital and human capital, according to the empirical findings. However, using the Wald test, it was shown that there is a short-run association between human capital investment and intellectual capital, with the causation going from human capital investment to intellectual capital only for a panel of high-income countries. To ensure larger intellectual capital, governments should adopt policy to increasing investments in human capital via education and health spending.

Because of the empirical findings which reveal that there is a long-run positive relationship between intellectual capital and human capital production, the government should place a greater emphasis on human capital by increasing expenditure in both education and health sector. As the immediate influence of human capital on intellectual capital arises in high-income countries, it makes sense for middle-income countries to increase their economy in order to catch up the high-income countries through investment in HCF as well as to IC formation.

11. 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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Announcements, Conferences, News

AMERICAN ECONOMIC ASSOCIATION

ASSA 2023 Annual Meeting
January 06 -08 2023 | New Orleans, USA

Event Overview[1]

The **American Economic Association** (AEA), which was established in 1885, is a non-profit, non-partisan, scholarly association dedicated to the discussion and publication of economics research. The Association currently **counts over 20,000 members** from academic, business, government, and consulting groups, within diverse disciplines from multicultural backgrounds.

The AEA is dedicated to economics research and teaching and supports established and prospective economists with a set of career-enhancing programs and services. The AEA, in conjunction with 64 associations in related disciplines known as the **Allied Social Science Associations** (ASSA), holds a three-day meeting, each January, to present papers on general economics topics.

Over 13,000 of the best minds in economics are assembled to network and celebrate new achievements in economic research.

The meeting is generally organized as follows:

- **Program:** Offers in-depth coverage of economics topics across many disciplines via hundreds of speakers and panels.
- **Job Interviews:** The concurrent economics job fair brings together thousands of job-seekers and recruiting companies in pre-registered interview sessions.
- **Special Events:** The Presidential Address, award presentations, lectures, and many networking opportunities are also part of the experience.
- **Proceedings:** The American Economic Association publishes a Papers and Proceedings edition, in May, highlighting selected papers from the meeting, and a limited number of sessions are featured on webcasts.
- **Exhibit Hall:** Meet representatives offering specialized products and services serving economists and those in related disciplines

ASSA is the premier event to expose scientific and research work with colleagues and hear about the latest research emerging in the field. Economists from around the world take advantage of this unique opportunity to share, collaborate, and learn... all in one place.

The **upcoming meeting** is **scheduled** to be held in **New Orleans, USA, on 6-8 January 2023 (Friday to Sunday)**. The headquarters hotel is the Hilton Riverside. Sessions proposals and papers were submitted electronically (submissions are no any more available), via the American Economic Association website, until April 15, 2022. Information about the upcoming 2022 annual meeting is announced on the AEA website (https://www.aeaweb.org) as it becomes available for presenters, attendees, and exhibitors.

[1] **Event overview edited by Dimitrios Tsiotas, Assistant Professor, RSI J**

Conference_2 62nd Annual Meeting of WRSA
February 15-18, 2023 | Big Island, Hawaii

Event Overview[2]

The 62nd Annual Meeting of the **Western Regional Science Association** (WRSA) will be held in Big Island, Hawaii from Feb 15th to Feb 18th, 2023. The **Regional Science Association International** (RSAI), founded in 1954, is an international community of scholars interested in the regional impacts of national or global processes of economic and social change. The meeting hotel is Hilton Waikoloa Village, located on Big Island. The Meeting should cover (but is not restricted to) several topics such as *Resource Utilization; Impact Analysis; Regional Modeling; Location of Economic Activity; Housing; Regional & Urban Planning; Environmental Quality; Regional Development; Migration and Demographic Analysis; Transportation; Locational Criteria for Public Services & Facilities; Tourism & Recreation; Local Public Finance; Energy Issues; Regional Science Epistemology & Pedagogy;* and *Urban & Regional Resilience*.

The paper submission for the Meeting is available online, through the WRSA's website https://www.wrsaonline.org/newsite/userarea/UserArea.php, with a deadline of 30 November 2022. No deadline extensions are further possible. Program invitations are only issued based on full paper submissions, not abstracts or outlines. Candidacies for the Tiebout Prize Competition will follow the initial deadline of 15 October 2022.

