

Annex 4 - Rethinking the monitoring of the Lisbon Strategy's targets

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1. INTRODUCTION

The Lisbon Strategy faces the shifts that come from globalization and from a new knowledge driven economy through the definition of a new strategic goal. This framework requires an overall strategy that, at the same time, can be disaggregated in particular objectives and ways to achieve them.

In order to measure and monitor this strategy process, a complex system of around a hundred indicators was developed, though a final Structural Indicators Table was implemented. These indicators should be a means for the Commission to draw up an annual synthesis report on progress on the basis of structural indicators to be agreed relating to five dimensions: employment, innovation, economic reform, social cohesion and environment. Additionally, the more important aspects of this Indicators System have been synthesized: from the initial 107 indicators to the final 14 indicators proposed by the same Commission. In our view, this process has followed the objective of getting the first criteria stated in the Communication from the Commission (8.10.2003): easy to read and understand. Nevertheless, the final result forgets one of the initial characteristics of the Lisbon Strategy: the multiplicity of objectives.

Taken this into account, we wonder if the structural indicators finally chosen reflect the ultimate objective of the Lisbon Strategy, which is in Commission words, “to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion”. In this sense, two approaches have been considered:

- The first one consisting in analysing the relationship between the main objective of the Strategy (defined as general economic background) and the rest of structural indicators, those merely try to pick up the five dimensions of the overall Strategy.
- The second one will allow us to know which have been the more important forces that have contributed to the growth of the EU countries during the last ten years. Or, in other words, whether general growth of the economies has been accompanied with a similar growth on employment, knowledge and human capital, investments or social cohesion among others. We focus particularly on the relationship between economic growth and the improvements made in the area of innovation and research, since this is seen as one of the main engines for growth in the Lisbon strategy and a base for modernizing the European model.

Additionally, a good way to improve the Structural Indicators System can be, as the Commission says, the Composite Indicators alternative, which can also be seen as an alternative to the reduction of the number of key indicators without losing proximity to the overall targets of the Lisbon Strategy. This

alternative is indeed proposed by the Commission in the Annex 2 of the Communication 8.10.2003 in which it is stated that “progress has been made in the domain of innovation and research on two composite indicators: investment in the knowledge-based economy and performance in the transition towards the knowledge-based economy”.

Therefore, since we also believe that a system of composite indicators is a good approach to gather the multidimensionality of objectives of the Lisbon Strategy and at the same time we also put special stress on the innovation and research dimension, we try to built a composite indicator system of this dimension as a complementary measure to the set of structural indicators selected by the Commission.

In order to achieve the above goals, the following steps are developed in this paper:

- a) A brief survey of the Lisbon Strategy is made, with an analysis of its objectives, list of structural indicators and an overall evaluation.
- b) Analysis of the structural indicators evolution against general economic background indicators both at cross section and temporal dimensions, focusing on economic growth.
- c) We focus on the relationship between economic growth and the improvements made in the innovation and research area, both theoretically and empirically.
- d) Definition of a system of composite indicators related to the innovation and research dimension and its relationship with economic growth.

2. DESCRIPTION OF THE LISBON STRATEGY

2.1. Objectives

In 2000, the Lisbon European Council decided to launch a ten year-strategy focused in reaching a leadership economic position in dynamic and competitive terms¹, based in four axes:

- *A.* Reaching a knowledge-based economy after:
- *B.* Modernising the European social model;
- *C.* Developing a framework of appropriate and stability oriented macroeconomic policies;
- *D.* Achieving sustainable development.

¹ We have to remark the fact that the Lisbon Strategy is extended to the New Member States of the European Union, and then all the objectives, implemented initially by the 15 Member States, are applied also to the new members.

The implementation of these policies would result in a sustainable and non-inflationist growth with lower unemployment rates and more sustainability of public finances.

In order to work in all four lines, the European Union (EU) has established in different European Councils (Lisbon, 2000; Stockholm, 2001; Gothenburg, 2001; Barcelona, 2002; Brussels, 2003) several objectives, grouped in five dimensions:

- **A.** Employment,
- **B.** Innovation and research,
- **C.** Structural economic reforms,
- **D.** Social cohesion, and
- **E.** Environment

These dimensions are quantified in a sort of structural indicators, comparable with a ten year temporal threshold of policy ciphers that allows policy makers evaluating the evolution of the overall strategy. Roughly speaking, all generic objectives have a list of specific objectives that ensure the completion of the initial concept that faces the strategy. These specific objectives can be summarized in the following list:

- ***A.1. More and better jobs for Europe: developing an active employment policy:*** in order to reduce unemployment and to rise the employment rate, four areas arise: improving employability and reducing skill gaps; increase adaptability through lifelong learning; increase employment in services; and reducing occupational segregation.
- ***B.2. Information society for all:*** the shift to a digital, knowledge-based economy has to be based on an inexpensive, world-class infrastructure that avoids info-exclusion. The promotion of sure e-commerce and a telecoms competitive regulatory framework is needed, together with ensuring resources in education and public services.
- ***B.3. Establishing a European Area of Research and Innovation:*** The creation of a European Research Area may ensure an integrated, efficient and innovative alternative to best brains. The basic steps are: networking research together with the coordination and benchmarking of national research and promoting mobility; improve private research investment and start-ups; and ensure the Community patent as a tool for rewarding innovation.
- ***B.4. Education and training for living and working in the knowledge society:*** Europe's education and training systems have to offer learning and training opportunities of the knowledge society

through three main components: development of local learning centres, the promotion of new basic skills, and increased transparency of qualifications. Particular targets arise: halving the proportion of 18 to 24 year olds with only secondary level; schools as multi-purpose local learning centres; a European diploma for basic IT skills; promoting mobility for the education actors; a common format for curricula vitae.

- ***C.5. Creating a friendly environment for starting up and developing innovative businesses, especially SMEs:*** lower costs of doing business can be achieved through a better regulatory climate and key interfaces in innovation networks (start-ups, risk-capital initiatives), with a special focus on small companies, an engine for job-creation in Europe (micro-enterprises).
- ***C.6. Economic reforms for a complete and fully operational internal market:*** certain sectors can still complete internal market: remove barriers in services; liberalise gas, electricity, postal services and transports; update public procurement rules (that should take place on-line); simplify the regulatory environment; and generally speaking to promote competition, reducing support to individual companies or sectors, and focusing on key areas.
- ***C.7. Efficient and integrated financial markets:*** more efficient financial and risk-capital markets through a set of particular policies such as enhancing the comparability of companies' financial statements or promoting the better functioning of government bond markets, among others.
- ***C.8. Coordinating macro-economic policies: fiscal consolidation, quality and sustainability of public finances:*** it must be created a relationship of trust between all the actors involved in policy making, in order to have a proper understanding of each other's positions and constraints. The clear objective is to pursue fiscal consolidation and to improve the quality and sustainability of public finances. Particular policies are recommended: reduce tax pressure on labour; redirect public expenditure towards physical and human capital accumulation; and ensure long-term sustainability of public finances.
- ***D.9. Modernising social protection:*** the European social model must be adapted as part of an active welfare state to ensure that work pays, to secure their long-term sustainability in the face of an ageing population, to promote social inclusion and gender equality, and to provide quality health services. It can be done through strengthen cooperation between Member States by exchanging experiences and to prepare studies on the future evolution of social protection from a long-term point of view.

- **D.10. Promoting social inclusion:** The potential of the new knowledge-based society for reducing poverty also brings a risk of an ever-widening gap of social exclusion. Several steps are recommended: promote a better understanding of social exclusion; national promotion of inclusion, complemented at the Community level by the Structural Funds framework; develop priority actions addressed to specific target groups (minorities, the disabled, etc.)

- **E.11. A strategy for sustainable development:** this environmental dimension was added to the Lisbon strategy, to complete the Union's political commitment to economic and social renewal, and establishes a new approach to policy making. Several themes have special emphasis: a new approach to policy making; the global dimension (Johannesburg); environmental priorities for sustainability; combating climate change (Kyoto); ensuring sustainable transport; addressing threats to public health; managing natural resources more responsibly; and finally maritime safety.

