International Journal of Economics, Business and Management Research

Vol. 8, No.09; 2024

ISSN: 2456-7760

The Symbiotic Role of GIS in Economics: The Spatial Economic Approach

[1]Kostis C. Koutsopoulos
National Technical University of Athens, Department of Geography and Reginal Planning
Zographou campus, Athens, Greece, 15780

doi.org/10.51505/IJEBMR.2024.8919 URL: https://doi.org/10.51505/IJEBMR.2024.8919

Received: Sep 07, 2024 Accepted: Sep 17, 2024 Online Published: Sep 24, 2024

Abstract
The object of this paper is what is termed the spatial economic approach (SEA), which is considered to be based on the fundamental principle that economic systems they have never been developed, cannot exist and seldom are applied (e.g., administering businesses) independent of **Geographic Space**. As a result, the conjunction of data science and spatial data science represents the spatial economic approach, which however require techniques to achieve its goals. The most successful of the new techniques are the Geographic information Science software and tools that can be used to capture, store, manipulate, analyze, and visualize both spatial and non-spatial data. The important aspects of the role and contribution of GIS is a fundamental factor of SEA and is presented to justify the position of this paper that the spatial economic approach by utilizing GIS should become the principal approach in economic studies.

Keywords: Spatial economic approach, evolution of Spatial economic approach, Procedures in Spatial economic approach, GIS in Spatial economic approach, Integrated Spatial economic approach and GIS.

1. Introduction

At the onset it should be stated that the object of this paper, under the term spatial economic approach (SEA), is defined as an economic approach to capture, store, manipulate, analyze, and visualize both spatial and non-spatial economic data. It is based on the fundamental principle that economic systems have never been developed, cannot exist and seldom applied (e.g., administering businesses) independent of geographic space. Moreover, nowadays when there is a need to address the spatial economic approach, three words are eminent: Data science, Spatial data science and Geographical Information Science (GIS), all of which are considered fundamental dimensions of this approach. More specifically, data science is a "statistical computing and how to access, transform, manipulate, explore, visualize and reason about data (Crabtree & Nehme, 2023); while spatial data science is having as key focus the geospatial data expressed in the principle that location matters and thus use of statistical computing to access, manipulate, explore, and visualize spatial data (Roger et. al. 2013). As a result, a SEA represents the intersect of these two scientific entities that is concerned with spatial-economic patterns, process and phenomena and their description, analysis, explanation and prediction. Moreover, a SEA requires a set of software, tools and techniques to achieve its goals. The most successful of the new scientific entities available to successfully achieve these goals are the Geographic Information Systems, which is the technological subset of the previous data conjunction

Vol. 8, No.09; 2024

ISSN: 2456-7760

representing the means to capture, store, manipulate, analyze, and visualize both spatial and non-spatial data (Duckham et al. 2004).

Within this SEA framework the determining factor is the difference between the traditional economic correlation and the spatial correlation. For example, in studding the relationship between the sale price and the size of the apartments in an urban area. On one hand, we could attribute this relationship by creating a simple diagram based on the two variables (cost and size) or in a further more advance step to calculate the correlation coefficient and estimate its statistical reliability. Finally, in a more elaborate effort we could describe the quantitative relationship and the mathematical model between these two variables by applying a regression. All these represent the traditional **economic correlation** tools (Albanesee et. al. 2010)

Undoubtedly, these forms of economic correlations could help us understand some elements of this economic relationship, but we cannot not be fully satisfied with the results. This is because, for example, we realize that a number of other factors that we did not take into account (e.g., the location of the apartments) could be included in the study as explanatory variables. In other words, there is a basic problem that becomes immediately obvious and concerns the spatial units of the study (e.g., city blocks), which have a spatial layout -some are adjacent or far from others- something that has a direct impact on the validity of the study.

For example, both the price and size of apartments may be related to city blocks, as well as the locational relationship they have with each other. The reasons for this dependence may hardly be traceable through the non-spatial techniques applied or the models created previously, but they can certainly be attributed to the geographical proximity of city blocks (e.g., economic behavior of the city blocks occupied by high-income residents behave differently from those with low-income residents - large and expensive apartments in the first category, small and cheap in the second) that they can act as substitute explanatory factors. Therefore, in this case, the values of the economic characteristics examined are spatially related to the city blocks, so the initial data available are less independent, due to the spatial arrangement of the city blocks. In other words, the location, or where an economic activity or phenomenon is located, plays an important role because it is the root cause of what we call **spatial correlation** (MacKenzie, D. I., et. al. 2018)**.** Therefore, the basic hypothesis of the independence of spatial observation of economic units, necessary in classical economic theory, cannot be substantiated, necessitating a different, spatially focused approach.

It is obvious, that the **spatial economic approach** focuses on the role of the geographic space and depends directly on specific spatial variables for the evaluation or explanation of an economic activity or phenomenon. In contrast, **non-spatial economic approach** does not require spatial factors and spatial information. The fundamental difference, therefore, between these two forms of economic approach is the involvement of spatial actors in in any economic approach.