WRSA is seeking several students to assist with meeting registration in Big Island, HI. In exchange for 10-15 hours of volunteering at the registration desk, students will receive a complete rebate of their preregistration fees (to be processed as a refund following the meeting). Additionally, volunteering students will be able to benefit from a discounted daily staff room rate (with a roommate volunteer).

The Meeting will also host Session Chairs and Paper Discussants even without presenting a paper. Interested scholars that wish to be assigned a session chair role or paper discussant duties should contact the conference committee via email to discuss preferences and availability constraints.

For further information, the interested reader should visit the WRSA's link: https://www.wrsaonline.org/newsite/wrsa-2023-our-62nd-anniversary-planning-for-bigisland-hi/>!.

[2] **Event overview edited by Dimitrios Tsiotas, Assistant Professor, RSI J**

Academic Profiles

Prof. **Ben Shalom Bernanke** is an American economist who was awarded the 2022 Nobel Memorial Prize in Economic Sciences, jointly with *Douglas W. Diamond* and *Philip H. Dybvig*, "for research on banks and financial crises". The laureates provided insightful studies in the 1980s of the essential economic functions performed by banks, the vulnerability of banks against runs (namely massive withdrawals of funds by bank depositors) during periods of financial crises, and how governments may improve the stability of banking systems and avert or properly manage financial crises. Through statistical analysis and historical source research, the laureates demonstrated how failing banks played a decisive role in the global depression of the 1930s, showing that bank crises can potentially have catastrophic consequences. These insights illustrate the importance of well-functioning bank regulation and form the foundation of modern bank regulation.

Prof. B. S. Bernanke was born on 13 December 1953 in Augusta, GA, USA, he studied economics at Harvard University (1975) and earned a Ph.D. from the Massachusetts Institute of Technology (MIT; 1979). He was professionally affiliated with the Stanford, Princeton, and New York Universities and MIT, while at the time of the award he was affiliated with the Brookings Institution, Washington, D.C., USA. He served as chairman of the Board of Governors of the Federal Reserve System ("the Fed"), the central bank of the United States, from 2006 to 2014. According to the Scopus database, he has published 71 articles enjoying so far more than 15,200 citations and an h-index of 29. According to the same database, the most contributed topics in the last five years are (but not exhausted) bank lending channels; loans; credit rationing; international accounting standards board; standard setting; lobbying; derivative markets; financial markets; and bankruptcy code.

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

References

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Britannica, The Editors of Encyclopaedia. "Ben Bernanke". Encyclopedia Britannica, Oct 11, 2022, https://www.britannica.com/biography/Ben-Bernanke [accessed: 29 October 2022].

Prof. **Douglas W. Diamond** is an American economist who was awarded the 2022 Nobel Memorial Prize in Economic Sciences, jointly with *Ben Shalom Bernanke* and *Philip H. Dybvig*, "for research on banks and financial crises". The laureates provided insightful studies in the 1980s of the essential economic functions performed by banks, the vulnerability of banks against runs (namely massive withdrawals of funds by bank depositors) during periods of financial crises, and how governments may improve the stability of banking systems and avert or properly manage financial crises. Through statistical analysis and historical source research, the laureates demonstrated how failing banks played a decisive role in the global depression of the 1930s, showing that bank crises can potentially have catastrophic consequences. These insights illustrate the importance of well-functioning bank regulation and form the foundation of modern bank regulation.

Prof. D. W. Diamond was born on 13 October 1953, he holds a degree in economics (1975) from Brown University, an M.A. (1976), M.Phil. (1977), and Ph.D. (1980) in economics from Yale University. He became an assistant professor of finance in 1980, associate professor in 1983, and full professor in 1986 at the University of Chicago. At the time of the award, he was affiliated with the University of Chicago, Chicago, IL, USA. He was nominated as *Theodore O. Yntema Professor of Finance* (1993) and *Merton H. Miller Distinguished Service Professor of Finance* (2000). According to the Scopus database, he has published 28 documents enjoying so far more than 12,800 citations and an h-index of 21. According to the same database, the most contributed topics in the last five years are (but not exhausted) financial crisis; shadow banking system; liquidity; current crises; capital flows; assets; exchange economy; and incomplete markets.

