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Teaching Regional Economics with Interactive Software: The Case of Shift-Share Analysis

by

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Abstract

The paper develops in four stages. First, it provides an overview of an interactive regional software designed by the authors at the Department of Economics of the University of Patras. The software is designed to facilitate teaching of regional economics and regional analysis methodology to undergraduate economics students.

Second, using the shift-share technique as an example, the paper examines the merits of using interactive software for teaching purposes. It shows how to introduce students to the basic operation of shift-share and how to link the technique to standard microeconomic theory. Third, it examines the ways an instructor can teach the pros and cons of using shift-share analysis as an explanatory tool for regional employment/output growth, and as a tool for designing regional economic policy in a static and dynamic framework.

Fourth, the work makes extensive reference to applied research that uses shift-share analysis as a regional analysis tool. In this way the instructor can demonstrate that a regional analysis method may be used in many fields of contemporary economic analysis where the regional dimension is important. Examples include the use of the technique in productivity analysis, public policy economics, financial economics, trade and exports, energy and natural resource economics, agricultural economics and rural development, health economics, and in scientific fields outside economics such as demography, human geography, etc.

JEL Classification: A22, R58, C88

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1. Introduction

Through our experience in teaching regional economic methodology to third year students for a long time, approximating now 10 years, we have realised that teaching of regional analysis methods, meets a number of obstacles. Students, despite their familiarity with contemporary economic theory and complicated statistical techniques are often not capable of understanding regional relationships and simple algebraic methods that attempt to standardise regional data. This is due to the emphasis placed on neoclassical micro-economic theory that systematically ignores the existence of spatial relationships at least at the basic undergraduate level. Furthermore, many fields in economics have developed a wide range of teaching tools including ready to use class material, computer software, multimedia, etc.

Regional economics, on the other hand, does not exhibit the same level of dynamism and, especially in the field of regional analyses and since the appearance of Walter Isard's seminal work (Isard et al., 1960; 1998) nothing spectacular has happened. This should be attributed to two distinct reasons. First, most primary regional analyses can be performed using spreadsheets available now to any personal computer (p.c.) as standard software. Second, regional analyses are directly linked to the visual representation of input and output data on regional maps. This is a difficult task to accomplish and, given the widespread use of Geographical Information Systems (GIS), many instructors would prefer the direct use of a GIS package. At the same time computer software for spatial (not regional) analyses have become widely used in teaching and research while GIS software has become simpler and cheaper and thus more available to students and young researchers. One very good approach in teaching spatial analysis is the book by Bailey and Gatrell (1995) with accompanying p.c. software for specialised spatial and statistical analyses. The focus of the book is not in economics and despite the fact that its level is somehow advanced, instructors can adapt the material and use it in teaching regional economics methodology while parts of the book can be used for teaching undergraduate students.

In the Department of Economics of the University of Patras we attempted to write from the start p.c. software specially designed to serve the needs of teaching regional analyses methods at a primary level. For this reason, we worked through the last six years and created the basic structure of p.c. software that aims to assist teaching and not stand as a self-instructing material. In this paper we will present the internal structure of the software and its primary teaching goals and demonstrate how we use it in teaching by referring to shift-share analysis. We choose shift-share analysis because this is a method that we characterise as difficult to teach and sometimes, students have a difficulty to understand it when is taught in the conventional way.

2. The Structure of the Software

Three distinct parts make up the software's integrated environment, namely the input, processing and output units. Figure 1 shows the software's internal structure explained in this part of the paper. Input facilities are designed to allow the use of regional maps, large datasets and images. A spreadsheet is integrated in the software to allow manual data entry

or data file entry from files created and stored using other software. The spreadsheet allows all basic spreadsheet operations provided for by commercial software. The software has its own facility for digitizing maps and defining regions on maps. Digitized maps are based on small areas, which may be variously defined to form larger spatial units and allow regional and sub-regional analyses. Furthermore, the software includes many ready to use maps for the European Union, the United States and many European Union member states.