2.2. Structural indicators

At the Lisbon Special European Council held in March 2000, it was determined the need to regularly discuss and assess progress made in achieving the strategic goal for the next decade, that is, “to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion”. In order to do it, the Council invited the Commission to draft an annual synthesis report (*Spring Report*) on this progress on the basis of commonly agreed structural indicators, ensuring this way the necessary coherence and standard presentation. This report and the indicators selected must be related to four policy domains: employment, innovation and research, economic reform, and social cohesion. Besides, some general economic background indicators had to be defined to present an overall economic context in which structural reforms were taking place. In addition, from the Gothenburg European Council held in June 2001, a new domain on the environment was included in the list of structural indicators.

In order to meet the request of the European Council, since 2000 the Commission presents annually, at the end of the year, a communication named “Structural Indicators” with a set of indicators to be used in the synthesis report for the respective Spring European Council (COM-2000 594 final, COM-2001 619 final, COM-2002 551 final, COM-2003 585 final). A consensus exists about the need that the selected indicators should be: easy to read and understand, policy relevant, mutually consistent, timely available, comparable across Member States and as far as possible with other countries (mainly US), selected from reliable sources and the data requirements should not impose too large a burden on statistical institutes and respondents. For that reason, the selected indicators are based as much as possible on information provided by the European Statistical System.

According to the Commission, the list of structural indicators should be short (to guarantee to send clear, simple and focussed policy messages) and balanced (to reflect the equal importance on each one of the five domains: employment, innovation and research, economic reform, social cohesion and environment).

Taking into account the points above, the final list used for the synthesis report for the 2001, 2002 and 2003² Spring European Councils incorporated 42 structural indicators (7 indicators for each domain, jointly with 7 general economic background indicators). However, the indicators proposed by the Commission can change from year to year. So, annually some of them can be replaced by new indicators in case the last were more politically relevant compared to the previous indicators, the quality of data for them was better or the previous indicator duplicated to some extent another indicator in the list. This way, new indicators are suggested to be developed in the near future. In any case, a great effort is being done by Eurostat in order to build an exhaustive data base, which is being completed every period.

However, the difficulties to provide a clear idea on progress towards the Lisbon European Council objectives (expanded at Gothenburg and refined at Stockholm and Barcelona) when using a high number of indicators lead to the Commission to reduce the list up to only 14 structural indicators in the 2004 Report from the Commission to the Spring European Council.³ In this sense, as the Commission says in the Communication COM(2003) 585 final, “using a smaller number of indicators it is also possible to achieve a better coverage of the acceding and candidate countries and to present information on both levels and changes in performance more easily” (§7). In any case, it must be said that the previous years’ structural indicators are maintained by Eurostat in its publicly-accessible database New Cronos and on the structural indicators website (<http://europa.eu.int/comm/eurostat/structuralindicators>).⁴

The final list of 14 structural indicators is shown in table 1, together with information about the definition, source, availability and overall policy objective and interpretation. In this sense, these indicators “should be considered primarily as measures of progress of the countries towards the Lisbon objectives, and not so much of policy effectiveness” (COM-2000 594 final, page 22).

² Consisting of 107 indicators when including disaggregations and sub-indicators.

³ “At the same time, and in order to enhance the quality, in particular the comparability over time, countries and regions, of statistical and analytical tools, so as to provide better analytical foundations for the design and monitoring of policies, the European Council notes the Commission's intention, in close cooperation with the European Statistical System, to report in time for the 2004 Spring European Council on how the use of structural indicators and other analytical tools for assessing progress on Lisbon strategy could be strengthened.”

⁴ This link provides information for 42 indicators and 117 sub-indicators.

Table 1. List of 14 Structural Indicators to the 2004 Report from the Commission to the Spring European Council.

GENERAL ECONOMIC BACKGROUND	
<p>1. Gross Domestic Product per capita in Purchasing Power Standards (GDP pc in PPS) Source: EUROSTAT; National Accounts Availability: Coverage: all MS, all ACCs, US, Japan, Norway, Iceland. Time series: 1991-2001 (forecasts for 2002-2005; non data available for some years for ACCs). Overall policy objective: Standard of living, and Social and environmental welfare. Interpretation: Temporal comparison, expecting its increase over time and the reduction of the gap with main competitors.</p>	
<p>2. Labour productivity per person employed (GDP in PPS per person employed) Source: EUROSTAT; National Accounts and OECD Availability: Coverage: all MS, all ACCs, US, Japan, Iceland and Norway. Time series: 1991-2001 (forecasts for 2002-2004; non data available for some years for ACCs). Overall policy objective: Overall efficiency of the economy. Interpretation: Temporal comparison, expecting its increase over time and the reduction of the gap with main competitors.</p>	
EMPLOYMENT	
<p>3. Employment rate* (Employed persons aged 15-64 as a share of the total population of the same age group) Source: EUROSTAT; Labour Force Survey Availability: Coverage: all MS, all ACCs, Iceland and Norway. No comparable data for the US and Japan. Time series: 1990-2002. (non data available for some years for ACCs) Overall policy objective: Full employment. Combating social exclusion. Interpretation: Temporal comparison, expecting its increase over time. Strategic target: EU should achieve an average employment rate as close as possible to 70% by 2010 (60% for females).</p>	
<p>4. Employment rate of older workers* (Employed persons aged 55-64 as a share of the population of the same age group) Source: EUROSTAT; Labour Force Survey Availability: Coverage: all MS, all ACCs, Iceland and Norway. No comparable data for the US and Japan. Time series: 1990-2002. (Non data available for some years for ACCs) Overall policy objective: Full employment. Combating social exclusion. Interpretation: Temporal comparison, expecting non decrease over time.</p>	
INNOVATION AND RESEARCH	
<p>5. GERD: Gross Domestic Expenditure on Research and Development (Gross Domestic Expenditure on R&D as a percentage of the GDP) Source: Eurostat questionnaire Availability: Coverage: MS (except Luxembourg), ACCs (except Malta), Iceland, Norway, Japan; USA. Time series: 1991-2001 (2002 and 2003 for some MS). Overall policy objective: R&D effort Interpretation: Temporal comparison, expecting its increase over time. Strategic target: Rise overall spending in the Union on R&D with the aim of approaching 3% of GDP by 2010.</p>	
<p>6. Youth educational attainment level* (Percentage of the population aged 20 to 24 having completed at least upper secondary education) Source: Eurostat; EU Labour Force Survey. Availability: Coverage: MS, ACCs (except Turkey), Switzerland, Iceland, Norway. No data for USA and Japan. Time series: 1992-2003 (non data available for some years for ACCs) Overall policy objective: Quality of human resources. Interpretation: Temporal comparison, expecting an increase over time.</p>	

ECONOMIC REFORM

7. Comparative price levels

(Comparative price levels of final consumption by private households including indirect taxes)

Source: Eurostat; OECD

Availability: Coverage: MS, ACCs, Norway, Iceland, USA, Japan. Time series: 1991-2001 (provisional for 2002; some years for some countries).

Overall policy objective: Product market integration. Market efficiency.

Interpretation: Temporal comparison, expecting a decrease over time.

8. Business investment

(Gross fixed capital formation by the private sector as a percentage of GDP)

Source: Eurostat; National Accounts

Availability: Coverage: MS, ACCs, Norway. Time series: varies from one country to the other (the longest series start in 1980).

Overall policy objective: Private investment effort

Interpretation: Temporal comparison, expecting an increase over time.

SOCIAL COHESION

9. At-risk-poverty rate after social transfers*

(Share of persons with an equivalised disposable income below the risk-of-poverty threshold after social transfers, which is set at 60% of the national median equivalised disposable income).

Source: Eurostat; European Community Household Panel (ECHP)

Availability: Coverage: MS, ACCs. No comparable data available for US, Japan. Time series: 1994-2003 (non data available for some years for some countries)

Overall policy objective: Combating poverty and social exclusion

Interpretation: Temporal comparison, expecting a decrease over time.