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

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Prof. **Philip H. Dybvig** is an American economist who was awarded the 2022 Nobel Memorial Prize in Economic Sciences, jointly with *Douglas W. Diamond* and *Ben Shalom Bernanke*, "for research on banks and financial crises". The laureates provided insightful studies in the 1980s of the essential economic functions performed by banks, the vulnerability of banks against runs (namely massive withdrawals of funds by bank depositors) during periods of financial crises, and how governments may improve the stability of banking systems and avert or properly manage financial crises. Through statistical analysis and historical source research, the laureates demonstrated how failing banks played a decisive role in the global depression of the 1930s, showing that bank crises can potentially have catastrophic consequences. These insights illustrate the importance of well-functioning bank regulation and form the foundation of modern bank regulation.

Prof. P. H. Dybvig was born on 22 May 1955, he holds a B.A. degree in mathematics and physics from Indiana University (1976), an M.A. and M.Phil. degree in economics from Yale University (1978), and a Ph.D. in economics from Yale Unive (1979). He was professionally affiliated with Yale University (1979), Princeton University (1980–81), the Southwest University of Finance and Economics in Chengdu, China (2010–21), and Washington University (1988–today). At the time of the award, he was affiliated with Washington University, St. Louis, MO, USA. At this University he was also nominated as *Boatmen's Bancshares Professor of Banking and Finance* (1990). According to the Scopus database, he has published 38 documents enjoying so far more than 4,700 citations and an h-index of 20. According to the same database, the most contributed topics in the last five years are (but not exhausted too) asset pricing models; value premium; factor; background risk; high order; prudence; motion pictures; filmmaking; documentary filmmaking.

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

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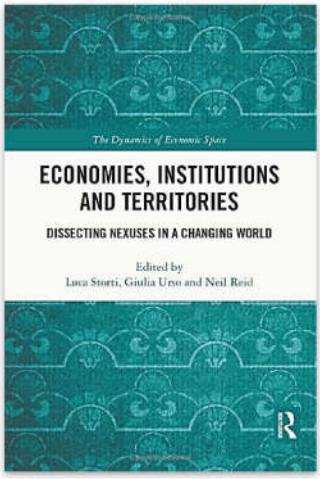
Book Reviews



Economies, Institutions, and Territories. Dissecting Nexuses in a Changing World, Edited By Luca Storti, Giulia Urso, and Neil Reid

The book *Economies, Institutions and Territories. Dissecting Nexuses in a Changing World* (p. 354), Edited By Luca Storti, Giulia Urso, and Neil Reid is an upcoming book published by Routledge, to be released in 2023. **Luca Storti**, is an Associate Professor in Economic Sociology, at the University of Torino, Italy, and a Research Fellow of the Ralph Bunche Institute for International Studies in the Graduate Center (City University of New York). His research interests involve the topic of organized crime groups at boundaries between legal and illegal markets, and the relationships between Institutions and the Economy. **Giulia Urso**, is a Tenured Assistant Professor of Economic Geography, at Gran Sasso Science Institute, Social Sciences, L'Aquila, Italy. Her research mostly focuses on the slow-burning pressures of peripheral areas and their resilience to different kinds of shocks. **Neil Reid** is a Professor, at the Department of Geography and Planning, University of Toledo, USA. He is an economic and urban geographer. Much of his current research examines the growth of the American craft brewing industry, with a focus on the role of craft breweries in neighborhood revitalization.