2. Understanding the Economic Spatial Approach

The importance of spatial factors in economic endeavors create an urgent need to describe the spatial economic reality. The main bridge between reality and its description, however, is the way we perceive this reality. That is, the way we interpret the various economic activities and phenomena, as well as the process of selecting those that interest us from the multitude of economic phenomena, situations and processes we observe depends on our experience, our political, cultural and social background and generally the type of person we are and mainly the purpose for which we want to make this description.

2.1 Spatial Economic Reality and its Description

However, despite this wide variety of factors that determine the way we perceive spatial economic reality, the fact that this in turn determines a number of other processes (e.g., recording, analyzing and managing these spatial economic data) requires special attention. This is because these processes are important both for our daily communication and especially for the spatial economic approach, where information about reality has many users, more recipients and an infinity number of applications. Therefore, this bridge between spatial economic reality and its description is necessary to be clarified and expressed precisely in order to ensure that elements of that reality are interpreted without ambiguity and communicated efficiently during this transition. Trying to solve economic problems without systematizing or clearly shaping the way we perceive spatial economic reality is not possible.

Although there are many different ways to illustrate spatial economic properties, experience and literature have shown that the ways to describe what happens on the spatial economic reality occupy a whole spectrum of alternatives the ends of which are: first, the perception that the spatial economic space is covered by entities and, second, that the differentiation of a spatial economic characteristic of interest changes smoothly and continuously in geographic space (figure 1). Therefore, the perception of reality fluctuates between the view that economic space consists of distinct economic entities and that which considers economic phenomena to be continuous and smoothly changing creating the corresponding models of reality.

In order to practically utilize these theoretical models, Data Models have been created, which are nothing more or less than a correspondence between perception and practice, with emphasis on the practical application of the theoretical models (spatial economic entities and a continues economic space). More specifically, they practically determine how the composition of the economic space is achieved through the recognition of spatial economic elements in a generalized form. That is, they create the basic tools or fundamental entities (points, lines, polygons and raster units) that economic phenomena, in practice, can be recognized, their characteristics measured or determined and their geographical coordinates recorded. In that sense, the spatial economic approach can become a success or a failure, depending on the successful transition of reality to data models.

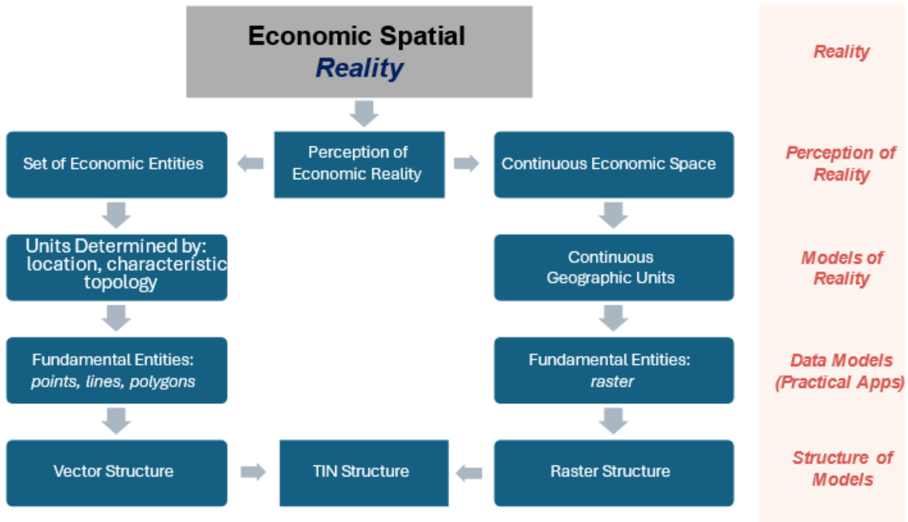

Fig. 1: Economic spatial reality and its description

In general, the application of data models enables the following:

1. Data are stored in Primitive Form
2. The Relationships between the Elements Are Included in the Information Base
3. The Physical Structure of the Information Base does not need to be known to users
4. Data are closely related to Operating Activities
5. Repetition of Data is avoided
6. Different "Logical Perspectives" are possible for Different Users
7. *Functional* Interventions Can Update the Information Base

However, these advantages directly lead to the use of GIS in any SEA. and has essentially been the driving force for its continued development.

2.1.1 SEA Representation

As a result, the final stage of the process from reality to the spatial economic approach, which by necessity is based on utilizing GIS, is the definition of the structure of the spatial economic data that provides the information in order to represent the modeled elements in digital form. The representation takes two basic structures: **Vector** and **Raster** and a third one, which is a combination of them, the **TIN** (Hansen & Johnson, 2005). The vector structure emphasizes the existence of discrete spatial economic entities (points, lines, polygons), defined by their boundaries and therefore resulting from data models based on spatial economic entities. The raster structure emphasizes the content of spatial economic units (raster units) of economic activities or phenomena and expresses the approach of the continuous economic space. Of course, the stored data models do not describe continuous characteristics, but a set of raster values that can be considered as a kind of sampling of the continuous field. Finally, there is the TIN (Triangulated Irregular Nets) structure which uses vector modeled elements to visualize continuous space. That is, it combines the entities of vector positions with continuous fields of raster. For all practical purposes all such SEA representations inevitably lead to the use of GIS, because they pose the only effective and efficient tools to utilize them