10. Dispersion of regional employment rates*

(Coefficient of variation of employment rates across regions- NUTS 2 level-within countries)

Source: Eurostat; Labour Force Survey

Availability: Coverage: MS, several ACCs. Indicator not relevant for DK, IRL and L. Time series: 1999-2002 (non data available for some years for some countries)

Overall policy objective: Cohesion

Interpretation: Temporal comparison, expecting a decrease over time.

11. Total long-term unemployment rate*

(Long-term unemployed -12 months or more- as a percentage of total active population aged 15-64)

Source: Eurostat/Labour Force Survey

Availability: Coverage: MS, ACCs, US, Japan Iceland and Norway. Time series: 1990-2002 (non data available for some years for some countries)

Overall policy objective: Full employment. Combating social exclusion.

Interpretation: Temporal comparison, expecting a decrease over time.

ENVIRONMENT

12. Total greenhouse gas emissions

(Percentage change in emissions of 6 main greenhouses gases-CO₂, CH₄,N₂O,HFCs,PFCs and SF₆-since base year and targets according to Kyoto Protocol/EU Council Decision for 2008-2012)

Source: European Environment Agency.

Availability: Coverage: MS, ACCs, Norway, Iceland, USA, Japan. Time series: 1990-2001

Overall policy objective: Limit climate change and implement the Kyoto Protocol.

Interpretation: Temporal comparison, expecting a decrease over time. Targets according to Kyoto Protocol/EU Council Decision for 2008-2012.

13. Energy intensity of the economy

(Gross inland consumption of energy divided by GDP)

Source: Eurostat; Energy statistics

Availability: Coverage: MS, ACCs, Norway, Iceland, USA, Japan. Time series: 1991-2001

Overall policy objective: Use energy more efficiently.

Interpretation: Temporal comparison, expecting a decrease over time

14. Transport-Volume of freight transport relative to GDP

(Index of inland freight transport volume relative to GDP, measured in tonne-km /GDP)

Source: Eurostat; Transport Statistics

Availability: Coverage: MS, ACCs, Norway, Iceland, USA, Japan. Time series: 1991-2002 (data non available for some years for some ACCs)

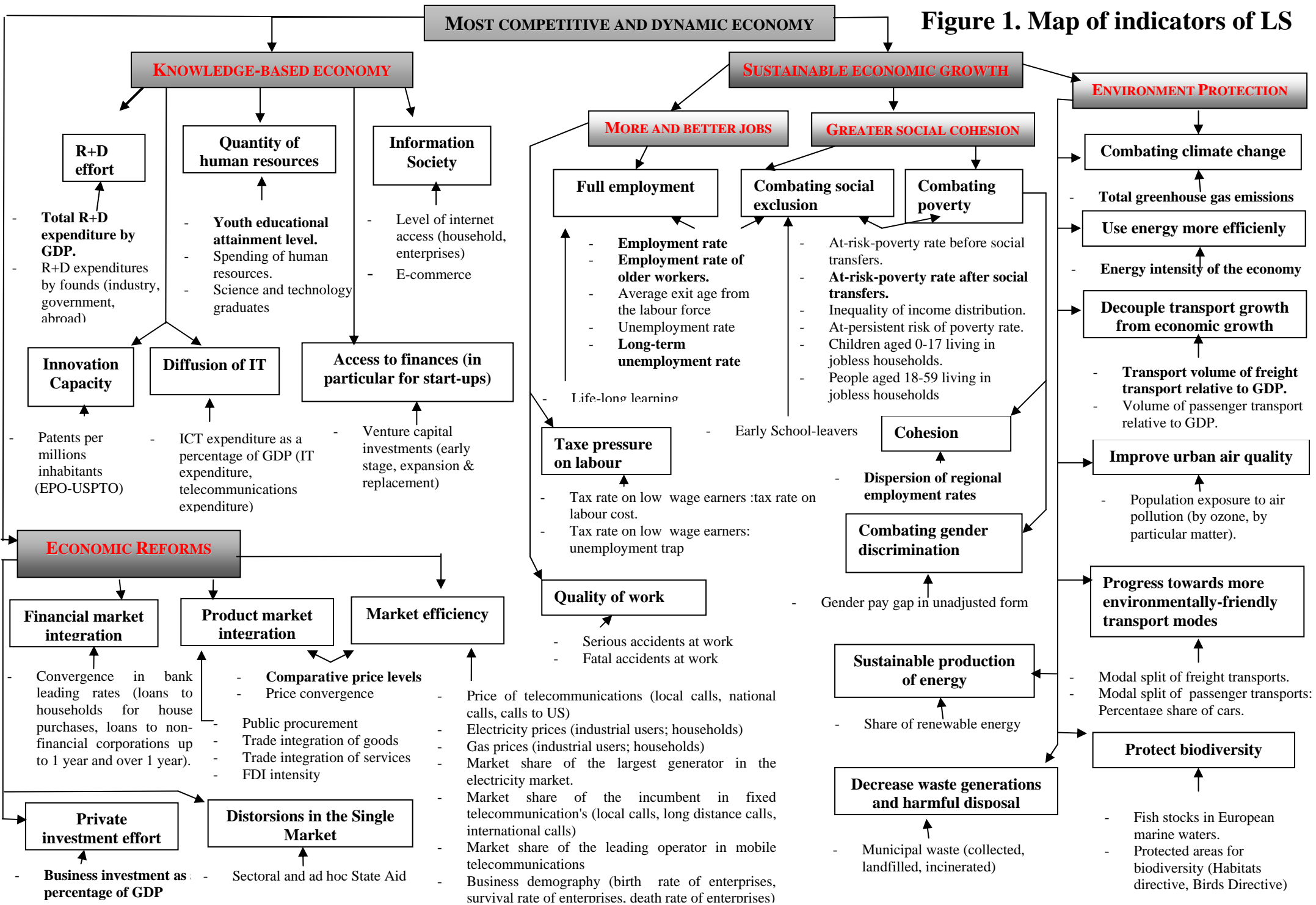
Overall policy objective: Decouple transport growth from economic growth.

Interpretation: Temporal comparison, expecting an increase over time.

*Indicators disaggregated by gender.

Finally, great efforts have been done by the Commission services, since 2000 up to present, to improve the quality and the presentation of the existing indicators, to integrate the acceding and candidate countries into the structural indicators (following the request from the Gothenburg European Council held in 2000) and to extent their coverage, to propose new indicators on structural issues and to developed a more detailed quality assessment procedure for the structural indicators.⁵ In Figure 1 we present a chart with the five main areas of the Lisbon Strategy and the whole set of indicators in each one (structural and complementary indicators). In bold you will find the indicators that are included in the list of 14 indicators. An exhaustively detailed analysis of all the indicators is given in Annex 1.

⁵ Eurostat has been working closely with other Commission services and with European Statistical System on a wide range of indicators in order to improve their quality, and country and time coverage.



2.3. Overall evaluation

Implementation, albeit partially, of the reforms under the Lisbon strategy seems to be starting to bear fruit as regards the initial objectives. So, as the Commission says in the last report to the European Council (COM-2004, 29 final), the overall progress already made in four years is proof of this:

- **More than six million jobs have been created** since 1999, boosting the total employment rate from 62.5% to 64.3% in 2002. In addition, long-term unemployment has dropped sharply in Europe, falling from 4% in 1999 to 3% in 2002.
- **Several key markets have been completely or partially opened up** to competition: telecommunications, rail freight, postal services, electricity and gas markets. This process makes it possible to modernise and stimulate these markets, to improve service quality and to lower costs, with no negative impact on employment.
- **The knowledge-based economy is becoming a reality**, with strong Internet take-up in 93% of schools, as well as in businesses, public administration and households, and thanks to the gradual development of the European Research Area.
- **The sustainable development approach is being taken more fully into account in policymaking.** Several Member States have embarked on reform of their pension systems/schemes to cope with the ageing of the population. Similarly, Community action is now paying increasingly greater heed to preserving our natural environment.
- Finally, the work done over the first four years has enabled some **one hundred regulations, directives and programmes** to be adopted, in different fields but all pursuing the Lisbon goals.