The book *Economies, Institutions and Territories. Dissecting Nexuses in a Changing World* explores the nexus between economies, institutions, and territories and how global phenomena have local consequences. Formal institutions are struggling to face challenges concerning uncertainties in several spheres (e.g., pollution, climate change, reconciling economic growth with social inclusion, recessionary disturbances, etc.). At the same time, these challenges have an impact on routines, interaction patterns, and cognitive orientations, thus affecting informal institutions. Territories, for their part, have experienced their "identity" changing dramatically. After a naive early phase of analyses of globalization, in which it has been thought that the relevance of territories would have disappeared, an actual spatial turn has begun. Due to these general reasons, the three broad spheres of economy, institutions, and territories have been intensely scrutinized and their relationship has often been carried out at the macro level. The edited book *Economies, Institutions, and Territories. Dissecting Nexuses in a Changing World* deals with the puzzling nexuses between economies, institutions, and territories, providing some further insights and knowledge into each of the three dimensions and a better understanding of their mutual interconnections. The book examines how original and innovative economic-related processes embed themselves in societies at the local level; how boundaries between the state and the market are placed under stress by unexpected changes. It explores whether new types of elites and forms of social inequalities are emerging as a result of institutional and economic changes and whether peripheral areas are experiencing insidious forms of economic and institutional lock-in. Presenting empirical cases and useful analytical and conceptual tools, the book makes current economic and territorial phenomena more understandable.

The book *Economies, Institutions and Territories. Dissecting Nexuses in a Changing World* is structured into three parts, where the first deals with Integration between the Economy and Society: Innovation, Tensions, and Dilemmas; the second one with Coordination between State and Market: Emerging Problems; the third with Social Inequalities, Displacement and Conflicts between Social Groups; and the fourth with the Challenge of Peripherality. In particular, the table of contents is structured as follows:

Chapter 1. *Economies, Territories, Institutions: Analytical Fragments of a Complicated Relationship* [Luca Storti, Giulia Urso, and Neil Reid].

PART I. INTEGRATION BETWEEN THE ECONOMY AND SOCIETY: INNOVATION, TENSIONS, AND DILEMMAS.

Chapter 2. *Change and Innovation within Florida's Food System in Response to COVID-19* [David Outerbridge, Christa D. Court, Laura Birou, Catherine Campbell, Liz Felter, Sebastian Galindo, Jennifer Hagen, Brittany Hall-Scharf, Lisa Hickey, Molly Jameson, Elias T. Kirche, Alexandre Magnier, and Fritz Roka].

Chapter 3. *Street Shock: How a Bike Lane Redefined a Neighbourhood* [Andrea Marpillero-Colomina].

Chapter 4. *Building Drought Resilience in the US Southwest: The Institutional and Economic Challenges in Rural Communities* [Haoying Wang].

PART II. COORDINATION BETWEEN STATE AND MARKET: EMERGING PROBLEMS.

Chapter 5. *A History of Modern European Monetary Unions as Territories, Regions, and Institutions* [Rebecca Jean Emigh, Michelle Marinello, and Zachary DeGroot].

Chapter 6. *Brussels Under Pressure: Compliance, the Single Market, and National Purpose in the EU* [Francesco Duina and Hermione Xiaoqing Zhou].

Chapter 7. *Institutional Context and Territorial Policy: Analyzing the New Regional Policy and Regional Development Agencies in Turkey* [Nuri Yavan, Şükrü Yilmaz, and Aykut Aniç].

PART III. SOCIAL INEQUALITIES, DISPLACEMENT, AND CONFLICTS BETWEEN SOCIAL GROUPS.

Chapter 8. *Bureaucrats, Local Elites, and Economic Development: Evidence from Chinese Counties* [Ling Zhu and Xueguang Zhou].

Chapter 9. *Working at the Nexus of Global Markets and Gig Work: US Gig Workers, Credential Capitalization, and Wealthy International Clientele* [Alexandrea J. Ravenelle and Ken Cai Kowalski].

Chapter 10. *Understanding Residential Sorting through Property Listings: A Case Study of Neighborhood Change in Charlotte, NC 1993-2018* [Isabelle Nilsson and Elizabeth C. Delmelle].

Chapter 11. *Making the Right Move: How Effective Matching on the Frontlines Maintains the Market for Bribes* [Diana Dakhlallah].

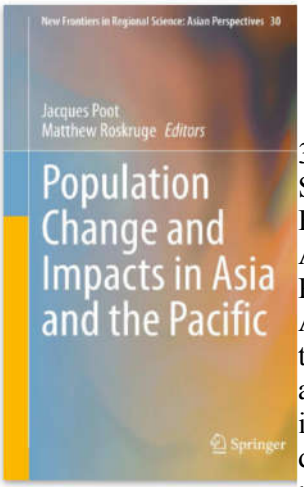
PART IV. THE CHALLENGE OF PERIPHERALITY.

