

## **Regional impacts of infrastructural programmes: ex-post assessment methodologies revisited**

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### **Abstract**

The main purpose of the project reported in this article consists in contributing to the methodological debate, and to developing a methodology on ex-post evaluation of public investments in large infrastructures.

Within this scope, the research was developed in the Northern Region of Portugal, in order to identify how much past investment in infrastructures (carried out throughout the last decade) engendered a sustainable regional economic growth, and to what extent they were able to reduce inter-regional inequalities.

It is proposed the development of an integrated and interactive set of tools to support regional planning decisions concerning the aggregate ex-post evaluation of these kinds of investments. This ex-post assessment of the regional impact of past public investments is likely to improve current regional development policies through: (i) analysis and computation of the regional benefits that accrued from public investments already performed, (ii) support to the definition of transparency and efficiency criteria in the application of public resources, (iii) redesign of future policies for public investments, and (iii) support to more balanced inter-regional development policies.

### **Keywords**

Ex-post evaluation; public aggregate investments; regional development

### **1. Introduction**

The performance and financial control over investments framed by European funding programmes has been strictly monitored in different moments, for each specific project. This shapes an ongoing control in relation to ex-ante settled goals, and are applied to the entities responsible for the reception and application of funds. This individual short-term assessment blurs a strategic assessment of economic, social and environmental impacts on true beneficiaries of performed aggregated regional investments: the general population, especially the most straightly affected by those investments. Additionally, considering the globalization and widespread competition processes, as well as the quick succession of changes, both external and internal changes occur during a project's useful life. This implies that the assumptions on which the analysis settles also change, and often the initial stated goals cease to be a strong and valid reference. This article aims at overcoming this flaw in the analysis, thus enabling the assessment of how past aggregated investments in infrastructures implies a sustainable economic development,

and to what extent they are able to shrink inter-regional disparities. This analysis holds two aspects: the compared evolution of some macroeconomic issues among different regions<sup>1</sup>, and the proper evolution of the economic performance of a certain region. But these kinds of analysis require from the beginning a strong management information system that enables the characterization of the regional situation, and that additionally includes the changes that take place in the meantime.

The research reported in this article, applied to the Portuguese northern region, is supported on the application of mathematical tools that enable the analysis and assessment of ex-post regional benefits that accrue from public aggregated investments, in order to support the settlement of rules for the transparent and efficient use of public money.

## **2. Theoretical framework**

The theoretical, methodological and empirical methods to evaluate public investments (Bradley et al., 1995; Bradley et al., 2005; Min. Finanças, 2003; Modesto and Neves, 1995), vest a macroeconomic and econometric nature, place on the supply side (Bradley et al., 1995, 2005), use variables that explain economic development and productivity issues (Mizutani and Tanaka, 2008; Nijkamp and Poot, 2004; De La Fuente, 2002; Bajo-Rubio and Sosvilla-Rivero, 1994), and have overall revealed a good performance along time (Moreno et al., 2002; Bradley, 2006). A string of Japanese regional research (Mizutani and Tanaka, 2008; Kataoka, 2005; Yamano and Ohkawara, 2000) has also focused on the relations between public investments and productivity. Some authors have additionally reflect on the trade-off between efficiency-equity goal-oriented public investments (Yamano and Ohkawara, 2000; De la Fuente, 2004).

The project here reported centres at the regional level, and considers investments in different kinds of infrastructures<sup>2</sup>, using their amounts at fixed prices (Mizutani and Tanaka, 2008; Bradley, 2006; Bradley et al., 2005). Analysis in principal factors and regression methodologies are used in order to assess the economic growth and the regional production function, relating them to, among other things, the amounts of performed investments along time (Kataoka, 2005).

## **3. Case study**

### **3.1. Brief characterization of the Portuguese northern region**

The northern region of Portugal is a territorial unit that comprises the districts of Viana do Castelo, Braga, Porto, Vila Real and Bragança, and part of the districts of Aveiro, Viseu and Guarda. It borders on Spain at the north (Galicia) and east (Castila and León). At south it connects to the Portuguese central region, and at west borders on the Atlantic Sea. Its surface amounts to 21 278 km<sup>2</sup> (24% of the continental Portugal). Its population is around 3 745 246 people (37% of the whole continental Portugal)<sup>3</sup>. It is a planning region – created as an administrative unit in 1969 – that splits into the North Cost (districts of Viana do Castelo, Braga and Porto) and the North Inland (districts of Vila Real and Bragança), and is made up of eight sub-regions: Alto Trás-os-Montes; Ave; Cávado; Douro; Entre Douro e Vouga; Grande Porto; Minho-Lima; and Tâmega<sup>4</sup>.

