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A Note for the Modelling and Measurement of Statistical Methods of Innovation Activities

Abstract:
Innovation activities contribute essentially to the regional dimension of growth. Technological infrastructure and innovation capabilities affect not only regional growth, but also the economy as a whole. Research and Development (R&D) and technical change are both directly related to industrial infrastructure conditions, modernization process, productivity levels, and regional socio-economic growth. In the last decades, new measures and indices have been introduced regarding R&D expenditure, innovation activities, patents etc., namely estimating innovation inputs and outputs. However, there are a lot of problems and questions regarding the measurement of innovation activities at regional level. This paper attempts to analyse the framework of innovation statistics, particularly examining the specific issues and perspectives regarding statistical methods applied in innovation activities estimation.

Key Words: Innovation activities, statistical methods, economic growth, competitiveness.

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1. Introduction

Innovation is a complex and multifaceted phenomenon. Technological innovation – even in the broad meaning of the Oslo Manual – is only a part of the set of activities firms carry out to sustain or advance their competitiveness. Regarding the statistical point of view, it is not an easy task to identify when technological innovation activities take place, nor to collect data on activities related to innovation, including scientific research. It is not surprising that several problems have been recorded during the implementation of statistical surveys on innovation, the two most important being the following:

▪ proposed definitions on technological innovation may not have been fully understood by firms,

▪ data on technological innovation of firms appear to be substantially different from those referred to manufacturing firms and should be carefully interpreted.

According to the Oslo Manual, the definition of technological innovation includes: "the set of knowledge, professional skills, procedures, capabilities, equipment, technical solutions required to manufacture goods or provide services ". Innovation in process includes "the adoption of technologically new methods in production of goods and services. Several changes concerning equipment, production organisation or both may be required ".

Three main topics related to such difficulties will be discussed in this paper:

▪ how the definitions of technological innovation should be applied; several factors should be actually taken into account, including the relation between technological and non-technological innovations;

▪ what are the characteristics of research and development (R&D), and also

▪ how we can apply and estimate the main implications and the effects through these variables

2. Innovation statistics

The – *Oslo Manual* (OECD, 1997a) defines technological product and process innovations as those implemented in technologically new products and processes and in significant technological improvements in products and processes. An innovation is implemented if it has been introduced on the market (product innovation) or used within a production process (process innovation). Innovation involves a series of scientific, technological, organisational, financial and commercial activities.

Innovation indicators measure aspects of the industrial innovation process and the resources devoted to innovation activities. They also provide qualitative and quantitative information on the factors that enhance or hinder innovation, on the impact of innovation, on the performance of the enterprise and on the diffusion of innovation. The variables common used variables for S-R&T activities are:

– R&D expenditures

– R&D personnel

– Patents of New Technologies.

Tables 1 and 2 illustrate some of the main type of variables in relation to the measurement of scientific and technological activities and also the Titles and Sources from which they derived. However, R&D statistics are not enough. In the context of the knowledge-based economy, it has become increasingly clear that such data need to be examined within a conceptual framework that relates them both to other types of resources and to the desired outcomes of given R&D activities. Similarly, R&D personnel data need to be viewed as part of a model for the training and use of scientific and technical personnel.

Table 1: Innovation and Not Innovation Activities

			Innovation		Not Innovation
			New to the World	New to the Firm	**Already in the Firm**
Innovation	Technologically New	Product			
		Production Process			
		Delivery Process			
	Significantly Technologically Improved	Product			
		Production Process			
		Delivery Process			
		Organisation			
Not Innovation	No Significant Change. Change without novelty or other creative improvements	Product			
		Production Process			
		Delivery Process			
		Organisation			

Source: OECD.

Table 2: Type of Variables for the Measurement of Scientific and Technological Activities

Type of Main Variables	*Titles and Sources*
Research and Development (R&D)	**Frascati Manual: "Standard Practice of Research and Experimental Development" and also Frascati Manual Supplement: "Research and Development Statistics and Output Measurement in the Higher Education Sector".**
Technology Balance of Payments	**OECD: "Manual for the Measurement and Interpretation of Technology Balance of Payments Data"**
Innovation	**Oslo Manual: OECD Proposed Guidelines for Collecting and Interpreting Technological Innovation Data**
Patents	**OECD-Patent Manual: "Using Patent Data as Science and Technology Indicators"**
Scientific and Technical Personnel	**OECD-Canberrra Manual: "The Measurement of Human Resources Devoted to Science and Technology"**
High Technology	**OECD: "Revision of High Technology Sector and Product Classification"**
Bibliometrics	**OECD: "Bibliometric Indicators and Analysis of Research Systems, Methods and Examples" (Paper – Yoshika Okibo).**
Globalisation	**OECD: "Manual of Economic Clobalisation Indicators"**
Education Statistics	**OECD: "OECD Manual for Comparative Education Statistics"**
Education Classification	**OECD: "Classifying Educational Programmes: Manual for Implementation in OECD countries"**
Training Statistics	**OECD: "Manual for Better Training Statistics: Conceptual Measurement and Survey Issues"**

Source: OECD.

The collection of R&D data of regional statistics implied a lot of problems in comparison to data of national statistics. For the collection of regional statistics, we should take into account the local differences and related difficulties. R&D units can operate in more than one regions and we should allocate these activities between regions. Usually, regional statistics focused on the three first levels of NUTS (Nomenclature of Territorial Units for Statistics).

The reliability of R&D and innovation regional statistics is directly connected and depended on estimation-method and the application of statistical technique. Another important question on R&D and innovation regional statistics is the confidentiality and the collection-method of data-set that may cover the whole or the majority of the local-units. For the statistical methods focused at regional level, we can use either the ‘’local-units’’ (i.e. enterprises, office, manufacturing etc.) or the ‘’local-economic-units’’ (NACE codes, which is a division of national codes of European member states). Therefore, we can use the first method «top-to-the-bottom method» for the collection of aggregate R&D data (for the whole country) and after that on the distribution of these figures into a regional-level; the disadvantage of this method is that there is not a direct method for collection of data from the regions.

The second method «bottom-to-the-top method» for the collection of dissaggregate R&D data (for the whole regions) based on the direct-collection at regional-level and after that on the summation of these figures in order to obtain the aggregate-total R&D data (for the whole country); the advantage of this method is that there is a consistency in the summary of figures between regional and national level.

3. Modelling the Research and Scientific Activities

There is a huge literature suggesting and demonstrating that research and scientific indicators make an important contribution to the growth of the firm, industry and national levels. Most of these studies have investigated the relation between productivity, employment, growth and R&D.

3.1. The Input-Output framework

The structural decomposition analysis can be defined as a method of characterizing major shifts within an economy by means of comparative static changes. The basic methodology was introduced by Leontief (1953) for the structure of the US economy and has been extended in several ways. Carter (1960) has incorporated some dynamic elements with a formal consideration of the role of investment in embodied technical change. Chenery, Syrquin and others (1963) added elements of trade into this framework.

Growth decomposition analysis uses input-output techniques because they capture the flows of goods and services between different industries. Input-output methods exploit the inter-linkages effects and also search for the components of growth. In addition, input-output techniques allow us to calculate the contribution of *technical change* to output growth. The principal argument of the method of interindustry analysis is to show explicitly the interdependence of growth rates in different sectors of the economy. Usually, two different compositional indicators are used to analyze the extent of structural change, the annual growth rate of real output in each industry and the share of national real output accounted for each industry.

Input-output tables are available both in current and constant prices. Following Kubo et al. (1986), we can consider the *basic material balance condition* for the gross output of a sector as given by:

$$X_i = W_i + F_i + E_i - M_i \qquad (\textit{material balance equation}) \qquad (1)$$

where: X_i=the gross output,

W_i=the intermediate demand for the output of sector i by sector j,

F_i=the domestic final demand for the output of sector i,

E_i=the export demand, and
M_i=the total imports classified in sector i.

The gross output of sector i is the sum of output to intermediate demand plus the domestic final demand plus the exports less the imports. In the matrix notation the *material balance condition* becomes:

$$X=AX+F+E-M=(I-A)^{-1}(F+E-M), \qquad (2)$$

where $(I-A)^{-1}$, the inverse of the coefficients matrix, captures the indirect as well as the direct flows of intermediate goods.

Holding one part of the material balance equation constant and varying the other components over time, the change in an industry's output can be decomposed into the following factors:

- technical change (corresponding to changes in the inverted I-A matrix);
- changes in final demand;
- changes in the structure of exports; and
- changes in the structure of imports

The positive or negative effects of structural change affect the final demand categories. Technological change plays an important role in the expansion and decline of sectors. Technology intensity and real growth rates of output can be used to classify individual industries into different performance groups. These groups can then be used to describe the patterns of structural change and to make comparisons among various countries. The effects of technical change are analyzed in order to find out how much the use of primary inputs has changed, because of changes in the endogenous factors of the model. Furthermore, the effects of technical change on industrial output are analyzed, in order to reveal how much output in each industry has changed because input-output coefficients have altered.

A way of measuring changes in input-output coefficients is to compute the weighted average changes in the input-output coefficients of various sectors and to compare the matrices at two different points of time. For instance, we can use the following formula (3), in order to compute the weighted indices:

$$T_j = \frac{1}{\frac{1}{2}\Sigma(X_{ij}^2 + X_{ij}^1)} \Sigma\left[\frac{(A_{ij}^2 - A_{ij}^1)}{(A_{ij}^2 + A_{ij}^1)}(X_{ij}^2 + X_{ij}^1)\right] \qquad (3)$$

where: A^2_{ij} is the elements of matrix of input-output coefficients for the second period,
A^1_{ij} is the elements of matrix of input-output coefficients for the first period,
X^2_{ij} is the matrix of interindustry transactions for second period at constant 1975 prices,
X^1_{ij} is the matrix of inter - industry transactions for first period at constant prices.

This index measures the overall input changes in each of the n production sectors due to technological changes, changes in the prices, and product mix (the so called *Rasmussen index* of structural change).

The total change in sectoral output can be decomposed into sources by category of demand. The total change in output equals the sum of the changes in each sector and can also be decomposed either by sector or by category of demand.

The relations, (with the two intermediate terms combined), can be shown as following:

$$\begin{array}{ccccccccc}
DD_1 & + & EE_1 & + & IS_1 & + & IO_1 & = & \square X_1 \\
DD_2 & + & EE_2 & + & IS_2 & + & IO_2 & = & \square X_2 \\
. & & . & & . & & . & & . \\
DD_n & + & EE_n & + & IS_n & + & IO_n & = & \square X_n \\
\hline
\square DD_i & + & \square\square EE_i & + & \square\square IS_i & + & \square\square IO_i & = & \square\square\square X_i = \square X
\end{array}$$

(4)

where: DD_i=domestic demand expansion in sector i,

EE_i=export expansion in sector i,
IS_i=import substitution of final and intermediate goods in sector i,
IO_i=input-output coefficients in sector i,
ΔX_i=change in the output of sector i.

Reading down the columns gives the sectoral composition of each demand category, while reading across the rows gives the decomposition of changes in sectoral demand by different demand categories. When making comparisons across countries and time periods, it is convenient to divide the entire table by $\Delta\Delta X_i$, so that all components across sectors and demand categories sum to 100. Alternatively, it is sometimes convenient to divide the rows by ΔX_i and then to look at the percentage contribution of each demand category to the change in sectoral output.

3.2 Production Function and Productivity Growth

A production function is by definition a relationship between output and inputs. For a single country, say ith, the production function may be written as:

$$y_{it}=F_i(X_{i1t},X_{i2t},.....,X_{imt},t) \quad (8)$$

where: y_{it} is the quantity of output produced per producer unit and X_{ijt} is the quantity of the jth input employed per producer unit (j=1,2,....m) in the ith country for the period.

The aggregate cost (or production) function is based on a cost function (or a production function), which is characterised by constant returns to scale:

$$C=F(P_K, P_L, Y, T) \quad (9)$$

where: P_K, P_L, Y, T indicate the price of capital input, labour input, the value added and time.

In a cross section study, technology can be regarded as given in each country, but this is clearly not in the case when we consider a single country over a period of time. The country's production function will shift as new and more efficient techniques are adopted. A major problem with time series data is to distinguish between increases in output resulting from movements along the production function (for instance, from increased inputs) and increases in output which occur because of shifts in the production function resulting from the technical progress.

The concept of a production function plays an important role in both micro and macroeconomics. At the macro level it has been combined with the marginal productivity theory to explain the prices of the various factors of production and the extent to which these factors are utilised. The production function has been used as a tool for assessing what proportion of any increase in the output over time can be attributed first to increase in the inputs of factors in the production, second to the increasing returns to scale and third to *technical progress*.

Most studies on production function (Solow 1957, Griliches 1967) have been handled under one or more traditionally maintained hypothesis of *constant returns of scale*, *neutrality of technical progress* and *profit maximization* with competitive output and input markets. Therefore, the validity of each of these hypotheses affects the measurement of technical progress and the decomposition of economic growth into its sources.

3.3 Partial or Single Factor Productivity

The partial or single factor productivity (PP) of labour or capital is indicated by the ratio V/L, or V/K i.e. output per unit, or the average product of the factor concerned. The productivity defined this way is merely the inverse of factor intensity. An increase in this ratio, other things remaining the same, implies an increased efficiency of input use, whereby, the same level of output can be produced by a smaller quantity of given input. However, when other things cannot be assumed to be the same, the interpretation of these

output factor ratios as indicators of productivity becomes problematic. For example, an increase in labour productivity may only reflect capital deepening - a rise in the K/L ratio. In such cases it becomes necessary to compute total factor productivity.

3.4 Total Factor Productivity

Total factor productivity (TFP) extends the concept of single factor productivity such as output per unit labour or capital to more than one factor. Thus TFP is the ratio of gross output to a weighted combination of inputs. For the case of production function shown above, TFP at time t would be given by:

$$A_t = \frac{V_t}{g(K_t, L_t)} \qquad (2)$$

where:
A_t : Index of TFP at time t.
g : the aggregation procedure implicit in the specific production function adopted.

Different functional forms of the production functions imply different aggregation procedures or weighting schemes for combining factor inputs.

3.4.1 Total Productivity (TP) versus Total Factor Productivity (TFP)

At this stage, choice exists in regards to the specification of output as value added (V) as in equation (1) above or gross value of output (Y). In the latter case, material and energy inputs are explicitly accounted for in both the left and the right hand sides in the production function.

This would give rise to the following general functional form which in recent years has come to be known as KLEM type production function.

$$Y_t = g(K_t, L_t, E_t, M_t, t)$$

where,
Y_t = level of gross output per unit of time,
K_t = capital input (or service of factor capital)
L_t = labour input
E_t = input of energy,
M_t = material inputs.
t = time

The choice between one form of the other depends on what one believes to be the correct measure of output. It also depends on whether one believes the production function to be separable in factor and material inputs or not. The above functional forms give rise to alternative concepts of productivity. One can define the productivity measure associated with the value added (V) production function as total factor productivity (TFP) and that associated with gross output (Y) production function as total productivity (TP).

In the survey which follows it will be seen that the majority of studies have been conducted using production functions with value added as output and with K and L as inputs.

3.5 Approaches to the Measurement of Productivity Growth

There are three principal approaches to measurement of productivity growth. These are:

- (i). The index number approach,
- (ii) parametric approach and
- (iii) non-parametric approach.

In the present survey we focus primarily on studies which have estimated productivity growth using the first approach. Wherever appropriate, the results from the estimation of cost and production functions have been mentioned in support of as alternative explanations to the results of the first approach. The non-parametric approach which is based on linear programming models of relative efficiency is not reviewed here.

3.5.1 Index Number Approach

In this approach the observed growth in output is sought to be explained in terms of growth in factor inputs. The unexplained part or the residual is attributed to growth in productivity of factors. It consists in assuming a certain functional form for the producers' production function and then deriving an index number formula that is consistent (exact) with the assumed functional form. Preferred functional forms are the flexible ones. These indices differ from each other on the basis of underlying production function or the aggregation scheme assumed. Following are some of the most commonly used indexes.

3.5.2 Kendrick Index

Kendrick's index of total factor productivity for the case of value added as output, and two inputs can be written as

$$A_t = \frac{V_t}{(r_0 K_t + w_0 L_t)} \qquad (3)$$

where,

A_t is the value of index in a given year,

V_t is the value of gross output,

w_0 and r_0 denote the factor rewards of labour and capital respectively in the base year.

The index measures average productivity of an arithmetic combination of labour and capital with base year period factor prices. It assumes a linear and a homogeneous production function of degree one. Besides constant returns to scale and neutral technical progress, it assumes an infinite elasticity of substitutability between labour and capital. The index can be generalised to allow for more than two factors. If a sufficiently long time series for this index can be constructed, then a trend rate of growth can be estimated econometrically. From the time series of Kendrick index yearly series (gt) can be formed by writing growth between successive years as

$$g_{t+1}^{K} = (A_{t+1} - A_t) / A_t$$

The growth rates thus obtained can be appropriately averaged for sub-periods.

3.5.3 Solow Index

Solow's measure of productivity growth for two input case is given by (4)

$$g_{t+1}^{S} = \left[\frac{V_{t+1} - V_t}{V_t}\right] - \left[\frac{L_{t+1} - L_t}{L_t} + \frac{K_{t+1} - K_t}{K_t}\right]$$

where,

V_j = measure of output,

This measure is based on the general neo-classical production function. It assumes constant returns to scale, Hicks-neutral technical change, competitive equilibrium and factor rewards being determined by marginal products. Under these conditions, the growth of total factor productivity is the difference between the growth of value added and the rate of growth of total factor inputs. The latter is in the form of a Divisia index number i.e. a weighted combination of the growth rates, the weights being the respective shares.If we assumed specific Cobb-Douglas production function, with unit elasticity of output (unlike in the general functional form above) and took base year factor shares as weights, we would get Domar's geometric index of TFPG.

Assuming $A_1 = 1$, a time series of Solow index of productivity (A_t) can be formed from the formula:

$$A_{t+1} = A_t * (1 + g_{t+1}^{S})$$

3.5.4 Malmquist Index

Over forty years ago Malmquist (1953) proposed a quantity index for use in consumption analysis. The index scales consumption bundles up or down, in a radial fashion, to some arbitrarily selected indifference surface. In this context Malmquist's scaling factor turns out to be Shephard's (1953) input distance function, and Malmquist quantity indexes for pairs of consumption bundles can be constructed from ratios of corresponding pairs of input distance functions.1 Although it was developed in a consumer context, the Malmquist quantity index recently has enjoyed widespread use in a production context, in which multiple but cardinally measurable outputs replace scalar-valued but ordinally measurable utility. In producer analysis Malmquist indexes can be used to construct indexes of input, output or productivity, as ratios of input or output distance functions.

