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Assessing the Alternative Paths for a Region's Sustainable Development

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Assessing the Alternative Paths for a Region's Sustainable Development

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ABSTRACT

Greece is a country with noticeable regional disparities. The need to bridge inequalities between Greek regions has been the focus of all regional policies implemented in Greece over the last 50 years. The main objectives of those policies were to limit further concentration of economic activities and population in large urban areas and ensure a well-balanced growth of all regions. Large amounts of money have been spent to improve the infrastructure of less developed regions and to provide financial incentives to industries and employees so as to move into those regions. However, the results of those measures have been rather poor and the main reason for this were that the policies employed were ill-designed and addressed to regions unprepared to take full advantage of them. Hence, a first step towards improving this situation would be to define a measure giving the true picture of the region and the prospects of its sustainable development. This measure, the Image of a region, has already been defined (Angelis, 1981, 1999, 2009). In this paper we substantially improve the way of measuring a region's image and we show that it can be used as a basis for selecting the optimum path for its future development. The method is applied to selected Greek regions.

Keywords: Region's Image, Regional Development, Regional Policy, Sustainable Development, Optimum Path

1. Introduction

Greece is a country with noticeable regional disparities. Those disparities are due to a number of reasons, historic, socioeconomic, structural and geographic, and create a series of adverse consequences such as over congestion and environmental degradation in big urban areas and depopulation, unutilized resources, low income and unemployment in rural areas. The need to bridge inequalities between Greek regions has been the focus of all regional policies implemented in Greece over the last 50 years. The main objectives of those policies were to limit further concentration of economic activities and population in large urban areas and ensure a well-balanced growth of all regions. Towards this end, regions were classified in various groups on the basis of their state of development. Within this framework, large amounts of money have been spent to improve the infrastructure of less developed regions and to provide financial incentives to industries and employees so as to move into those regions. However the results of those measures have been rather poor and the main reason for that were that the policies employed were ill-designed and addressed to regions unprepared to take full advantage of them.

Following this brief introduction, section 2 outlines the regional policies implemented in Greece over the last 50 years, discusses their relative ineffectiveness and suggests that a first step towards improving this situation would be to define a measure giving the true picture of the region and the prospects of its sustainable development. Section 3 describes a region as a socio-economic unit and outlines the process of both business and residential location. Section 4 introduces and defines the concept of a region's Image. Section 5 presents the basic properties characterizing a region's Basic Image, while Section 6 develops a mathematical model for its estimation. Section 7 applies the proposed model to the case of the thirteen Greek regions and the values of their Images, as well as the values of their Indicators, are calculated. Furthermore, starting from the Image value of each region at the year 2007, the optimum path for its future development is drawn. Finally, Section 8 summarizes the conclusions and makes suggestions for further research.

2. Regional Policy in Greece

The need to bridge regional disparities between Greek regions had led Greek governments to adopt and implement a variety of measures. A brief outline of the measures taken of the last 50 years is given below.

The 1960s marked the appearance of small handicrafts and agricultural enterprises. The basic incentive during that period was tax reductions.

During the 1970s the small handicraft and agricultural enterprises, which had been created in previous decade expanded and they began to adjust their structure and operation to European standards. Also the first industries appeared and the first industrial regions were established. Apart from tax reduction, other financial incentives appeared such as: low-interest loans, grants and subsidies. The basic innovation from 1971 onwards was that regional development legislation was enacted and the incentives included therein referred to some specific Greek prefectures, which were divided into five development zones according to their level of development. The most significant regional legislation in that decade was Act 289/1976, which specifically addressed the economic development of the Greek border prefectures: Thrace, the Eastern Aegean islands and the Dodecanese and Act 849/1978 which ranked the sectors of the Greek economy into three categories depending on their need for support.

During the 1980s, the policy of incentives and the legislation for development assumed a definite direction and structure. The legislation was robust and was concerned with making the institutional framework permanent. Its main innovation was the establishment of a different framework of incentives for tourism and the participation of new production sectors like informatics and software within the terms of this legislation. The basic legislation in that decade was Act 1262/1982, which was later amended and completed by Act 1360/83, Act 1563/85 and Act 1282/87. In contrast to Act 289/1976, the above laws include all the Greek prefectures in their terms and the development incentives that provided for investment were grants, loans, subsidies, legal reductions and high depreciations (Doumi, 2006).

Legislation in the 1990s introduced various examples of specialisation concerning economic activities. The basic legislation in this decade was the following:

- Act 1892/1990, which focused on specific industrial activities like informatics, tourism and hotel business.
- Act 2008/92, which adjusted the issuing of incentives to attract productive investment in the border regions.
- Act 2234/1994, which intended to increase the international competitiveness of the Greek economy and create permanent jobs, balance regional development and protection of the environment.

- Finally Act 2601/1998, which intended to contribute to meeting regional development targets, to boost employment, and to reform production sectors, to make full use of domestic and international business opportunities and to contribute to environmental protection and energy preservation.

The main incentives used during that period were grants, loan interest subsidies, leasing subsidies and tax break. Furthermore, specific combinations of the above incentives were provided as packages. One such package included grant, loan interest subsidy and leasing subsidy, whereas a second package consisted of tax breaks and loan interest subsidy.

Looking back at the measures presented above, we may say that their effectiveness has been rather limited. The reason for that is obvious. The effectiveness of this type of measures implies that the regions themselves have development perspectives Romer (1986). However, the majority of Greek prefectures, in need for such measures, do not have the mechanisms required to take the full advantage of the benefits offered. Hence, the effects of those measures are in the best of the cases doubtful and short lasting. A first step towards improving this situation would be to define a measure giving the true picture of the region and the prospects of its sustainable development. Hence, the next section introduces Basic Image, i.e. a measure of the region's present state of development and future prospects and suggests ways of measuring it.

3. The Region as a Complex Unit and the Process of Location

Every region performs a number of functions and its development has three dimensions: economic, social and environmental. However, the relative weight attached to each (importance) of those dimensions have not remained constant over time. Up to 1950's and 1960's the focus of economic progress was on growth and increase in output based mainly on the concept of economic efficiency. By the early 1970's the large and growing numbers of poor in the developing world led to greater efforts of directly improving income distribution. The development paradigm shifted towards equitable growth where social objectives were recognized as distinct from and as important as economic efficiency. The end of this decade also marks the appearance of environment as a new factor affecting economic activity but with limited importance. Environmental threats are conceived of as local in time and space hence easy to overcome. However, by the early 1980's protection of the environment has become the third objective of development showing that environmental degradation was a major barrier to progress. The concept of sustainable development has therefore evolved to encompass three major points of view: economic, social and

environmental. Furthermore by the end of the decade environmental concern is for the first time integrated into the business decision making process. In the 1990's, environmental matters are considered to be the major component of the wider economic activity. Furthermore environmental threats are now perceived as emerging on a very large scale, often related to socio-economic turbulent factors and requiring immediate corrective action. Furthermore, the region's three dimensions are not always compatible; on the contrary the idea of a conflict between the economic dimension on one hand and the social and environmental dimensions on the other is widespread in Urban Literature (Angelis, V. & Dimaki, K. 2010).