2.1.2 Choosing a Model for the Representation of an Economic Phenomenon

The choice between models representing economic activities and phenomena in space is neither easy nor follows rules that can be easily applied. A general and certainly not absolute rule is that economic activities affected by natural environmental processes usually use the continuous space model. On the contrary, activities operating in a planning or an administrative framework treat economic space as a series of distinct spatial economic units, while in order to represent areas related to density of economic activities, the use of TINs is required. From the above it is obvious that each of these representations has its value and fits into specific categories of spatial economic approaches. Therefore, because it is almost always not obvious which representation is better, it is necessary to consider a number of issues such as:

1) Characteristics or location
2) Data Availability
3) Accuracy of characteristics
4) Types of characteristics

3. Evolution of the Spatial Economic Approach

The SEA has not been constant through time, but has gone through a process of evolutions, whose major characteristic essentially concerns the use of different aspects of GIS utilization. This evolution can easily be described and understood by considering the following examples expressing different time periods and technologies (a detail presentation is given in Koutsopoulos, 2005):

1) The first SEA example, developed in the early 1970s, is a primitive non digital effort by the state of Colorado USA, to decide on the location of an economic activity, which provided the impetus for the development of the GIS as we know now.
2) The second SEA example, created in 1982 for the economic development of a coastal area in Greece, is one of many that could have been produced from a simple Geographical Information System.
3) The third SEA example illustrating the impact of the METRO in the capital of Austria is a very recent implementation of a very sophisticated GIS.

These three cases refer to different countries (Greece vs Austria vs USA), different size of area (entire state vs small area), different type of areas (urban vs non-urban), different level of economic development and generally present a number of other characteristic differences.

But all these applications have one thing in common. They all refer to a SEA, which has two main characteristics. First, in all three cases it is considered, and this is commonly accepted, that **spatial economic planning** (regardless of the economic activity) could not be done without some form of **a management system** of spatial economic data. In other words, it is accepted that

Vol. 8, No.09; 2024

ISSN: 2456-7760

spatial economic planning requires a database describing the economic phenomena that operate within the geographic area that concerns them. Second, spatial economic planning requires **spatial economic analysis** capable of describing the complex economic processes that exist in a unit of space. That is, to be able to capture the spatial patterns and relationships between demand and supply (in whatever form they are defined), it is necessary to accept that they are inheritably spatially correlated. Therefore, all SEA objectives can only be efficiently and effectively achieved with the help of GIS.

The previous three applications are typical examples of the evolution over time that the three main components of SEA (spatial economic management, analysis and planning) have undergone. More specifically, the form and type of spatial economic planning, as well as the analysis and the way of managing their spatial economic data, show a clear differentiation-evolution over time. In these few years changes have been observed that Thomas Kuhn called paradigm shifts, were old knowledge, through an exciting synthesis, is combined with new knowledge to create new methods and approaches. Thus, planning, analysis and management of the SEA is changing, evolving and mutating over time (Figure 2). What remains constant is that spatial economic data, which are transformed into spatial economic information are the connecting links between spatial economic planning and the way it is implemented. These paradigm shifts, however, represent a key tool in understanding the relationship between spatial information management systems, spatial economic analysis and economic planning, but mainly provide the framework GIS offers in helping applying a SEA. That is, the way that we cannot talk about progress in the management of spatial economic data outside the economic spatial planning, for the sake of which we manage these data. In the same way spatial economic planning cannot be carried out without some form of spatial economic analysis, (i.e., application of some methods and techniques that lead to the recognition of the necessity of spatial distributions and processes, which impose the use of GIS) (Koutsopoulos, 2011).

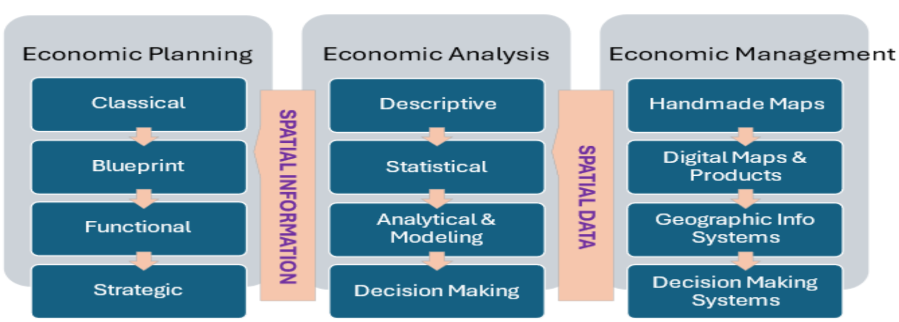

Figure 2: Evolution of Spatial Economic Paradigms

The following is a brief overview of the changes in the paradigms of the three areas of SEA, which are illustrated in Figure 2 and where the temporal developments of the paradigm changes (vertical relationships) are combined with the deterministic interconnections between them (horizontal relationships).

3.1 Evolution of Spatial Economic Management Paradigms

The management of spatial economic data cannot be considered static, but presents significant paradigm changes lasting many years. The term management of spatial economic data is understood in its broadest sense and includes the storage, utilization, transformation and visualization of spatial economic data.