Figure 1. The Software's Internal Structure

The central processing unit contains ready to use regional analysis routines that are menu driven. In particular, this menu facilitates a range of basic statistical analyses, the whole range of primary regional analyses and an option to include some specialized applications such as input-output modeling, and applications from regional demography and political sciences. The regional analyses sub-menu contains routines designed to calculate a range of indices including location, concentration and association measures, shift-share analysis, and other basic regional analysis methods.

Output is realized under three different kinds of files. Data files in the form of spreadsheet files can display and store output data. Data can then be displayed on maps, linked to the specific regions. Maps allow editing and printing and thus, students can produce their own customized results on maps. Finally, input and output data can be used in graphs. This part of the software includes some graphs specially designed for use in regional analysis such as the Lorenz curves and others.

The central screen of the software and an output screen including output data displayed on a map are shown in figures 2 and 3 of appendix B in this paper.

3. The Shift-Share Analysis

Shift-Share analysis is a method for standardizing large amount of data on employment change between two time periods. The original method identifies three components of change for each region or sub-region. The basic components of the method include the national component, the structural component and the differential component. The national component is the employment change, which would have occurred in a region if this had grown at the same rate as employment in the country as a whole. The structural component is the employment change, which would have occurred in a region if each of the industries in that region had changed its employment at the same rate as that industry nationally, less the national component. The differential component is the difference, which is left over of the actual net change after calculation of the national and regional components.

Early approaches to further analyse the differential component include those by Stilwell (1968), Keeble (1976), Fothergill and Gudgin (1979), and other researchers. Furthermore, many researchers, in their attempt to provide remedies to the technique's limitations analysed the differential component and introduced elements of core economic theory into the shift-share. The most pronounced of these approaches are that introduced by Esteban-Marquillas (E-S) and Arcelus (Esteban-Marquillas, 1972 ; Arcelus, 1984). Appendix A of this paper presents the basic equations used to construct the algorithm for estimating a standard version and the E-M and Arcelus modifications of the shift-share's components.

Due to its simplicity, relative to more complicated statistical models, the technique has found wide application to many fields in economics and other sciences. In regional economics the method has been extensively used as an instrument for policy analysis and design and a planning tool. Furthermore, extensions of the method have been used in various fields of economics including productivity analysis, trade, financial economics, etc. The technique however, has been the subject of heavy criticism and, at the same time, of clever and intellectual defense.

Criticism has been directed towards the fact that the technique is based on the implicit assumption that what happens in one industry has no influence whatever on any other industry in the region. Thus, the analysis takes no account of the income multiplier or input-output relationships. Yet, such technological linkages might have the result that a fall in output in one industry will lead directly to a fall in output and incomes in other industries within the region.

Besides criticism on theoretical grounds, evidence show that the results obtained from shift-share analysis can be sensitive to the level of data dissagregation used, whether by industrial breakdown, spatial boundaries or time period. Analysis with highly dissagregated data tends to produce larger structural components and smaller differential shifts. The structural and differential components at the one digit of industrial classification are definite and unambiguous.

Evidence show that results may also differ considerably between adjacent geographical areas. Different researchers have worked on a regional and sub-regional level and results differ considerably according to the size of the spatial unit used, namely region, country, etc. Finally, fluctuations in the results may occur between different time periods, especially when

very short periods, such as one or two years only are chosen. So, it is necessary to choose a time period sufficiently long for basic trends to become apparent, although not so long those significant break in trends are concealed with it. Albeit all the aforementioned problems the technique remains an invaluable tool for initially condensing large amount of information and a useful method in policy formation.

4. Teaching Shift-Share Analysis by Using an Interactive Software

Taking into account the aforementioned discussion on shift-share analysis and especially:

- its foundation and use in regional economics and planning,
- its extension to other fields in economics and in other sciences, and
- its problems associated with the dissagregation of data,

the instructor faces the task of accomplishing multiple objectives when she introduces undergraduate students to the basic operations of the method.