Many examples of that inherent conflict between the economic dimension of a region on one hand and its social and environmental dimensions on the other may be given. The construction of a motorway, for example, may improve the communications of the region and consequently its industrial potential but at the same time it may cause a deterioration of its environmental conditions. Similarly, the use of a large proportion of the land available for industrial purposes may improve the industrial potential of the region but at the same time it will restrict the land available for houses, open spaces, recreational grounds etc. and hence it may lower the quality of its environment and the level of its social amenities. Those were two examples of a rather direct conflict between the factors influencing the industrial potential of a region and those influencing quality of its environment and the level of its social amenities. More generally, however, a kind of indirect conflict between them may also be detected. The improvement of both sets of factors depends largely on the amount of expenditure the region is prepared to place on each one of them. Since however, the budget of a region is always limited a conflict of priorities is bound to develop.

If, as in most cases happens, heavy emphasis is placed on the region's economic growth this primarily leads to deterioration of its social conditions and a consequent decrease (fall) of its attractiveness. Reversing the trend is always difficult and the probability of success seems to be higher in the case of regions with healthy environment which act as a buffer limiting the decrease of attraction and facilitating the reversal of this declining trend (Angelis, V. & Dimaki, K. 2010).

Having discussed the nature of a region as a socio-economic unit we can now outline the location process of both business units and employees. Mobility is largely a voluntary process. Hence the growth and decline of a region depends on its ability to attract and retain business activities and the right blend of people to run them.

Regarding the location of business units empirical evidence suggests that although purely industrial factors such as accessibility to natural resources, land availability, transportation facilities etc. remain important, the availability of suitable labour is also of a primary concern. Therefore, social and economic factors indirectly influence industrial location. Furthermore, healthy environment has become a powerful stimulus of capital flow potential industrial development has been lost simply because the quality of the region under consideration was not good enough. Further analysis of the process of industrial locational choice suggests that this is a two-stage process whereby the final choice is made from a small group of possible locations all of which satisfy a basic set of criteria. Regarding the movement and location of households although job and pay prospects are always among the most important factors – underlying therefore the importance of industrial investment – a new set of factors such as housing, social amenities, healthy environment are becoming increasingly significant. Although the two-stage process described in the case of industrial location is not explicit in the case of people the existence of certain minimum standards is beyond doubt. A Government Survey (Harris and Clausen⁶) showed that around 50% of the people who would generally consider moving with their present employer were not prepared to move to certain particular areas. More important, no specific reasons could be given for this attitude but most of the people justified it in terms of “general dislike of the area” or “lack of appeal” for them. Hence as in the case of business units location, people are also prepared to consider moving only to areas satisfying a set of basic criteria (Angelis, V. & Dimaki, K. 2010).

The apparent existence of sets of minimum requirements for both people and industries, together with the ever increasing interdependence between industrial and residential location seems to suggest that a general set of basic criteria applicable to both industries and people could be defined. A region satisfying this general set of criteria will be considered as a potential final choice for both people and industries. As long as the region does not satisfy the minimum standard set for the attraction of new industries and skilled employees to run them, piecemeal improvements will not avert the decline.

4. The Concept of a Region's Image

The growth or decline of an industrial region depends on its power to "pull" and retain both industries and the right blend of people to run them; this pulling power depends on what I call the Image of the region. At each point in time the region "sends out" its Image and depending on its impact on the people (both employers and employees) the region may be

considered Attractive or Repulsive. One may argue that since people "receiving" the image of the region belong to various distinct groups (i.e. employers, unskilled workers, skilled workers etc.) and are sensitive to different factors, the impact of the Image of the region on the members of each particular group will be different. Whilst this is plausible, the discussion in section 3 suggests that all groups of potential movers react similarly to a basic set of factors; more precisely a set of minimum standards largely common to all groups must be satisfied if the region is to be considered as a potential choice by any of them. To reconcile these two views we refine the concept of a region's Image by introducing the following two concepts: the Basic Image and the Specific Image.

Basic Image of a given region measures the degree to which the region satisfies a set of basic criteria common for all movers. A region satisfying those criteria is considered by all potential movers as worth a closer examination and as a potential final choice.

Specific Image of a given region, as perceived by a particular group of potential movers, measures the degree to which movers belonging to that particular group consider the region as their best final choice. This Specific Image however, although a function of specific factors appealing mainly to members of that group, is primarily a function of the Basic Image.

Basic Image is a rather abstract concept which expresses the actual state of the region; a physically realizable measure for the Basic image is difficult to find. Specific Image on the other hand expresses the opinion of the potential movers about the region and is theoretically measurable. Net change in the number of the members of each group due to migration may provide a good measure of their respective Specific Images. Such information however, is not readily available from the usual statistical sources. What may be measured more easily is the net change of a region's population due to migration during each, time period. Such a change however is of very little importance as a measure of the real state of the region. The perception and reaction times to any change are different for the various groups of potential movers and are particularly long for certain vulnerable minorities who lack real choice in place to live and work. Hence, the measurable changes of the region's population due to migration may be generally considered as the delayed and considerably smoothed consequence of changes in the Basic Image. It will be argued later that Basic Image is a function unstable for a wide range of values around zero; hence, its transition, from a positive to a negative value may, in certain cases, be considered as a sudden jump. If the model is correctly built one would expect that changes in the Basic

Image of a region and measurable changes of its population due to migration would generally agree in sign (i.e. both positive or both negative).

The study of the mechanisms governing the shaping and the changes of a region's Basic Image is a task of imperative importance. Apart from simplifying the analysis of a region's behaviour, the Basic Image as an overall measure of its attractiveness and performance has the following two advantages:

- i. It gives an early warning of any potential danger of decline.
- ii. It gives the "true" picture of the region and helps us to detect the causes and not only the symptoms of any existing problems.

An early and correct diagnosis of a problem is perhaps the biggest step towards its solution. In the case of urban development however, the seeds of decay are usually planted during a period of prosperity and no action is taken against them until it is too late (Kondakis, 2009, Angelis, V. & Dimaki, K. 2010).