An analysis of the progress made highlights the relatively positive developments but also the major problems which need to be tackled urgently: the need for public finances to be viable, the unsatisfactory contribution of employment and productivity to growth, the disappointing development of the internal market and, finally, the lack of sustainability of growth.

Ensuring that public finances are viable: Budgetary and fiscal discipline has not been kept in the same way by all Member States. Thus, due to the weak economy, and also as a result of expansionary budgetary policies in some cases, the average EU deficit stood at 2.7% of GDP in 2003. It should also be noted that these policies have led to an increase in savings instead of the desired aim of boosting consumption, which has thereby reduced confidence. Furthermore,

more has to be done to make national public finances viable in the medium and long term to guarantee sustainable development of our economy so as to cope with the demographic trends. If immigration rates remain constant, the contraction of the working population coupled with the costs of ageing is likely to bring economic growth down below 2% in the long term. At least half the Member States are at risk here: in 2003, the average level of government debt for the European Union is expected to rise to 64.1% of GDP, with six Member States exceeding the reference value of 60% of GDP.

Employment and productivity still insufficient for growth: Although the interim goal for 2005 will not be attained, the employment target remains valid as long as in the seven years remaining until 2010 employment picks up at a similar pace to that at the end of the 90s. Also, growth in Europe has remained low over the past three years. As a result, the relative level of GDP pc for the Union remained unchanged in 2003. The Union cannot catch up on the United States as our per capita GDP is 72% of our American partner's. The reasons for this insufficient growth are known: unlike in the United States, employment and productivity are still not contributing enough. The low growth in overall productivity in Europe is due in particular to two main factors: the contribution of information and communication technologies (ICTs) is too low and investment is inadequate. In this respect, the European Growth Initiative and the Quick Start Programme, which have been given the green light by the European Council, are a major source of leverage to unlock investment in the infrastructure and knowledge sectors. While the number of researchers in the Union rose slightly from 5.4 per 1000 workforce in 1999 to 5.7 in 2001, this is well below the level in countries that are near or on the EU 3% R&D investment target (USA 8.1/1000; Japan 9.1/1000). Investment, both public and private, in human capital is still inadequate. But simply raising the overall level of investment in human resources will not be enough: there is a clear need to invest more effectively, that is, to identify and invest in those areas of education and training which produce the greatest returns.

Weaknesses in our internal market and competitiveness: Despite the successes of the past decade, the internal market has still not reached all its potential. There are several warning signs which need to be dealt with urgently: the Union is facing a slowdown in its product market integration; the internal market is still highly fragmented in the services sector, especially in distribution and retail sales; market opening in network industries is not yet fully implemented and the benefits relating to efficiency, inter-connectivity and security of supply in the Union have not yet been realised; at the same time, several strategic measures to increase our competitiveness have not got off the ground because of a lack of political will.

Growth still not sustainable enough: While some progress, particularly on the legislation front, has been made with regard to sustainable development and taking better account of the environment in Community action, the Union is still finding it difficult to capitalise on the synergy between various policies, especially environment, research and competitiveness. There is real risk of poverty increasing in several Member States, mainly due to the increase in unemployment but also to the fact that the social protection and pensions systems are not sustainable. In the environmental sphere, Member States' performance is generally inadequate. This shows a lack of awareness of the fact that growth may harm the environment and prove counter-productive in the medium and long term.

Finally, it must be said that a detailed analysis of the current situation indicates more clearly that there are still problems in all Member States and that all of them need to make a greater effort to achieve results. In sum, the revision of the Lisbon Agenda shows a moderate progress in most of the areas under consideration.

As a summary of the situation of each member state we suggest the use of some figures which show the position in a ranking for each country of each structural indicator in the last year available. This way, the length of the bar for one indicator shows the position of this country in the ranking of this indicator. If the bar is the longest it can be, it would imply that this country keeps the best position in this indicator, and with no bar (just in the central point) the country would present the worst position. An additional indicator has been added (GEB1b) which refers to GDP pc growth, as a dynamic indicator of the GEB.

Figures 2 to 16 show an overview of the position of each country in each of the main 14 indicators, both in 1995 and 2001, in order to capture the relative changes of every country. As it can be observed, in 2001 there are 3 countries such as Denmark, Netherlands and Sweden which present good positions in a majority of indicators. On the opposite situation we find in 2001 Greece, Spain, Italy and Portugal with relative bad positions in most of the indicators.

Taking into consideration the relative changes of every country position between 1995 and 2001, we see how Denmark, Ireland, Netherlands, Finland and Sweden have experienced an expansion of their positions in the structural indicators rankings, while France, Germany, Italy and Austria have worsened in relative terms in the lapse of the six considered years.

Figures 2 to 16. Relative positions of each country in the structural indicators in 2001

Figure 2-1995.

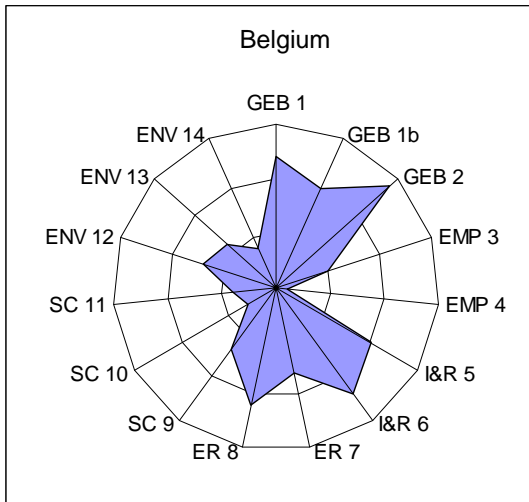


Figure 2-2001.

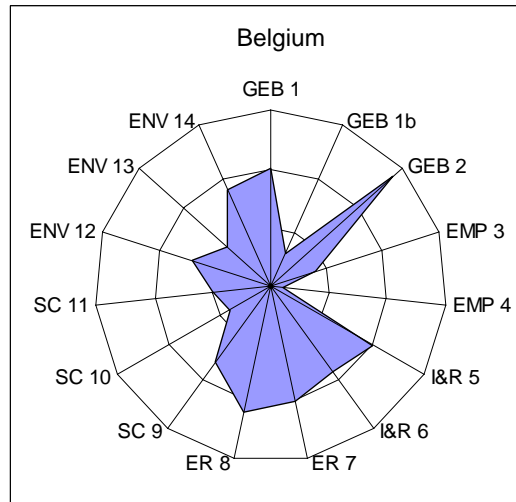


Figure 3-1995.

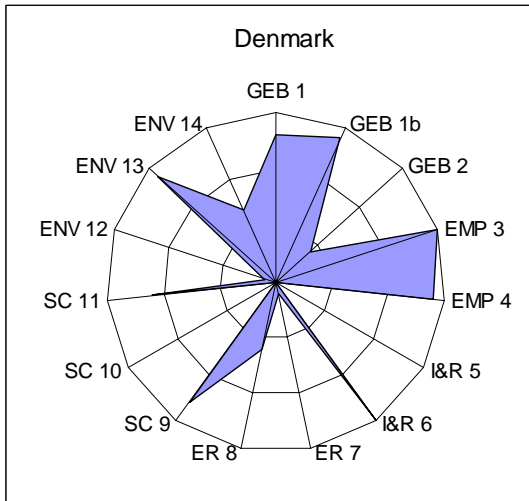


Figure 3-2001.

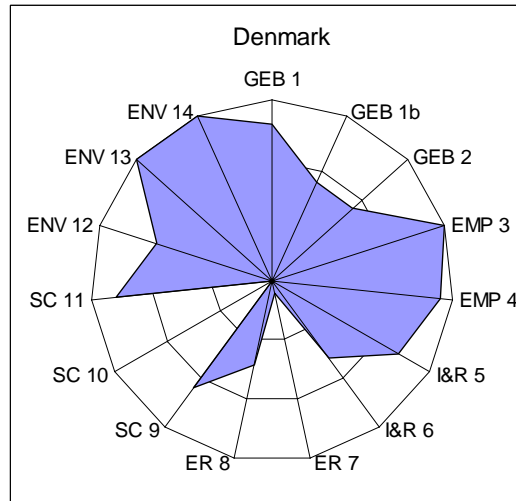


Figure 4-1995.