We propose the use of the interactive regional analysis software in teaching shift-share analysis as an example of accomplishing all the above-cited targets. The dialogue window of the shift-share analysis in the analysis menu contains two choices. First, the student can choose the regions and industrial classes for which a shift-share analysis will be performed. Second, there is a choice of various methods (standard, E-M, Arcelus), and various facilities for storing output data. Thus, the student can choose to display output closely linked to planning decisions on a map. For example the student can choose to display only the positive structural components of the standard variant of the technique or the two components of the differential shift in the E-M and Arcelus variants of the technique. All these components have direct interpretation in the framework of the shift-share analysis and show favourable or unfavourable mix of industries, competitive advantage or disadvantage and regional specialisation. In this way, policy needs and proposed planning actions may become evident.

Besides the many applications of the technique in regional policy and planning the teacher can demonstrate the use of the technique in other related fields of economics. The merits of the technique as a predictive tool may be demonstrated given that appropriate data exist (Hellman, 1976; Andrikopoulos et al., 1990). The technique may be linked to an analysis of productivity growth and separate the effects of output and productivity using the Rigby-Andersen (R-A) model and its extensions (Rigby and Andersen, 1993; Haynes and Dinc, 1997). The technique has been used in export research (Khalifah, 1996; Brownie and Dalziel, 1993) with success. Such an exposition of the method can introduce the student to the use of the technique outside the field of regional sciences and independently of using region specific data, in the sense that regions are replaced by importing countries and employment in industries is replaced by a monetary or physical measure of exports of goods.

Shift-share analysis has been applied in research in energy economics where results have been either the final end of research or have been used as input in consequent analyses (regression, etc.). The instructor may refer to contemporary uses of the technique in energy

economics and use class material from published sources (Keil, 1995; Klodt, 1994; Polenske and Lin, 1993;). Furthermore shift-share applications in agricultural economics (Nguyen and Saldivar, 1979) or health economics and policy (Hoppes, 1997) can be used to exhibit the fact that a method specifically designed to analyse regional economics data can be used to many other fields which face regional data.

Finally, the use of the proposed software provides a good visual introduction to the method's problems and deficiencies. Given that appropriate data are entered for regional and sub-regional levels, for various time periods and for different levels of industrial dissagregation, the student can simultaneously display results from two analyses (regional vs. sub-regional, 5 year period vs. 10 year period, one digit vs. two digits) and observe the changes caused in the components. In this way, instability of components over time and space can be visually inspected and understood. Furthermore, the software's dialogue window for shift-share analysis allows for hypothetical questions to be realised and tested. For example, when one defines the regions and industries to be included in the analysis she may exclude one region (especially an influential one) and see how the results would have been should this region (or industry) was not part of the analysis. The software's mapping facilities allow the instructor to design her own maps and put emphasis on the method's application at her own specific country or region and utilise her own data sets.

The software is continuously upgraded with the inclusion of new applications and methods and an experimental version is available by the authors upon request.

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APPENDIX A – SHIFT-SHARE ALGORITHMS

Assume that for a nation with R regions and K sectors of economic activity we can define E_{ij} to be region's i employment in sector j in the basic year. We construct a table such as:

Region / Sector	1	2	. .	j	. .	K	*Total*
1	.	.	. .	E_{1j}	. .	.	E_{10}
2	.	.	. .	.	. .	.	E_{20}
.	.	.	. .	.	. .	.	.
.	.	.	. .	.	. .	.	.
i	.	.	. .	E_{ij}	. .	.	E_{i0}
.	.	.	. .	.	. .	.	.
.	.	.	. .	.	. .	.	.
R	.	.	. .	E_{Rj}	. .	.	E_{R0}
Total	E_{01}	E_{02}	. .	E_{0j}	. .	E_{0K}	E_{00}

Assume that a similar table may be defined for year * and the corresponding elements of the matrix denoted by E_{ij}^{*}. Then, we define:

$$e_{00} = \left(E_{00}^{*} - E_{00}\right) / E_{00}$$
$$e_{i0} = \left(E_{i0}^{*} - E_{i0}\right) / E_{i0}$$
$$e_{ij} = \left(E_{ij}^{*} - E_{ij}\right) / E_{ij}$$
$$e_{0j} = \left(E_{0j}^{*} - E_{0j}\right) / E_{oj}$$