We have so far introduced the Basic Image of a region as a function of a number of factors which influence the movement of people and industries. Mobility is essentially a voluntary process and state intervention may only be negative in the sense that it can stop or influence movement but it can not direct it. Hence, any attempt to improve or sustain the attractiveness of a region must be directed towards providing the framework within which this voluntary process can flourish. The Basic Image as defined may be the basis for such a framework and the factors affecting will be the prime targets for improvement. The factors affecting the Basic Image that have been presented so far, include land availability for industrial expansion, access to markets and materials, housing conditions, sanitary and environmental conditions, regional influence etc. Furthermore they may be divided into various groups depending on which dimension of the region's development they refer to.

In some previous papers (Angelis, 1981, 1990, 2009; Angelis & Dimopoulou 1991) the factors affecting a region's Image were divided into two groups related to the economic and social dimensions of its development, providing in that way measures of its economic and social potential. These measures were referred to as the Economic Indicator and the Social Indicator. Evidence was also presented to support that the economic and social indicators may be seen as conflicting indicators. The expression of a region's Basic Image as a function of two conflicting Indicators and the use of the Cusp Catastrophe to model it is, up to a certain point in time, in line with the overview presented in the previous section. Indeed, according to this overview, economic growth was the only concern of development until the early 1970's when social objectives gradually began to appear as distinct from and

as important as economic efficiency. However, by the early 1980's protection of the environment appeared and soon became the third objective of development. (Svedin, 1991; Munashinghe, 1993). In Angelis et al (1999) the environmental quality was one of the factors that have been considered as affecting the area's Social Indicator. However as environmental quality becomes increasingly important there is a growing need to isolate it and to treat it separately as a third indicator let's say Environmental Indicator (Bovolos et al, 2009). In this work we present a novel way to model a region's Image by taking into account the effect of economic, social and environmental impact. To this end we classify the various factors affecting a region's Image into three groups according to whether they express the economic, the social or the environmental function of the region. More specifically the factors of the first group (*Accessibility to Centers of Influence, Land Availability, Financial Conditions*) provide a measure of the region's economic potential. This measure is referred to as **Economic Indicator**. Similarly, the factors of the second group (*Housing Conditions, Social Conditions*) provide a measure of a region's social potential. This measure is referred to as **Social Indicator**. The factors of the third group (*Environmental Conditions*) provide a measure of the region's environmental quality. This measure is referred to as **Environmental Indicator** Hence,

$$\text{Basic Image} = \varphi(\text{Economic Indicator}, \text{Social Indicator}, \text{Environmental Indicator})$$

The expression of the Basic Image as a function of the Economic and Social Indicators is not accidental; on the contrary, it is consistent with the concept of a region as a socio-economic unit. The main advantage of such an expression is that it may be used to underline and eventually describe, the basic conflict that characterises the development of a region (Perloff, H. S. and Wingo, L., 1971 and Zolotas, X., 1981). Furthermore, the Environmental Indicator may be seen as a buffer limiting the decrease of attractiveness of a declining region and facilitating the reversal of its declining trend.

At this point it should be mentioned that the growth of a region may be expressed both in absolute or relative terms. In the latter and most interesting case the development pattern of a given region is compared to that of a hypothetical region, which is referred to as the "typical" region and expresses, as far as possible, an average of the main regions of a similar type to that of the study. In this paper we shall be looking at the relative development patterns of a region. Hence, all the factors affecting its images (Basic and Specific) should be expressed in relative terms as compared to the corresponding values of the "typical" region.

Let us now move a step further and concentrate on the problem of the theoretical shape of the graph of the Basic Image. In order to get a first feeling of the shape of those graphs I start by stating the following simple observations describing the way in which the two or three indicators operate.

- i. The higher the Industrial Indicator of a region the more Attractive its Basic Image.
- ii. The lower the Social Indicator of a region the less Attractive its Basic Image.
- iii. The lower the Environmental Indicator of a region the less Attractive its Basic Image.
- iv. If the Industrial Indicator of a region is continuously increasing but at the same time its Social Indicator is continuously decreasing, the Basic Image of the region may be either Attractive or Repulsive and sudden changes in its state may be expected.
- v. If the Industrial Indicator of a region is continuously increasing but at the same time its Social and/or Environmental Indicator is continuously decreasing, the Basic Image of the region may be either Attractive or Repulsive and sudden changes in its state may be expected.

Such observations although trivial and only a first approximation of the truth they nevertheless give us some useful background information and help us deduce the shape of the three-dimensional graph. Observation (iv) and (v) are the most interesting because they imply that the graph we want to draw is discontinuous. Those observations together with the fact that a continuous graph will implicitly rule out the existence of certain properties, such as hysteresis and divergence, which I consider as fundamental in the process of shaping of a region's Basic Image makes the idea of a discontinuous graph credible and worth pursuing further.

The general mathematical theory of discontinuous and divergent behaviour from continuous underlying forces is called Catastrophe Theory (Thom, 1975; Zeeman, 1973, 1977). The theory is derived from Topology and is based upon, some new theorems in the geometry of many dimensions which classify the ways in which discontinuities may occur in terms of a few archetypal forms, called elementary catastrophes. Although the underlying mathematics are difficult and the proofs of the theorems involved complicated, the elementary catastrophes themselves are relatively easy to understand and can be used profitably even by non-experts in the subject. Table 4.1 summarizes the elementary catastrophes in the case where a process is expressed through one behaviour variable depending on one up to four control variables.

Table 4.1. Some Elementary Catastrophes

| Number of Behavior Variables | Number of Control Variables | Type of Catastrophe |
|------------------------------|-----------------------------|---------------------|
| 1 | 1 | Fold |
| 1 | 2 | Cusp |
| 1 | 3 | Swallowtail |
| 1 | 4 | Butterfly |

In the case of a process, for example, whose behaviour depends on two control variables it is sufficient to know that a theorem exists giving the qualitative shape of a 3-dimensional surface which shows all possible ways in which a discontinuity in the behaviour may occur. The two control variables are usually referred to as normal and splitting factor respectively and the three dimensional graph as the Cusp Catastrophe Surface.

Elementary Catastrophes have characteristic invariant properties and often even wave flags to gain our attention. Once one of these catastrophe flags has suggested the presence of a catastrophe, the control parameters may be varied in a search for the relevant remaining flags. The others will occur under suitable conditions (Gilmore, 1993).

Modality: This means that the physical system has two or more physical states in which it may occur.

Sudden Jumps: A small change in the value of the control parameter may result in a large change in the value of the state variable as the system jumps from one local minimum to another. The transition from the neighborhood of one local minimum to another represents a large change in the value of the state variable which often occurs on a fairly rapid time scale.