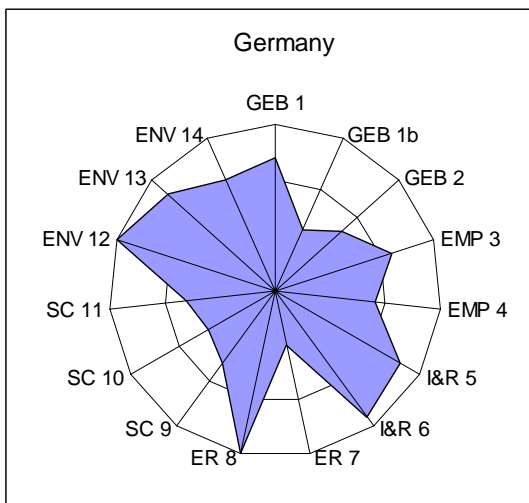


Figure 4-2001.

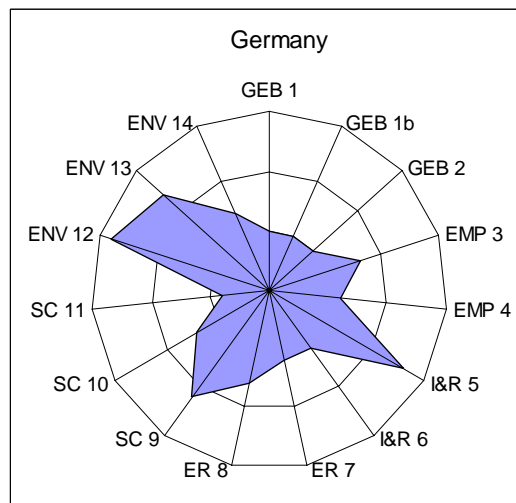


Figure 5-1995.

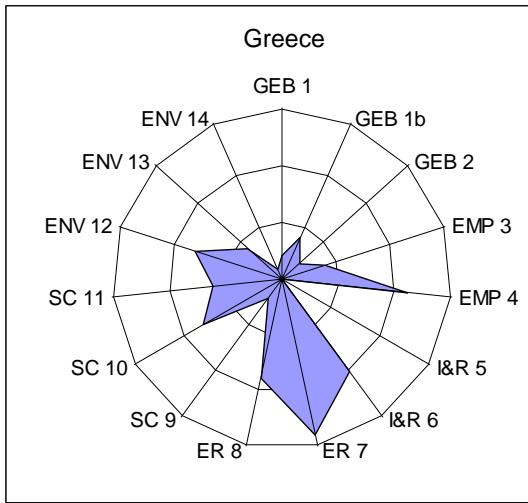


Figure 5-2001.

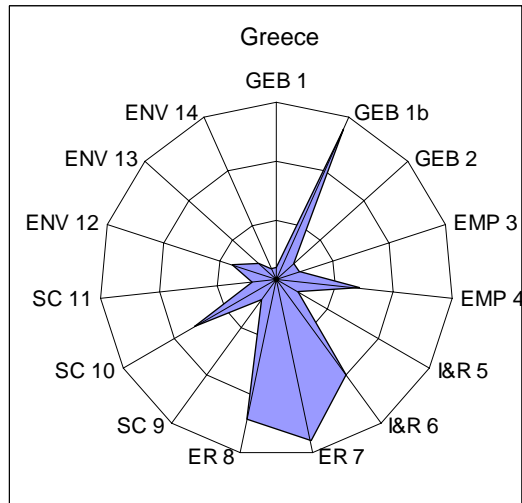


Figure 6-1995.

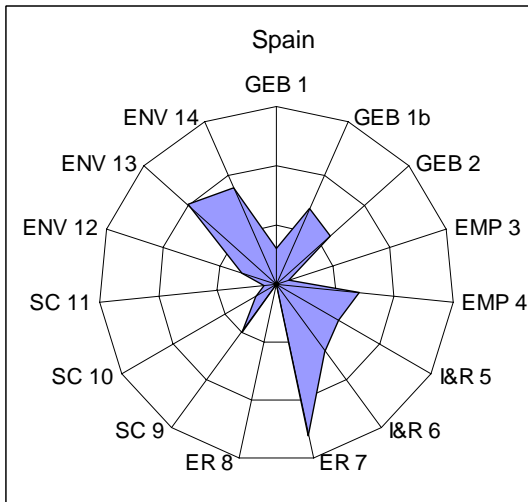


Figure 6-2001.

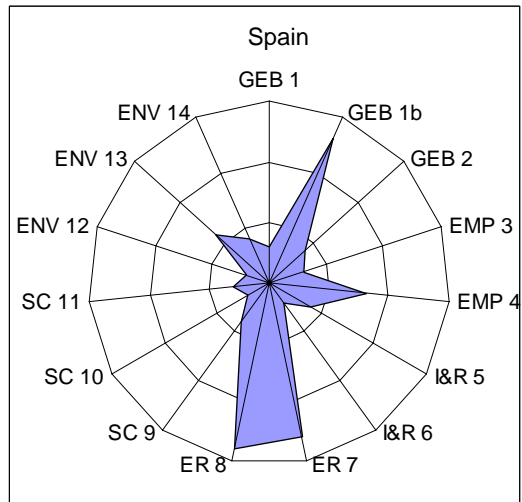


Figure 7-1995.

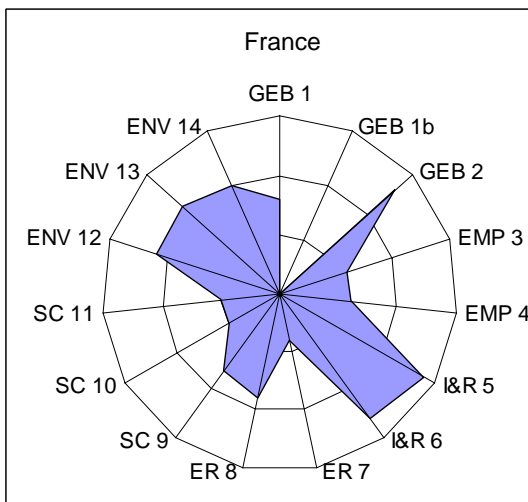


Figure 7-2001.

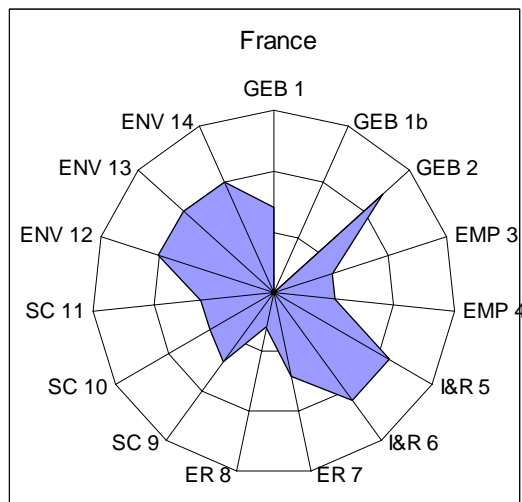


Figure 8-1995.

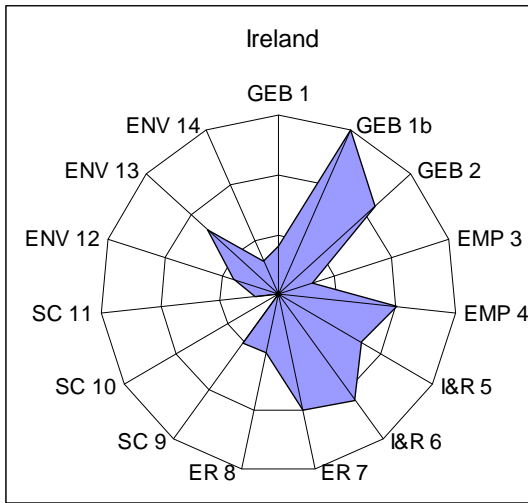


Figure 8-2001.