Then, for the **standard shift-share technique**, the change in employment is defined as:

$$\Delta E_{ij} = N_{ij} + NI_{ij} + C_{ij} = E_{ij}^{*} - E_{ij}$$

where the national component (or national growth) is defined as:

$$N_{ij} = E_{ij} e_{00}$$

the structural component (or industry mix) is defined as:

$$NI_{ij} = E_{ij}\left(e_{i0} - e_{00}\right)$$

and the differential component (or competitive position) is defined as:

$$C_{ij} = E_{ij}\left(e_{ij} - e_{i0}\right)$$

In the **Esteban-Marquillas extension** of the technique, the change is defined as:

$$\Delta E_{ij} = N_{ij} + NI_{ij} + C_{ij}^{'} + A_{ij} = E_{ij}^{*} - E_{ij}$$

where the homothetic employment term is defined as,

$$\hat{E}_{ij} = E_{ij}\left(E_{i0} / E_{00}\right)$$

and the differential component is broken up to two terms. The competitive position defined as:

$$C_{ij}^{'} = \hat{E}_{ij}\left(e_{ij} - e_{i0}\right)$$

and the allocation effect defined as:

$$A_{ij} = \left(E_{ij} - \hat{E}_{ij}\right)\left(e_{ij} - e_{i0}\right)$$

In the **Arcelus extension** of the technique, the change is defined as:

$$\Delta E_{ij} = N_{ij} + NI_{ij} + R_{ij} + RI_{ij} = E_{ij}^{*} - E_{ij}$$

where the homothetic employment term is defined as in the Esteban-Marquillas extension but the two parts of the differential component are defined differently. The regional growth component is defined as:

$$R_{ij} = \hat{E}_{ij}\left(e_{oj} - e_{00}\right) + \left(E_{ij} - \hat{E}_{ij}\right)\left(e_{0j} - e_{00}\right)$$

while the regional industry mix is defined as:

$$RI_{ij} = \hat{E}_{ij}\left[\left(e_{ij}e_{0j}\right) - \left(e_{i0} - e_{00}\right)\right] + \left(E_{ij} - \hat{E}_{ij}\right)\left[\left(e_{ij} - e_{oj}\right) - \left(e_{i0} - e_{00}\right)\right]$$