The period t output-oriented Malmquist productivity index is

$$M_0^t(x^t, y^t, x^{t+1}, y^{t+1}) = D_0^t(x^{t+1}, y^{t+1}) / D_0^t(x^t, y^t).$$

$M_0^t(x^t, y^t, x^{t+1}, y^{t+1})$ compares (x^{t+1}, y^{t+1}) to (x^t, y^t) by scaling y^{t+1} to Isoq $P^t(x^{t+1})$, that is, by using period t technology as a reference. Although $D_0^t(x^t, y^t) \le 1$, it is possible that $D_0^t(x^t, y^t) > 1$, since period t+1 data may not be feasible with period t technology. Thus $M_0^t(x^t, y^t, x^{t+1}, y^{t+1}) \gtreqless 1$ according as productivity change is positive, zero or negative between periods t and t+1, from the perspective of period t technology.

The period t output-oriented Malmquist productivity index decomposes as

$$M_0^t(x^t, y^t, x^{t+1}, y^{t+1}) = \Delta TE(x^t, y^t, x^{t+1}, y^{t+1}) * \Delta T^t(x^t, y^t, x^{t+1}, y^{t+1}) =$$

$$= \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} \bullet \frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^{t+1}(x^{t+1}, y^{t+1})},$$

where ΔTE(*) refers to technical efficiency change and $\Delta T^t(*)$ refers to technical change.

3.5.5 Translog Index

Translog measure of TFPG is given by:

$$g_{t+1}^{T} = \ln\left[\frac{Y_{t+1}}{Y_t}\right] - \left[\left[\frac{s_{t+1}^{L} + s_t^{L}}{2}\right] * \ln\left[\frac{L_{t+1}}{L_t}\right] + \left[\frac{s_{t+1}^{K} + s_t^{K}}{2}\right] * \ln\left[\frac{K_{t+1}}{K_t}\right]\right] \quad (5)$$

This expresses TFP as the difference between growth rate of output and weighted average of growth rates of labour and capital input. This is equivalent to Tornquist's discrete approximation to continuous Divisia index. The index is based on the translog function which describes the relationship between output and inputs and also between the aggregate and its components. The homogeneous translog functional form is flexible in the sense that it can provide a second order approximation to an arbitrary twice continuously differentiable linear homogeneous function. This functional form helps overcome the problem which arises with the Solow index where discrete set of data on prices and quantities need to be used in a continuous function. This index also imposes fewer a priori restrictions on the underlying production technology. The index can be generalised for more than two inputs.

Like in the previous case, from year to year changes in productivity growth one can construct a time series of the translog index as follows:

$$A_{t+1} = A_t * (1 + g_{t+1}^{T})$$

3.6 Parametric Approach

Parametric approach consists in econometric estimation of production functions to infer contributions of different factors and of an autonomous increase in production over time, independent of inputs. This latter increase, which is a shift over time in the production function, can be more properly identified as technological progress. It is one of the factors underlying productivity growth. An alternative to estimation of production functions is estimation of cost functions using results from the duality theory. Below we give some commonly used specifications of production functions.

3.6.1 Cobb-Douglas Specification

The general form of Cobb-Douglas Function has the following form:

$$V = A_0 e^t LK \quad (6)$$

where, V, L, K and t refer to value added, labour, capital and time. a and b give factor shares respectively for labour and capital. A_0 describes initial conditions. Technological change takes place at a constant rate l. It is assumed to be disembodied and Hicks-neutral, so that when there is a shift in the production function, K/L ratio remains unchanged at constant prices. In log-linear form this function can be written as

$$\log V = a + \alpha \log L + \beta \log K + \lambda_t \quad (7)$$

The estimated value of l provides a measure of technological progress, which is often identified with total factor productivity growth.

3.6.2 Constant Elasticity of Substitution (CES) Specification

The general form of Constant-Elasticity of Substitution Function has the following form:

$$V = A_0 e^t \left(L^{-\delta} + (1-\lambda)K^{-\rho}\right)^{-\nu} \quad (8)$$

Where l is the efficiency parameter, δ the distribution parameter, ρ the substitution parameter and u is the scale parameter. The elasticity of substitution σ = 1/(1 + ρ) varies between 0 and μ. Technical change is Hicks neutral and disembodied. The value of λ (a measure of technical progress) can be estimated using a non-linear estimation procedure, or by using the following Taylor-series linear approximation to the CES function:

$$\ln V = \ln A_0 + \lambda t + \nu\delta \ln L + \nu(1-\delta)\ln K - (1/2)\rho\nu\delta(1-\delta)(\ln L - \ln K)^2 \quad (9)$$

This function can be estimated by OLS.

3.6.3 Transcendental Logarithmic (TL) Specification

The general form of Transcendental Function has the following form:

$$\log V = \alpha_0 + \beta_L(\log L) + \beta_K(\log K) + \frac{1}{2}\beta_{LL}(\log L)^2 + \frac{1}{2}\beta_{KK}(\log K)^{2\,2}$$

$$+ \beta_{LK}(\log L)(\log K) + \beta_{Lt}(\log L)t + \beta_{Kt}(\log K)t + \frac{1}{2}\beta_{tt}t \quad (10)$$

where α's and β's are the parameters of the production function.

The rate of technical progress or total factor productivity growth is given by

$$\frac{\log V}{t} = \alpha_t + \beta_{tt}t + \beta_{Lt}(\log L) + \beta_{Kt}(\log K) \quad (11)$$

where,
α_t is the rate of autonomous total factor productivity growth.
β_{tt} is the rate of change of TFPG, and
β_{Lt},, β_{Kt} define the bias in TFPG.

If both β_{Lt} and β_{Kt} are zero, then the TFPG is Hicks-neutral type. If β_{Lt} is positive then the share of labour increases with time and there is labour using bias. Similarly, a positive β_{Kt} will show a capital using bias.

3.6.4 Direct Estimation of Cost Functions

Due to results of the duality theory, one may estimate a cost function instead of production function to calculate technical progress. In its general form a four factor cost function can be written as

$$C = C(P_L, P_K, P_E, P_M, Q, t) \quad (12)$$

Specific forms of cost functions corresponding to each of the above functional forms can be derived. We give below the translog cost function which has many desirable properties sought out by researchers and which has been used most commonly in recent years.

3.6.5 Translog Cost Function

The general form of Translog Function has the following form:

$$\log C = \beta_i + \sum_i \beta_i \log p_i + \frac{1}{2}\sum_i \sum_j \log p_i \log p_j + \beta_Q \log Q +$$

$$+ \frac{1}{2}\beta_{QQ}(\log Q)^2 + \beta_{Qt} \log Q \log t + \beta_t \log t + \frac{1}{2}\beta_{tt}(\log t)^2 +$$

$$+ \sum_i \beta_{Qi} \log Q \log p_j + \sum_i \beta_{ti} \log t \log p_i \qquad (13)$$

Using Shepherd's lemma one can estimate demands for individual factors and shares in total cost of individual factors as follows:

$$\frac{\log C}{\log p_i} = \frac{x_i p_i}{C} = S_i = \beta_i + \sum_j \beta_{ij} \log p_j + \beta_{Qi} \log Q + \beta_{ti} \log t \qquad (14)$$

Rate of technical progress (λ_t) is given by

$$(t) = \frac{\log C}{t} = \frac{1}{t}\left(\beta_t + \beta_{tt} \log t + \beta_{Qt} \log Q + \sum_j \beta_{ti} \log p_i\right) \qquad (15)$$

Technical progress has a factor i using bias if $\beta_{ti} > 0$. It is neutral with respect to factor i if $\beta_{ti} = 0$ and it is factor i saving if β_{ti} is < 0.

3.7 The Catching Up Models

The majority of empirical studies in the estimations between productivity growth and R&D follow a standard linear model; on this context we use a similar approach. The reason is that even though a more dynamic relationship exists, the data limitations (lackness of time series annual data on R&D activities for most countries) prevent the application of some complex models.

We can use and test the basic technological gap model (with and without these variables) reflecting the structural change, in order to decide to what degree these variables add something to the other explanatory variable of the model. We will use the external patent applications (EXPA) and gross expenditures on research and development (GERD) as proxies for the growth of the national technological activities, GDP per capita (GDPCP) (in absolute values at constant prices) as a proxy for the total level of knowledge appropriated in the country (or *productivity*). Investment share (INV) has been chosen as an indicator of growth in the capacity for economic exploitation of innovation and diffusion.

The share of investment may also be seen as the outcome of a process in which institutional factors take part (since differences in the size of investment share may reflect differences in institutional system as well). For the structural change we used as an approximation changes in the shares of exports and agriculture in GDP.

We can use and test the following version of the models:

GDP(or PROD)= f[GDPCP, EXPA (or GERD), INV],(basic model) (5)
GDP(or PROD)= f[GDPCP, EXPA (or GERD), INV, EXP] (6)
GDP= f[GDPCP, EXPA (or GERD), INV, TRD] (7)

The first model may be regarded as a pure *supply model*, where economic growth is supposed to be a function of the level of economic development GDPCP (GDP per capita with a negative expected sign), the growth of patenting activity (EXPA with a positive sign) and the investment share (INV with a positive sign). However, it can be argued that this

model overlooks differences in overall growth rates between periods due to other factors and especially differences in economic policies. We can easily investigate the relationship between these two approximate measures using cross-section data on average growth rates for the EU member states.

The correlation between productivity and patenting is much closer than between productivity and research expenditure. When conducting an econometric analysis of the technological gap models, it is important to include the most relevant variables. For the level of productivity, as a proxy we can use real GDP per capita (GDPPC). For the national technological level we can use some approximate measures, for instance we can again use the traditional variables of technological input and technological output (GERD and EXPA). In both cases we can use the same approach, first testing the basic model and then introducing the terms of trade and export variables. It is worth noting that for the technologically advanced member states the estimated coefficients display the expected signs except for exports (EXPA) and gross expenditure on R&D (GERD).

4. Conclusions

This article attempts to identify the R&D activities and also to investigate the estimation methods, the techniques of scientific and technological activities and the measurement problems. According to 'International Standardization of Statistics on Science and Technology', we can estimate the most important inputs and outputs of scientific and technological activities and also the Scientific and Technical Education and Training and Scientific and Technological Services. The term of «Research and Development Statistics» covers a wide range of statistical series measuring the resources devoted to R&D stages, R&D activities and R&D results. It is important for science policy advisors to know who finances R&D and who undertakes it.

Series of R&D statistics are only a summary of quantitative reflection of very complex patterns of activities and institutions. In the case of international comparisons, the size aspirations and institutional arrangements of the countries concerned should be taken into consideration. One way of constructing reliable indicators for international comparisons is to compare R&D inputs with a corresponding economic series, for example, by taking GERD as a percentage of the Gross Domestic Product. However, it is quite difficult to make detailed comparisons between R&D data and those of non-R&D series both because of the residual differences in methodology and because of defects in the non-R&D data.

UNESCO, OECD and EUROSTAT divisions organised the systematic collection, analysis publication and standardization of data concerning science and technological activities. The first experimental questionnaires were circulated to member states by UNESCO in 1966 and standardized periodical surveys were established in 1969.

The collection of R&D data of regional statistics implied a lot of problems in comparison to data of national statistics. For the collection of regional statistics, we should take into account the local differences and difficulties. In addition, we can use either the 'local-units' or the 'local-economic-units'. The first method «top-to-the-bottom method» focused on the collection of aggregate R&D data (at country level) and after that on the distribution of these figures into a regional-level; the disadvantage of this method is that there is not a direct collection of data from the regions or the second method «bottom-to-the-top method» for the collection of disaggregate R&D data (at regional level) based on the direct-collection at a regional-level and after that on the summation of these figures in order to obtain the aggregate-total R&D data (at country level).

Technological progress has become virtually synonymous with long run economic growth. It raises a basic question about the capacity of both industrial and newly industrialized countries to translate their seemingly greater technological capacity into productivity and economic growth. Usually, there are difficulties in the estimation of technical change and

productivity function. Technological change may have accelerated, but in some cases there is a failure to capture the effects of recent technological advances in productivity growth or a failure to account for the quality changes of newly introduced technologies.

In the literature there are various explanations for the slow-down in productivity growth for OECD countries. One source of the slow-down may be substantial changes in the industrial composition of output, employment, capital accumulation and resource utilization. The second source of the slow down in productivity growth may be that technological opportunities have declined; otherwise, new technologies have been developed but the application of new technologies to production has been less successful. Technological factors act in a long - run way and should not be expected to explain medium run variations in the growth of GDP and productivity.

Technological gap models represent two conflicting forces, innovation which tends to increase the productivity differences between countries and diffusion which tends to reduce them. In the Schumpeterian theory, growth differences are seen as the combined results of these forces. However, research on *why growth rates differ* has a long history which goes well beyond growth accounting exercises.

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Globalization, Foreign Direct Investment (FDI) and Economic Growth: A Study for EU Member States

Abstract:
Globalisation has become a fashionable concept in the social sciences. It is widely asserted that we live in an era in which the greater part of social life is determined by global processes, in which national cultures, national economies, and national borders are dissolving. The world economy has internationalised in its basic dynamics. In the period 1945-1975, the dominant f actor driving the world economy was growth in international trade. Since 1980s, international short-term financial-flows have expanded rapidly. International short-term financial-flows have some impact upon economic growth, since they affect the exchange rate and the interest rate. Usually, MNCs (Multinational Corporations) are responsible for FDI (Foreign Direct Investment). This paper attempts to overview and to investigate the international mechanisms that impact on the structure and growth in the real economy, namely, trade, FDIs (Foreign Direct Investment) and MNCs (Multinational Corporations) and also to examine and measure the effects on socio-economic growth.

Keywords: FDI, MNCs, trade, globalisation, inequality convergence, growth.

JEL Classification (O).

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1. Introduction

Economists have often suggested that investment yield technological advances which in turn foster productivity growth. Many studies (Denison 1962, Abaramovitz 1986, Fagerberg 1987) have suggested that the post-war acceleration of productivity growth was due to mainly the pace of investment on new technologies and on technical progress. However, productivity growth in most OECD countries started to decline in the second half of the 1960s. There is no single cause for the decline of productivity.

The main objectives of this paper is to examine the role of foreign direct investment and the implications on economic growth and social development. In particular, it attempts to overview the theories related to investment theory, productivity, and socio-economic growth. This paper will also examine the empirical studies and evidence, in order to reach in some policy conclusions.

2. Defining the Foreign Direct Investment and Productivity

There is a huge literature and there are many definitions we can use for investment and productivity. Moreover, following the IMF definition, we can say that:

- Direct investment refers to investment that is made to acquire a stake in an enterprise operating in an economy other than that of the investor, the investor's purpose being to have an effective voice in the management of the enterprise. The foreign entity or group of associate entities that makes the investment is termed the direct investor. The unincorporated or incorporated enterprise (a branch or subsidiary, respectively) in which a direct investment is made is referred to as a direct investment enterprise.

According to the OECD definition:

- A foreign direct investor is an individual an incorporated or unincorporated public or private enterprise, a government, a group of related individuals, or a group of related incorporated and/or unincorporated enterprises which has a direct investment enterprise (that is a subsidiary, associated enterprise or branch operating in a country other than the country(ies) of residence of the direct investors).

- Also, *Direct Investment Enterprises* defined as incorporated or unincorporated enterprises in which a single foreign investor either controls ten per-cent or more of the ordinary shares or voting power of an incorporated enterprise (or the equivalent of an unincorporated enterprise) or has an effective voice in the management of the enterprise.

Moreover, the OECD definition states that:

- Direct investment flows are defined to include for subsidiary and associated companies: the direct investor's share of the company's reinvested earnings plus the direct investor's net purchases of the company's share and loans plus the net increase in trade and other sshort-term credits given by the direct investor to the company. For branches this includes the increase in unremitted profits plus the net increase in funds received from the direct investor.

- Finally, loans on short-term balances from fellow subsidiaries and branches to foreign direct investment enterprises, loans by subsidiaries to their direct investors and loans guaranteed by direct investors and defaulted as well as the value of goods leased by direct investors should be included in direct investment, with an exception only for the bank, deposits, bills and short term loans which should be excluded from direct investments.

Finally, the United Nations definition states that:

- *Foreign direct investment, net flows* Net inflows of investment to acquire a lasting management interest (10% or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital and short-term capital.

According to economic theory investment usually takes place as a capital stock. The relationship between investment and the capital stock depends on which measure of capital we use. It is important to distinguish between changes in the value of stocks that are the result of inflation (stock appreciation) and the physical change in stocks, for it is only the latter that constitute investment in stocks or stockbuildings. So we can define:

- Gross capital stock which includes the value (at replacement stock) of all capital goods that have not been scrapped. Gross capital stock is estimated using the formula: GK(t) = GK(t-1) + GI(t) – S(t), where GK(t) is the gross capital stock at the end of period t, GI(t) is gross investment period t, and S(t) is scrapping in period t. Net capital stock includes the value of all capital goods net of depreciation. A machine that is part of the capital stock is valued at a smaller and smaller price as it depreciates. It is calculated according to the formula: NK(t) = NK(t-1) + GI(t) – D(t), where NK denotes net capital stock and D denotes depreciation. If we are interested in finance, then the net capital stock, which measures the value of the capital stock, is the right one. If on the other hand, we are interested in productive capacity, then the gross capital stock is more appropriate. Net investment (gross investment minus depreciation) is the change in the net capital stock. The change in the gross capital stock is gross investment minus scrapping.

We an also follow the main definitions of productivity, using the economic theory, in accordance which:

- The simplest and the most frequent used measure of productivity is the output per head.

However, it is important to develop a better measure for productivity due for example that firms may be using more capital-intensive methods or resources may be being used more efficiency. The way economists most often attempt to disentangle the effects of productivity growth from the other factors which cause output per head to change is to calculate what is usually referred to as the growth of either total factor productivity or multifactor productivity.