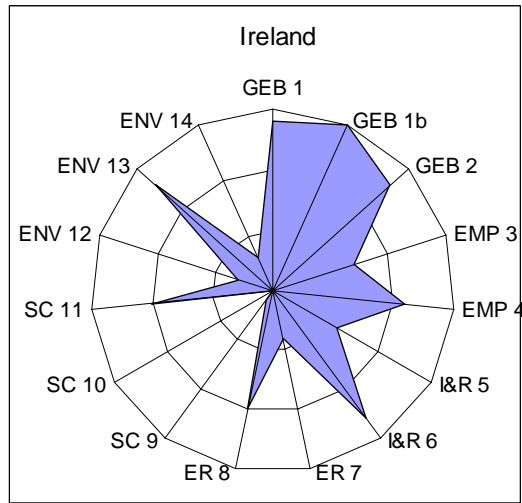


Figure 9-1995.

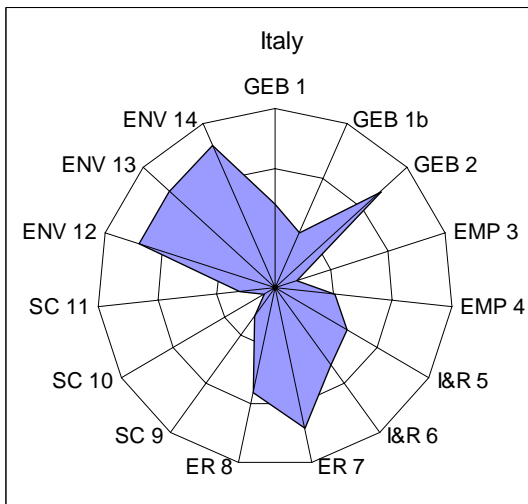


Figure 9-2001.

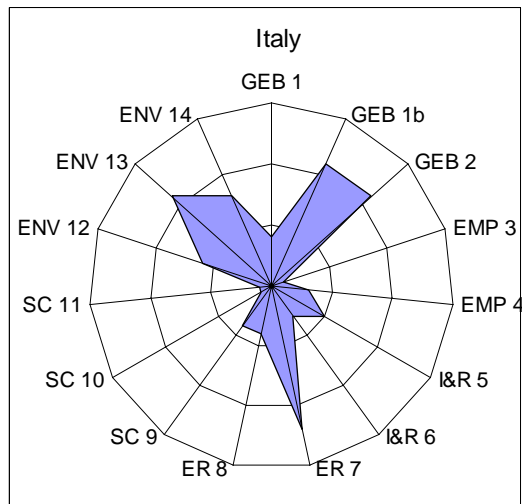


Figure 10-1995.

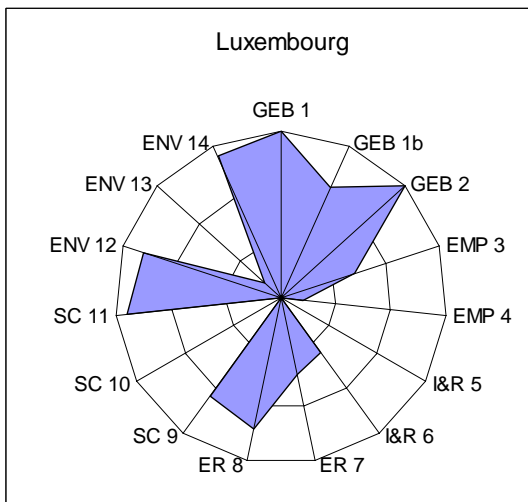


Figure 10-2001.

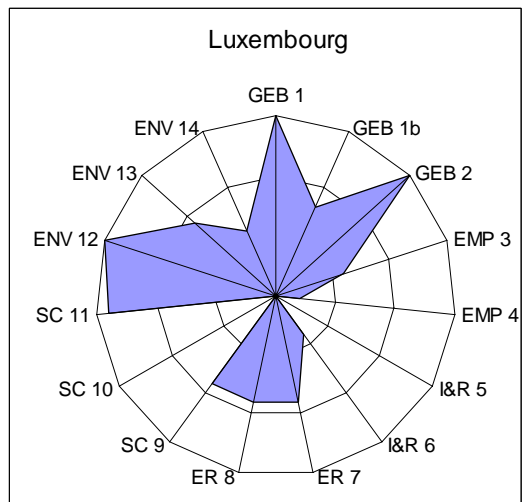


Figure 11-1995.

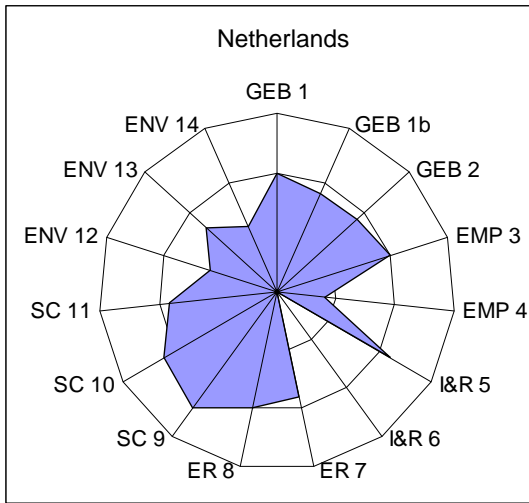


Figure 11-2001.

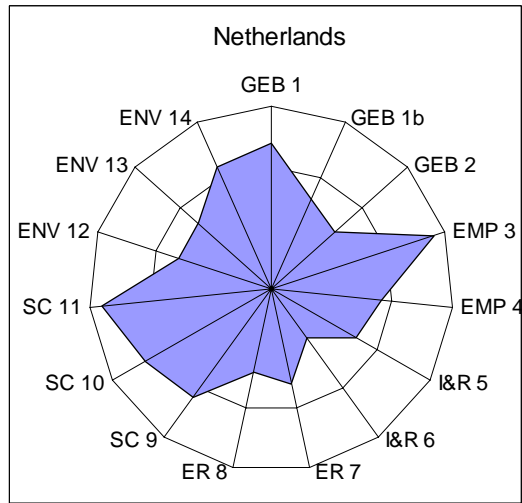


Figure 12-1995.

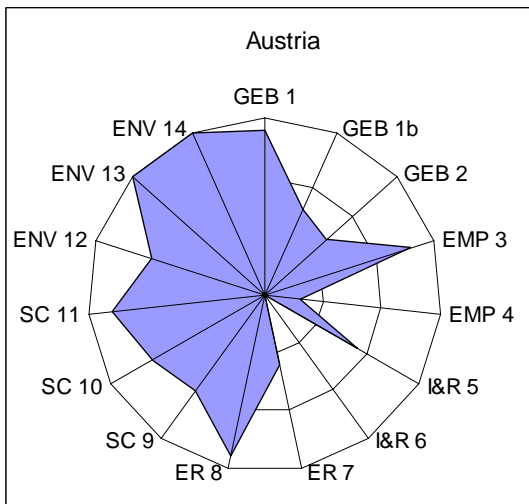


Figure 12-2001.

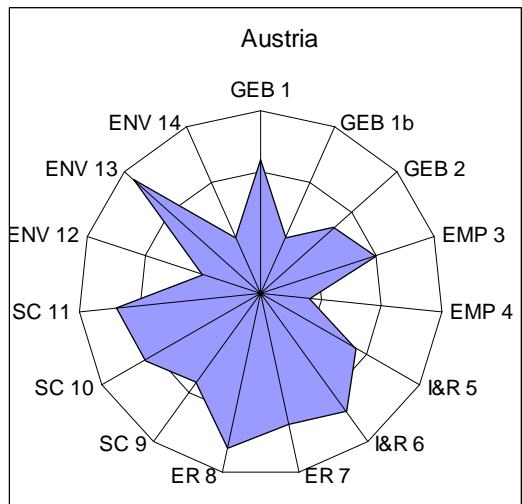


Figure 13-1995.