APPENDIX B – INDICATIVE SCREENS

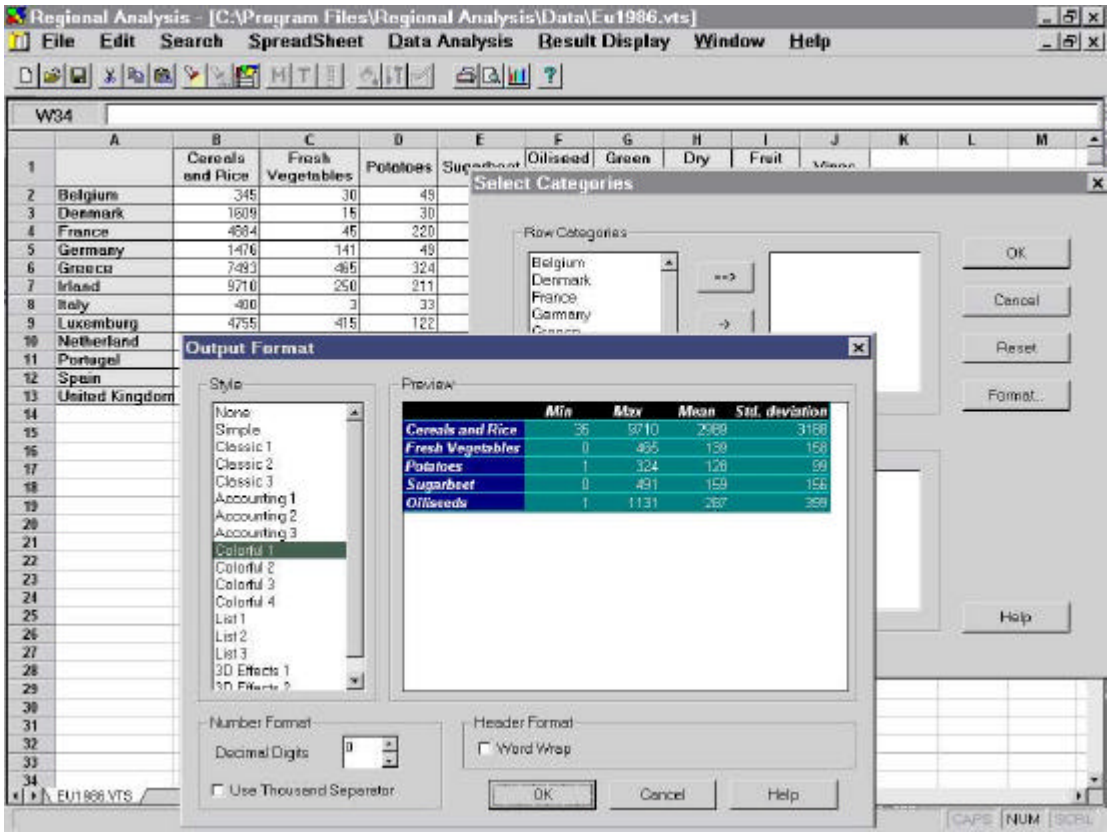

Figure 2. Spreadsheet and Dialogue Window for Specifying Method Parametres.

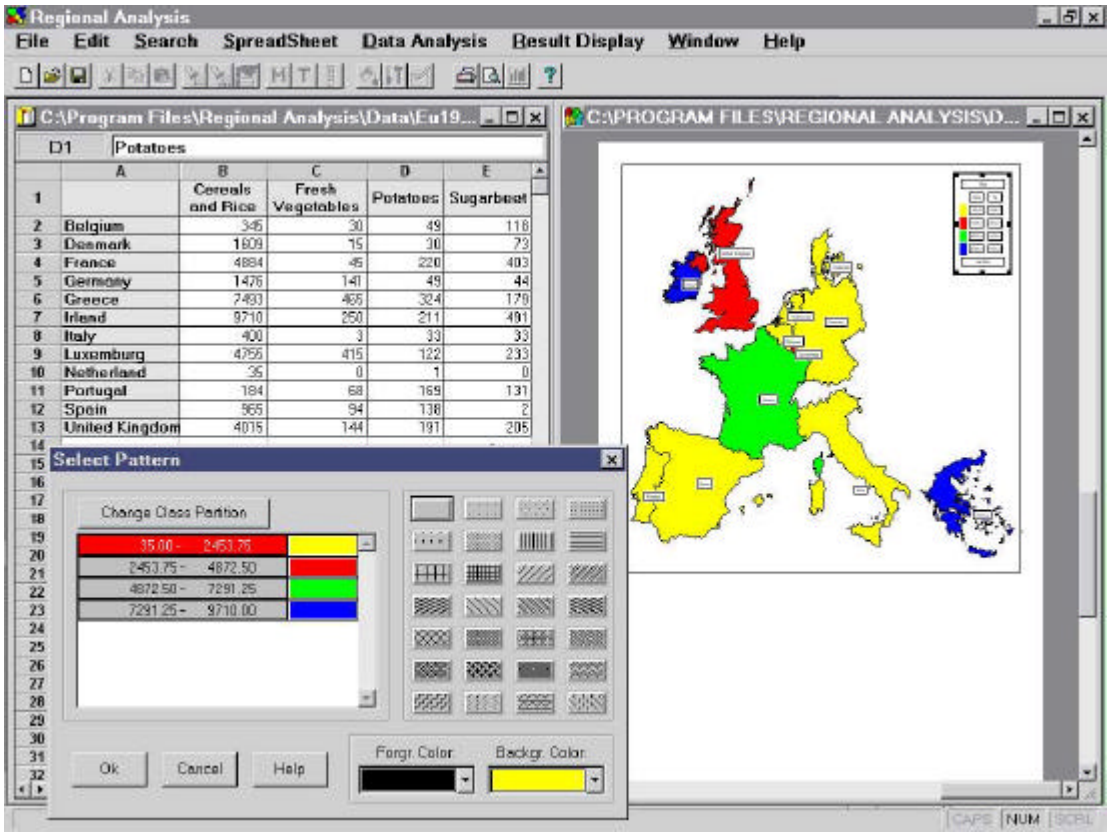

Figure 3. Output Data Displayed on Regional Map.