Hysteresis: Hysteresis occurs whenever a physical process is not strictly reversible. That is, the jump from local minimum 1 to local minimum 2 does not occur over the same point in control parameter space as the reciprocal jump from local minimum 2 to local minimum 1.

Divergence: A finite change in the value of the control parameters leads to a finite change in the equilibrium value of the state variables. Small changes in the control parameter initial values may lead to large changes in the state variable final values. The instability of physical processes against perturbation of the control parameter trajectory is called divergence.

Inaccessibility: This means that the physical system has an equilibrium state which is unstable.

5. Properties of a Region's Basic Image

Returning to the present case our intention is to show that the process of shaping of a region's Basic Image may be modeled in terms of Catastrophe Theory. The first step towards this direction will be to show that at least some of the five invariant properties characterizing phenomena that may be described by the Catastrophe Theory (i.e. modality, sudden transitions, hysteresis, divergence and inaccessibility) are present in our particular case.

The concept of modality and sudden transitions in the development of a region is certainly not novel in urban literature. Regions exhibit phenomena of broken growth, of partial death, of self regeneration. Furthermore, a region is by its nature in a state of permanent unbalance and its main problem is to reduce its tendency to swing violently from prosperity to bankruptcy (Mumford, L., 1938). Sixty years later, Boschma, R. and Lambooy, J. (1999) writing about the industrial cities of the 1970's and 1980's mentioned that had often showed long periods of economic growth, before they declined or even collapsed. Their position became vulnerable due to developments like technological change or the increasing opportunities to shift production to other regions or countries with cheap labour. Within a decade or so, many urban agglomerations lost many jobs in mature industries like textiles, steel making, coal mining and shipbuilding. This was something quite unexpected, because, traditionally, regional economists focus attention on the positive impacts of agglomeration economies on regional development.

Hysteresis arises in non-linear systems possessing memory. It is a characteristic property of the development of an industrial region and is reflected in the delays observed before any sudden changes in the Basic Image of the region take place. For an attractive region in the process of decline those delays extend its stay on the attractive side and they are due to what we call "locational inertia", or in other words the strong attachment to an area displayed by both business units and people. Some industrial activities writes are maintained in districts where the original reasons for their development are no longer significant, or even no longer exist. This phenomenon is sometimes referred to as "industrial inertia" (Monkhouse, F. J., 1938). While the main reasons for the industrial (business units) attachment to any area are economic, in the case of people they are essentially psychological. The strength of psychological factors has been reflected on the poor results of various government schemes aiming to transfer unemployed workers and their families from depressed to more prosperous areas. This finding verifies the existence of strong "residential inertia". On a similar line Boschma, R. and Lambooy, J. (1999) argue that the poor ability of

old agglomerations to learn, innovate and adapt is explained in terms of socio-cultural factors (such as sclerotic milieus and institutional lock-in) rather than purely economic factors (such as over-specialisation and vertical integration of the division of labour). For a region that has fallen on the repulsive side, the forces of inertia make the return to prosperity very difficult. Economic depression like economic growth is an essentially cumulative process. Once the city has reached a certain stage of its development it needs a terrific exertion of social force of overcome the inertia, to alter the direction of movement (Angelis, V. & Dimaki, K., 2010).

A process is generally considered as divergent if insignificant changes in the initial stages of its development may result in large differences in later stages. **Divergence** is usually recognizable in the case of two competing cities especially in a period of rationalization of their main industries. The very different routes of development for many ship-building areas, for instance, after the reorganization of the industry in the 1930s underline the presence of divergence.

A set of values in the co- domain of a given function are generally considered as inaccessible if they are only attainable in an unstable way. In our particular case, inaccessibility means that certain values of the axis measuring the basic image of a region may not attained, or rather that they may be attained only very briefly. Those values are around zero representing a neutral region image. The idea of **inaccessibility** although never expressed in this explicit way, is not novel in Urban Literature. The loss of confidence of the community in the future of a city leads to accelerated immigration, rapid shifts in investment and physical neglect. The more sudden the loss of confidence, the more rapid the decline. A region in decline enters a vicious circle where problem mount as income from rates shrinks. The blight spreads at an accelerating rate and acts as a negative multiplier reinforcing and speeding up the depression. Boschma, R. and Lambooy, J. (1999) argue that, once a process of regional decline has set in, it becomes self-reinforcing through all kinds of multiplier and accelerator mechanisms.

The **Dynamic** of the model, representing the changes in the state of the Basic Image of a region, is the desire of the prospective movers to maximize their satisfaction. We have already presented evidence suggesting that a set of minimum criteria must be satisfied if the region is to be considered as a potential final choice by any group of movers. As long as their satisfaction is maximized by moving into (or staying in) the region the Basic Image of

the region remains attractive. It becomes repulsive when their satisfaction is maximized by moving (or staying) out.

6. Modeling a Region’s Basic Image

We have so far shown that the process of shaping a region’s Basic Image has all the properties characterizing phenomena which may be modeled in terms of Catastrophe Theory. Hence we may now use Catastrophe Theory to estimate a region’s Basic Image. It is reminded that the Basic Image of a region has been defined as a function of three indicators. Therefore, the appropriate elementary catastrophe is the butterfly. Consequently, the value x , of a region’s Basic Image, at each point in time, is given as a solution of the equation:

$$x^5 - Cx^3 - Bx - A = 0 \tag{6.1}$$

The relationship (6.1) is a quintic equation, which describes a 4-dimensional manifold with a fold of a complicated structure, which is called pleat (Figure 6.1). Such a pleat is determined as a three dimensional surface with a butterfly shape. It can be proved that the butterfly pleat is described by the following parametric equations.

$$\begin{aligned} A(r, s) &= -4s^5 + 4rs^3 - 3s^2q(r, s) \\ B(r, s) &= 15s^4 - 2rs^2 + 6q(r, s)s \\ C(r, s) &= 10s^2 - 4r \\ q(r, s) &= \frac{12rs - 20s^3}{3} \end{aligned} \tag{6.2}$$