- Total Factor Productivity (TFP) indicates the productivity of all purchased inputs and is the most useful approach to productivity measurement. Technological change is a concept based on the physical measurements of science and engineering, while the TFP measures the economic impact of technological change. Any change in the quantities or qualities of inputs or outputs is classified as technological change. Total Factor Productivity (TFP) is defined as the ratio of aggregate gross output to aggregate purchased input, expressed in real terms. Therefore, we can defined as TFP: $TFP = \Sigma_j w_j Y_j / \Sigma_i z_i X_i$ where:Y_j=physical quantity of output j, X_i=physical quantity of input i, w_j=share of output j in the total revenue, ($w_j = q_j y_j / \Sigma_j q_j y_j$)$z_i$=share of input i in the total cost, ($z_i = p_i x_i / \Sigma_i p_i x_i$ is the total input cost or the total cost of production), q_j=the price of output j (j=1,2,.....,j), p_i=the price of input i (i=1,2,.....,i). TFP aggregates are created by adding individual factor productivity weighted by the corresponding share of each input in the total cost of production. This procedure assumes that the production process is organized to minimize the total cost of production.TFP is given in terms of unit factor requirements by: $TFP = u_i z_i (1/u_i) = u_i z_i (y/x_i)$, where:$u_i$=physical units of input x_i per unit of standard output,(i=1,2,.,m).

2. Globalisation, investment, productivity and economic growth

Economies may have internationalised to a considerable degree, but wealth, investment, productivity and output remains local and extremely unevenly distributed. The danger of globalisation is that it tends to ignore these distributions, it treats the world as a single open competitive market and the location of economic activity as dictated by purely commercial considerations.

International flows of goods and of finance capital have doubtless increased sharply over the last few decades. Nontraditional manufacturing exports from the newly industrializing countries (NICs) of Asia to the developed have scaled new heights. The rapid growth of national incomes in China, Malaysia, Thailand and Indonesia has been accompanied by an accelerated expansion of foreign direct investments (FDI) from outside and within the region, especially Japan, Hong Kong, South Korea and Singapore.

Some have heralded a new era of globalization marked by rapidly growing world trade and capital movements. Others argue, however, that the world economy is actually less integrated today than it was in the late nineteenth century (see for example Rodrik, 1997). But such comparisons invite further scrutiny. It is true that labour movements, in the form of mass migrations from the old world to the new, were substantially higher during the nineteenth century than they are today. Similarly, net capital outflow relative to GNP was much higher in the United Kingdom before World War I than at any time since.

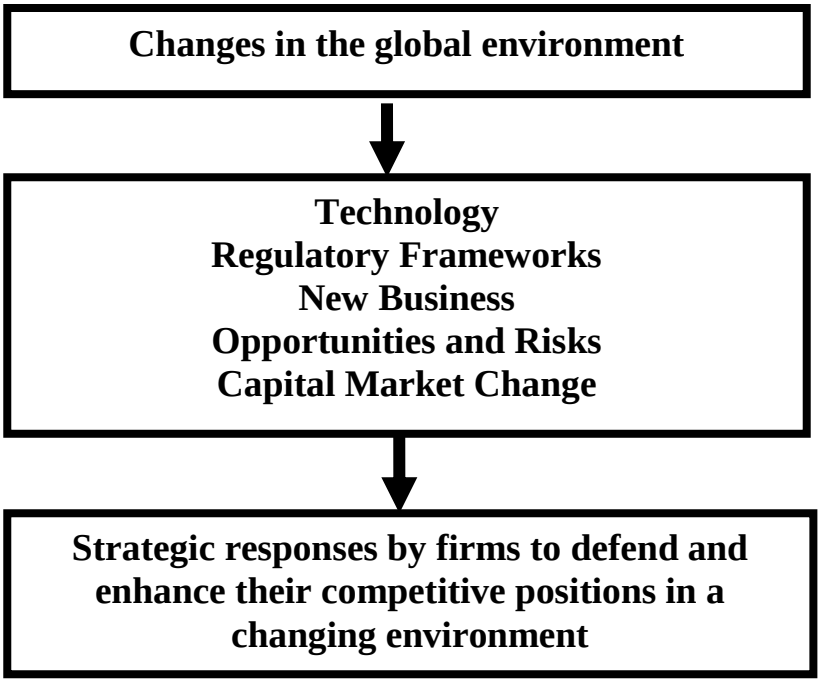
Investment is an important factor on the process of the technology transfer, economic development and economic performance. MNEs (Multinational Enterprises) and FDIs (Foreign Direct Investment) are the main policy tools for the international technology transfer and the development of innovation activities in many countries. Multinationals also produce and control most of the world's advanced technology. About four fifths of the FDIs and the production of advanced technology originates from the Japan, Germany, United Kingdom, United States and Switzerland.

A large share of these labour and capital flows was restricted to the same group of countries which today account for the lion’s share of goods flows. The significance of capital and labour movements in such a comparison cannot be considered apart from trade flows. Economies may be “integrated” by goods flows even in the absence of any factor movements. Turning to trade volumes relative to national incomes, measured openness in the United States and in Europe peaked before World War I, fell sharply between the wars and trended upward after World War II. By this measure, the advanced economies of the world are not any more open in 1997 than they were in 1897. But per capita incomes in these advanced economies are many times larger today and, as a result, the share of services, which tend to be far more nontradable than goods, is considerably higher. Hence, even constant trade ratios represent a significant increase in openness.

There are several strands of economic theory that describe the relationship between innovation and economic growth (and by implication productivity growth). These strands model the relationship in various ways, but they are all agreed that innovation is fundamentally important for, and indeed the prime driver of, economic growth. In the neoclassical tradition stemming from Solow, 1956, long-run economic growth comes only through growth in factor inputs, such as capital and labour, and innovation. This innovation is exogenous, i.e. unexplained by the model. Technical progress improves the production functions of firms and countries, allowing goods and services to be produced more efficiently. This increase in efficiency, whereby more output is produced for less input from the factors of production, amounts by definition to an increase in productivity. So-called growth accounting techniques have applied the neoclassical model to empirical data, decomposing growth into the contributions of growth in factor inputs and the residual: total factor productivity (TFP)

growth. Figure 1 illustrates the effects and the impact of FDI and innovation and the way that expand the capacity of the economy, allowing economic growth.

Figure 1: FDI, Innovation and Growth Process



Source: Own elaboration

The discovery of the apparent importance of innovation led to movements to try to endogenise the innovation process itself, i.e. to explain it in the model. Endogenous growth theory models the innovation process by the addition of a knowledge capital input factor and spillovers. The stock of knowledge in the economy grows because firms and organisations undertake R&D. They know how much to invest in R&D because, even if they do not know whether a particular R&D investment will lead to successful innovation, they know the probabilities of success or failure, a situation described as weak uncertainty. The usual assumption of diminishing marginal returns to R&D investment is relaxed in endogenous growth models in by using spillovers. Knowledge spills over, either inter-temporally or to other firms (e.g. Romer, 1990). This means that there can be increasing returns to R&D investment in the economy at the aggregate level and hence long-run economic and productivity growth is possible.

Efforts in the areas of FDIs and Research Activities have been associated in the economic literature with higher growth rates, increases in exports and trade, gains in productivity, growth in income and output, bigger business profits and lower inflation, international competitiveness.

Solow's 'neoclassical' growth model argued that capital investment could not generate long-run economic growth: diminishing returns to capital investment would limit the availability of profitable investment opportunities and so investment could only generate growth through short-run adjustment dynamics. But this viewpoint has been discredited by the recognition of the presence of positive externalities from investment identified by 'new' growth theorists. Where externalities arise from investment in assets such as human capital and R&D, investment will always have a positive impact on economic growth. This approach suggests that while diminishing returns to investment may occur at the level of individual decision-making, increasing or constant returns may hold at the whole economy level, meaning that investment can generate ongoing economic growth.

A rather more compelling argument against the liberal use of the term globalization is that the movement of goods, capital and enterprises across national boundaries is marked by great unevenness. First, developed nations, whether as sources or as destinations, account for a disproportionate share of these flows relative to their share in global income. Second, even as tariff barriers have declined, old forms of nontariff restraints on trade persist while new ones are coming into vogue. Third, the formal and informal creation of regional blocks for trading and investment may be seen as a threat to the forces of integration across these blocks and, even more, as a factor further isolating the numerous countries and regions in the South that do not enjoy political or economic proximity with Japan, the United States or the EU. Finally, there remain great asymmetries in the stability and composition of exports as between the developed nations and NICs on the one hand and the less developed countries (LDCs) on the other.

Most of the empirical studies emphasized the profits, the age and the amount of new technologies transferred by MNEs. Usually, the affiliate companies operate in a monopolistic market where the new technologies gives its products a *quality advantage* and a higher market share. FDIs contributed substantially to the transfer of technological inputs and consequently to the modernisation process.

As we have mentioned, we can define productivity as the ratio of output to input. A productivity ratio may be changed when the price or unit cost of an output or input is changed. Productivity change is an important aspect of technological change, so that productivity measurement plays a crucial role in assessing the effects of technological change.

The studies of Abramovitz (1986), and Fagerberg (1987, 1988, and 1994) have suggested that there is a close correlation between investment on technological development and that of the productivity level.

Economists have analyzed different possible views of why productivity growth has declined. These alternative explanations can be grouped into the following categories:

- (a). the capital factor, for instance investment may have been inadequate to sustain the level of productivity growth;
- (b). technology factor which affects the productivity level, for instance a decline in innovation activities can affect productivity growth;
- (c) increased price of raw materials and energy;
- (d). government regulations and demand policies that affect the productivity level;
- (e). skills and experience of labour force may have deteriorated or moreover workers may not work as hard as they used to;
- (f). products and services produced by the economy have become more diverse;
- (g). productivity levels differ greatly across industries.

Productivity growth exhibits a strong cyclical pattern. Productivity rises first in booms and falls or rises more slowly in recessions. This can be accounted for simply by variations in utilisation rates, in boom factors, both capital and labour are more fully utilised so output per head and TFP rise. Whereas, in recessions the reverse occurs. Usually, productivity has risen faster in manufacturing than in the economy as a whole. This may reflect more rapid technical change in manufacturing, but it probably also reflects measurement problems.

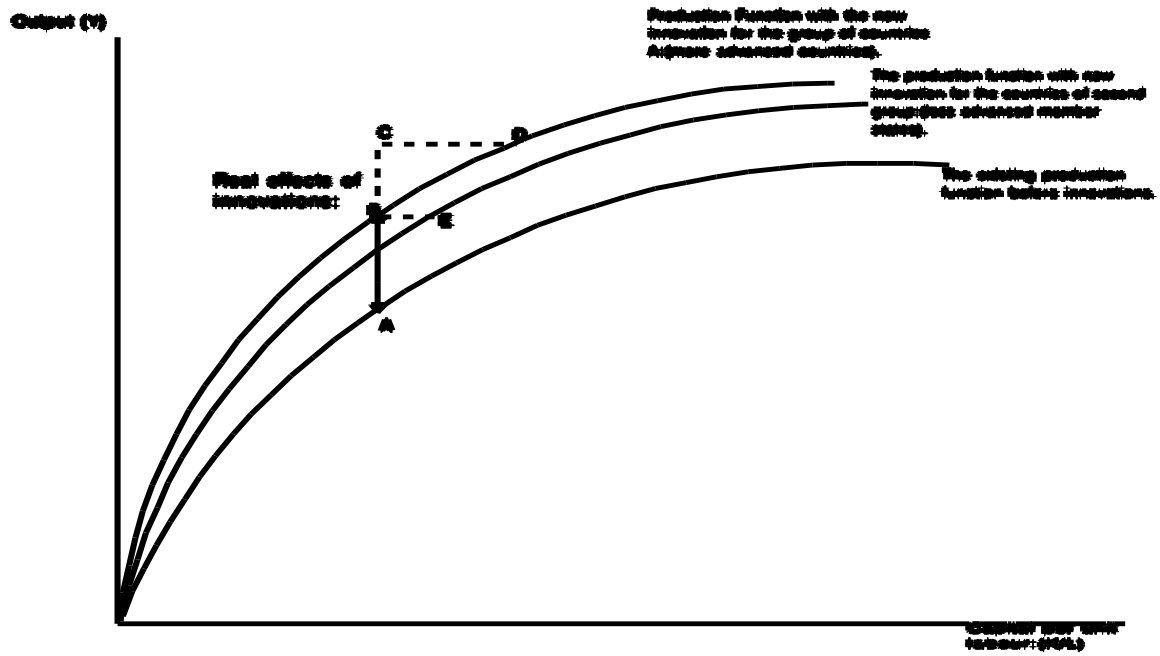
Most manufacturing output is directly measurable which means it is fairly easy to observe productivity growth, despite the inevitable index-number problems. In contrast, many as services have to be valued at the cost of the inputs used, the reason being that output cannot directly be measured. For example, education and public administration, may be becoming more efficient without this being reflected in measures of output.

Following the analysis of Landau, we can assume that there is a production function that relates output to capital per unit of labour and also we also assume first that the economy is at the point A (where labour force growth is static and investment is at an average level). When a new investment takes place (in the form of a new technology, for example) is introduced there is an upward shift in the productivity and consequently in the production function. Of course, the shift of the production function will be different across different countries. This shift of the production function implies additional output per person and probably this can lead to extra savings and consequently to more capital per worker, which means that the economy will moves along the production function. Figure 1, illustrates that the economy reaches the point E for less advanced countries and point D for more advanced countries. The real effects of investment on innovation, for exampple, can now be measured by the distances AE and AD respectively

As we have seen, it is widely accepted among economists that the term *productivity* refers to the relationship between outputs and inputs in real terms. The ratio of real gross product to real factor costs (*Total Factor Productivity* TFP) reflects the net saving of factor inputs per unit of output and thus the increase in productive efficiency. TFP is to be distinguished from what may be termed as *total productivity* which is the ratio of gross output to all associated tangible inputs, (labour, capital and intermediate products). This ratio is useful to compute for industries, establishments and firms since there is usually substitutability among all classes of inputs intermediate and basic factors. The TFP for the entire economy can be calculated as a weighted average of total productivity measures for the various industries when weights are the ratios of the value of gross output for each industry to total value added (GDP) which sum to more than unity.

The studies of Schmookler, Kendrick (1984), Abramovitz (1986), have recognized the interaction between investment on technologies and that of productivity. In these studies, factor prices were used to weight the various inputs so as to get a measure of total input growth. The approach which was developed by Abramovitz (1986), Solow (1957), Denison (1962), refers to the common method for decomposition of output growth into its various sources, which can be defined as the *growth accounting and residual method*. Figure 2 illustrates the impact of investment-technology on production and productivity

Figure 2: Investment-technology and the impact on production and productivity



Growth accounting theories began with Kuznets and were developed by Abramovitz (1986). One of the main tools used in the measurement and analysis of TFP is the *growth accounting framework*. This analysis assumes the existence of a production function, constant returns to scale, cost minimization and competitive input and output markets. However, important sources of growth in TFP, such as economies of scale, and learning effects cannot be directly derived by the growth accounting techniques; econometric models can give estimates of these effects.

TFP growth is amounted as a residual after the measurement of the effects of other factors. These studies were mainly based on comparison between the growth of inputs (capital and labour) and the growth of output; one part of actual growth could not be explained and it has been classified as *unexplained total factor productivity growth* (or the so called *residual*). These can be incorporated in the *growth accounting framework* using the following formula:

$$\Delta TFP_R = \Delta TFP - \Delta TFP_{SE} - \Delta TFP_{LC}$$

We can also write the following equation for the output growth:

$$\Delta Y = \sum_i \Delta X + \Delta TFP_{SE} + \Delta TFP_{LC} + \Delta q_y + \Delta TFP_R$$

the output growth is explained in terms of the growth in inputs, scale effects (ΔTFP_{SE}), learning curve effects (ΔTFP_{LC}), changes in the quality of output (Δq_y) and residual or unexplained growth in TFP (ΔTFP_R).

"Growth Accounting" begins with the measurement of factor accumulation and then imputes output expansion to the inputs that have been accumulated by assuming that market factor prices reflect value marginal products. The part of output growth that cannot be attributed to the accumulation of any input is referred as the *Solow residual* and is attributed to technological progress. By differentiation the rate of growth of technology could be viewed as the difference between the rates of growth of output and of a weighted average of the inputs.Later, Domar called this variable as *the residual*. The growth-accounting approach attempts to explain changes in real product and TFP. Denison's objective was to explain as much of the TFP residual as possible by the major determinants other than *advances in knowledge* applied to production and then attribute the final residual to technological advance.

Following the decomposition analysis of Solow, many alternative factors can explain the path of economic growth. The *residuals* of Solow are attributed to technical change; according to his findings, technology was responsible for 90 per cent of the increase in labour productivity for the United States in the twentieth century.

The purpose of growth accounting is to determine from the empirical data how changes in real output (between two periods, say t=0 and t=T) can be attributed to changes in the inputs (capital, labour and technology respectively). The unexplained decline of productivity growth can thus be regarded as a result of the collapse in technological activities. In particular, this may have happened because the availability of technological opportunities was temporarily or permanent reduced. The *residual* could contain a number of important influences on productivity growth, but to equate the *residual* to technological change is not justified. It can be explained by technology, resource allocation, education, and scale factors. The basic-point of criticism of these theories was that most of the variables in the *growth accounting models* are interdependent and there is no precise theory of how these variables interact. Some countries may grow rapidly because they use capital more intensively, others may have fast growing populations. The standard interpretation of technological change is that *knowledge* evolves exogenously. Knowledge is relatively costless to import and all countries should attain the same term in their production functions. This implies a sort of *catching up* in which poorer countries acquire techniques and learn over time how to use them effectively.

Total Factor Productivity was introduced by J.Kendrick and applied to the output of industries, economic sectors or the economy. It can be measured the tangible inputs of labour (which is measured by man hours worked) and capital inputs (which is measured by capital stock derived as past investment less depreciation). The labour and capital indexes are then combined into an index of factor inputs by means of weights that represent distributive shares in industry product in the base period. Productivity growth is the difference between the growth of output and the growth of tangible input as measured by this index. According to this method, the productivity which arises from improvement in the quality of labour and capital is included in residual growth. It has been suggested that it will be necessary to determine and to explain the relationship between *active* (*engines of growth*) and the *passive* factors. *Growth accounting* tries to explain changes in real product and TFP. Denison concluded that technological change (or *advanced knowledge*) contributed by only 40 per cent to United States productivity growth.