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<sup>1</sup> In this research this inter-regional analysis is performed within Portugal, but it can be easily extended to comparison to other European regions.

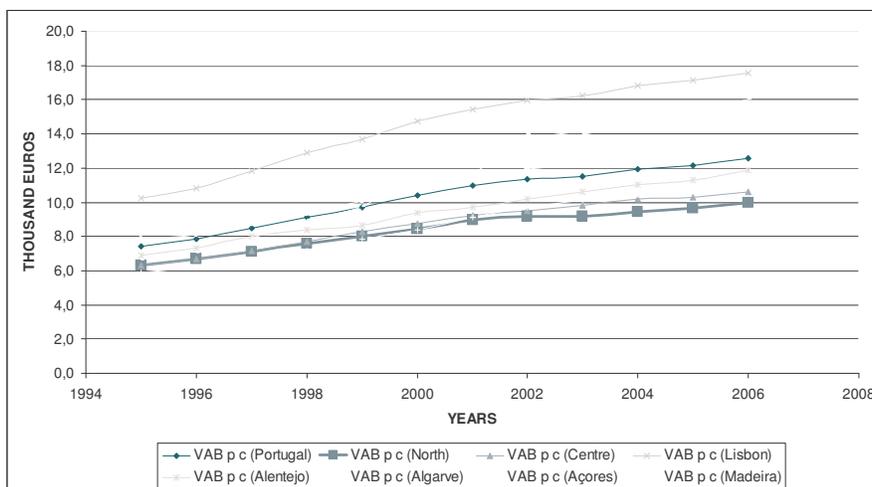
<sup>2</sup> According to a classification of big investments by categories.

<sup>3</sup> These statistical values refer to 2007.

<sup>4</sup> [http://pt.wikipedia.org/wiki/Regi%C3%A3o\\_do\\_Norte\\_\(Portugal\)](http://pt.wikipedia.org/wiki/Regi%C3%A3o_do_Norte_(Portugal)).

**Figure 1.** Portuguese Northern Region

Through comparison with the other Portuguese regions<sup>5</sup> and with the average values for the whole country, it can be noticed that the northern region is the one that, along the last decade and a half, showed the lowest per capita gross added values, and their distance to average values have been growing up, especially in relation to the Lisbon and Tagus valley region.

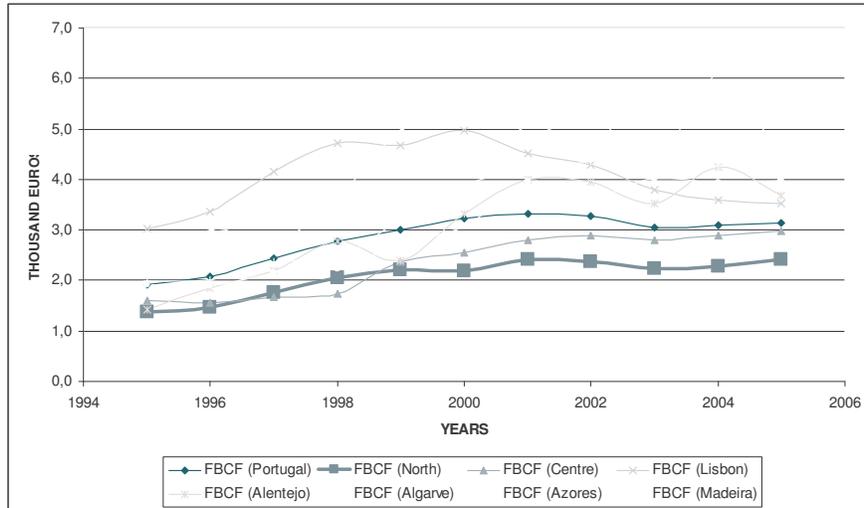


**Figure 2.** Evolution of the per capita gross added value in Portugal (by regions and average Portuguese values), between 1984 and 2006

In what concerns the investments – measured by the gross formation of fixed capital, according to the national statistics system<sup>6</sup> – the scenery is not much different, as the northern region has received lower amounts of public investments, despite these investments have been growing gradually along the last fifteen years (with the exception of the ones allocated to the region of Lisbon and Tagus valley).

<sup>5</sup> Portugal is split into seven regions: North; Centre; Lisbon and Tagus Valley; Alentejo; Algarve; Azores Autonomous Region, and Madeira Autonomous Region.