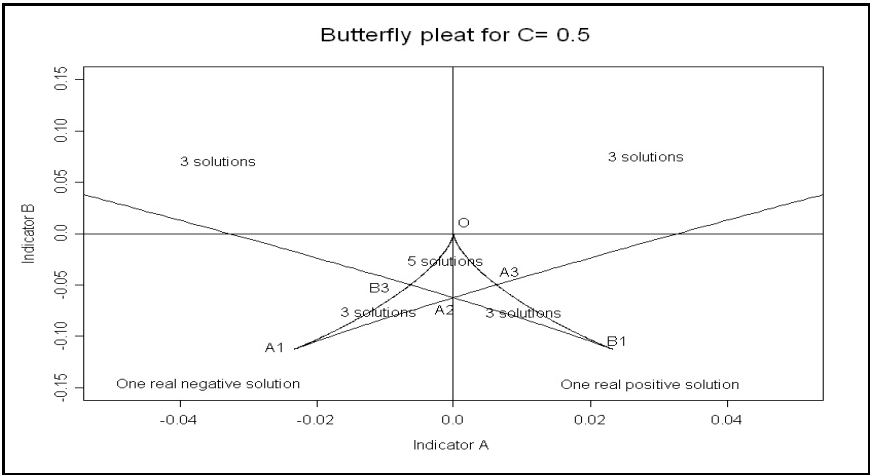


Figure 6.1 Butterfly pleat for C fixed at 0.5

It can be proved that:

$$\begin{pmatrix} A \\ B \\ C \end{pmatrix} = \begin{pmatrix} mk & k & -\sqrt{m^2+1} \\ \sqrt{k^2+1} & -m\sqrt{k^2+1} & 0 \\ m & 1 & k\sqrt{m^2+1} \end{pmatrix} \begin{pmatrix} a-a_0 \\ b-b_0 \\ c-d_0 \end{pmatrix} \text{ when } \begin{matrix} \tan \theta = m \leq 1 \\ \tan \varphi = k \leq 1 \end{matrix}$$

$$\begin{pmatrix} A \\ B \\ C \end{pmatrix} = \begin{pmatrix} k & \frac{k}{m} & -\frac{\sqrt{m^2+1}}{m} \\ \frac{\sqrt{k^2+1}}{m} & -\sqrt{k^2+1} & 0 \\ 1 & \frac{1}{m} & \frac{k}{m}\sqrt{m^2+1} \end{pmatrix} \begin{pmatrix} a-a_0 \\ b-b_0 \\ c-c_0 \end{pmatrix} \text{ when } \begin{matrix} \tan \theta = m > 1 \\ \tan \varphi = k \leq 1 \end{matrix}$$

$$\begin{pmatrix} A \\ B \\ C \end{pmatrix} = \begin{pmatrix} m & 1 & -\frac{\sqrt{m^2+1}}{k} \\ \frac{\sqrt{k^2+1}}{k} & -\frac{m}{k}\sqrt{k^2+1} & 0 \\ \frac{m}{k} & \frac{1}{k} & \sqrt{m^2+1} \end{pmatrix} \begin{pmatrix} a-a_0 \\ b-b_0 \\ c-c_0 \end{pmatrix} \text{ when } \begin{matrix} \tan \theta = m \leq 1 \\ \tan \varphi = k > 1 \end{matrix}$$

$$\begin{pmatrix} A \\ B \\ C \end{pmatrix} = \begin{pmatrix} 1 & \frac{1}{m} & -\frac{\sqrt{m^2+1}}{mk} \\ \frac{\sqrt{k^2+1}}{km} & -\frac{\sqrt{k^2+1}}{k} & 0 \\ \frac{1}{k} & \frac{1}{km} & \frac{\sqrt{m^2+1}}{m} \end{pmatrix} \begin{pmatrix} a-a_0 \\ b-b_0 \\ c-c_0 \end{pmatrix} \text{ when } \begin{matrix} \tan \theta = m > 1 \\ \tan \varphi = k > 1 \end{matrix}$$

where,

a : The value of the region's Economic Indicator

b : The value of the region's Social Indicator

c : The value of the region's Environmental Indicator

a_0 : The value of the typical region's Economic Indicator

b_0 : The value of the typical region's Social Indicator

c_0 : The value of the typical region's Environmental Indicator.

Also,

$m = \tan \theta$: Variable expressing the relative weight attached between the Economic and Social Indicators in defining the area's Basic Image

$k = \tan \varphi$: Variable expressing the relative weight between the plane defined by the Social and the Economic Indicators and the Environmental Indicator.

For the purposes of this work, the values of all Indicators lie in the interval $[0,1]$, whereas the value of its Basic Image lies in the interval $[-1,1]$. The value of the "typical" region's Basic Image is 0. Hence, positive Basic Image indicates an attractive region that may be considered as a potential final choice by the various groups of prospective movers.

From the definition of θ it follows that when it tends to 0^0 , fluctuations in the Economic Indicator alone, will hardly lead to a catastrophe, whereas variations of the Social Indicator are crucial for the changes of the Basic Image. In this case the Social indicator is the dominant one. On the other hand, when θ tends to 90^0 the Economic Indicator is the dominant one. Similarly, from the definition of φ , it follows that when it tends to 90^0 , the Environmental Indicator dominates as compared to Social-Economic Indicators, whereas when φ tends to 0^0 the Social-Economic Indicators are the dominant ones. In practice, this means that the environmental issues draw less attention than the socio-economic ones.

Figure 6.2 presents a graph showing all the alternative paths of a region's Basic Image over a period of time as it moves from a stable state point P_1 with a positive Basic Image value to a stable state point P_3 with negative Basic Image value. This graph is the projection on the plane of the Butterfly surface when keeping m and c almost constant throughout the period under consideration.

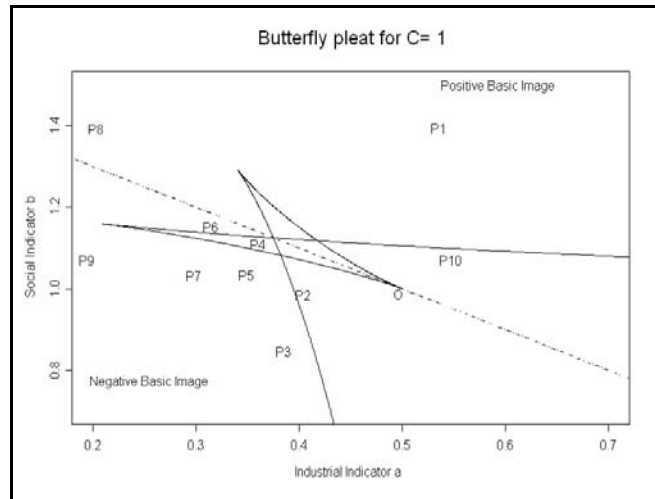


Figure 6.2 Paths on Butterfly transformed pleat, when C is fixed at 1 and Typical Region is at vector $(a_0 = 0.5, b_0 = 1, c_0 = 0.5)$

Starting from point P_1 we can reach point P_3 , using four different paths. The first path exhibits a discontinuous change in the Basic Image value and sign as it goes through a high potency point P_2 . The second path exhibits two discontinuous changes in the Basic Image

value; the first as it moves from P_1 to P_4 (negative value, unstable state) and the second as it moves from P_4 to P_5 (lower negative value, stable state). The third alternative path also exhibits two sudden changes in the Basic Image value; the first as it moves from P_1 to P_6 (lower positive value, unstable state) and the second as it moves from P_6 and P_7 (negative value, stable state). Finally the fourth path is a smooth and continuous one through the points P_8 and P_9 . In order to return from the terminal point P_3 to the starting point P_1 , the same four paths may be followed in the reverse order.