3.1.1 Handmade Maps Paradigm

Basically, graphs and more specifically maps have been throughout the history of mankind indispensable tools for managing spatial economic data and of course supported the corresponding analysis. Over the past 4,000 years, various cultures have used graphic symbolism and maps to represent and analyze spatially distributed economic phenomena, to keep records of economic activities in space, and even to transmit spatial economic concepts to others (from cave sketches indicating hunting grounds to land property maps). This paradigm application inevitably led to a descriptive analysis and to a classical planning approach (horizontal relationships)

3.1.2 Digital Maps and Products paradigm

While the development of maps and graphs took thousands of years, advances in technology for the management of spatial economic data were constantly enriched. Indeed, in the last few years there have been major changes in the way spatial economic data management tools are developed and used. Of these changes, three are the most important. The first change is the one that has led from the classic "handmade" maps to the use of digital automated maps. A second change is from the creation and use of automatic mapping for a specific economic application, to uses where through a new technology of database of spatial economic activities and phenomena is created for a continuous utilization by a variety of users (data base management), But there are two ways of looking at this technology. The first treats it as a technology that produces various digital economic "products". As a result, a statistical spatial economic analysis is possible and consequently the corresponding blueprint planning can be achieved (horizontal relationships).

3.1.3 Geographic Information Systems paradigm

The second way treats spatial economic information systems technology as a basic structure for correlating economic activities (i.e., functions performed to meet analytical, planning and management needs) and spatial economic data. Based on this last view, a third most recent and clearly more important change has occurred, which is from the simple digital coding of spatial economic maps to data models of these data, where spatial economic relationships and the various characteristics of their data are explicitly and clearly represented in the database. Therefore, modeled data is a way of describing the structure and operation of the database, a new generation of tools for managing and analyzing spatial economic data known as Geographic Information Systems. In these systems, both elements and functions exist in the system in their most generalized (generic) form possible and therefore it is possible, but not always easy, to analytically model spatial relations and to take a functional approach to spatial economic planning (horizontal relationships).

3.1.4 Spatial Decision-Making Systems paradigm

Nowadays an economic decision maker investigating any economic problem creates and evaluates alternatives that require different forms of management and analysis using spatial economic data. However, the literature (Densham,1994) shows that classical GIS cannot, for many reasons, meet these needs and therefore need spatial economic information systems that enable decision-makers to use their own decision-making process based on specialized spatial economic analyses. These systems, known as Spatial Decision Support Systems, applied in an economic environment are designed to create for decision-makers a framework that allows them flexible spatial decision-making economic analyses for their own needs, such as determined by strategic planning (horizontal relationships).

3.2 Evolution of Spatial Economic Analysis Paradigms

Spatial economic analysis that by necessity refers to methods and techniques exhibiting continues variations and developments can also be differentiated into four basic paradigms:

3.2.1 Descriptive Analysis paradigm

Until the development of the so-called quantitative revolution in the social sciences and economics in the early 1950s, descriptive processing (usually classification and coding) was for many centuries the only analytic approach to economic activities. Essentially the only way to process spatial economic data was the map. The result, of course, was that spatial economic planning was limited to the classical model of description (horizontal relationships).

3.2.2 Statistical Analysis paradigm

Statistical processing takes advantage of technological developments in automation, data collection and storage methods and digital products in general. It basically uses the language of mathematics and probabilistic theory and analyzes economic statistics of the data. It also uses them to create other digital products and control spatial economic distributions (with the well-known criteria x^2, t, F, etc.). Thanks to the new forms of statistical methods that came to the fore in the 1950s, hypotheses about spatial economic patterns and the relationships between economic activities can be tested creating the information for blueprint planning (horizontal relationships).

3.2.3 Analytical Processing and Modelling paradigm

Recently, the analysis of spatial economic data based on the application of statistical techniques to spatial economic data, has been extended to modeling, the application of operational research methods and other analytical techniques and methods. As a result, spatial economic analysis focuses on uncovering possible relationships between spatial patterns and other features (i.e., spatial processes) of the study area and modeling these relationships with the aim of understanding or predicting them. In general, GIS automation and their analytical processing capabilities are closely related to functional planning, which is today the main way of spatial economic planning (horizontal relationships).

3.2.4 Spatial Economic Analysis for Decision Making paradigm

The latest and most recent approach to SEA refers to its use as a decision support tool. In particular, traditional approaches to description, statistical hypotheses and modelling give way to the need to make decisions based on the results of spatial analyses. This, of course, creates on the one hand the need for spatial economic information systems focused on the decision-making process, while on the other hand it creates the framework within which modern strategic planning based on decision-making processes can be achieved (horizontal relationships)

3.3 Evolution of spatial economic planning paradigms

Regarding the paradigm changes of the spatial economic planning the following four changes can be detected:

3.3.1 Classical Planning paradigm

The first SEA paradigm essentially refers to the classical economic planning and was dominant from antiquity until the first decades of the 20th century. In this paradigm, the SEA transforms or recreates the man-made environment, according to the basic principles of traditional economic theory. Its needs, therefore, in data (descriptive) and their management tools (i.g., handmade maps) are limited (horizontal relationships).