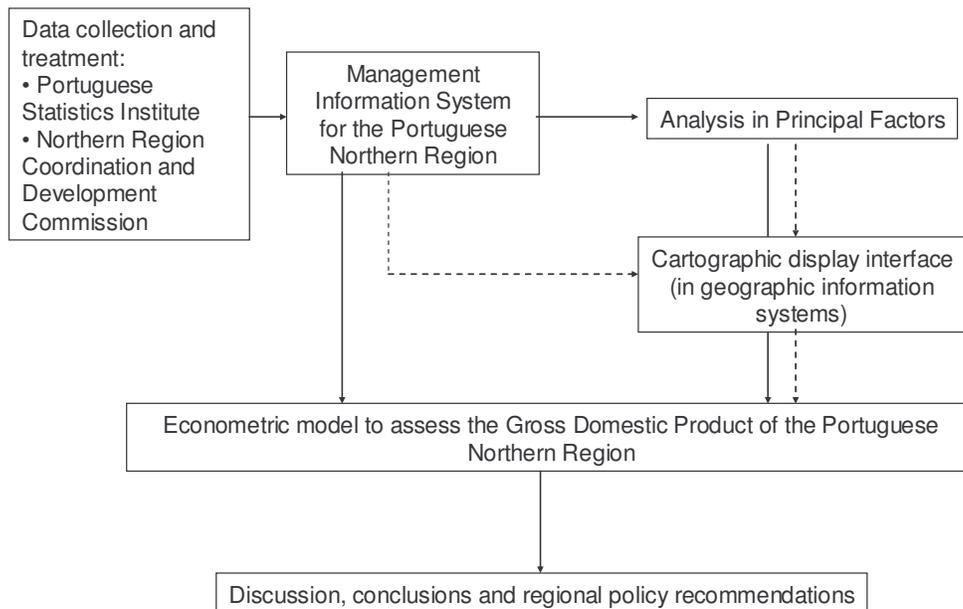
<sup>6</sup> Data provided by the Portuguese Statistics Institute.



**Figure 3.** Evolution of the per capita gross formation of fixed capital in Portugal (by regions and average Portuguese values), between 1984 and 2006

### 3.2. Methodology

The methodology pursued in this research consists of the following steps: (1) design and construction of a management information system for the Portuguese northern region; (2) identification of the variables that potentially explain the regional gross internal product (including variables concerning aggregate public investments); (3) analysis in principal factors; (4) development of a cartographic display interface (using geographic information systems); (4) adjustment of an econometric model to assess the impact of the principal factors on the change of the regional gross domestic product; (5) discussion, conclusions and regional policy recommendations (Figure 4).



**Figure 4.** Outline of the methodology pursued in this research

### 3.2.1. Data collection and treatment: initial variables considered in the analysis

The data sources used in this research were the Portuguese Statistics Institute (Northern Regional Statistical Yearbooks and Regional Accounts 1995-2005) and the database on investment projects subject to Environmental Impact Assessment, performed in the northern region since 2001 (provided by the Northern Region Coordination and Development Commission). Then a management information system was developed as a result of the exhaustive collection and treatment of all available data for each year.

The data on the macroeconomic characteristics of the region used on the annual analysis (collected by municipalities and assembled by sub-regions<sup>7</sup>) was the following<sup>8</sup>:

- Gross domestic products from 2002 up to and including 2006 – expressed in million euros.
- Absolute and percentage variation of the gross domestic product between each pair of consecutive years.
- Investments performed in 2001, 2002, 2003, 2004, 2005 and 2006 in projects subject to environmental impact assessment, whose responsible entity was the Northern Region Coordination and Development Commission – expressed in euros.
- Employment in each of the years of the decade – expressed in thousand people.

In what concerns the data that characterizes the economic situation of the region for each of the considered years, the variables fit four main groups: (i) indicators related to the labour market; (ii) indicators related to firms; (iii) indicators of the dwelling park; and (iv) indicators on the external trade of the region.

There were considered the following variables concerning the labour market:

- Employees in establishments by municipality and according to size-classes in number of employees - 1 to 9; 10 to 19; 20 to 49; 50 to 99; 100 to 249; 250 to 499; 500 or more – in number;
- Employees in establishments by municipality and according to education level – lower basic education; first cycle of basic education; second cycle of basic education; third cycle of basic education; secondary education; baccalaureate; higher education; master degree; and doctorate – in number;
- Mean monthly earning of employees in establishments by municipality and according to size-classes in number of employees – 1 to 9; 10 to 19; 20 to 49; 50 to 99; 100 to 249; 250 to 199; and 500 or more people – in euros;
- Mean monthly earning of employees in establishments by municipality and according to education level – lower basic education; first cycle of basic education; second cycle of basic education; third cycle of basic education; secondary education; baccalaureate; higher education; master degree; and doctorate – in euros;
- Mean monthly earning of employees in establishments by municipality and according to sector of main activity (NACE-Rev.1.1) – total; in the primary sector (CAE A – B); in the secondary sector (CAE C – F); and in the tertiary sector (CAE G – Q) – in euros;

There were used the following indicators concerning firms:

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<sup>7</sup> Data was assembled at the level of sub-regions, not only in order to make data compatible, but also to enhance the aggregated importance of the considered indicators.