In addition, *gap theories* (Abramovitz 1986, Fagerberg 1987, 1988, 1994) relate the investment on new technologies and innovation activities to the level of economic growth. *Catching up theories* (Abramovitz 1986, Fagerberg, 1987) started with the investigation of growth performance. The main idea was that large differences in productivity levels among countries tend to be due to *unexpected* events (for instance wars). For the productivity measure, we can use the real GDP per capita as an approximate measure. The most representative measures for *technological inputs and outputs* are the indicators of patent activities and the research expenditures.

3. Analysis and modelling of Data

This section attempts to measure the relationship between technology and productivity, or in other words to investigate the relation between the decline in productivity growth and technology (*technological and catching up models*).

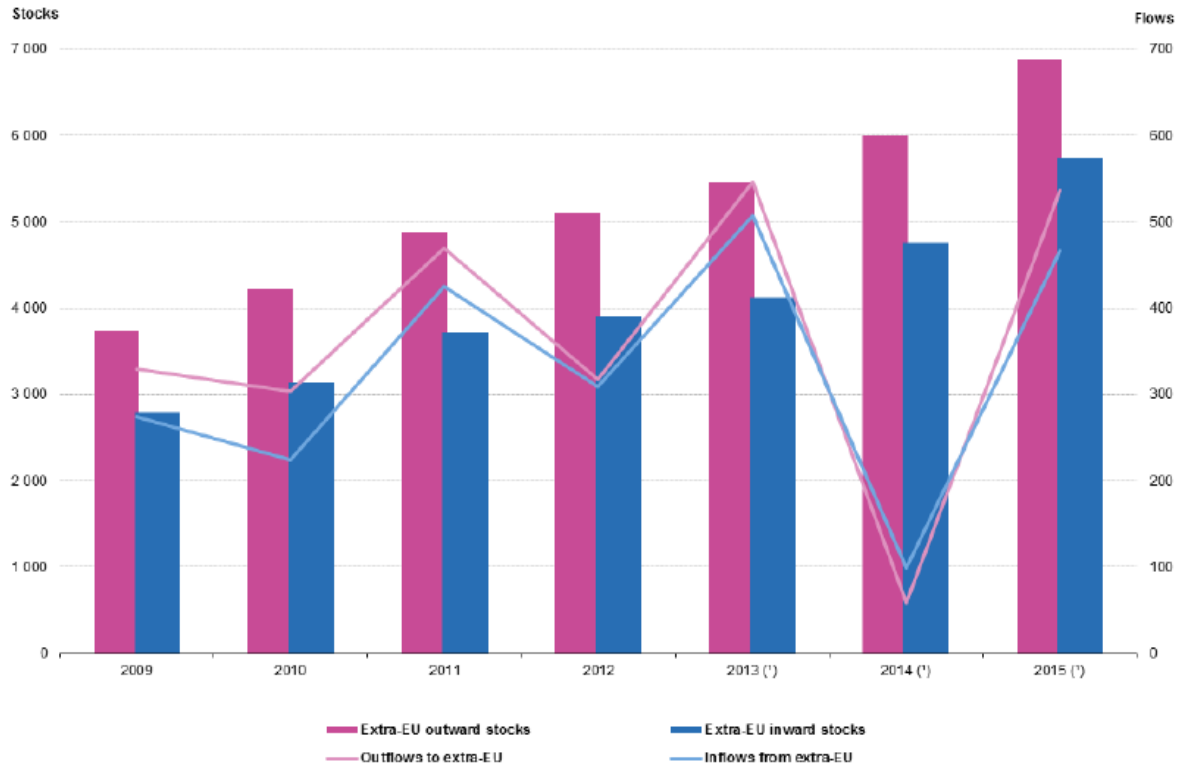
In this literature, economic development is analyzed as a disequilibrium process characterized by two conflicting forces:

(a) investment which tends to increase economic and technological differences between countries and

(b) diffusion (or the imitation) which tends to reduce them.

MNEs and FDI are very closely linked. According to United States, there were an estimated 37,000 MNEs in the early 1990s, controlling about 170,000 affiliated organisations. Of these, 24,000 (about 70 per cent) were “home based” in the fourteen major developed OECD countries. Ninety per cent of MNEs headquarters are in the developed world. In 1997, the stock of FDI was $ 2 trillion. The MNEs controlling this stock were responsible for domestic and international sales of US $ 5.5 trillion. This was much more than the total of world trade at US $ 4 trillion in 1977. Only 5 per cent of the stock of FDI has its origins with a developing country’s MNEs. About 80 per cent of US trade was conducted by MNEs. For total US trade as much as a third was estimated to inta-MNE trade. Intra-MNE trade conducted within the boundaries of the company involving transfers across borders between different parts of the organisation. The following Figure 3 illustrates the FDI flows and stocks, EU-28, 2009–2015 (billion €).

Figure 3: FDI flows and stocks, EU-28, 2009–2015 (billion €)



Source: IMF Database

Both EU inward flows (direct investments in EU Member States from non-member countries) and outward flows (EU Member States' direct investments in countries outside the EU) fell sharply in 2014 and were at their lowest levels during the period 2009–2015. These big falls were mainly due to large disinvestments in the traditional partner countries — the United States and Switzerland — as well as disinvestments from the United States in the EU. In 2015, the level of inward and outward FDI flows returned to a similar level to that recorded in 2013. in 2015, the EU Member States' direct investments in countries outside the EU rebounded strongly, nearly recovering to the level recorded in 2013. In particular investments in the United States and Switzerland increased greatly, in both cases exceeding the levels of outward flows to these countries in any of the years from 2012 to 2014.

Table 1 presents the GDP per capita for EU' member states. Gross domestic product is the gross value added, at purchaser prices, by all resident producers in the economy plus any taxes and minus any subsidies not included in the value of the products. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. Gross domestic investment consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Growth rates are annual averages calculated using constant price data in local currency. Private investment covers gross outlays by the private sector (including private non-profit agencies) on additions to its fixed domestic assets. Net private capital flows consist of private debt and non-debt flows. Private debt flows including commercial bank lending, bonds and other private credits, while private non-debt flows are foreign direct investment and portfolio equity investment. Table 2 illustrates the multifactor productivity: total annual growth rate (%) for the time-period 2005 – 2018. Using these measures, it is obvious that productivity growth rates have declined rapidly in the last two decades.

Table 1: GDP per capita in PPS in EU member-states, 2007-2018

	2007	2008	2009	2017	2018
European Union - 28 countries	100	100	100	100	100
European Union - 27 countries (2007-2013)	100	100	100	100	100
Euro area (19 countries)	109	109	108	106	106
Euro area (18 countries)	110	109	109	106	106
Belgium	117	115	118	116	115
Bulgaria	40	43	43	49	50
Czechia	82	84	85	89	90
Denmark	123	125	125	128	126
Germany	117	117	117	124	123
Estonia	69	68	63	79	81
Ireland	148	134	129	181	187
Greece	93	93	94	67	68
Spain	103	101	100	92	91
France	108	106	108	104	104
Croatia	61	63	62	62	63
Italy	107	106	106	96	95
Cyprus	104	105	105	85	87
Latvia	57	59	52	67	70
Lithuania	60	63	56	78	81
Luxembourg	265	262	255	253	254
Hungary	60	63	64	68	70
Malta	79	79	81	98	98
Netherlands	139	140	138	128	129
Austria	125	125	127	127	127
Poland	53	55	59	70	71
Portugal	81	81	82	77	76
Romania	43	51	52	63	64
Slovenia	87	90	85	85	87
Slovakia	67	71	71	76	78
Finland	119	121	117	109	110
Sweden	128	127	123	121	121
United Kingdom	112	110	108	106	104
Iceland	130	130	130	130	133
Norway	177	187	172	146	150
Switzerland	156	158	160	156	157
Albania	23	25	27	30	31
Serbia	35	38	39	39	40
Turkey	47	48	48	66	65
Bosnia and Herzegovina	27	29	30	31	31
United States	151	146	146	141	143
Japan	109	105	103	99	98

Source: Eurostat

Table 2: Multifactor productivity: total annual growth rate (%), 2005 – 2018

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Austria	1.99	-0.44	-2.15	1.00	0.70	0.28	-0.29	-0.16	0.77	-0.21	0.58
Belgium	0.83	-1.32	-1.95	1.57	-0.67	-0.77	-0.00	0.42	0.76	-0.21	-0.11
Denmark	-0.65	-2.23	-2.84	2.66	0.28	0.98	0.40	1.13	1.19	0.42	0.87
Finland	2.77	-1.42	-6.30	2.79	1.51	-1.81	0.07	-0.27	0.48	2.37	2.18
France	-0.60	-1.27	-1.98	0.93	0.78	-0.24	0.60	0.43	0.33	-0.14	1.62
Germany	1.34	-0.18	-3.68	2.55	2.04	0.29	0.46	1.02	0.51	1.23	0.83
Greece	1.00	-2.67	-4.21	-2.41	-5.39	-3.42	-1.09	1.85	-0.98	-0.10	0.12
Ireland	0.42	-4.91	0.25	8.30	3.27	-1.51	-2.25	4.40			
Italy	-0.42	-1.38	-3.50	1.73	0.23	-1.19	0.12	0.18	0.41	-0.06	0.84
Luxembourg	2.88	-6.14	-3.55	2.38	-0.76	-3.18	1.21	0.66	0.46	-0.88	-1.74
Netherlands	0.28	0.14	-3.16	1.46	0.40	-0.79	-0.05	0.62	-0.24	0.35	1.00
Portugal	0.58	-0.83	-2.03	1.82	-0.25	-0.86	0.28	-0.59	0.26	0.35	
Spain	0.26	-0.87	-0.22	0.66	-0.18	-0.29	-0.22	0.07	0.77	0.61	
Sweden	-0.06	-2.59	-3.90	3.37	0.43	-0.94	0.29	0.89	2.11	-0.19	0.12
United Kingdom	1.04	-0.66	-3.28	1.49	0.08	-0.64	0.10	0.16	1.28	-0.59	0.63

Source: Dataset, OECD Publications.

Note: Multifactor productivity (MFP) reflects the overall efficiency with which labour and capital inputs are used together in the production process. Changes in MFP reflect the effects of changes in management practices, brand names, organizational change, general knowledge, network effects, spillovers from production factors, adjustment costs, economies of scale, the effects of imperfect competition and measurement errors. Growth in MFP is measured as a residual, i.e. that part of GDP growth that cannot be explained by changes in labour and capital inputs. In simple terms therefore, if labour and capital inputs remained unchanged between two periods, any changes in output would reflect changes in MFP. This indicator is measured as an index and in annual growth rates. The total factor productivity, that is, a weighted average of the growth in labour and capital productivity. CP = Capital Productivity, that is, the ratio of output to capital. LB = Labour Productivity that is output per employed person, (with the indexes of other sectors, agriculture, industry, manufacturing and service sectors derived in a similar way).

Massive increases in inequalities among nations during the era of modern economic growth do not inspire confidence in the liberal prediction or prescription. Living standards over much of the old world were proximately similar around 1600. Even as late as 1800, per capita income in Europe and North America was roughly the same as that prevalent in Asia. But by 1900, incomes in the centre were around 10 times as large as in the periphery and the gap had doubled again by 1960. Yet, markets in the periphery were largely open to world commerce (and to investments financed by the richer nations) for the century preceding World War II. Notably, however, most peripheral states lacked sovereignty and were subjected to colonial exploitation. India's per capita income, for example, precisely stagnated under the Crown-imposed policy of laissez faire and virtual free trade. By contrast, a strongly regulated import-substitution regime after independence served to more than double India's per capita income.

A significant element of the convergence purportedly associated with globalization is, implicitly or explicitly, associated with the transfer of technology. Closing the technological gap between production in developing and developed countries is seen as allowing a process of catching-up in productivity and thus incomes; and FDI is seen as embodying (in varying degrees, according to the sector) such technological progress. In practice, however, the extent to which the transfer of technology increases growth depends on the extent to which it is transferred to the local economy rather than merely being used by a single (foreign-owned) producer—what Rao terms the "localization of development." Various mechanisms are put forward as assisting this process, for example "learning-by-doing" by employees who subsequently work for other, locally owned, companies, or who establish their own enterprises. Table 3 presents some main indices, namely net foreign direct investment, exports of goods and services, imports of goods and services, and GDP growth rates, for a selected number of countries.

Imports of goods and services including the value of all goods and non-factor services purchased from the rest of the world, including merchandise freight, insurance travel and other non-factor services. Whereas, exports of goods and services including the value of all goods and non-factor services provided to the rest of the world, including merchandise freight, insurance travel and other non-factor services. Foreign direct investment is the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital flows, reinvestment of earnings, other long-term capital flows, and short-term capital flows. Data on foreign direct investment do not give a complete picture of international investment in an economy.

The corollaries of globalization and economic integration at the national level have been domestic liberalization (primarily through structural adjustment programmes) and greater macroeconomic discipline. These have been widely promoted by their proponents as improving long-term growth (and, in the latter case, have faster growth as their central objective). However, apart from their potential effects on income distribution, poverty and social conditions, more critical voices have raised serious questions about their actual effects on growth. An almost universal finding of studies on the macroeconomic effects of structural adjustment programmes has been a marked negative impact on investment.

We can easily investigate the relationship between these two approximate measures using cross section data of average growth rates in the period 2003-2017 for the EU member states. Whatever the form of the independent variable, a positive relation between productivity and national patent activity exists.

As expected, the best results are obtained for the logarithmic models, which imply a steeper curve. Patenting data reflect the innovation process better, while the research indexes reflect both imitation and innovation processes. Research and development data reflect imitation, innovation and diffusion activities. The relation between productivity (as measured by GDP per capita) and innovation activities should be expected to be log linear rather than linear and steeper for the patent data than for the index based on research data.

The popular method which we are used attempt to overcome the problem of spurious correlation and to estimate the relationships between the rates of change of variables rather than between their absolute levels. The effect of looking at the rate of change in a variable is typically to remove any trend element. That is, many non stationary economic time series become stationary when they are first differentiated.Unfortunately, when attention is concentrated on relationships between rates of change, there is real danger that valuable information on the long-run relationship between the levels of the variables will be lost. First difference is an unsatisfactory method of dealing with a spurious correlation problem. Table 4 illustrates the results for the basic gap-model.

Table3: Basic socio-economic indices for European Union.

	Gross domestic product at market prices (GDP) bn EUR (2018)	Gross domestic product at market prices (GDP) per inhabitant (PPS) (2017)	GDP growth rate (%) (2018)	General government deficit/surplus % of GDP (2018)
Germany	3 386	37 100	1,4	1,7
Austria	386	38 100	2,7	0,1
Belgium	451	35 000	1,4	-0,7
Bulgaria	55	14 800	3,1	2,0
Croatia	51	18 500	2,6	0,2
Cyprus	21	25 400	3,9	-4,8
Czechia	207	26 900	2,9	0,9
Denmark	298	38 400	1,4	0,5
Estonia	26	23 600	3,9	-0,6
Finland	234	32 700	2,3	-0,7
France	2 349	31 200	1,5	-2,5
Greece	185	20 200	1,9	1,1
Hungary	132	20 300	4,9	-2,2
Ireland	318	54 300	6,7	0,0
Italy	1 757	28 900	0,9	-2,1
Latvia	30	20 000	4,8	-1,0
Lithuania	45	23 500	3,4	0,7
Luxembourg	59	75 900	2,6	2,4
Malta	12	29 300	6,6	2,0
Netherlands	773	38 400	2,7	1,5
Poland	496	20 900	5,1	-0,4
Portugal	202	23 000	2,1	-0,5
Romania	203	18 800	4,1	-3,0
Slovakia	90	22 900	4,1	-0,7
Slovenia	46	25 500	4,5	0,7
Spain	1 208	27 600	2,6	-2,5
Sweden	467	36 300	2,3	0,9
United Kingdom	2 394	31 700	1,4	-1,5
EU-28	15 877	30 000	2,0	-0,6

Source: Eurostat Database.

According to these theories, countries with a higher level of investment on innovation activities tend to have a higher level of value added per worker (or a higher GDP per head) and a higher level of investment on innovation activities than others.

For the econometric analysis of *gap models*, the important issue is to include the most important variables. For the level of productivity, we can use as a proxy real GDP per capita (GDPCP). For the measurement of *national technological level*, we can use some approximate measures; for instance, we can again use the traditional variables of *technological input* and *technological output* measures, (GERD and EXPA).

The majority of empirical studies in the estimations between productivity growth and investment follow a standard linear model; on this context we use a similar approach. The reason is that even though a more dynamic relationship exists, the data limitations (lackness of time series dissaggregate annual data for most countries) prevent the application of some

complex models. Following the model of Fagerberg (1987, 1988, 1994), we can test the basic gap model (with and without these variables) reflecting the structural change, in order to decide to what degree these variables add something to the other explanatory variable of the model. We will use the external patent applications (EXPA) and gross expenditures on research and development (GERD) as proxies for the growth of the national technological activities, GDP per capita (GDPCP) (in absolute values at constant prices) as a proxy for the total level of knowledge appropriated in the country (or *productivity*). Investment share (INV) has been chosen as an indicator of growth in the capacity for economic exploitation of innovation and diffusion; the share of investment may also be seen as the outcome of a process in which institutional factors take part (since differences in the size of investment share may reflect differences in institutional system as well). Since annual observations are heavily affected by the short-run fluctuations, average values of the variables covering the period 2003-2017 were calculated. We have tested the following version of the model:

GDP (or PROD)= f[GDPCP, EXPA (or GERD), INV], (basic model),

This model may be regarded as a pure *supply model*, where economic growth is supposed to be a function of the level of economic development GDPCP (GDP per capita with a negative expected sign), the growth of patenting activity (EXPA with a positive sign) and the investment share (INV with a positive sign).