3.3.2 Blueprint planning paradigm

In this SEA paradigm, the rules of rationality are applied to create an economic environment that is more humane, but above all orderly and efficient. Isard, founder of the Regional Science Association, who first applied the spatial economic approach, is the typical representative of this paradigm. Its needs, therefore, move from the collection of spatial economic data to the creation of information mainly through their statistical processing and the use of digital products (horizontal relationships).

3.3.3 Functional Planning paradigm

This SEA paradigm coincides with the great development of computers and applies a systemic approach to SEA planning focusing on social problems. The economist is transformed into a social engineer who has in his possession a large number of data and refers to a myriad of parameters and variables (spatial and economic), which, however, must be processed in order to optimize the functions of the economic system operating in the study area. Spatial economic planning, therefore, requires strong analytical techniques and spatial organization models that in turn are based on mass data management tools such as those of GIS (horizontal relationships).

3.3.4 Strategic Planning paradigm

The failure of comprehensive plans (i.g., five-year, ten-year, etc.) economic plans and the recognition that life and reality are more flexible than well designed economic plans can portray, and less tangible than financial analysts would like, has led to the latest SEA paradigm. It has been understood that spatial economic planning, in order to be efficient and in contact with social and economic reality, must be a process planning. In this paradigm, therefore, significance moves from plans to decision-making, where information systems and analysis techniques using spatial economic data are not simply used, but integrated into the overall decision-making process that constitutes the new paradigm of spatial economic planning (horizontal relationships).

3.4 Spatial Economic Planning-Analysis-Management Relationships vs GIS

A number of conclusions can be drawn from this extremely brief review. First, it should be obvious that although for spatial economic planning it is not absolutely necessary to apply a corresponding analysis, in the same way that for spatial economic analysis the use of a GIS is not necessary. However, there are significant advantages for these two close interconnections, because the relationship between them could, at least today, be described as inevitably symbiotic. In other words, spatial economic analysis is the sufficient but not necessary condition for achieving spatial economic planning, while for economic planning the sufficient condition is a GIS.

Indeed, any change in the process of spatial economic planning creates different needs for the analysis and management of the spatial economic activities under consideration. But at the same time, it should be clear that the evolution in the know-how and technology of spatial information systems, which in turn shapes new ways of spatial economic analysis, leads to a differentiation of the way spatial economic planning is implemented. In other words, it is evident that while the basic components of spatial economic planning such as: formulating hypotheses, identifying objectives, designing alternative strategies and plans, formulating new policies, implementing economic plans and programs and monitoring and renewing them remain constant. The efficiency with which these activities are performed varies over time, because they depend on the existence and appropriate use of spatial information. This information, the result of specific analyses of spatial economic data organized within a GIS, creates the necessary framework to support the planning process, which together with the other two complementary components, constitute what is called a SEA. Therefore, GIS is a basic and integral component of dealing with economic problems and spatial economic planning, in the same way that the spatial economic approach should be considered as processes of management and analysis of spatial economic activities or phenomena.

A second finding is that while there are clear and documented paradigm sifts over time (vertical relationships) and deterministic interconnections (horizontal relations) in economic management, analysis and planning, these relationships cannot be characterized as uniform and equally developed. In the evolution over time, the spatial economic management technologies are continuous and complete. GIS have been fully established in economic management, while Spatial Decision-Making Systems have begun to be applied in many cases for economic issues. By contrast, the evolution of spatial economic analysis is not complete. Although analytical processing is relatively widely applied in economic studies due to the GIS, it faces serious problems, especially in modeling issues, while spatial economic analysis for economic decision making is in an embryonic state, despite recent GIS developments. Even worse, however, is the evolution of planning, where economic planning is taking their first tentative steps in operational planning, while strategic planning is currently a primitive economic construct. The development of horizontal interconnections presents a similar picture. For example, blueprint planning, through the statistical processing of spatial economic data with the help of computers and digital products (integral abilities of GIS), is a successful and commonly accepted process. Modeling in a GIS environment to achieve functional planning has made strides, but faces problems. On the contrary, the implementation of strategic planning is hindered by its experimental application, as well as by theoretical and software factors, despite GIS development.

In sum, the development and interconnection of these three cognitive areas in economics are clearly unbalanced and, above all, out of sync with each other. The reason, of course, is that these three areas in economic studies evolved independently of each other and without any attempt to interconnect them. However, year after year more and more GIS packages are supplemented with spatial economic analysis routines (or the possibilities of interconnection with external models of economic analysis are created, or even surreptitious spatial economic analysis routines are placed within the GIS). Software has also been developed that allows the dynamic connection of economic analysis and planning with the use of so-called open GIS, which have been established in academia and promises real-time management of spatial economic data combined with different spatial economic approach packages. Finally, new methods of economic approach have been proposed and applied in a GIS environment, while the functional requirements for a "language" of spatial economic approach have been defined and implemented.