<sup>8</sup> Neither the gross added value nor the per capita gross added value were used in this dataset (despite they were available) because of their macroeconomic correspondence to the gross domestic product.

- Enterprises by head office municipality and according to classification of economic activities NACE-Rev. 2.1 (A+B; C; D; E; F; G; H; I; J; K; M a O) – in number;
- Manufacturing enterprises by head office municipality and according to classification of economic activities NACE-Rev.2.1, 2006 (DA; DB; DC; DD; DE; DF+DG; DH; DI; DJ; DK; DL; DM; DN) – in number;
- Formation of companies, by municipality and according to classification of economic activities NACE-Rev.2.1 (Total; A+B; C; D; E; F; G; H; I; J; K; L a Q) – in number;
- Formation of manufacturing companies by municipality and according to classification of economic activities NACE-Rev.2.1. (DA; DB; DC; DD; DE; DF+DG; DH; DI; DJ; DK; DL; DM; DN) – in number;
- Dissolution of companies, by municipality – in numbers;
- Proportion of employment in joint stock companies – in percentage;
- Proportion of employment in companies with mostly foreign capital – in percentage;
- Proportion of business services employment in knowledge-intensive services – in percentage;
- Proportion of total employment in ICT activities (information and communication technologies) – in percentage;
- Proportion of manufacturing industry employment in medium and high technology industries – in percentage;
- Company formation rate – in percentage;
- Company dissolution rate – in percentage;
- Density of establishments – in number/Km<sup>2</sup>;
- Proportion of establishments employing less than 10 persons – in percentage;
- Proportion of people employed by establishments whose head office is situated in the municipality – in percentage;
- People employed by establishment – in number.

The following variables were used in housing stock estimates by municipality, also grouped by sub-region:

- Number of buildings of classic family housing;
- Number of classic family buildings.

Finally, in what concerns the indicators of international declared trade of goods of operators with the headquarters in the region, the used variables (expressed in thousand euros) were:

- Dispatches;
- Exports;
- Arrivals;
- Imports.

As far as investments are concerned, our database has 84 records with complete information on the projects - including the amount of investments - (out of a total of 311 projects subject to environmental impact assessment during the last decade). The environmental impact assessment of these projects is the sole responsibility of the Northern Region Coordination and Regional Development Commission. These projects mainly concern stone quarries (27%); roads (21%); dams (12%); industries (8%); and

aeolian parks. In addition, some typologies present a sole project<sup>9</sup>. The category of other projects includes the enlargement of Francisco Sá Carneiro airport's facilities, a sewage disposal, a pig breeding, an electrical network substation, a land division, and a mining development. The total aggregated investments amounted to 1047 million euros. The greatest investment corresponded to the enlargement of the Oporto's airport, followed by the one in the Swedwood company (134 million euros) and by the project of a paper machine led by the Portucel Viana company (125 million euros). Both commercial sets included in this database (Nassica and Espaço Braga) correspond to the higher than 100 million euros remaining investment projects.

### **3.2.2. Analysis in principal factors**

Then was pursued an analysis in principal factors considering: (i) the high number of variables initially considered; (ii) the importance of the whole available data on the analysis; and (iii) the fact that much information refer to the same realities and is superimposable. The analysis in principal factors assembles many advantages, namely: (i) it enables a substantial reduction in the number of relevant dimensions in the explanation of data, through the joint consideration of strongly correlated explanatory variables; (ii) the principal factors are linear combination of the initial variables; and (iii) the principal factors are orthogonal among each other and linearly independent, and their correlation is null, what removes the colinearity problem between the explanatory factors, thus strengthening the accuracy and robustness of the adjusted models.

In this article the analysis in principal factors was applied to 2006 data, using software SPSS 17.0, and taking the variables systematized in the management information system, by northern sub-regions.