Returning to the present case it is reminded that the factors affecting a region's Basic Image may be divided into two sets according to whether they express the economic or the social aspect of the region. The factors of the first set provide a measure of the region's economic development prospects. This measure is referred to as the **Economic Indicator**. Similarly, the factors of the second set provide a measure of a region's social profile. This measure is referred to as the **Social Indicator**. Finally the factors of the third set provide a measure of the region's environmental profile. This measure is referred to as the **Environmental Indicator**.

A list of all variables affecting a region's Basic Image and a detailed outline of their conversion into the two Indicators and finally into the region's Basic Image is given in Angelis & Dimaki (2010).

7. Application of the Proposed Model

The methodology presented in the previous section is now used for the estimation of the Basic Image of the thirteen Greek regions. The results are summarized below.

Table 7.1. Values of the Economic Indicator of the 13 Greek Regions, 2003-2007

| Administrative Region | 2003 | 2004 | 2005 | 2006 | 2007 |
|-------------------------|-------|-------|-------|-------|-------|
| East Macedonia & Thrace | 0.464 | 0.465 | 0.465 | 0.463 | 0.464 |
| Central Macedonia | 0.522 | 0.522 | 0.523 | 0.523 | 0.522 |
| West Macedonia | 0.501 | 0.501 | 0.504 | 0.505 | 0.504 |
| Thessaly | 0.536 | 0.536 | 0.534 | 0.532 | 0.532 |
| Epirus | 0.492 | 0.494 | 0.491 | 0.493 | 0.491 |
| Ionian islands | 0.440 | 0.437 | 0.437 | 0.437 | 0.436 |
| West Greece | 0.520 | 0.518 | 0.519 | 0.517 | 0.517 |
| Central Greece | 0.554 | 0.556 | 0.557 | 0.555 | 0.552 |
| Peloponnese | 0.511 | 0.512 | 0.515 | 0.516 | 0.516 |
| Attica | 0.639 | 0.643 | 0.642 | 0.638 | 0.644 |
| North Aegean | 0.400 | 0.399 | 0.400 | 0.402 | 0.400 |
| South Aegean | 0.434 | 0.431 | 0.429 | 0.432 | 0.432 |
| Crete | 0.423 | 0.423 | 0.422 | 0.423 | 0.424 |

Table 7.2. Values of the Social Indicator of the 13 Greek Regions, 2003-2007

| Administrative Region | 2003 | 2004 | 2005 | 2006 | 2007 |
|------------------------------------|-------------|-------------|-------------|-------------|-------------|
| East Macedonia & Thrace | 0.486 | 0.477 | 0.483 | 0.470 | 0.515 |
| Central Macedonia | 0.502 | 0.502 | 0.499 | 0.501 | 0.557 |
| West Macedonia | 0.509 | 0.513 | 0.502 | 0.499 | 0.549 |
| Thessaly | 0.515 | 0.512 | 0.509 | 0.507 | 0.506 |
| Epirus | 0.553 | 0.559 | 0.547 | 0.549 | 0.535 |
| Ionian islands | 0.523 | 0.528 | 0.522 | 0.518 | 0.504 |
| West Greece | 0.487 | 0.490 | 0.489 | 0.488 | 0.488 |
| Central Greece | 0.479 | 0.480 | 0.481 | 0.476 | 0.456 |
| Peloponnese | 0.505 | 0.505 | 0.503 | 0.501 | 0.472 |
| Attica | 0.485 | 0.485 | 0.488 | 0.487 | 0.468 |
| North Aegean | 0.510 | 0.518 | 0.516 | 0.512 | 0.470 |
| South Aegean | 0.504 | 0.521 | 0.522 | 0.523 | 0.477 |
| Crete | 0.521 | 0.530 | 0.521 | 0.519 | 0.496 |

Table 7.3. Values of the Environmental Indicator of the 13 Greek Regions, 2003-2007

| Administrative Region | 2003 | 2004 | 2005 | 2006 | 2007 |
|------------------------------------|-------------|-------------|-------------|-------------|-------------|
| East Macedonia & Thrace | 0.553 | 0.551 | 0.554 | 0.554 | 0.554 |
| Central Macedonia | 0.557 | 0.557 | 0.560 | 0.559 | 0.560 |
| West Macedonia | 0.615 | 0.620 | 0.621 | 0.619 | 0.619 |
| Thessaly | 0.554 | 0.551 | 0.552 | 0.551 | 0.552 |
| Epirus | 0.588 | 0.588 | 0.594 | 0.594 | 0.593 |
| Ionian islands | 0.614 | 0.612 | 0.616 | 0.615 | 0.614 |
| West Greece | 0.562 | 0.562 | 0.564 | 0.564 | 0.566 |
| Central Greece | 0.549 | 0.548 | 0.551 | 0.550 | 0.552 |
| Peloponnese | 0.578 | 0.577 | 0.582 | 0.581 | 0.581 |
| Attica | 0.560 | 0.559 | 0.562 | 0.560 | 0.559 |
| North Aegean | 0.619 | 0.613 | 0.617 | 0.616 | 0.622 |
| South Aegean | 0.621 | 0.621 | 0.622 | 0.621 | 0.621 |
| Crete | 0.592 | 0.590 | 0.591 | 0.588 | 0.589 |

Tables 7.1-7.3 present the values of the Economic, Social and Environmental Indicators for the thirteen Greek regions over the period 2003-2007, whereas Table 7.4 presents their Basic Image values of Greece over the same period.