Table 4: The Basic model tested for all EU member states, (2003-2017):(*)

<1>.The basic model: GDP=2.824-0.002GDPCP+0.10EXPA+0.027INV t=(1.53) (-3.30) (2.30) (0.32), R^2=0.52 (adj.d.f:0.39) DW=1.52, Rho(autocorrelation coefficient)=0.385, t=1.475. The logarithm model: LGDP=1.499-0.384LGDPCP+0.155LEXPA+0.806LINV t=(0.593) (-2.569) (0.930) (1.340),R^2=0.56 (adj.d.f:0.42) DW=1.36, Rho(autocorrelation coefficient)=0.297, t=0.985.
The basic model: PROD=0.453-0.00015GDPCP-0.0198EXPA+0.174INV t=(-0.386) (-3.979) (-0.245) (3.012),R^2=0.64 (adj.d.f:0.54) DW=1.49, Rho(autocorrelation coefficient)=0.301. The logarithmic model: LPROD=-0.566-0.384LGDPCP-0.131LEXPA+1.558LINV t=(-0.220) (-2.519) (-0.770) (2.541),R^2=0.75(adj.d.f:0.66) DW=1.38, Rho(autocorrelation coefficient)=0.241, t=0.786.
<1>.The basic model: GDP=1.775-0.00129GDPCP+0.0142GERD+0.0646INV t=(0.92) (-1.86) (0.21) (0.75), R^2=0.40 (adj.d.f:0.24) DW=2.30, Rho(autocorrelation coefficient)=-0.153, t=-0.539. The logarithm model: LGDP=0.619-0.275LGDPCP+0.00625LGERD+0.837LINV t=(0.246) (-2.098) (0.0396) (1.408), R^2=0.47(adj.d.f:0.33) DW=2.38, Rho(autocor.coefficient)=-0.228, t=-0.815.
The basic model: PROD=0.349-0.00018GDPCP-0.0716GERD+0.168INV t=(0.231) (-3.413) (0.933) (2.677), R^2=0.66 (adj.d.f:0.57) DW=1.43, Rho(autocorrelation coefficient)=0.301. The logarithmic model: LPROD=-0.404-0.421LGDPCP-0.0345LGERD+1.568LINV t=(-0.130) (-2.585) (-0.176) (2.126), R^2=0.61 (adj.d.f:0.50) DW=1.79, Rho(autocorrelation coefficient)=-0.0131, t=-0.0402.

Note:(*)=Including the three prospective member states. The standard errors & the variance shown in the above examples that are heteroskedastic-consistent estimates. Definition of variables: GDP = annual average growth rates (2003-17) for real gross domestic product. PROD = annual average growth rates (2003-17) for product.(defined as labour prod: GDP per person employed). GDPCP = average absolute values constant (2000) prices (000 US $) for GDP per capita. EXPA = annual average growth rates for external patent applications. GERD = annual average growth rates for GERD. INV = annual average growth rates (2003-17) for investment as a share of GDP. LGDP, LPROD, LEXPA, LGERD, LINV, are the above variables in a logarithmic form.

However, it can be argued that this model overlooks differences in overall growth rates between periods due to other factors and especially differences in economic policies.

Some other attempts (such as Fagerberg) have been made which trying to explain the economic growth (or the productivity growth) as a function of both gaps and efforts or capacity for exploiting the gap. We will follow the Fagerberg approach. In the basic model, we will use the variables of GDPCP (GDP per capita), INV investment) and EXPA/GERD (external patent applications/gross expenditures on R&D); however the variables EXPA and GERD had some disadvantages because the patent index clearly overestimates the absolute differences in technological level between countries and the GERD data do not exist for several periods.

The conventional view is that inequality can be beneficial for growth, as the concentration of income in relatively few hands provides resources surplus to consumption needs to finance investment. However, this does not appear to have happened in most developing countries in recent years: cross-sectional evidence shows no significant positive relationship between inequality and investment.

Two reasons are put forward for this:

- That high levels of inequality give rise to social and political instability, which discourage saving and investment; and
- That excessive inequality puts pressure on governments to pursue redistributive policies, in particular reducing after-tax rates of return on capital, which tend to discourage savings and investment.

4. Conclusions

The current economic period has been characterized as one of globalization. Globalization may be defined as a process of movement toward a situation where the obstacles to trade flows and factor movements *between* countries are no greater than the obstacles *within* countries. Although this end state remains a long way off, such movement has occurred at an accelerated pace since the early 1980s, through liberalization of trade, foreign direct investment (FDI) regimes, capital controls, etc. in developing countries under structural adjustment programmes and similar, if more limited, changes in the developed countries under the GATT Uruguay Round, which also served to entrench many of the measures taken in developing countries. Technological changes have also contributed by reducing the cost of transport and communication and by facilitating trade in services (e.g., data processing) that would previously have been impractical.

FDI may be seen as an alternative economic strategy, adopted by those enterprises that invest to establish a new plant/office, or alternatively, purchase existing assets of a foreign enterprise. These enterprises seek to complement or substitute international trade, by producing (and often selling) goods and services in countries other than where the enterprise was first established. There are two kinds of FDI: the creation of productive assets by foreigners (so-called greenfield investments), or the purchase of existing assets by foreigners

(for example, through acquisitions, mergers, takeovers). FDI differs from portfolio investments because it is made with the purpose of having control, or an effective voice, in the management of the enterprise concerned and a lasting interest in the enterprise. Direct investment not only includes the initial acquisition of equity capital, but also subsequent capital transactions between the foreign investor and domestic and affiliated enterprises.

Orthodox neoliberal economic theory predicts that global integration will bring benefits to developing countries through economic convergence. Lower barriers to trade and capital flows, even without free movement of labour, will tend to equalize factor prices, productivity and incomes over time. Convergence will not be absolute, in that the prices of nontradable goods will vary between countries, and production technology will differ between countries, according to their factor endowments, giving rise to differences in the productivity and real incomes of nontradable factors (land and labour).

According to the neoliberal model, freeing international markets and liberalizing domestic economies allows countries to move toward specialization in their areas of comparative advantage. For developing countries, where labour is plentiful and capital scarce, this implies a shift from often capital-intensive import-substituting industries to more labourintensive sectors, primarily for export. Coupled with capital inflows to finance investment in these sectors, the result is, in principle, labour-intensive growth, absorbing surplus labour.

In the literature there are various explanations for the slow-down in productivity growth for OECD countries. One source of the slow-down may be substantial changes in the industrial composition of output, employment, capital accumulation and resource utilization. The second source of the slow down in productivity growth may be that technological opportunities have declined; otherwise, new technologies have been developed but the application of new technologies to production has been less successful. Technological factors act in a long run way and should not be expected to explain medium run variations in the growth of GDP and productivity.

Gap models investigate the link between technology and growth over time, across countries and across sectors. The empirical estimates suggest that the convergence hypothesis applies among industrialized countries. Research on *why growth rates differ* has a long history which goes well beyond growth accounting exercises. The idea that the poorer countries should catch up on the richer ones was advanced already in the nineteenth century, in order to explain continental Europe's convergence with Britain. In the 1960s one of the most basic was the Marx-Lewis model of abundant labour supplies which explained the divergent growth experience in the Western European countries.

To achieve safe results, it is necessary to apply a cross country multi sectoral analysis, in order to be able to examine how technological activities affect the different sectors. According to our estimates there is a relationship between the level of economic growth and growth of investment.

Investment and technological activities contribute seriously to economic growth, unless this is a negative demand effect. Specifically, our results confirm that there is a close relationship between the level of economic growth (as measured by GDP per capita) and the level of technological development (as measured by the number of external patents).

Our results indicate that both imitation and innovation activities have a significant impact on the growth of GDP and productivity. The countries that are technologically backward have a potentiality to generate more rapid growth even greater than that of the advanced countries, if they are able to exploit the new technologies which have already employed by the technological leaders. The pace of the catching up depends on the diffusion of knowledge, the rate of structural change, the accumulation of capital and the expansion of demand.

However, our results confirm that some of the small and medium sized EU member states have attained high levels of GDP per capita without a large innovation capacity. To explain the differences in growth between these countries in the post-war period a much more detailed analysis of economic, social and institutional structures should be implemented. If we are comparing technologically advanced and less advanced member states, we can easily find that the less advanced countries lacked experience of large scale production, technical education and resources.

Catching up hypothesis is related to economic and intra-trade and flow relations among countries. There are different opportunities for countries to pursue a development strategy which depends directly on resource and scale factors. In summary, we can say that the introduction of new technologies influenced industrialization and economic growth. Of course, for the countries with a poor technological apparatus the impact of new technologies is much smaller. Finally, it seems that the technological gap between the less and more advanced countries is still widening.

Conclusions cannot be easily drawn from simple summary measures of the extent or the rate of compositional structural change, without having some additional information regarding the direction of change, the path followed from the previous industrial structure and associated and institutional factors.

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Urban sprawl in Greece: The case of Heraklion

Abstract:
Urban sprawl is a phenomenon that has intensively been examined by urban planners. In Greece the lack of coordinated spatial planning combined with the lack of controlling mechanisms led to arbitrary urban expansion. In most cases this expansion was formed in a sprawled away in different forms in all available areas. The current research analyzes the characteristics of sprawl and the policies for its containment. It will proceed to the examination of sprawl in a representative case of a Greek city, Heraklion, which faces intense sprawl phenomena and it will investigate its development after the Olympic Games until today, in order to evaluate the role of economic crisis and spatial planning in the area's spatial expansion. The paper examines certain areas in the legislative limits of the city and will evaluate the factors that cause sprawl or effect its development in different time periods.

Keywords: urban sprawl; spatial planning; Heraklion; economic crisis; land values

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1. Methodology and case study

The current research will investigate new sprawled areas and their forms in certain dates through the comparison of aerial photos for certain dates. The area that will be examined is Heraklion, the capital of the region of Crete. The city according to the 2011 census has approximately 150.000 inhabitant's and 35.000 arbitrary constructions. It defines a representative case for sprawl investigation as it concentrates all the elements of a typical Greek city. It has developed an industrial zone, tourism development and infrastructures that have supralocal function, as a hospital and a University. Efforts for the city's expansion have been made through spatial plans that were legislated, but still the area has been developed beyond their rules, as the city's borders are not clear and both planned and un-planned zones of the city's limits are constructed with the same aim, market forces maximization. So, it is of great interest to investigate how the city has been diachronically sprawled and if sprawl is intensified, towards which directions and forms, and simultaneously to evaluate the effectiveness of Greek spatial planning for the development of compact cities.

The paper will proceed to the area's analysis in 2004, the period of the Olympic Games when Greece faced economic development. The next date is the analysis of sprawl in 2008, in order to examine the way, the country's economy encouraged the sector of construction. Then it will investigate sprawl in 2012, when the first signs of crisis were reflected in the Greek cities' spatial development. According to records, the sector of construction was downgraded so it is important to investigate how this fact influenced the cities new borders. Finally, the last date which will be examined is 2016, the most recent date for which all the case studies have available aerial photos, which shows how the boundaries of the urban areas are shaped through the period of Greece economic reform.

2. Definition forms and characteristics of urban sprawl.

Many urban scientists have tried to define sprawl. One of the most descriptive is the one that was formulated by Galster. He defined sprawl as a ''a pattern of land use in an urbanized area that exhibits low levels of some combination of eight distinct dimensions: density, continuity, concentration, clustering, centrality, nuclearity, mixed uses and proximity'' [3]. A second definition that describes the basic economic dimension of sprawl is that was formulated by Bruegmann. He defined sprawl as an intrinsic urban process related to the city's economic maturity [4].

According to its spatial characteristics, sprawl appears in four different forms. It appears as

_ 'suburban' sprawl, or contiguous expansion away from a central core;
_ 'strip' sprawl, which is spatially developed along major transport routes;
_ 'scattered', sprawl positioned against a compact city; and
_ 'leapfrog' sprawl, a form of growth that is discontinuous and it is positioned against a monocentric city [5-6].

The research about sprawl was intensified in the mid-1990's when there was a growing concern about its social and environmental effects that were caused by its development [7, 8, 9].

The experience from research in the European large cities shows that it is caused by the processes of centralization and decentralization in large cities [10, 11, 12]. Regardless the European cities economic, administrative and geographical characteristics sprawl appears as a common way of development in most of the European urban tissue.

The European planning policy tried to confront sprawl with growth boundaries control and city centers regeneration programmes. The case of Southern Europe is different as the strong rates of growth that were experienced between the 1950s and the 1980s was causing

sprawl not only in the metropolitan areas but also in their small and medium sized urban centers, which were gradually connected with the centers and created a spatial continuous.

Research, focusing on the consequences of sprawl in the European cities, identified that it causes consumption of resources and rural land, ecosystem fragmentation, loss of environmentally fragile land and intensification of car use. It also caused increased cost for infrastructure and it has led to income-related spatial segregation of residential development, weakened sense of community and increased risk of social exclusion in the inner cities [13].

The main aim of spatial planners is to control sprawl, through policies that encourage compact development. The proposals for sprawl management present differences according to the countries where they are applied. In the United States smart growth concept and growth management policy are applied in order to limit the American cities in a compact form [14-17]. Policies for urban containment are also extensively used in many countries [18]. The three basic tools for urban containment are the definition of spatial boundaries, the definition of urban service boundaries and the definition of greenbelts. [19]. In the Mediterranean cities which are shaped by similar histories, lifestyles and geographies, the sprawl that has been developed presents many differences and many similarities [20]. A basic similarity is the high dependence of private automobile, which combined with the lack of planning and controlling mechanisms explain the status of today's urban landscapes [21].

Urban sprawl is defined as the process of urban change through which the urban area is extended, and density gradients reduced [1]. Mumford observed that suburbia that results from urban sprawl was not much of a problem when it served only a favored minority. But when it became a mass phenomenon, urban and natural values were being destroyed without producing anything, but a dreary substitute, devoid of form and even more devoid of the original suburban values [2]. Sprawl is recorded worldwide as a result of urbanization with different forms, characteristics and intensity. In Greece it has been a subject of research and a matter that policies tried to control without the expected results. The paper aims to examine sprawl, in a city that combines, tourism with industrial development in order to investigate the sprawl forms that have been developed and their changes through the years in order to evaluate their causes.

The paper attempts to answer to the following questions:

What forms of sprawl have developed in the examined cities during the period 2004-2016?

How has the economic crisis of 2009 influenced the intensity of sprawl?

How has spatial planning influenced the sprawl status?

Which urban functions have attracted sprawl?

3. The sprawl of Greek cities.

The Mediterranean cities due the touristic exploitation of land and to the lack of planning restrictions have as a result dispersed urban forms that were more intense in the coastal and the islander areas. Athens is a typical case of a Mediterranean city [22,23]. The Greek urbanization process is characterized by high density urban cores and low-density peripheries, lack of open areas and high degree land-use mix. It has been developed diachronically with high private car dependence and a distortion of the historical and natural topography. A further characteristic of the Mediterranean city noted in Athens is the unplanned mode of its expansion [24].

As for the Greek cities sprawl is noted in specific historic phases. The small existing settlements that were developing since the declaration of the Greek state in 1833, were expanding with slow paces until 1923 when a wave of refugees came to Greece and 1,4 million people caused urgent housing needs. That period many Greek cities presented scattered sprawl in the forms of new small arbitrary settlements in the cities existing limits.

After the Second World War and the Civil War the country's industrialization led to intense sprawl phenomenon that this time differed. The few legislative restrictions of urban

and regional planning allowed unplanned arbitrary constructions that were never demolished. Additionally, pressures for new tourism constructions were also causing strip sprawled forms in coastal areas So, growth in most of the Greek cities is a result of unplanned urban expansion and, hence, sprawl [25].

4. The case of Heraklion.

Heraklion is the most populated city of the region of Crete (Figure 1). It is a coastal city with a significant role as a center of the island and a supralocal pole in the South Mediterranean area. It concentrates all kinds of activities and infrastructures in the sectors of tourism, research and technology and industries. It has a port and an airport in its limits, which function as gates for the island of Crete.

Figure 1. The urban tissue of Heraklion

The history of Heraklion started many centuries ago, but its spatial development was taking place inside the today existing walls. In 1922 the arrival of 15.000 refuges led to the arbitrary construction of new residence areas beyond the walls in the east, west and south areas. By that time, the city had 25.000 residents, so this kind of development was inevitable, as the new 15.000 needed many new infrastructures. Although arbitrary construction was an easy and cheap way for housing the refugees, it continued in the next decades as a main way of the area's expansion due to the lack of planning and controlling mechanisms.

In 1936 the authorities decided to define regulations for both the existing inner-walled city and the arbitrary new settlements. This plan (Figure 2), defined the new building blocks, new roads and new infrastructures to encourage an organized development in a city which was constantly expanding. The building systems of the historic area concentrated all central functions and the new residential zones beyond the walls presented different urban layouts [26-27].

Figure 2. The plan of 1936

An important infrastructure that drastically affected the city's development was the allocation of an airport in the area in 1939. This fact combined with the area's industrial development, intensified the sprawl phenomenon and in 1958, a new plan tried to organize the city's new urban limits. In 1961 the city had 69.983 inhabitants and in 1971 84.710 inhabitants. In 1979 a new plan tried to organize the city as a system of different multi-functional cores that would be functioning as zones with certain limits. This plan was never

legislated but it represents the need to define limits in the city's development as the built environment was rapidly increasing in an arbitrary way.

This rapid population increase, led to new urban sprawled settlements that were not planned and were allocated in forests, agricultural land and other zones that were not proper for construction. These settlements gradually attracted other uses that served the local needs of these settlements, while supralocal infrastructures, as an industrial zone, a hospital and a university changed drastically the way the peri-urban areas were developing as they attracted more residents. In the following years, the east coastal zone of the city became an attractor of tourism, so in a few years' new arbitrary tourism infrastructures, changed the way the city was spatially developing. In 1988, a new plan that was legislated, legitimized the existing arbitrary constructions and defined new wider limits for the city. It set regulations for the area's future development and proposed the construction of new infrastructures. (Figure 3) [27].

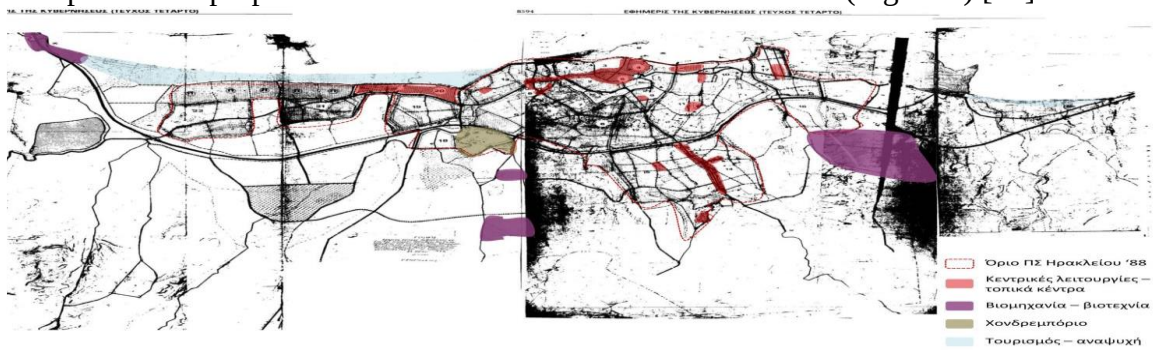

Figure 3. The 1988 urban plan

In 2001 the population of Heraklion was 150.253 inhabitants. In 2003 a new plan was legislated (Figure 4) [26]. It had common principles with the corresponding plan of 1988 and it expanded the city's borders in order to legitimize the newer arbitrary constructions. It proposed demolitions of the existing arbitrary buildings in the west coastal zone in order to facilitate the construction of the infrastructures for the Olympic Games but at the same time the new expanded city's borders made the existing illegal buildings in the rest areas, legal. This decision had two different results. Initially it upgraded the arbitrary-sprawled areas that were gradually becoming urban but on the other hand it showed that all the future constructions could be built almost anywhere, under any condition as the State would finally recognize them as legal.