3.5 Spatial Economic Approach and Geographic Space

The previous discussion explains the interest of economists in space, since they see clearly and anxiously that the way of thinking that characterizes economic science there is a lack of understanding and consideration of the spatial dimension of economic activities (Piacentino D, et.al.,2021). Yet, the examination of five- year and ten-year plans, annual budgets, short-term planning, formulation of economic horizons etc. clearly show that the questions that concern governments revolve mainly around the spatial dimension of human activities, which justify the principle that economic systems have never developed independent of Geographic space, which can be handled by GIS. It should be evident, therefore that:

1) Knowledge of the location is important and requires spatial economic analysis which is an integral part of GIS.
2) Many of the everyday economic problems of modern society, regardless of their scale or level, require spatial information to solve them. In other words, they are spatial economic problems whose solution inevitably passes through the use of GIS.
3) In solving economic problems, the mere description of reality is not in itself capable of creating the necessary knowledge. On the contrary, a needed spatial economic analysis leading to forecasting is the necessary and sufficient condition, which is easily attainable mainly with the help of GIS.
4) There is a need for tools to bridge the gap that exists between scientific "curiosity" and solving everyday economic problems. That is, there is a profound need for GIS.

5) This bridging is particularly important because GIS provide an additional solution to the common problem between "theory" and "practice", which is the combination of general scientific as well as specific practical information, which gives both added values.

4 Understanding GIS and its Role in SEA

Having established that an efficient and effective economic study or a SEA has to focus on spatial distributions and processes of economic activities and phenomena, which however practically imposes the use of GIS (Koutsopoulos, 2011). Basically, SEA data representations inevitably lead to the use of GIS and thus understanding the nature and role of a GIS is paramount in examining SEA

4.1 Considerations of GIS

Despite the great interest and tremendous development observed in the use and application of the Geographic Information Systems or Science in the last 50 years, all efforts for a clear and commonly accepted definition of what GIS is and especially what their applications (especially in economics) are have not yet been successful. For a variety of reasons, clearly defining GIS and their applications in the economy is more difficult than GIS vendors claim and economists would like. Apparently, the view that has prevailed is that there is a local rather than a global optimal or, in other words, in SEA the application defines the tool.

Such a view, however, clearly violates scientific ethics and can lead to dangerous paths. On the contrary, it is believed that all these ideas are small parts of an overall "puzzle" concerning the geographical dimension of economic applications. Indeed, the different ideas that have been expressed from time to time about GIS and their applications in SEA can be combined into three separate groups, which are interrelated with each other (koutsopoulos, 2005)

The first group can be characterized as a **Management** approach and its main objective is the creation and management of spatial economic data. It consists of two subgroups. The first subgroup concerns the **Cartographic** approach which focuses mainly on the cartographic characteristics of GIS. More specifically, many economics consider GIS to be systems for the creation and management of cartographic data that express economic activities or phenomena in the Geographic space. Therefore, they refer to maps, manage maps, and the output of the SEA is again maps. Of course, now is universally accepted that spatial economic activities and phenomena, either in the form of spatial patterns or spatial relations, clearly go beyond the one-dimensional logic of maps.

The second subgroup concerns the **Information Technology** approach which emphasizes the importance of GIS as modern systems for managing databases of spatial economic data. This approach is fanatically supported by those with a strong computer background. However, complex spatial economic analytical functions that require the use of many kinds of economic data can be included in this approach with great difficulty. These two subgroups definitely need to be classified together, since both focus mainly on spatial economic data management.

The second group is referred to as the **Spatial Economic Analysis** approach and certainly supports the importance of GIS. According to this approach, GIS are part of SEA, and not just a new technological development that serves it. The emphasis on spatial economic analysis is the most accepted by the economic scientific community, because of GIS's ability to analyze spatial (and non-spatial) data and thus differentiates them from systems whose main goal is either the production of maps or the management of spatial data.

The third group refers to the **Planning** approach and focuses on the ability of GIS to help solve spatial economic problems, (e.g., to actively participate in formulating spatial economic plans). But again, a scientific approach, or even a tool, should not be determined solely by its applications.

4.2 GIS and SEA

These views of GIS as tools of SEA (management, analysis and planning) that their individual proponents consider as contradictory, can fortunately be seen as scientific fields that have in common the spatial dimension and are therefore interrelated and are part of a symbiotic spatial economic approach. However, such a position requires to:

1) Accept the principle that a proper SEA is necessary, because economic activities do not operate in a vacuum, but in Geographic space.
2) Delineate the different but interrelated areas of spatial economic management, analysis and planning in SEA.
3) Highlight the relationships between spatial economic data management, analysis and planning, which constitute the basic spatial dimensions of any SEA.
4) Determine the problems that arise when in a system of interrelated and interacting cognitive areas, their development is uneven and not in sync with the others.
5) Realize that SEA and GIS basic components (management, analysis and planning) coincide.

4.3 Symbiotic SEA and GIS

For many years economist have recognized the existence of certain rules associated with the use of GIS in SEA. For example, they have realized that the same spatial economic processes can create different spatial economic patterns, while different spatial economic processes can result in the same patterns. Therefore, economic spatial patterns alone are not the surest way to deal with economic spatial processes necessary in a SEA. That is, if the most we can achieve is the description of spatial patterns, which is not enough because the process requires answers about spatial economic relations that express the determining mechanism that create them. Therefore, the need for a spatial economic approach that must at the same time focus on the spatial dimension is obvious. In other words, there is an urgent need to interconnect with GIS, since each dimension of SEA (spatial economic management, analysis and planning) must be seen as part of a system that is linked to each other by feedback relationships (Figure 6.1) interconnected with GIS functions. More specifically, in this symbiotic SEA, every economic intervention requires an approach to the specific problem that it aims at and can be achieved by GIS.