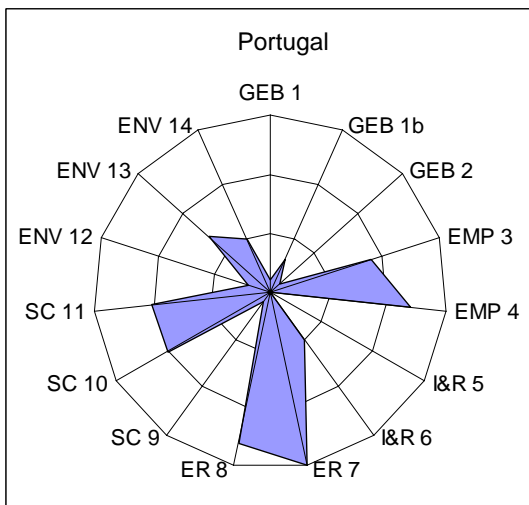


Figure 13-2001.

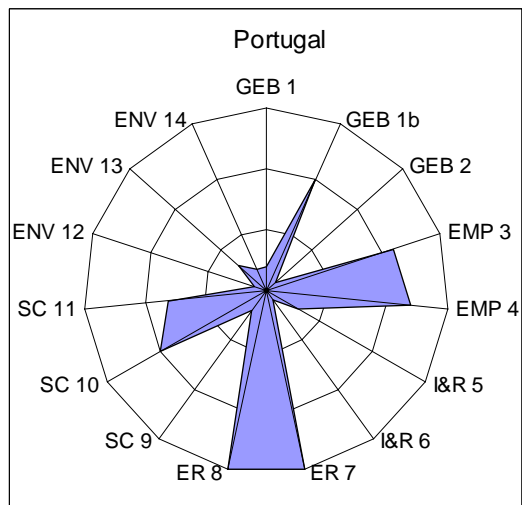


Figure 14-1995.

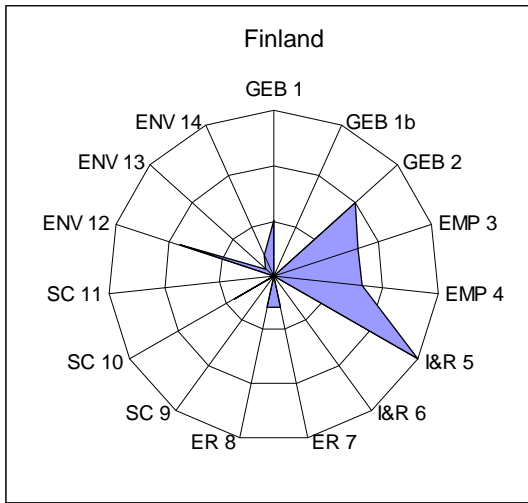


Figure 14-2001.

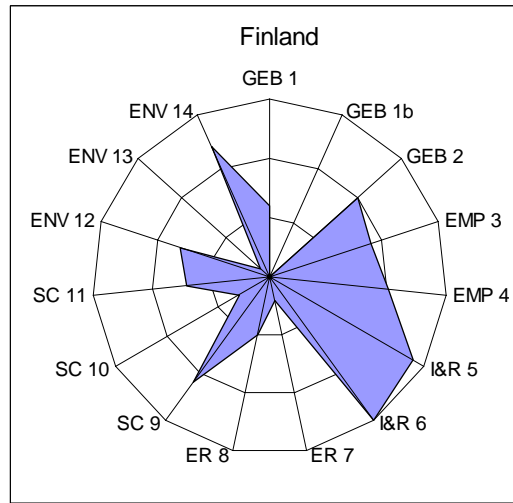


Figure 15-1995.

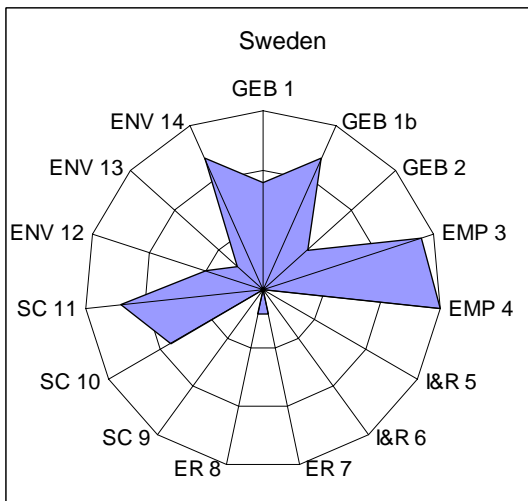


Figure 15-2001.

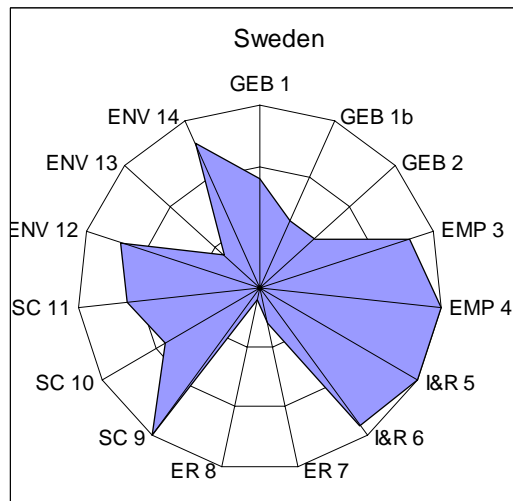


Figure 16-1995.

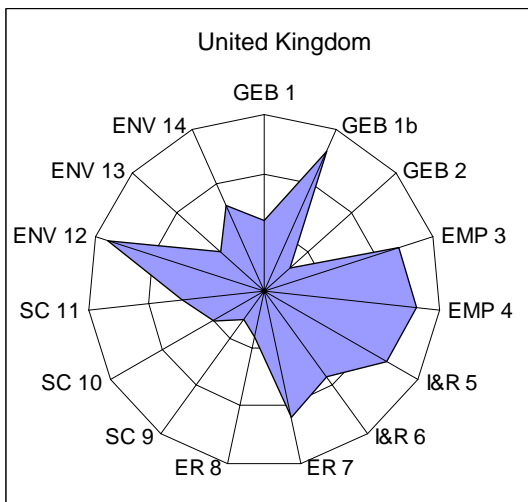
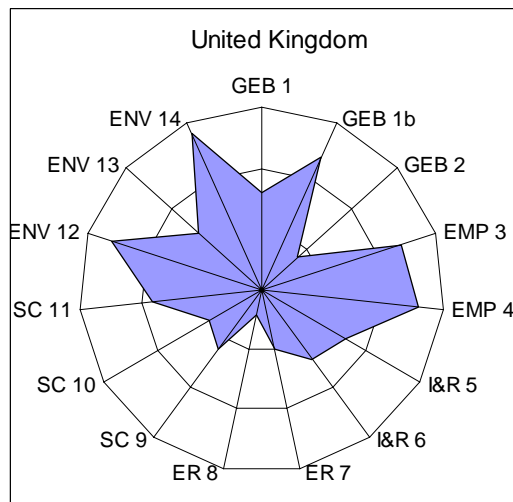


Figure 16-2001.



The information given by the Commission on the state of the play of the different countries and the EU as a whole in order to evaluate the objectives of the Lisbon Strategy is merely based on in the evolution of the different indicators. However, in our belief, a deeper analysis consisting of the implications that the evolution of these indicators may have on economic growth could provide a richer explanation on the role that these aspects are having in EU development and growth.⁶ Without trying to carry on an exhaustive analysis of the determinants of growth, in the next two sections we analyse how growth has been accompanied by the presence of a high level or an improvement of the 14 structural indicators that synthesize the Lisbon Strategy.

⁶ In this sense, some of this work is exhaustively done in several dimensions of the Lisbon Strategy: see chapters 2 and 3 of the volume 6 of *European Economy* (2003), *Drivers of productivity growth*, an economy-wide and industry-level perspective, and *Education, training and growth*.

3. ANALYSIS OF THE STRUCTURAL INDICATORS EVOLUTION DURING THE LAST DECADE

3.1. Global analysis for period 1994-2003

As has been already seen, the Lisbon strategy is revisited in an annual synthesis report, in which a list of structural indicators is presented in order to reflect the European position in economic and competitive terms, and its position in each one of the proposed particular objectives.