Chapter 12. *Measuring the Interaction between the Interregional Accessibility and the Geography of Institutions: The Case of Greece* [Dimitrios Tsiotas and Vassilis Tselios].

Chapter 13. *Marginal Returns? Institutional Dynamics, Peripherality and Place-based Development in Canada's and Australia's Natural Resource-Dependent Regions* [Laura Ryser, Neil Argent, Greg Halseth, Fiona Haslam-McKenzie, and Sean Markey].

Chapter 14. *Economies–Institutions–Territories: Old Issues Revisited and New Research Avenues* [Luca Storti, Guilia Urso, and Neil Reid].

Book Review by
Dimitrios TSIOTAS, Assistant Professor – RSI J



Population Change and Impacts in Asia and the Pacific, Edited By Jacques Poot and Matthew Roskruge

The book *Population Change and Impacts in Asia and the Pacific* (p. 358), is Edited by Jacques Poot and Matthew Roskruge and published by Springer. **Jacques Poot** is the Emeritus Professor of Population Economics at the National Institute of Demographic and Economic Analysis (NIDEA), University of Waikato, New Zealand; and a Visiting Professor at the Department of Spatial Economics at the Vrije Universiteit Amsterdam, the Netherlands. His research interests include all aspects of the economics of population (such as migration, fertility, labor force, and aging). Over the last two decades, he has led several large-scale multi-institution research programs in New Zealand and Europe on population diversity, migration impact assessment, immigrant integration, and regional population change and its socio-economic consequences. **Matthew Roskruge** is a senior lecturer in economics at Massey University and co-director of Te Au Rangahau Māori business research center. Dr. Roskruge specializes in applied econometrics, mixed methods, and kaupapa Māori research with a passion for social capital, population economics, public economics, and the Māori economy. His research is supported by a Rutherford Discovery Fellowship alongside grants from the Ministry of Business, Innovation and Employment, Health Research Council, and Ngā Pae o te Māramatanga, with whom he is collaborating to invigorate Māori economics and inspire new Māori economists.

The book *Population Change and Impacts in Asia and the Pacific* brings together a range of contributions that provide contemporary regional science perspectives on population change and its socio-economic consequences in the Asia-Pacific region. Accounting for close to two-thirds of the world's population, the Asia-Pacific region is highly diverse in terms of key demographic indicators such as population size, growth, composition, and distribution. The authors provide quantitative assessments, either descriptively or through modeling, of important demographic issues affecting this part of the world. The topics addressed book *Population Change and Impacts in Asia and the Pacific* include broad demographic trends across the Asia-Pacific region and its sub-regions; assessment of population decline, urbanization, and spatial distribution using cases from China, Colombia, Japan, and Australia; migration and economic impacts in Australasia, Chile, and Timor Leste; and the impacts of declining or low fertility and population aging in China, India, Thailand, and across Asia.

The book *Population Change and Impacts in Asia and the Pacific* is structured in three parts, one dealing with Population Distribution, the second one with Migration and Development, and the third one with Population Age Composition and Impacts. In particular, the table of contents is structured as follows:

Front Matter,

Population Change in the Asia-Pacific Region: Trends, Issues and Models [Jacques Poot, Matthew Roskruge]

POPULATION DISTRIBUTION

Pareto's Law and City Size in China: Diverging Patterns in Land and People [Gibson, Chao Li]

City Size Distribution in Colombia and Its Regions, 1835–2005 [Gerson Javier Pérez-Valbuena, Adolfo Meisel-Roca]

Exploring Economic Futures for Japan Under Rapid Depopulation: A Dynamic Regional CGE Model Approach [Suminori Tokunaga, Mitsuru Okiyama]

Using Spatial Microsimulation to Derive a Base File for a Spatial Decision Support System [Robert Tanton, Yogi Vidyattama]

MIGRATION AND DEVELOPMENT

Front Matter

The Drivers of Long-Distance Commuting in Chile: The Role of the Spatial Distribution of Economic Activities [Francisco Rowe, Martin Bell]