Figure 3 clearly show the feedback relationships governing not only the processes within SEA, but also the dimensions of the GIS which assist it. That is, on one hand every intervention in geographic space requires an SEA for the specific spatial economic problem that the intervention aims to resolve. Each such intervention, however, results in the creation of new or the change of previous spatial patterns and procedures, which may in turn create other problems and thus the SEA leads to further interventions in space and the beginning of another feedback. On the other hand, the processes from managing the collected spatial economic data to create spatial information that through their analysis provide a solution to the economic problem can either feed the SEA or initiate a new GIS feedback.

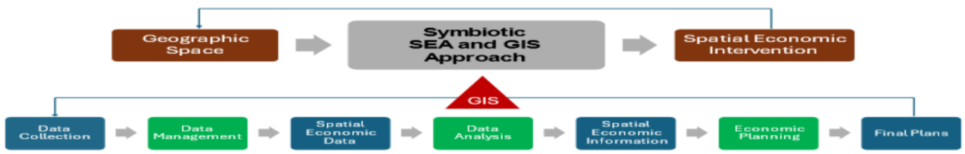

Figure 3: Symbiotic SEA and GIS

In sum the implementation of a symbiotic SEA using GIS has the following significant advantages: first, given the tremendous growth of GIS, the much-needed and at the same time so absent from SEA utilization of GIS will be available to a larger circle of users including economists; second, the presentation capabilities of GIS allow economists to immediately address any difficulties and peculiarities both during searches for solution of economic problems and confirmation of planning results; third, the computational power of modern GIS enables economists to process data in new ways that can be particularly useful in revealing spatial patterns and existing relationships that are ultimately of interest to SEA; fourth, a symbiotic approach of SEA using GIS (spatial management, analysis, and planning) inevitably focuses everyone's attention on the basic problem of the need to use the GIS, which is often ignored.

5. Procedures in SEA and the Role of GIS

The well-known epistemologist T.S. Kuhn (1982) suggested that every "normal science" should have three main objectives:
1) The verification of significant facts.
2) The connection of facts with Theory.
3) The creation of Theory.

SEA, although interdisciplinary in nature, is clearly a scientific process aiming at a range of activities that starts from the accurate description of elements related to economic patterns and processes in space (verification), the disclosure of patterns and relationships through these elements (connection with theory) and the research to explain them, which often ends in the creation of spatial economic models (creation of theory). Under this scientific arrangement, SEA refers to a collection of methods and processes differentiated into the following categories, which however in many classical economic studies are not always present. Moreover, given that a SEA represents the conjunction of spatial and not spatial data, the utilization of GIS is the only viable alternative in these scientific activities, but their role is paramount and makes their achievement possible.

5.1 Description

A number of procedures are included under the general heading of the description, but they all have to do with identifying the data so that it can be used efficiently in the next stages of an economic study. Basically, it becomes an organization and classification of data in a system that follows some logic, so that everyone knows exactly what each economic activity represents. Description occupies an important place in SEA, because its main purposes are: to systematize experiences, summarize knowledge and suggest hypotheses that may explain the location and distribution of specific categories of economic phenomena. In conclusion, the description focuses exclusively on the questions of **what**? **where**? and **when**? of economic activities and phenomena, which inevitably leads to the use of GIS.

5.2 Explanation

The most important stage in a SEA is the stage of explanation. The search for explanation leads to the search for theory and thus it is at the heart of explanation. In general, an explanation can be considered any satisfactory answer to a question that seeks to answer the **how** and **why**. Usually there are a number of alternative explanations and therefore theories about the same series of economic activities and phenomena, thus the explanation can be done in different ways. In the **idiographic** style that characterizes earlier studies, the emphasis was on **genetic** explanation. But the main types of explanation in SEA today are based on sequential, logical and decisive arguments, expressed either in **deterministic or probabilistic** terms. The deterministic explanation is based on the classical idea of the direct cause and effect relationship between economic activities and the determination of the necessary and sufficient conditions for their occurrence. Many economic activities and phenomena however, especially those associated with economic behavior in space, are difficult or almost impossible to be predicted. For such activities the explanation should be less specific and expressed in terms of probability. Finally, another form of explanation, found almost only in modern economic work is **functional explanation,** where economic activities and phenomena are explained by the functions that they fulfill in an economic system.

But the importance in explanation in SEA is the required flexibility of the tools available to achieve efficiently all these forms and this is the fundamental reason that a tool such as a GIS is inseparable from any SEA in order to facilitate the application of any of these alternatives.

5.3 Prediction

In a SEA, prediction is usually formulated in terms of hypothetical statements such as: if **X** happens then **Y** will occur. That is, the appearance of an economic activity X could result in or be associated with the appearance of a phenomenon Y. Prediction is of great importance for economic planning, since the realization of economic intervention, especially in geographic space has multiple effects on it. Such interventions, however should not be done randomly, but based on some theory, which explains their effects on these spatial economic activities and phenomena. As a result, there is a great need for tools that can bring to completion multiple tasks with spatial and non-spatial data such as the GIS.