Figure 4. The 2003 urban plan [26]

5. The urban sprawl of Heraklion in 2004.

In Heraklion all kinds of urban sprawl forms were already shaped until 2003, as it shown in Figure 5. The city had already been developed in the industrial sector and at the same time, many infrastructures for tourism were constructed.

Figure 5–The shaped city and the limits of the plan in 2003.

By 2004, the city had already shaped different functional zones. The west zone had developed the infrastructures linked with tourism. In this area the new sport facilities that were constructed for the Olympic Games, attracted new housing units and hotels. The east zone of the city had different characteristics, as the existence of the airport and the noise and the pollution that were produced by its function, attracted mainly industrial uses and low-income residence.

The south zone had different a kind of development. The main road network that connects Heraklion with the other urban areas of Crete, initially was the limit for the city's expansion. Diachronically mainly arbitrary constructions appeared in a scattered form in the north zone, beyond the main road, that through the years was developing in a denser way. The existence of the University and the Hospital made the area more attractive for sprawl which was intensified through the years.

As the functional characteristics of the east, west and south areas have played a decisive role in the way sprawl has been developed, the research will examine separately these three areas, in order to examine how different kinds of supralocal functions define the forms of sprawl that appear in certain areas.

6. The west part of the city

The west area is divided by the border that defines the planned and the unplanned city (Fig. 6)

Figure 6–The planned and the un-planned west zone in 2016.

6.1.Historic background

In 1936, the area was characterized as a non-urban area as it was not inhabited. The first signs of arbitrary constructions appeared in the following years and a research of 1984 records many arbitrary constructions in the zone. Four years later, the 1988 plan defined the west area of Heraklion, as a legal area of expansion, with building regulations. It defined that the coastal zone would accommodate tourism and the rest would be an area for residence.

6.2.Geomorphology and infrastructures

The west zone has a simple flat geomorphology that encourages construction. At the same time the National road crosses through this zone, fact that makes it easily accessible.

6.3.Planning restrictions

The 1988 plan defined that the maximum building ratio for the area is 0.8 and that the allowed uses for the area would be tourism and residence.

6.4.Land values

The investigation of the land values for the examined periods shows that although the planned zone of the examined area has the lowest land values compared with the rest Heraklion zones, still due to the lack of regulations and restrictions, the unplanned area that has even lower land values, remains more attractive for arbitrary constructions compared with the planned expensive zone.

6.5.Recorded forms of sprawl

Although the road is the limit for expansion by 2004 the south area had already constructions that were developed in a scattered form. In 2008 the areas status was different. In the coastal zone, tourism infrastructures were denser, and the remaining coastal plots were constructed. As for the non-planned zone it is interesting that although there are available gaps in the planned zone, many new buildings are recorded in a scattered form in available un-planned areas. A comparison of the area's aerial photos shows that the allocation of new construction is scattered. Four years later, in 2012, the three years of the 2009 economic crisis are reflected in construction. The interesting phenomenon is that the same kind of development is presented in the planned zone of the city, where very few scattered new constructions are built. Almost the same status is recorded in 2016, where a comparison between the 2012 and 2016 shows very few changes, also in a scattered form (Fig. 7).

So, the first conclusion is that until the 2009 economic crisis, the examined area was developing in a random way, as intense construction activity was taking place both in the planned and the unplanned west city's areas. The planned zone attracted mainly tourism infrastructures as it was coastal, while the non-planned zone attracted the same uses in a scattered form. The initial scattered cores became denser compared with 2004 but after 2009 this situation changed as few new buildings were added in these existing scattered cores.

(a)2004 (b) 2008 (c) 2012 (d) 2016

Figure 7–Indicative sprawl development of the un-planned west zone in 2016.

7. The east zone of the city

The east extents of the city were developed under the influence of the existing since 1939 airport. The industrial zone that was developed in the area was also a decisive factor for other uses allocation as storage and big-scale trade infrastructures (Figure 8).

Figure 8–The planned and the un-planned east zone in 2016.

7.1.Historic background

The area functioned as a zone for low-income residence. Although its natural characteristics were appropriate, still the existing land uses degraded the area which initially concentrated arbitrary constructions of the workers in the existing industries.

7.2.Geomorphology and infrastructures

The area is coastal in the north zone, the geomorphology is mild, and a stream was the only natural limit for construction. The area is crossed by the National road and it encloses the airport and the industrial zone of Heraklion.

7.3.Planning restrictions

According to a 1978 research, the area was already shaped by arbitrary constructions. The allowed uses for the area according to the 1988 and the 2003 plan were special uses, which supplement the airport and the industrial zone as wholesale trade and storages.

7.4.Land values

Since the 1995 definition of land values, the zone had the lowest land values compared with all the rest areas of Heraklion. In the next years (2007) these land values presented a slight decrease (it is estimated about 5%) which is the lowest reduction, compared with the rest Heraklion zones.

7.5.Recorded forms of sprawl

The function of the airport acted as a factor that discouraged tourism infrastructures, so the coastal zone of the east area was not a field for new buildings. The comparison of the 2004 and 2008 aerial photos, shows that only three plots were constructed while the rest remained in their 2004 status. This area was not built at all, after the beginning of the economic crisis, as the photos of 2012 and 2016 show (Figure 9).

(a)2004 (b) 2008 (c) 2012 (d) 2016

Figure 9–Indicative sprawl development of the un-planned coastal east zone in 2016.

(a)2004 (b) 2008 (c) 2012 (d) 2016

Figure 10–Sprawl development of the area around the industrial east zone in 2016.

On the contrary the area that surrounded the industrial zone of Heraklion became denser with scattered new construction after 2004 (Figure 10). The period between 2004-2008 big scale new buildings mainly industrial surrounded the existing organized industrial zone, while from 2008 until 2016 this area has not changed. The same phenomena are recorded in the planned area. So, the economic crisis has influenced both the planned and the non-planned zones in the same degree. Although the east area is coastal, the functions that have already been developed are crucial for its sprawl. Despite the decreased land values, still the area presents quite low degree of sprawl compared with the corresponding west zone. The airport has discouraged new infrastructures around it, but the industrial zone has functioned as an attractor for new scattered allocations. It is interesting that both areas, since the beginning of the economic crisis have not changed.

8. The south zone of the city

For years the south limit of the city was the National road. The rapid urbanization of the city changed that fact as the city expanded towards the south and after many years a part of this

area was included in the 1988 and 2003 plan and the arbitrary constructions of the area were legitimized (Figure 11).

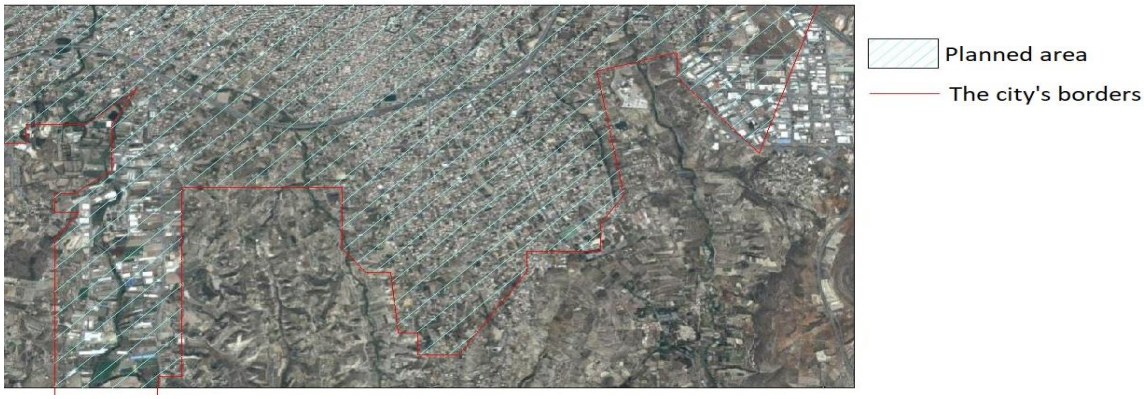

Figure 11–The planned and the un-planned south zone in 2016

8.1.Historic background

The 1936 plan shows that the area was not yet constructed. The 1958 plan shows that the area had already been inhabited so the efforts of planners were focusing on regulations regarding this arbitrary kind of development. Many years later, in 1988 the plans show that the south zone was a part of Heraklion urban tissue that was due to the lack of controlling mechanisms it was expanding beyond the borders all plans had defined.

8.2.Geomorphology and infrastructures

The south zone is a flat area which has been developed beyond the limit of the National road. It is crossed by streams. Two of them have remained in their natural form while others have been covered and they are today functioning as roads that have developed constructions at both of their sides. Supralocal uses as the Hospital and the University have encouraged construction

8.3.Planning restrictions

The south zone was defined by the 1988 plan as an area for residence. This zone was expanded with the 2003 plan and the maximum building ratio for the area was 0.8.

8.4.Land values

The land values of the area in 1995 were higher than the corresponding of the east and west zones. They increased in 2007, when they were redefined even higher (the estimated increase is 100%). With the new 2016 redefinition of land values the areas present a low land values reduction (14%) compared with other urban zones.

8.5.Recorded forms of sprawl

The area by 2004 had already shaped sprawl in a ribbon form in the roads that connect the city with the south settlements. In this strips, wholesale and retail trade were allocated. In the rest areas of the zone, where mainly residence is recorded, constructions are developing in scattered forms with the same intensity almost anywhere expect the zone where streams are.

The area during the 2004-2008 period did not have noticeable changes and this phenomenon continues until 2016. This can be explained by the fact that this area is a residence zone and the economic crisis has influenced mostly the housing construction sector. Although the land values of the area have been reduced (the reduction since 2007 is estimated in 13%) still this zone, planned and unplanned has the less recorded sprawl compared with the east and west zones.

(a)2004 (b) 2008 (c) 2012 (d) 2016

Figure 12–Indicative sprawl development of the un-planned south zone in 2016.

9. Conclusions

Sprawl is a phenomenon caused by urbanization that is expressed spatially in many different forms. Its intensity differs according to many economic, environmental, geomorphological, social political and many others. In Greece, the 2004 Olympic Games and their infrastructures combined with the economic developed of that period had shaped a built environment that was not controlled by the existing spatial planning framework.

The paper investigated sprawl and its expressions in the periods after 2004 until 2016.It examined the changes through periods of development and the changes through periods of crisis, which started in the country in 2009.

The case study Heraklion is chosen as it is a representative urban center of Greece that presents a variety of characteristics presented in most Greek cities. The main conclusion is that although the existing plan defined areas for construction, still sprawl beyond the city's limits was the basic way of spatial development. Although plans that define the borders of the city, exist since 1936, still the common way of construction is arbitrary construction in all the available zones.

The historic background oh Heraklion has a decisive role in the way sprawl is formed as diachronically many areas have been developed in a way that defines their characteristics. The geomorphology of the city has made sprawl easier as it is not hilly or mountainous, and the fact that some areas are coastal is a factor that attracts sprawl especially when it is formed in order to serve tourism.

Spatial Planning has not been able to prevent sprawl as all the plans that have defined zones where construction is allowed are not followed and the built up environmental prefers to be allocated in un-planned areas as well. The low land values that have been defined and their changes have not attracted constructions as the non-planned cheaper land, is preferable for construction.

As for the economic conditions, in the 2004-2008 many new constructions were allocated in the non-planned areas of the city. They were mostly tourism infrastructures, attracted by the coastal zone and storages and trade inftastructures attracted by the airport and the industrial zone. The residence buildings were developed in a scattered form, mostly in the south areea, filling the low density existing gaps in the existing non-planned zones.

After 2009, the economic crisis was decisive for sprawl. Constuction was reduced and very few changes are recorded. The zones that present intense changes compared with the others, still remain the tourism and industrial uses while the residence areas present the less changes. The research shows that in a typical Greek city, sprawl was mainly influenced by economic crisis. The fact that the ability for construction was reduced led to the reduction of sprawled areas. Other parameters that shape the way sprawled areas are developed are the uses and infrastructures, especially the large-scale ones which determine the way their perimetric zones are expanding. Finally, spatial planning, geomorphology or land values definition have not been significant as they were not able to define the way the city is expanding beyond its limits.

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The Changes land values due to economic crisis and their influence on private tourism investments in Greece

Abstract

Real estate-land markets around the world are attracting a number of international investors, seeking opportunities in various areas and searching for optimal return on investment. Greece is an emerging real estate-land market, especially after a downfall in property prices due to the country's long-running financial crisis. In recent years, the Greek state has made efforts to encourage the inflow of foreign capital with a particular emphasis on tourism investment. However, despite the number of policies promoted to boost tourism investment, only a few large-scale investments have so far been implemented in Greece. This is probably attributable to a number of other factors considered along with the present study. Thus, in light of the current situation, the present study aims to highlight the extent to which private tourism investment in Greece has been affected by the decline in property values resulting from The economic crisis. Moreover, it attempts to relate factors that could contribute positively to the same direction.

Keywords: land values, economic crisis, private tourism investments

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1.Introduction

The economic crisis that has deeply affected Greece for the last 10 years, has led to a decline in land values by nearly half the pre-crisis price. The country needs to cover the budget deficit created by the massive privatization of public land in a very short time. This fall in land prices, along with the growing tourist demand in recent years and the tourist assets of historical, cultural and tourist value available for sale, make Greece a very attractive investment destination (Hadjimichalis, 2014; Holtslag-Browckhof, 2014; Sarantakou E.,2017b).

2. Literature review

2.1 The financial crisis at international and Greek level

The global economy has experienced great volatility and uncertainty over the last ten years. The global financial crisis of 2008, which originated in the United States of America, continued its course by creating a serious debt crisis in Europe that affected national economies in different ways (Melvin & Taylor, 2009; Bentley & Pugalis 2013; Brakman et al., 2015; Grotte et al., 2016). This crisis has shown the cracks between the center (e.g. Germany) and the periphery (e.g. Greece, Spain). It is indicative that while the unemployment rate in Greece and Spain has jumped steadily since 2008, in the same period it declined in Germany. Consequently, the negative effects of the global economic crisis have spread to the regions (Reinhart & Rogoff, 2009, 2010; De Grauwe, 2010; Giannakis & Bruggeman, 2017).

The economic crisis was rapidly spreading to countries characterized by large fiscal deficits. Greece belonged to these countries and has been the most affected than any other European Union (EU) country (Sarantakou & Tsartas, 2015). However, in the early 2000s, the Greek economy was one of the fastest growing economies in the Eurozone with an annual growth rate of 4.2%. Factors such as high public spending, structural rigidities, tax evasion and corruption have all contributed to the accumulation and acceleration of Greek debt (Schneider et al., 2010; Giannakis & Bruggeman, 2017). The result was a rising cost of borrowing, which forced the Greek government to devise and adopt a fiscal consolidation program to reduce public debt and provide the framework for improving economic stability and growth (Kouretas & Vlamis, 2010; Lekakis & Kousis, 2013; Doran & Figleton, 2014).

2.2 Financial crisis and changes in property values in Greece

Changes in land values make no sense when they are not correlated with the fundamental value of the land's finished product. The concept of fundamental value is defined as the present value of future cash flows associated with the use of a specific business asset. In the case of hotels, future cash flows are high and are related to room and occupancy rates, as well as the costs determined by local and international markets, affecting room rates in mass tourism areas. (Camerer, 1989; Lavin & Zorin, 2001; Pizam, 2009; Triandafyllopoulos, 2017).

On the other hand, economic factors (such as income, unemployment, GDP, inflation) provide a clear picture of how the financial crisis affects the real estate-land market (Renigier-Bilozor & Wisniewski, 2012; Lux & Sunega, 2013). Starting with the most important factor, unemployment, which has affected prices on a larger scale. This has led to the inability of residents to acquire property, minimizing demand and consequently reducing values (Mareli et.al., 2012; Mameli e.t al., 2014). Inflation also plays an important role in determining values. As inflation rises, property prices fall. Subsequently, this decrease leads to a decrease in demand and market potential, which in turn has a negative impact on real estate-land prices (Karousos & Vlamis, 2008; Giannoulakis et al., 2016).

Greece has a fairly developed coastline (about 16,000 kilometers), with much of the public land remaining unused, including valuable coastlines. By comparison, Greece's coastline is the second largest in Europe and the 12th largest in the world. In addition, only 165 of the 2,500 Greek islands are inhabited and developed, while the wider public sector and the Ministry of Defense possess significant urban property, coastal land and other assets mainly located in commercially attractive locations. Public Properties Company S.A. (PPC S.A.), holds a total of 71,459 public assets, totaling 3,427,871 sq. M. They include, among other things, 277 tourist assets characterized by both their historical and cultural value and their natural beauty. Many of these had been developed by the GNTO (Greek National Tourism Organization) tourism infrastructure (Karamouzis et al., 2017).

However, the investment needed for construction, upgrading and maintenance of hotel units in Greece is estimated at 4.8 billion euros by 2020. The financing needs for investment in new beds are estimated at 1.7 billion euros (HCH, 2017). This image of Greece presents great opportunities for tourism investment, especially in the hotel sector, which begin to emerge. Less than two years after the outbreak of the financial crisis that hit Greece in 2008, real estate-land values began to decline gradually. Pre-crisis real estate-land prices have been rising for almost a decade. Due to the fact that real estate is an equity hedge and the main form of investment in Greece, they began to decline after 2010. Years before 2010 there were positive signs, indicating an active real estate-land market. On the contrary, negative symptoms are observed in the years 2011-2015 (Fotopoulos et al., 2010; Gallagher & Buchanan, 2012; Giannoulakis et al., 2016).