Table 7.4. The Basic values of the 13 Greek Regions, 2003-2007

| Administrative Region | 2003 | 2004 | 2005 | 2006 | 2007 |
|------------------------------------|-------------|-------------|-------------|-------------|-------------|
| East Macedonia & Thrace | -0.5423 | -0.5222 | -0.5638 | -0.3220 | -0.3012 |
| Central Macedonia | 0.5145 | 0.5132 | 0.5190 | 0.5731 | 0.5590 |
| West Macedonia | 0.4464 | 0.3895 | 0.4240 | 0.5316 | 0.5240 |
| Thessaly | 0.5714 | 0.5690 | 0.5605 | 0.5527 | 0.5536 |
| Epirus | 0.4813 | 0.4695 | 0.4586 | 0.4340 | 0.4221 |
| Ionian islands | -0.3452 | -0.4097 | -0.4382 | -0.5093 | -0.4830 |
| West Greece | 0.4867 | 0.4726 | 0.4785 | 0.4791 | 0.4782 |
| Central Greece | 0.5969 | 0.6040 | 0.6040 | 0.5839 | 0.5746 |
| Peloponnese | 0.4751 | 0.4770 | 0.4897 | 0.3996 | 0.3871 |
| Attica | 0.7486 | 0.7538 | 0.7512 | 0.7446 | 0.7524 |
| North Aegean | -0.5022 | -0.5150 | -0.5273 | -0.6345 | -0.6388 |
| South Aegean | -0.4329 | -0.4296 | -0.4333 | -0.6028 | -0.5911 |
| Crete | -0.3822 | -0.4384 | -0.4469 | -0.5390 | -0.5462 |

By looking at Table 7.4 the following conclusions may be drawn:

- All mainland regions have positive Basic Image with the exception of East Macedonia and Thrace, whereas all island regions have negative Basic Image.
- East Macedonia and Thrace, the only mainland region with a negative Basic Image value, is a remote border region with poor accessibility, something which is reflected in the relatively low value of its Economic Indicator. Hence, any effort to improve its Basic Image should start from the improvement of its accessibility i.e. transportation infrastructure and means.
- The negative Basic Image value of all island regions is a natural consequence of their high spatial discontinuity which makes it extremely difficult for them to attract economic activities involving transportation of materials and goods. All efforts aiming to reduce their geographic discontinuity, through the improvement of transportation infrastructure and means, have limited results. Hence, a realistic alternative way to overcome the problem will be to bypass geographic discontinuity through one of the following measures or a combination of them:
 - The first measure is to develop local business activities, not requiring extensive transportation of physical entities. The effectiveness of this measure, however, is questionable, as the potential markets for the local products are usually very limited.

- A second measure is to develop business activities for which unfavourable location is not necessarily a handicap. Tourism is such an activity, where geographical discontinuity may not be a problem but on the contrary, in certain cases, a strong comparative advantage. The exclusive dependence of the region's development, however, on a single activity, such as tourism, is vulnerable to external factors and therefore risky.
- Finally, a third measure, is to establish a communication network where no discontinuity occurs. In this way the regions will be able to attract or develop economic activities involving the production of intangible goods (financial services, computer software) locally, which then may be communicated to customers located elsewhere. The rapid development of Information and Communication Technologies (ICT) over the last years has made the third solution possible.

Figure 7.1 presents the graphs showing the Basic Image traces of one of the Greek regions, namely East Macedonia and Thrace, for the years 2003-2007. As we can see, the region's image improves over the period under study but remains negative. Similar graphs have been drawn for all Greek regions.

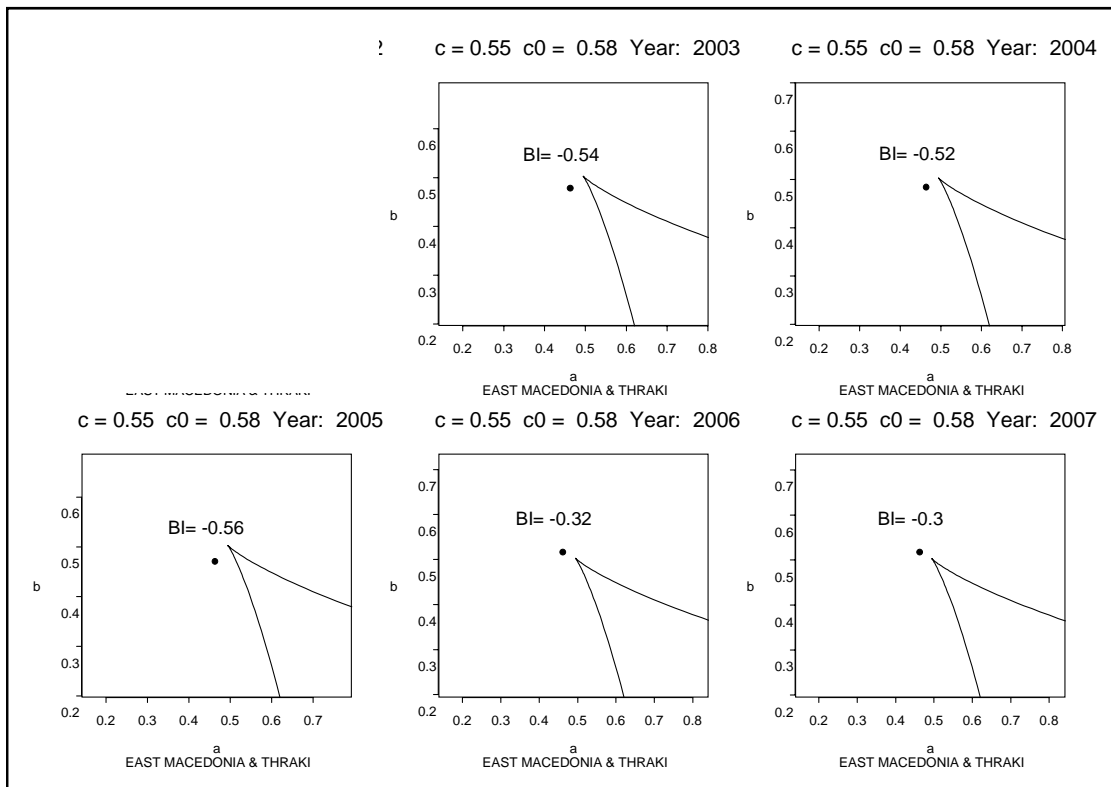


Figure 7.1: Basic Image values of East Macedonia & Thrace, 2003-2007

The last part of the application focuses on the regions with negative Basic Image values in 2007, namely East Macedonia & Thrace, Ionian Islands, North Aegean, South Aegean and Crete. Using the graph showing the trace of the Basic Image, we try to select, in each case, the optimum path for the respective region’s development.