Can Regionally-Targeted Temporary Visas Be an Effective Policy Instrument? A General Equilibrium Analysis [Nhi H. Tran, Elizabeth L. Roos, James A. Giesecke, John R. Madden]

Modeling the Dynamics of Circular Migration [Natasha T. Duncan, Jacques Poot, Brigitte Waldorf]

The Changing Composition and Fortunes of Overseas Graduates in Australia: The Case of Chinese and Indian Graduates [Angelina Zhi Rou Tang, Francisco Rowe, Jonathan Corcoran, Alessandra Faggian]

Effective Work Experience and Labour Market Impacts on New Zealand Immigration [Sholeh A. Maani, Michael M. H. Tse]

Migration and Regional Development in Timor-Leste [Tomaz Ponce Dentinho, Pedro Damião, Maria da Conceição Rego]

POPULATION AGE COMPOSITION AND IMPACTS

Front Matter

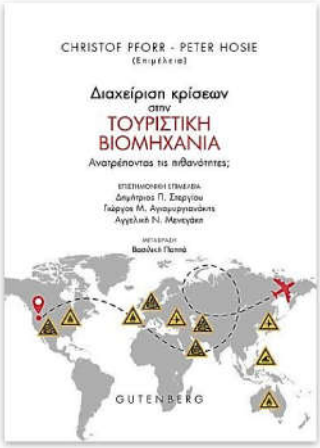
China's Ageing Population: The Present Situation and Prospects [Guoping Mao, Fuzhong Lu, Xuchun Fan, Debiao Wu]

Population Aging in India: Facts, Issues, and Options [Arunika Agarwal, Alyssa Lubet, Elizabeth Mitgang, Sanjay Mohanty, David E. Bloom]

The Child Deficit and the Changing Value of Children in Asia [Philip S. Morrison]

Situational Stressors Among Caregivers of Older Persons in Thailand [Amara Soonthorndhada, Denis Akankunda Bwesigye, Jeerawan Hongthong, Wannee Hutaphat]

Book Review by
Dimitrios TSIOTAS, Assistant Professor – RSI J



Crisis Management in Tourist Industry, Edited By Christof Pforr, Peter Hosie, Dimitrios P. Stergiou, George M. Agiomirgianakis, and Angeliki N. Menegaki [in Greek]

The book *Crisis Management in Tourist Industry*, Edited by Peter Hosie, Dimitrios Stergiou, George M. Agiomirgianakis, and Angeliki Menegaki [published by Gutenberg, in Greek] serves as a course book aiming to provide the tourist sector's students valuable knowledge about the crises management in the tourism sector. The COVID-19 pandemic highlighted in the hardest way the need for obtaining systematic knowledge and methodology, as tools against situations deviating from regularity and putting in danger human life, as well as the survival of the tourist sector. Tourism is a particularly sensitive sector in crises caused by pandemics, natural hazards, terrorist attacks, wars, and other disturbances. This book is composed of fourteen chapters dealing with various cases of crisis in tourism and their management, concerning international examples and cases. Moreover, it illustrates the framework of crisis management, the importance of the right preparation and proactive strategy towards these situations, along with a vulnerability analysis against the dangers driving crises. Except for students studying tourism, this book can also be useful for those studying business administration, along with professionals and practitioners of tourist and other related sectors.

Christof Pforr is a Professor of Tourism, Hospitality, and Events at the Curtin Business School. He holds a Ph.D. in Political Science from the German University of Tübingen, he has a variety of research interests in tourism and destination management and a rich publication inventory. **Peter Hosie** is a Professor at the University of Wollongong in Dubai (UAE). He has an extensive publication inventory on the subjects of management and industrial psychology. **Dimitrios P. Stergiou** is an Associate Professor and Associate Dean at the School of Social Sciences of the Hellenic Open University and Director of the Master's Program in Tourism Business Management. He has a long teaching experience in undergraduate and postgraduate study programs at Greek and foreign Universities, and an extensive professional experience as a researcher and consultant for tourism businesses and agencies in Greece and abroad. His research work has been published in prestigious scientific journals. **George M. Agiomirgianakis** is a Professor at the Hellenic Mediterranean University, Director of the Tourism Management Study Program of the Hellenic Open University, and Vice-President of the Hellenic Institute of Economics of Education & Lifelong Learning, Research & Innovation. He has taught at several universities in the UK and Cyprus and authored numerous articles, books, and studies in economic analysis and policy. He is an evaluator of study programs and universities in the EU. **Angeliki N. Menegaki** is an Associate Professor at the Agricultural University of Athens in the Department of Regional & Economic Development. She taught at the Department of Management, Economy and Communication of Tourist and Cultural Units (Amfissa, Phocis), of the former Technological Institute of Central Greece, as well as at other Greek