5.4 Determination

Another concept, which is closely related to SEA, is that of prescription. This **normative** concept refers to spatial economic processes aimed at what should exist and not at what exists or what will exist, which of course can be accomplish effortlesly with the use of GIS

In sum, the activities of description, explanation and prediction are clearly fundamental in any SEA. Moreover, there is a close interconnection between them since from the description of economic data, interesting economic processes can be discovered and explained, which in turn can lead to the creation of models for prediction. More specifically, the explanation occupies the central place, forming the basis of any SEA effort, it follows the description and logically leads to predictions. But for these to be possible two factors are necessary: first, the availability of reliable, flexible, adaptable, efficient and effective tools able to accommodate them; and second, such tools can be offered by the GIS, which should represent an integral part of any SEA

6. Conclusions

The way most economists perceived and are practicing their science nowadays does not correspond to its needs and its very nature. In response to that situation this paper presented what is termed as the spatial economic approach, which is characterized by the following:

1) Economic data management, analysis and planning can not be performed in a void. They are dependent on Geographic space requiring a spatial economic approach (SEA).
2) The operating framework of SEA signifies the cooperation of three scientific fields. More specifically, the conjunction ($x \wedge y$) of data science and spatial data science supported by the software, techniques and the tools of the Geographic information Science, which are used to capture, store, manipulate, analyze, and visualize both spatial and non-spatial data.
3) The literature and experience have shown that in a system such as a SEA every part of it is linked to each other by feedback relationships and therefore there is an urgent need to interconnect with GIS, which can accomplish it in an efficient and effective way.
4) The utility and applicability of the SEA is possible only when the fundamental concepts of the spatial correlation, as opposed to the traditional economic correlation, is understood and faithfully applied.
5) The SEA has gone through a process of paradigm changes of its three dimensions (management, analysis and planning), which essentially concerns the GIS utilization. However, these paradigm changes (vertical relationships) and deterministic interconnections between them (horizontal relationships) cannot be characterized as uniform and equally developed.
6) The three dimensions of a SEA correspond to the GIS capabilities, which formulates a symbiotic relationship.

7) GIS by its very nature can be considered as a set of tools to bridge the gap between scientific "curiosity" and solving everyday economic problems. This bridging is particularly important because GIS provide an additional solution to the basic problem of economics between "theory" and "practice", which is the combination of general scientific and specific practical information.
8) In conclusion, the implementation of a SEA using GIS has a series of advantages: first, the much-needed and basically absent from economic efforts will be available to all economists; second, the capabilities of GIS will allow economists to immediately address any economic difficulties and peculiarities; and third, the computational power of modern GIS will enable economists to process data in new ways that can be particularly useful in revealing spatial economic patterns and relationships.

Acknowledgment

This paper is the result of the efforts of my excellent doctor GEORGE KARIANAKIS who for the last two and a half year keeps me alive by putting up with my incurable decease, but mainly with my demands and bad Jokes!!

References

Albanese, C. D., Li, Lobachevskiy, E. Meissner G. (2010). *A Comparative Analysis or Correlation Approaches in Finance*. SSRN 1769302

Duckham, M, Goodchild, M. F. & Worboys, M. (2004). *Foundations of Geographic Information Science*. CRC Press. ISBN 9780203009543.

Hansen, C. D., & Johnson C. R. (eds.) (2005). *The Visualization Handbook*. New York, NY: Elsevier.

Kuhn, T.S. (1962). *The structure of scientific revolutions*. Chicago, IL: University of Chicago Press.

MacKenzie, D.I, Nickols, J. D., & Royle, J. A., (2017). Spatial Correlation in Dynamics. In MacKenzie D. I., et. al (editors) *Occupancy estimation and modeling.* New Yok NY; ISBN 978-0-12-407197-1 DOI h10.1016/C2012-0-01164-7

Koutsopoulos, C.K. (2002). *Geographic Information Systems.* Athens: Papasotiriou, 401p. (In Greek).

Koutsopoulos, C.K. (2005). *Geographicl Information Systems and Spatial Analysis*. Athens: Papasotiriou, 2005, 417p. (In Greek).

Koutsopoulos, C.K. (2011). *Changing Paradigms of Geography*. European Journal of Geography, 2, (1), pp.54-75.

Crabtree, M, & Nehme, A. (2023). *Datacamp, blog*. https://www.datacamp

Piacentino, D., Arbia, G., & Espa, G. (2021). *Advances in spatial economic data analysis: methods and applications.* Spatial Economic Analysis, 16 (2), 121–125. https://doi.org/10.1080/17421772.2021.1883102

Princeton.edu. (2024) *What is a data Model*. *Center for Data Analytic and reporting*. Princeton University. Retrieved 29 June 2024.

Roger, S., Bivand, S. R,, Pebesma, E., & Gómez-Rubio, V. (2013). *Applied Spatial Data Analysis*. New York, NY: Springer, **DOI** https://doi.org/10.1007/978-1-4614-7618-4