During the period 2007-2016, investment in Greece declined by more than 65% cumulatively, returning to levels that had been observed since the mid-1990s. During the same period, the share of investments in real estate-land mainly collapsed (Giannoulakis et al., 2016; Karamouzis et al., 2017). In addition to uncertainty and bureaucracy, Greece has traditionally lagged behind European partners and other regional economies in Foreign Direct Investment (FDI) inflows. During the period 2006-2015, France and Germany were the main countries of origin in terms of FDI inflows. After a fall in 2015, foreign investment in Greece began to rise up in 2016, with gross FDI inflows reaching almost 3.5 billion euros (up 82% and 14% from 2015 and 2014 respectively). . The main bulk of the investment comes from European Union (EU) Member States, with Luxembourg being the leading country of origin, followed by the United Kingdom, the Netherlands, Germany, Cyprus and France. In terms of FDI inflows by activity sector, in recent years the land sector has attracted the lion's share. This situation is directly linked to the sharp decline in real estate-land prices due to the economic crisis, but also to those introduced by the Troika and the Memorandums that imposed enormous public privatization in a very short time (White et al., 2012; Hadjimichalis, 2014). Therefore, the overall economic situation brought attractive investment opportunities to the forefront (Gallagher & Buchanan, 2012; Karamouzis et al., 2017), especially in the hospitality sector (accommodation and food services). The hospitality industry, despite significant losses due to the financial crisis, recorded a slight decline relative to other sectors and a more rapid recovery, which began in 2011 (Pizam, 2009; Kapiki, 2012; Malaj & Kapiki. 2016; Kritikos et al. ., 2018).

During the period 2012-2017, 498 hotels were opened throughout Greece, an increase of 1.3% in terms of units, with a total capacity of 17,153 rooms. Furthermore, 86% of the units that have opened belong to 3*, 4* and 5* hotel categories**.** This new situation resulted in 2017 the 5-star rate representing 18.1% of the total hotel potential. During the same period, however, 427 units stopped operating , with a total capacity of 11,715 rooms, 70% of which came from the lower two categories (HCH, 2017).

According to the above, it is found that the fiscal imbalances in the Greek economy have had a negative impact on the Greek real estate-land sector. The implementation of rigorous austerity programs designed by the Greek government to reduce budget deficits and

stabilize public debt have caused a significant decline in demand for goods and services, pushing the real estate-land market into deep recession (Kalfamanoli and Vlamis, 2010; Kouretas & Vlamis, 2010; Vlamis, 2013).

3.Methodology

3.1 Aim and objectives of this research

The purpose of the present survey is to show the extent to which changes in property values - due to the economic crisis in Greece- have affected the development of private tourism investment. The specific objectives of the research are:

• The recording and reflection of the views and positions of the responsible authorities, in the public and private sector, on the extent of the impact of changes in property values due to the financial crisis and its influence on private tourism investment.

• The degree to which public and private sector representatives agree or disagree at the impact of changes in property values due to the financial crisis and how that has affected private tourism investment.

• Deriving safe conclusions and proper policies that need to be developed to create the right conditions for the development of private tourism investment.

3.2 Investigation questions and cases of research

Therefore, the main questions considered in the present research revolve around three main axes:

• The value relationship between real estate-land market and tourism investment.

• The extent to which changes in land values, due to the financial crisis, have affected the private tourism investment.

• Policies to be implemented to boost private tourism investment in Greece.

Independent hypothesis testing variables were ΄΄ type of institution (private-public sector) ΄΄ and the level of tourism development (high-low) ΄΄ of the area where each institution is active.

Therefore in the first case the null hypothesis symbolized by H_0 is worded as follows:

- H_0: There is no difference in the perceptions between public and private sector representatives for the measure of impact of changes in real estate-land values due to the financial crisis and how that has affected private tourism investment.
- Whereas the alternative hypothesis symbolized by H_1 and states exactly the opposite:
- H_1: There is a difference in the perceptions between public and private sector representatives for the measure of impact of changes in real estate-land values due to the financial crisis and how that has affected private tourism investment.
- In the second case, the null hypothesis H_0 is worded as follows:
- H_0: There is no difference in the perceptions of public and private sector representatives for the measure of impact of changes in real estate-land values due to the financial crisis and how that has affected private tourism investment, regardless of the degree of tourism development in institution area.

Whereas the alternative hypothesis H_1 states exactly the opposite:

- H_1: There is a difference in the perceptions of public and private sector representatives for the measure of impact of changes in real estate-land values due to the financial crisis and how that has affected private tourism investment, regardless of the degree of tourism development in institution area.

3.3 Method of data collection – Sampling

The primary data was collected by using a questionnaire and in particular a questionnaire of events. The method of sending questionnaires via e-mail was chosen because of the ability to

reach a large sample in different regions and in a relatively short period of time. Also, subjective non-random sampling was chosen due to the short duration of the survey due to the limited time and peculiarity of the research topic and the need for specific knowledge to answer the questionnaire.

Table 1: Population, sample and final participants.

Entities: Public Sector	Directorates	Initial Population	Final Sample	Response Rate
1. Ministry of Tourism	A Regional Tourism Services	14	11	78,57
2. Ministry of Environment and Energy	B. Directorates of the Ministry of the Environment	5	3	60,00
	Γ. Urban planning	17	13	74,47
Ministry of Rural Development and Food	-	1	1	100,0
Total		**37**	**28**	**75,67**
EOT		1	**1**	**100,0**
Hellenic Chamber of Hotels		1	**1**	**100,0**
Chambers of Prefectures		21	18	85,71
General Secretariat for Trade and Consumer Protection		1	1	100,0
Regions	A. Department of Commerce and Tourism	13	9	69,23
	B. Directorates of Environment and Spatial Planning	16	10	62,50
Economic Chamber of Greece		1	**1**	**100,0**
Total		**54**	**41**	**75,92**
Entities: Private Sector				
SETE		1	-	-
ENTERPISE GREECE		1	-	-
Pan-Hellenic Federation of Hoteliers, Guides, Tourist Offices ,ect.		20	14	70,00
Hotel and Hoteliers Association		30	11	36,66
Association of Tourist & Travel Agencies		10	5	50,00
Unions Restaurateurs and Related Occupations		10	5	50,00
Academy of Tourism Research and Studies		1	1	100,0
Union of Marines of Greece		1	-	-
Marketing Greece		1	-	-
Total		**75**	**36**	**48,00**

Final sum	**166**	**105**	**63,25**

The population selected in the present survey was finite with geographic and demographic characteristics that were deemed necessary for a firmer integration of research. Table 1 shows the sample selected and its characteristics as well as the number of final participants.The survey sample consisted of a total of 105 private and public sector entities. An attempt was made for a representative distribution of the sample, both in the relatively equal number of public and private sector entities, and in the geographical distribution where regions from all over Greece were selected with increased but also reduced tourist interest. This option aimed at presenting information that responds to areas in different stages of tourism development, with different needs and different structural problems. The survey was conducted at the premises of each institution and the period of primary research was from June to July 2019. A quantitative survey was carried out and a structured questionnaire was used.

3.4 Structure of the questionnaire

The questionnaire is structured in four thematic sections that include a total of 18 questions. More specifically:

- Section A: Research Identity. The first section gathered data concerning the respondent's name, gender, age, workplace, job position, educational level and contact information.
- Section B: Land use - real estate values and tourism investment. In the second section, there are questions regarding the extent of large-scale tourism investment and the potential inhibitors for their realization.
- Section C: Land use - real estate values and tourism development. In the third section, the questions seek to find out the extent to which factors such as real estate-land values are affected by the economic crisis in tourism field.
- Section D: Policies that can be applied to boost private tourism investment in Greece.

3.5 Data analysis-statistical criteria

The Statistical Package for Social sciences (SPSS) version 24 was used to analyze the data. Both descriptive and inductive statistics were used for data processing. The present research, by its very nature, is described as descriptive with both quantitative and categorical variables as well as relational in that it attempts to discover and interpret the correlations between the “independent and dependent” variables as they are posed in the research questions.

Both quantitative and qualitative measurements, as well as a series of statistical analyzes, were used both to describe these variables and to investigate and verify possible relationships between them. The regularity of the sample was first checked. Where normal, parametric analyzes were performed, namely t-test, ANOVA and Pearson correlation coefficient. Where there was no regularity, non-parametric analyzes were performed, Mann-Whitney U, Kruskal-Wallis and Spearman correlation coefficients. The obtained results were made by parametric and non-parametric analyzes and present almost the same findings with minimal variations. For all the above analyses the level of statistical significance was set between 1% ($P < 0.01$) and 5% ($P < 0.05$). The marginal statistical significance represents the probability of 6% to 7% ($P < 0.06$ - $P < 0.07$), thus a probability greater than 7% ($P < 0.07$) means that the statistical differences are insignificant. In conclusion, if $P > 0.05$ it will be accepted at significance level that the answers have no statistical difference in the two categories, whereas if $P < 0.05$ that there is a difference.

4. Results and discussion

Subsequently, some sample questions from the questionnaire, are presented by Thematic Field, that provide useful information for the research. Specifically, in the first section on the identity of the survey, the following interesting facts are observed Table 2: a total of 105

individuals responded to the survey questionnaire. Of the 105 people, 56 were men with 53.33% and 49 women with 46.67%. As far as the age is concerned, it is noted that 73.32% of employees are an age-old workforce capable of working, performing and learning new techniques and ways to improve their working conditions. Finally, as far as the educational level, there are high levels of knowledge among the participants since 80 out of the 105 respondents, 76.20% hold a Postgraduate or PhD degree and 18, 17.14% have University education. According to the above, the public and private sectors have a workforce highly educated who is able to cope better with their job responsibilities.

Table 2: Demographic sample data

Variables		Frequency (n=105)	Rate
Sex	Man	56	53,33%
	Woman	49	46,67%
Age	31-40	33	31,42%
	41-50	44	41,90%
	60+	28	26,66%
Education	Master's degree-Doctorate	80	76,20%
	University	18	17,14%
	High School	7	6,66%
	Primary school	-	-

In the second section on land use-real estate values and tourism investment, respondents to the question about the degree of realization of private tourism investment in Greece in the last 10 years (2009-2019), answered with a percentage of 60,30% that the rate of realization of tourist investment in Greece is small (Figure 1).

Figure 1: Percentages of private tourism investment in Greece over the last 10 years (2009-2019).

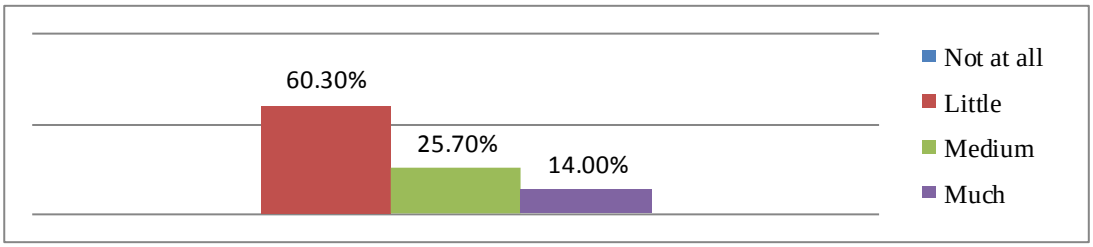
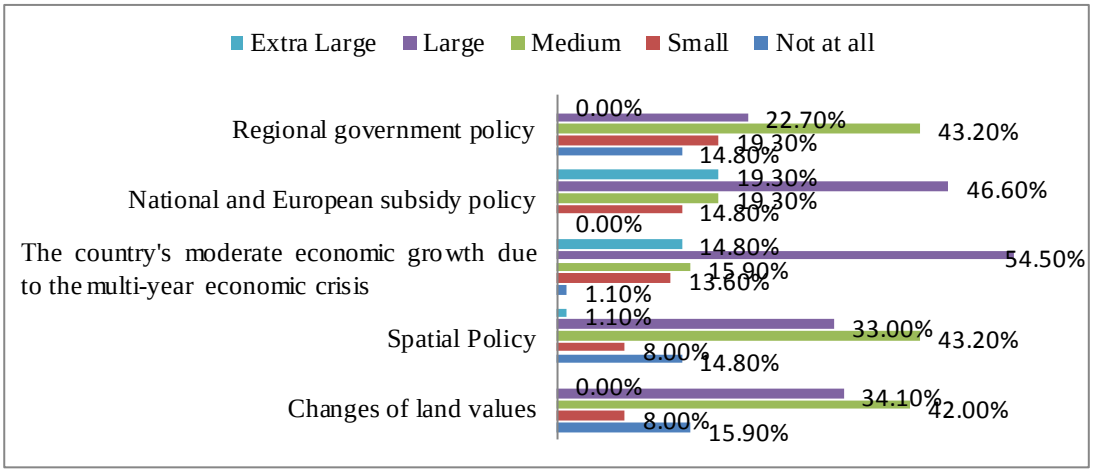


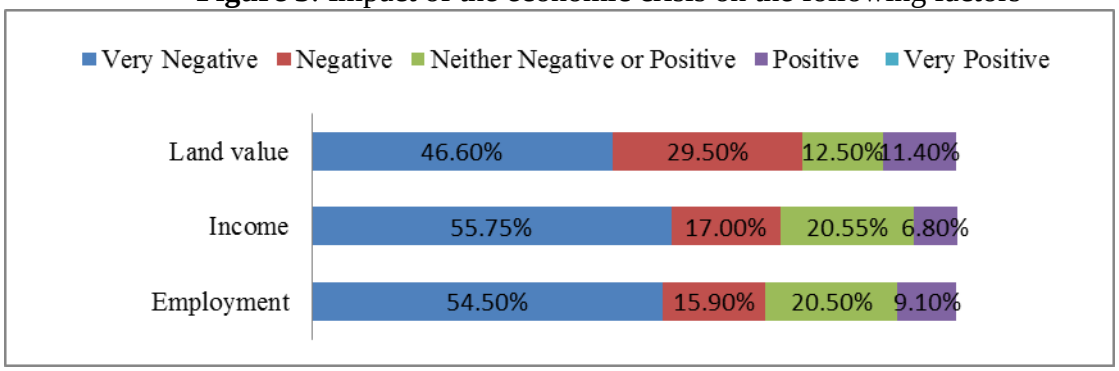
Figure 2: Factors affecting the tourism development of the country



In a further question on the degree of influence of the parallel factors on the overall tourism development of the country, the majority of the respondents (54.50%) believe that the

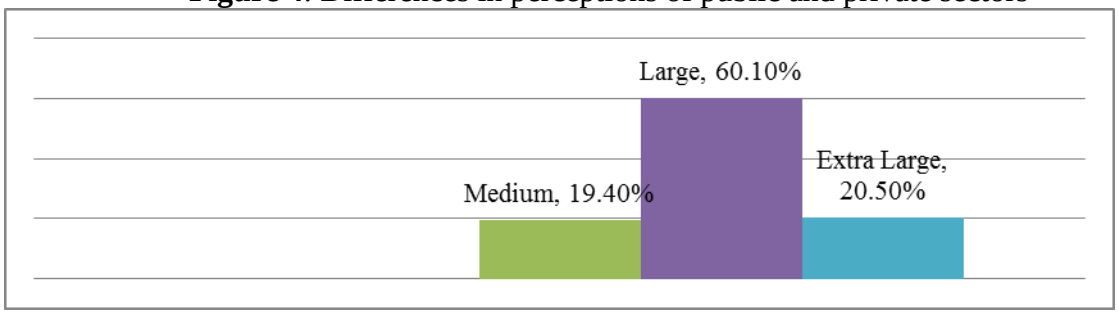
moderate economic growth of the country due to the multi-year economic crisis is the main inhibitory factor for tourism development (Figure 2). In the third section which refers to land use-values and the local economy, participants responded that all three factors (real estate, income and employment) were very negatively affected. Specifically, negative affected with percentage 46.60% real estate values, 55.75% income and 54.50% employment respectively (Figure 3).

Figure 3: Impact of the economic crisis on the following factors



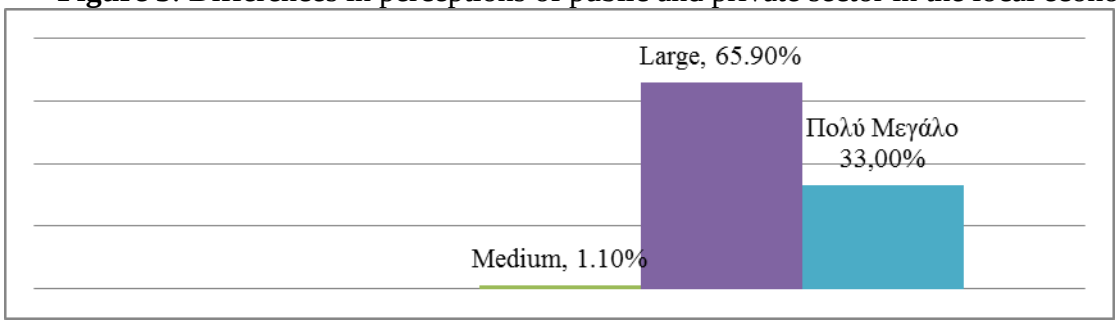
Furthermore, in the question about the difference in perceptions between public and private sector about the impact of changes in property values due to the financial crisis on private tourism investment, most respondents (60.10%) said that there is a large difference in perceptions (Figure 4).