and foreign institutions. She authored many articles and books on economics, while her scientific interests concern (amongst others) the interactions between tourism and the environment.

The book *Crisis Management in Tourist Industry* is structured into two parts, where the first one (consisting of five chapters) provides a theoretical background, while the second one (consisting of eight chapters) provides representative international case studies and discusses strategies and conclusions. In particular, the table of contents is structured as follows:

1. Preface; Introduction: beating the odds? [Christof Pforr, Peter Hosie]

PART I

2. Crisis management and security: strategize versus improvise in a turbulent environment [Bella Butler]
3. From conception to implementation: towards a crisis management framework [Samir Ranjan Chatterjee, Cecil Arthur Leonard Pearson]
4. Crisis management in tourism: a review of the emergent literature [Christof Pforr].
5. Tourism crisis management, knowledge management, and organisational learning [Deborah Blackman, Brent W. Ritchie]
6. Human resource development: proactive preparation to manage crises [Peter Hosie}

PART II

7. Vulnerability analysis and sustainability in tourism: lessons from Phuket [Alan Nankervis]
8. Terrorism, tourism, well-being and sense of security: the case of Australia [Alfred Michael Dockery]
9. Disaster response and tourism recovery strategies in the Maldives [Jack Carlsen]
10. Training for crises responses: a case study of Chinese medical professionals [Cecil Arthur Leonard Pearson, Samir Ranjan Chatterjee]
11. Precautions against future tsunamis: a case study of Galle district, Sri Lanka [Acushla Felix, Ross K. Dowling, Raguragavan Ganeshasundaram]
12. An exploration of risk management strategies in regional tourism businesses: the case of the Eurobodalla region [Tracey J. Dickson]
13. Crisis and post-crisis tourism destination recovery marketing strategies [David Beirman]
14. Conclusion: beating the odds [Peter Hosie, Christof Pforr]

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.**

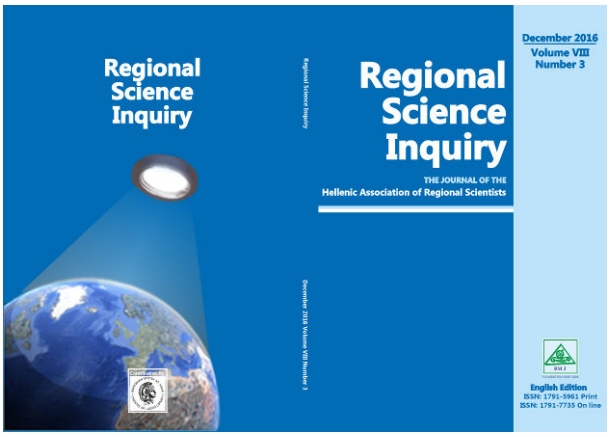
5.1.1. Reference inside the text

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

Bureau of Labor Statistics. 2000–2010. "Current Employment Statistics: Colorado, Total Nonfarm, Seasonally adjusted - SMS08000000000000001." United States Department of Labor. http://data.bls.gov/cgi- bin/surveymost?sm+08 (accessed February 9, 2011).

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Heidhues, Paul, and Botond Kőszegi. 2005. "The Impact of Consumer Loss Aversion on Pricing." Centre for Economic Policy Research Discussion Paper 4849.

Zitzewitz, Eric. 2006. "How Widespread Was Late Trading in Mutual Funds?" http://facultygsb.stanford.edu/zitzewitz.