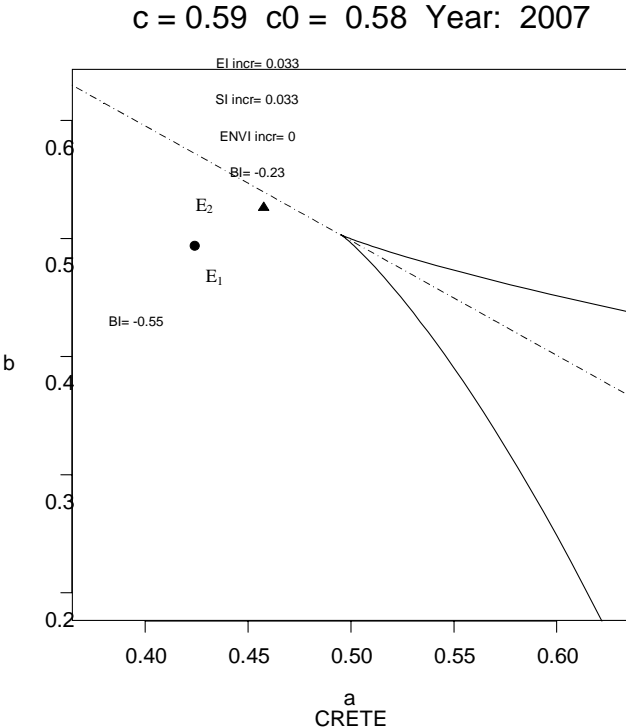


Figure 7.2: The optimum path for improving the Basic Image of Crete

Figure 7.2 refers to the case of Crete. As we can see, point E_1 representing the trace of this region’s Basic Image for the year 2007, lies on the repulsive section of the Butterfly Surface and the Basic Image value at that point is -0.55. Hence, the region’s objective is to move on the attractive side of this surface, thus reversing the sign of its Basic Image value. A first step in this direction would be to move the trace of the Basic Image from E_1 to E_2 as shown in Figure 7.2. According to our model, implementation of this path requires increase in both the Economic and Social Indicator values by 0.033 and the region’s Basic Image value at point E_1 will be -0.23. The required increase in the region’s indicators may be achieved by selecting and implementing the appropriate measures among those suggested before for all island regions.

8. Conclusions

Greece is a country with noticeable regional disparities. The need to bridge the inequalities between Greek regions has been the focus of all regional policies implemented in Greece over the last 40-50 years. During this time, large amounts of money have been spent to improve the infrastructure of certain regions and provide financial incentives, for both industries and employees, so as to move into selected regions.

The first part of the paper discussed the issue of regional inequalities in Greece, the policies used to bridge them and the results obtained. The limited success of those efforts is, among other factors, due to the fact that the policies employed were rather ill-designed and addressed to regions unprepared to take full advantage of them. Hence, the second part of the paper introduced Basic Image, i.e. a measure of a region's current state of development and future prospects, and suggested ways of measuring it. This methodology is applied to a number of selected regions of Greece and the values of their Basic Images for the period 2003-2007 are calculated and placed on an appropriate graph. Finally, using this graph and starting from the Basic Image value of each region at the year 2007, we draw the optimum path for its future development.

The introduction of the Basic Image as a measure of a region's current state of development and its use as the basis for drawing the region's optimum course of development is the first step towards the design of tailor-made measures for every region. An area of further research would be to introduce a financial dimension and try to estimate the implementation cost for each alternative path of development. Such information would be of great value for the decision makers, since apart from knowing a region's alternative paths of development, they will also have an indication of the investment needed to implement each one of those.

References

1. **Angelis, V. (1981).** Basic Image, A New Approach in Modelling Growth and Decline in Industrial Cities. Proceedings Volume, *Conference on Dynamic Non-Linear Theory and General Urban/Regional Systems*, Organised by the U.S National Foundation and the U.S Department of Transportation, Washington D.C. USA. (*Invited Paper*).
2. **Angelis, V. (1990).** Factors affecting the movement and location of both industrial units and their employees, *Proceedings Volume, J. Karkazis and J.B. Boffey eds, Meeting of the Euro Working Group on Location Analysis*, Chios.

3. **Angelis, V. (2009)** The Image of a Region: A Tool for its Sustainable Development, *Proceedings, 5th National & International HSSS Conference "From Systemic Thinking to Systems Design and Systems Practice"*, 24-27 June, Xanthi, Greece.
4. **Angelis, V., Dimaki, K. (2010).** A Region's Basic Image as a Measure of its Attractiveness (*submitted*).
5. **Angelis, V. and Dimopoulou, M. (1991).** A Decision Support System for the Location of Industrial Units. Theoretical framework and Applications. *Studies in Locational Analysis* 3.
6. **Angelis, V., Tsetseri, M. and Dimaki, K. (1999).** The Economic, Social and Environmental Dimensions of Sustainable Development. The Transition from Conflict to Synthesis and the Future Prospects. *Studies in Regional and Urban Planning*, Issue 7.
7. **Boschma, R. and Lambooy J. (1999).** Why do old industrial regions decline? An exploration of potential adjustment strategies. *European RSA Congress, Proceedings*, August 23-27, Dublin, Ireland.
8. **Bovolos, T., Dimaki, K., Angelis, V. and Mavri, M. (2009).** Measuring Sustainable Regional Development: A Theoretical Framework, *Studies in Regional and Urban Planning*, (*to appear*).
9. **Doumi, M. (2006).** *Study of both Regional Inequalities and the Effectiveness of Some Measures Taken to Face Them*. Ph.D. Thesis, Department of Business Administration, University of the Aegean. (*in greek*).
10. **Gilmore, R. (1993).** Catastrophe Theory for Scientists and Engineers. New York: Dover
11. **Kondakis, M. (2009).** *Measuring and Analysing the Health of a Prefecture in a Dynamic Sustainable Regional Development. An Application to the Greek Prefectures*. Ph.D. Thesis, Department of Statistics, Athens University of Economics & Business.
12. **Monkhouse, F.J. (1971).** *The Material Resources of Britain*, Longman, London.
13. **Mumford, L. (1938).** *The Culture of Cities*. Hancourt, Brace and World Inc., New York.
14. **Munashinghe, M. (1993).** Environmental Economics and Sustainable Development, World Bank Environment, Paper number 3. *The International Bank for Reconstruction and Development*, Washington D.C
15. **Perloff, H. S and Wingo, L. (1971).** Planning and Development in Metropolitan Affairs in Leahy. *Urban Economics, Theory, Development and Planning*, The Free Press, New York.

16. **Romer, P. (1986).** Increasing Returns and Long-Run Growth. *Journal of Political Economy*, 94.
17. **Svedin U. (1991).** The Economy-Ecology in Dialogue in Folke C and Kaberger T. Linking the Natural Environment and the Economy: *Essays from the Eco-Eco Group*. Kluwer Academic Publishers
18. **Thom, R. (1975).** *Structural Stability and Morphogenesis: An Outline of a General Theory of Models*. Addison-Wesley, Reading, MA.
19. **Zeeman E.C. (1973).** Applications of Catastrophe Theory, *Manifolds*. Tokyo.
20. **Zeeman, E.C. (1977).** *Catastrophe Theory-Selected Papers 1972*, Addison-Wesley, Reading, MA.
21. **Zolotas X. (1981).** *Economic Growth and Declining Social Welfare*, University Press, New York.