Figure 4: Differences in perceptions of public and private sectors



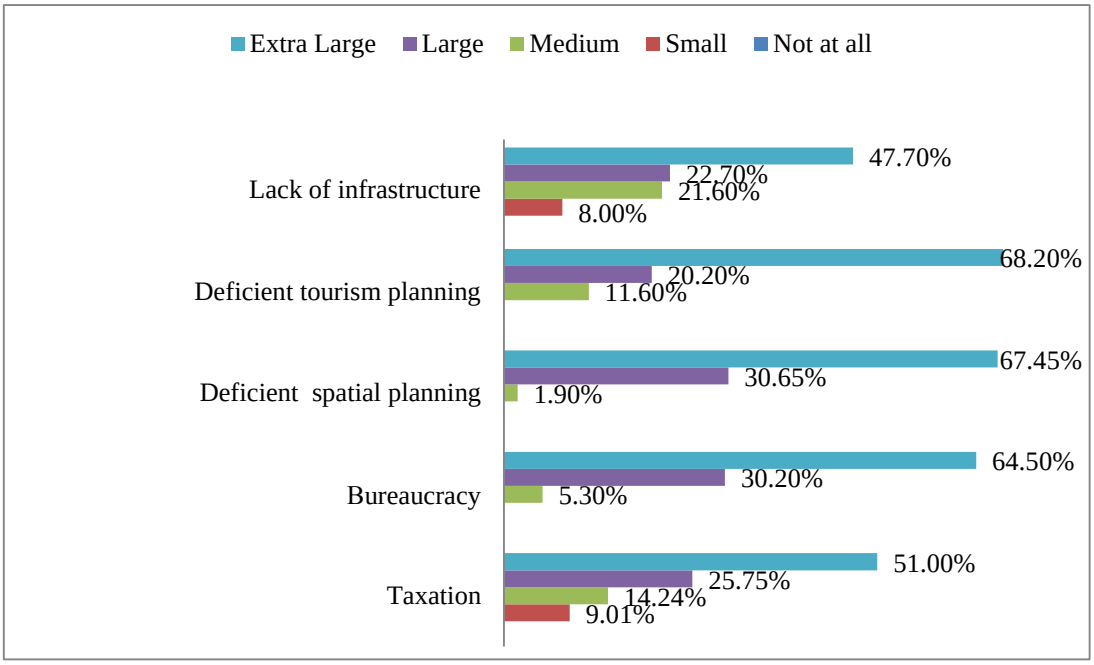
Moreover, in the question about the difference in perceptions of representatives of public and private sectors regarding the extent to which the economic crisis has affected the local economy (income, employment, real estate-land values), the respondents (65.90 %) believe that there is a large difference in perceptions (Figure 5).

Figure 5: Differences in perceptions of public and private sector in the local economy



In the fourth and last section, in the question that investigating general inhibitors of private tourism investment, the participants answered the following. Inadequate tourism - spatial planning, lack of land use and bureaucracy at rates above 64.00%, are considered to be the most important factors for not accomplish private tourism investments. Taxation and lack of infrastructure are followed by lower rates (Figure 6).

Figure 6: Inhibitors of private tourism investment



4.1 Analysis of connections between thematic fields

As discussed above, the questionnaire is divided into 4 thematic fields (T.F). The three thematic fields (T.F) (except The A thematic field which is not taken into account in the correlation analysis) are followed by reliability testing through the internal consistency method. For this reason the Alpha coefficient of Chronbach is used where its values are between 0 and 1 Table 3.

Table 3: Internal consistency check

Thematic Fields (T.F)	Chronbanch's Alpha	Number of questions
T.F 1: Land use - real estate values and tourism investment.	0,721	17
T.F 2:Land use - real estate values and tourism development	0,741	6
T.F 3: Policies that can be applied to boost private tourism investment in Greece.	0,739	5*

** In T.F3 considered only the number of questions has been scaled by none at all*

As shown in Table 3, the coefficient values range between 0.721 and 0.741, which means that all values are greater than 0.700 (p> 0.700) which according to Nynally (1967) and Field (2005) is considered to be below the acceptable value, so the subject areas used proved to be reliable.

The Pearson's correlation coefficient is most commonly used in surveys where regularity is observed and shows the relationship between two variables. While another known correlation coefficient Spearman's is used when there is no regularity (Landau & Everitt, 2004; Daniel, 2005;), as presented in Tables 4 & 5. The correlation coefficients obtain values between -1 and +1.

Table 4: Correlations between Pearson Thematic Fields

Correlation Factor Pearson	T.F 1: Land use - real estate values and tourism investment.	T.F 2:Land use - real estate values and tourism development	T.F 3: Policies that can be applied to boost private tourism investment in Greece.
T.F 1: Land use - real estate values and tourism investment.	1	0,548	0,308
T.F 2:Land use - real estate values and tourism development	-	1	0,405
T.F 3: Policies that can be applied to boost private tourism investment in Greece.	-	-	1

Table 5: Correlations between Spearman Thematic Fields

Correlation Factor Spearman	T.F 1: Land use - real estate values and tourism investment.	T.F 2:Land use - real estate values and tourism development	T.F 3: Policies that can be applied to boost private tourism investment in Greece
T.F 1: Land use - real estate values and tourism investment.	1	0,595	0,145
T.F 2:Land use - real estate values and tourism development	-	1	0,476
T.F 3: Policies that can be applied to boost private tourism investment in Greece	-	-	1

In the survey, normality test was performed quantitatively, using the Kolmogorov-Smirnov test (Landau & Everitt, 2004; Daniel, 2005) because the sample was over 50 individuals (Field, 2005). Then the sig basis of the null and the alternative hypothesis was checked in all three thematic fields. Sig was found to be greater than 0.05 (sig> 0.05), so in all, it is acceptable for H0: the sample follows a normal distribution, so analyzes are carried out parametrically.

In two samples, analyzes were performed using the Independent t-test, and in the case of more than two samples, ANOVA analysis was performed (Landau & Everitt, 2004).

The thematic fields were first analyzed in relation to the two independent variables, the type of operator (private-public) ´´ and the level of tourism development (high-low) ´´. According to the results of the analysis in TF1 and TF2 you can see that sig is less than 0.05 (sig <0.05) and therefore H1 is acceptable, that is, there is a difference between thematic fields based on for both independent variables, while at TF3 where sig is greater than 0.05 (sig> 0.05) the hypothesis H0 is acceptable, namely, there is no difference between the subject area and the two independent variables.

Next, an analysis of the relationship of independence between TF and the two independent variables set to test the research hypotheses followed by the chi-square test was followed. The analysis showed that sigs at TF 1 and TF 2 by carrier type (public-private) are less than 0.05, (sig <0.05) so H1 is acceptable, that is, there is a difference between the subject areas per institution (whether public or private), in relation to the geographical location. While sigs in TF3, public and private sectors are greater than 0.05 (sig> 0.05), so in this case H0 is acceptable, that is, there is no difference between the subject areas per entity (either public or private) in relation to geographical location.

An analysis was also performed on the relationship of independence between T.F by geographical location with the operator, means of ANOVA control system. It was found that in 6 regions (Northern Aegean, Eastern Macedonia & Thrace, Western Greece, Central Macedonia, Crete and Ionian Islands), sig is less than 0.05 (sig <0.05), so the hypothesis H1 is acceptable, that there is a difference between the subject areas by geographical location with the operator.

Completing the cross-validation, analyzes were performed among all questions with public and private sectors using the t-test method and the results showed statistically significant that in questions 5.1, 5.4, 5.5, 6.1 and 6.4 sig were less than 0,05 (sig <0.05), so the hypothesis H1 is acceptable, namely that there is a difference of opinion between representatives of the public and private sectors. Finally, analyzes were performed among all questions based on the geographical location of the players using the ANOVA method, and the results showed statistically significant that questions 5.1, 5.5, 7.1 and 8 showed sig less than 0.05 (sig <0.05). Therefore, the hypothesis H1 is acceptable, namely, there is a difference in the responses given by the representatives of the public and private sector depending on the geographical location of their activity.

5. Conclusions

Firstly, the participation of stakeholders, in our survey, was very impressive. Especially the participation of public sector, which was much larger than the private sector. Although the sample was not large, a similar study has not been carried out in Greece to date, and its findings are revealing and can provide valuable information in various directions.

The research and its results confirm both its original purpose and the answers to the exploratory questions raised. In the first place, it is found that the long-term financial crisis in Greece has greatly affected real estate-land values and its impact is strongly reflected in the sector of private tourism investment. Also, based on the independent variables used to control the research hypotheses, there are statistically significant differences in the views of public and private sectors as well as the degree of tourism development of the area in which they operate.

In particular, there is a significant divergence of views on the extent to which regional government and spatial policy have an impact on supporting the country's private tourism investment. There is also a difference in perceptions of the impact of taxation, bureaucracy and lack of infrastructure on private tourism investment.

In terms of the geographical location of the operators, the most significant differences were identified to the extent that the economic crisis affected real estate-land values, to the extent that taxation and lack of infrastructure acted as a inhibitor to private tourism investment and

eventually public and private sector stakeholders on the extent to which changes in property values affect private tourism investment.

The general conclusions of the survey are as follows: Private tourism investment in Greece has been low for the last 10 years (2009-2019). In addition, the country's moderate economic growth due to the multi-year economic crisis is the main inhibitor for tourism development. Also, real estate-land values, income and employment were negatively affected by the financial crisis. Finally, incomplete tourism and spatial planning as well as bureaucracy are the main inhibitors to private tourism investment.

The financial crisis may have led to a decline in the value of land, but it has also brought attractive investment opportunities to the forefront of the tourism industry. Since 2015, the field of tourism investment has changed with positive developments. The growing numbers of tourists to the country in recent years, the range of unused islands and areas, and of course the falling land prices; have attracted a large number of foreign investors to Greece. However, although many investment moves have been made, few have come to terms with bureaucracy, the lack of spatial and tourism planning and the lack of co-operation between stakeholders.

The creation of a new Special Spatial Planning for Tourism (SSPT) will resolve issues, such as, restricting unbalanced tourism development and off-site tourism facilities and will clearly define the frameworks within which the various infrastructures can be developed. At the same time, it will make a positive contribution to removing the delays on the part of the Greek State in approving and implementing private tourism investment, by defining and delimiting the frameworks within which operators can move.

The state also needs to accommodate taxation relief and create a better legal framework that will lead to a strong investment environment. In addition, the state's greater involvement in infrastructure projects will provide a very important incentive for private tourism investment.

The importance of tourism is crucial for the country because of its great economic opportunities. The economic crisis may have affected many sectors such as the real estate-land sector, but it is tourism investments that can form the basis for the country's long-term overall growth.

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Looking at the knowledge Economy: Theory and Evidence

Abstract:
Innovation activities contribute essentially to the regional dimension and growth. The technological infrastructure and innovation capabilities affect not only the regional growth, but also the whole periphery and economy as well. In the last decades, OECD /introduced some measures and indexes, concerning the Research and Development Expenditures, patents etc., that measuring the innovation activities. However, there are a lot of problems and questions regarding the measurement of innovation activities at a regional level. This paper attempts to analyze the whole framework of innovation statistics and in particular to examine the measurement and also the statistical estimation of innovation activities. On this context, it's also aiming to emphasize and to review the appropriate techniques, the most common methods and the particular problems.

Keywords: Knowledge Economy, Innovation Activities, Techniques and Methods, Research and Development.

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1. Introduction

The increasing recognition by policy makers and academics of the importance of the "knowledge-based economy" for future output and employment growth has yet to be reflected in any policy action. Of course these positive employment outcomes achieved with a "painful" process of structural adjustment. On the one-hand, the move towards an information society is likely to lead to substantial changes in the demand for various sorts of educational and skill requirements. On the other hand, it is highly likely that large parts of the unskilled labour force will become excluded.

The overall long-term tendency towards a more strongly knowledge-based economy, in terms of both input proportions and the nature of the output, is accelerating. At the firm level, this is reflected in the fact that the shift in the demand for skills is strongest in firms introducing information technology. The measurement problem is probably as pervasive as information and communication technologies. Even individual firms' accounts are becoming increasingly unreliable. Not surprisingly the debate on trends in aggregate productivity is strongly influenced by questions about measurement, not least because the decline in aggregate total factor productivity seems to be concentrated in the service sector and in conventionally measured capital productivity.

A coherent system of innovation has necessarily to include a series of more or less coordinated network-like relations such as:

- Customer-producer relations, i.e., forward linkages of manufacturing firms with distributors, value-added resellers and end users,
- Producer-manufacturing supplier relations which include subcontracting arrangements between a client and its manufacturing suppliers of intermediate production units,
- Producer-service supplier relations which include arrangements between a client and its producer service partners [especially computer and related service firms, technical consultants, business and management consultants],
- Producer network relations which include all co-production arrangements [bearing on some degree or another on technology] that enable competing producers to pool their production capacities, financial and human resources in order to broaden their product portfolios and geographic coverage,
- Science-industry collaboration between universities and industrial firms at various levels pursued to gain rapid access to new scientific and technological knowledge and to benefit from economies of scale in joint R&D, such as direct interactions between particular firms and particular faculty members, or joint research projects, as through consulting arrangements, or mechanisms that tie university or research programs to groups of firms.

2. The Knowledge Economy

For many years the received wisdom in economic development focused on building infrastructure and factories. The focus was on the "weighty economy" - if we use the metaphor of knowledge as the basis for the "weightless economy." As we move into the "knowledge economy" just as the new technologies provide greater scope for the suppression of competition, the consequences may be more adverse. Organizationally, small new enterprises often have provided more fertile ground for this kind of creative engagement than do large established bureaucracies. Many of the most important innovations have originated in these small enterprises. Knowledge and information differ from other commodities in a number of other ways, which result in markets for information and knowledge differing markedly from markets for other commodities. "Knowledge is power" so, in some cases, knowledge that should be freely available in an organization might be hoarded to create an

artificial scarcity or monopoly. There is widespread agreement that a defining aspect of the New Economy is the increased importance of knowledge.

Innovation has a variety of roles. As a driving force, it points firms towards ambitious long-term objectives. It also leads to the renewal of industrial structures and is behind the emergence of new sectors of economic activity. In brief, innovation is:

- the renewal and enlargement of the range of products and services and the associated markets;
- the establishment of new methods of production, supply and distribution;
- the introduction of changes in management, work organisation, and the working conditions and skills of the workforce.

The Knowledge Innovation Assessment is an integrated design of ten diverse competencies essential in an innovation system:

Collaborative Process	**Products/Services**
Performance Measures	**Strategic Alliances**
Education/Development	**Market Image/Interaction**
Learning Network	**Leadership/Leverage**
Market Positioning	**Computer/Communications**

Research, development and the use of new technologies - in a word, the technological factor - are key elements in innovation, but they are not the only ones. Incorporating them means that the firm must make an organisational effort by adapting its methods of production, management and distribution. Human resources are thus the essential factor. In this respect, initial and ongoing training play a fundamental role in providing the basic skills required and in constantly adapting them. Many studies and analyses show that a better-educated, better-trained and better-informed workforce helps to strengthen innovation. The ability to involve the workforce to an increased extent, and from the outset, in the technological changes and their implications for the organisation of production and work must be considered a deciding factor. Innovation in work organisation and the exploitation of human resources, together with the capacity to anticipate techniques and trends in demand and the market, are frequently necessary preconditions for the success of the other forms of innovation.

The analysis of system of innovations helps us to understand and to explain, why the development of technology is necessary in a certain direction and at a certain rate. We should be very careful in the definition of the "national systems" according to which sub-systems should be included and which process should be studied in the different countries. The government engages itself towards innovation policy because it has been considered that innovation is a key point for the national economic growth. In order to decide how the governments should decide to promote the innovations, it is useful to know the specific context in which the national government interfears. There is the concept of "national innovation system" itself. Each of the terms can be interpreted in a variety of ways and there is a question of whether in which technology and business are transnational increased the concept as a whole makes more sense.

Innovation in processes increases the productivity of the factors of production by increasing production and/or lowering costs. It provides room for flexible pricing and increased product quality and reliability. Competition makes this quest for productivity an ongoing activity: successive improvements are a guarantee of not falling behind. Replacement of equipment is increasingly accompanied by changes to and improvements in methods, i.e. in organisation. Radical changes, which are rarer, completely transform the methods of production and sometimes pave the way for new products.

Innovation in terms of products (or services) makes for differentiation vis-à-vis competing products, thus reducing sensitivity to competition on costs or price. Improved quality and performance, better service, shorter response times, more suitable functionality and ergonomics, safety, reliability, etc., are all elements which can be strengthened by innovation and which make all the difference for demanding customers.

Innovation is at the heart of the spirit of enterprise: practically all new firms are born from a development which is innovative, at least in comparison to its existing competitors on the market. If it is subsequently to survive and develop, however, firms must constantly innovate - even if only gradually. Innovation and technology management techniques such as the quality approach, participative management, value analysis, design, economic intelligence, just-in-time production, re-engineering, performance ratings etc. - give the firms concerned an undeniable competitive advantage.

There are a lot of proposals and strategies that can be followed and developed from the small size and weak technologically countries. Among them, an interesting view suggesting that they should develop some "new high technology areas" that may have not been developed and expertised, but the perspective potential economic benefits may be greater and they can develop a comparable advantage in the future. Another interesting view for the small countries suggesting the relevant strategies that are related to "specialisation" in some certain points for research and technological activities, in order to make an appropriate use of available resources. Alternatively, it has been suggested that it might be more appropriate for small countries to abandon the idea of competing with the large and more advanced technological countries and to concentrate on the improvement of their technological infrastructure, in order to enforce and to compete mostly in the medium technological sectors.

3. Conclusions

In knowledge-based economies, the efficient systems are those which combine the ability to produce knowledge, the mechanisms for disseminating it as widely as possible and the aptitude of the individuals, companies and organisations concerned to absorb and use it. The crucial factor for innovation is thus the link between research (the production of knowledge), training, mobility, interaction (the dissemination of knowledge) and the ability of firms, particularly SMEs, to absorb new technologies and know-how. The attractivity stems from three basic characteristics of the approach that deserve to be summarized here:

- First, it places innovations and knowledge creation at the very centre of focus, and goes beyond a narrow view of innovation to emphasize the interactive and dynamic nature of innovation.
- Second, it represents a considerable advance over the network school of innovation by a decisive shift in focus from firm to territory, from the knowledge creating firm to the knowledge-creating territory.
- Third, it views innovation as a social process that is institutionally embedded, and, thus, puts special emphasis on the institutional context and forms [i.e. formal and informal institutions] through which the processes of knowledge creation and dissemination occur.

Small countries are likely to need a more comprehensive and oriented policy of co-operative innovative effort, in order to develop their future capabilities and to make the necessary choice for technological priorities. Technological diffusion is the process by which innovations (by the new products or new processes) spread within and across economies. The various factors which might influence the incidence of innovation and the speed of its diffusion are the following:

- the *technical applicability*;
- *profitability*;

- *finance*, (lack of financial resources might delay the diffusion of new processes);
- *size, structure and organisation*, (large companies may for a number of economic and technological reasons which behave differently from the SMEs;
- *management attitudes*, (which is the most difficult to assess or to quantify, but nevertheless they may be as important as economic factors in influencing the rate of adoption of new methods);
- *other factors*, such as research and development activities, access to information, the labour market availability of certain skills, licensing policy, the market situation and more precisely the growth of demand for the product as well as the competitive position with special regard to the import competition. All these illustrate the wide range of factors which could contribute to explain the differences in the speed of diffusion.

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