This analysis lead to seven principal factors described following on:

- Factor 1 characterises the current situation of the northern region in terms of the activity fields (manufacturing industry; power production and distribution; construction, and all services activities); employment (number of workers per establishment no matter their dimension, and whichever their education level); workers' earnings (especially those belonging to the first and second cycles of basic education, secondary education, and baccalaureate; mainly in the tertiary sector, and in firms with a number of workers till 249); density of establishments; turnover by firm; rate of gross added value; and operational sales value; buildings and dwellings; international trade; and investment in projects subject to environmental impact assessment performed in 2001 (5 years before) and in 2004 (2 years before).
- Factor 2 highlights the proportion of small and medium enterprises; people employed by enterprise and respective costs; as well as indicators of labour and fixed capital productivity.
- Factor 3 translates the importance of firms belonging to extractive manufactures; as well as the formation of new building companies; earnings of workers with master degrees; the relevance of external economies (expressed by turnover concentration); and the number of buildings.

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<sup>9</sup> These include a thermal power station; a pisciculture; a urban solid waste treatment station; a oil pipeline; a sewage treatment station; an airfield; and a tourism setting.

- Factor 4 reveals the importance of firms in the fishery; firms' liquidity and solvency; and investments in projects subject to environmental impact assessment in 2003 (3 years before).
- Factor 5 draws the attention to the relevance for the gross added value that accrues from scale economies (express both by turnover concentration in the four major firms and at the municipality level); information and communication technologies' activities; and firms return on equity.
- Factor 6 translates the increasing importance of the earnings of people with the doctorate degree; the concentration of the gross added value in the 4 major firms; and the investment in projects subject to environmental impact assessment in 2002 (4 years before).
- Factor 7 shows the increasing importance of workers' earnings in big firms (with a number of employees that spans from 250 to 499).

### **3.2.3. Adjustment of an econometric model to assess the gross regional domestic product**

Considering that the main objective of this article consists in the determination of how past public investments relate to or influence the regional gross domestic product – together with other macroeconomic explanatory factors – a regression was carried between the variation of the regional gross domestic product between 2005 and 2006, and the principal factors. This adjustment reinforces the dynamic perspective adopted in this research.

$$\% \text{ VAR PIB}_{2005-2006} = 0.400 \cdot \text{Factor 1} - 0.171 \cdot \text{Factor 2} + 0.314 \cdot \text{Factor 3} + 0.061 \cdot \text{Factor 4} + 0.190 \cdot \text{Factor 5} - 0.545 \cdot \text{Factor 6} + 0.613 \cdot \text{Factor 7}$$

### **3.2.4. Discussion of results**

The percentage increase in the regional gross domestic product between 2005 and 2006 strongly resulted from the ongoing regional economic situation, which means from the maintenance of the prevailing economic conditions in terms of activity fields, employment, employees' mean earnings, firms' economic-financial indicators, buildings and dwellings, international trade, and investments performed in 2001 and in 2004 [factor 1].

The characteristics that most impacted that change in the regional gross domestic product were: the activity of extractive manufactures and of new building firms; the higher qualifications of employees; external economies; firms' liquidity and solvency; the fishing activity; the investments in projects subject to environmental impact assessment performed in 2003 (mainly investments in stone quarries, in manufacturing firms, and in industrial parcelling); activities of information and telecommunication technologies and respective impact on regional productivity and profitability [factors 3 and 4].

For the positive percentage regional GDP's changes between 2005 and 2006 were also important scale economies and the turnover concentration into a reduced number of big firms, the activities of information and telecommunications technologies, and the proper firms' profitability [factor 5].

The regional biggest firms (with a number of employers that ranges from 250 to 499) also assumed a relevant role in regional GDP explanation [factor 7].

Small and medium firms exerted a negative effect on GDP percentage variation [factor 2], and the same holds true for the investments in projects subject to environmental impact assessment in 2002 (mainly investments in stone quarries), probably because the exploration of these stone quarries had already finished by then [factor 6].

#### **4. Conclusions, implications and recommendations of regional policy, and statement of open questions and further research**

The reached results translate, before all, a regional dynamic process. It means that, despite the current economic situation detains a strong importance in gross domestic product changes, the activity of the extracted manufactures, and the emergence of new information and communication technologies, scales of economy, and the increasing concerns with productivity and profitability have exerted more and more impact on the region, and the firms of higher dimension are also reinforcing their standing. The small and medium firms in the traditional economic fields are, on the contrary, increasingly losing importance.

In face of the reached results, what should be done next? Some public policy proposals can be suggested in order to reinforce the factors that present higher potential to value the regional product, thus fostering regional economic self-sustainability. Some measures include, namely: reinforce the incentives to installation of new information and communication technologies, and strengthen the conditions for scale economies (through reinforcement of the functionalities of manufacturing parks).

Interesting issues for future research refer to the assessment of the leverage effects of public investments on private entrepreneurship decisions, and how these joint investments will impact regional economic development and, thus, the delineation of future regional policies.

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