Although we assume that the list of indicators is the result of a hard work, we also consider the need of revisiting the overall indicators strategy by computing a set of basic statistics. Thus, tables 2 and 3 summarize the cross and serial correlations of structural indicators with the general economic background indicators, which are thus considered as a sort of summary of the overall objective of the Lisbon strategy, this is, to become an economic leader. Concretely, table 2 displays the 15 Member States (MS) crossed country correlations in three different moments of time, which can be seen as different moments of the business cycle (1994, 1997 and 2001). These correlations were computed taking into account the relative size of every country. Focusing on the evolution of GDP pc, table 3 shows the serial correlations, including two leads and lags, of the general EU (15 countries) structural indicators and annual growth of GDP. In Annex 2 a series of plots with crossed correlations between GEB structural indicators and structural indicators are displayed.

Additionally, it could be interesting to know which have been the more important forces that have contributed to the growth of the EU countries during the last ten years. Or, in other words, whether general growth of the economies has been accompanied with a similar growth on employment, knowledge and human capital, investments or social cohesion among others. In order to answer this question, and focusing exclusively on growth of GDP pc, the correlation between this variable and the evolution of the structural indicators has been analysed. So, figures 17 to 26 depict a scatter plot for growth of GDP pc during 1994-2003 (Y-axis) and growth of each one of the structural indicators during 1994-2001 (X-axis)^{7,8}. In addition, these figures include information about the cross correlation between GDP pc growth and both the growth of structural indicators and the value of these indicators at the beginning of the period.

⁷ For most of the structural indicators, data for 2002 and 2003 are non available.

⁸ There is not information available for this period for two indicators: at-risk-poverty rate after social transfers and dispersion of regional employment rates.

Table 2. Crossed correlations between Structural Indicators and General Economic Background Indicators

		GEB 1: Gross Domestic Product per capita in Purchasing Power Parity (GDP pc in PPS)			GEB 2: Labour productivity per person employed (GDP in PPS per person employed)		
		1994	1997	2001	1994	1997	2001
EMP 3	3. Employment rate*	0,470	0,449	0,449	-0,366	-0,412	-0,371
EMP 4	4. Employment rate of older workers*	-0,177	-0,101	0,005	-0,710	-0,712	-0,602
I&R 5	5. GERD: Gross Domestic Expenditure on Research and Development	0,612	0,703	0,572	-0,071	0,231	0,131
I&R 6	6. Youth educational attainment level*	0,589	0,436	0,550	0,313	0,366	0,472
ER 7	7. Comparative price levels	0,724	0,757	0,777	0,428	0,346	0,232
ER 8	8. Business investment	0,266	-0,196	-0,609	-0,027	-0,393	-0,400
SC 9	9. At-risk-poverty rate after social transfers*	n.a.	-0,652	-0,496	n.a.	-0,188	-0,020
SC 10	10. Dispersion of regional employment rates*	n.a.	n.a.	-0,081	n.a.	n.a.	0,412
SC 11	11. Total long-term unemployment rate*	-0,536	-0,452	-0,402	0,189	0,323	0,264
ENV 12	12. Total greenhouse gas emissions	-0,554	-0,606	-0,613	-0,107	-0,037	-0,109
ENV 13	13. Energy intensity of the economy	-0,470	-0,419	-0,474	-0,449	-0,382	-0,322
ENV 14	14. Transport-Volume of freight transport relative to GDP	-0,541	-0,718	-0,745	-0,386	-0,488	-0,360

Note: n.a. = Non Available

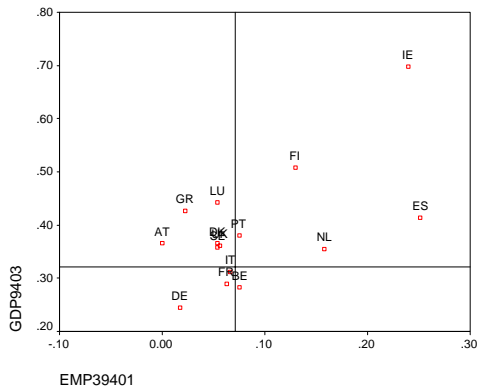
Table 3. Serial correlations between Structural Indicators and annual growth of GDP during the period 1991-2003

Lag of structural indicators		-2	-1	+0	+1	+2
EMP 3	3. Employment rate*	-0,67	-0,36	0,10	0,52	0,71
EMP 4	4. Employment rate of older workers*	-0,67	-0,40	-0,04	0,37	0,70
I&R 5	5. GERD: Gross Domestic Expenditure on Research and Development	-0,75	-0,52	-0,35	0,14	0,55
I&R 6	6. Youth educational attainment level*	-0,96	-0,47	-0,18	-0,05	0,41
ER 7	7. Comparative price levels ⁹	-0,44	-0,54	-0,55	-0,42	-0,42
ER 8	8. Business investment	-0,76	-0,01	0,60	0,69	0,27
SC 9	9. At-risk-poverty rate after social transfers*	0,43	-0,13	-0,32	-0,43	-0,73
SC 10	10. Dispersion of regional employment rates*	n.a.	n.a.	n.a.	n.a.	n.a.
SC 11	11. Total long-term unemployment rate*	0,59	0,61	0,17	-0,44	-0,66
ENV 12	12. Total greenhouse gas emissions	-0,25	-0,31	0,07	0,48	0,30
ENV 13	13. Energy intensity of the economy	0,14	-0,16	-0,63	-0,59	-0,50
ENV 14	14. Transport-Volume of freight transport relative to GDP	0,15	0,29	0,61	0,67	0,49

Note: n.a. = Non Available

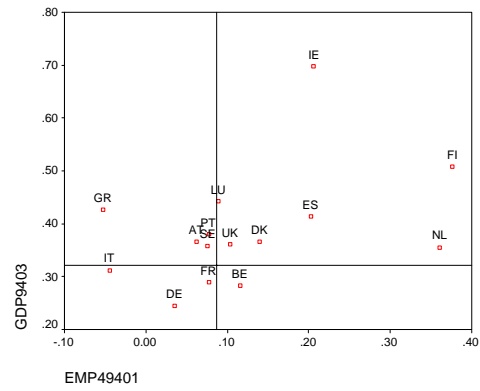
⁹ As this structural indicator was stated at level 100 for EU15 for each period, we compute serial correlation between GDP and the inflation rate for each year.

Figure 17 GDP pc growth (1994-2003) and Employment rate growth (1994-2001).



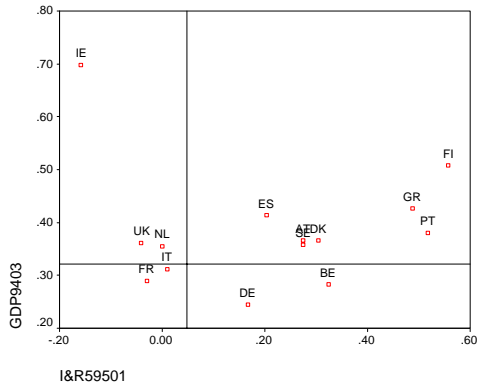
growth correlation : 0.626
correlation with indicator in 1994: 0.153

Figure 18 GDP pc growth (1994-2003) and Employment rate of older workers growth (1994-2001).



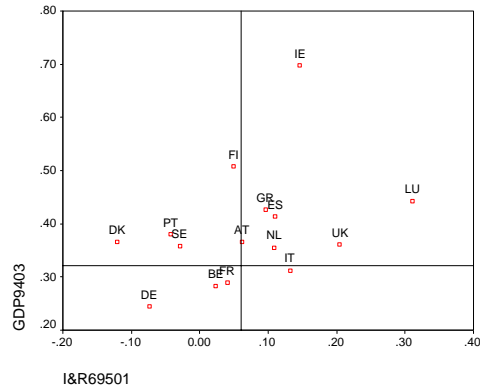
growth correlation : 0.478
correlation with indicator in 1994: 0.394

Figure 19 GDP pc growth (1994-2003) and GERD growth (1995-2001).



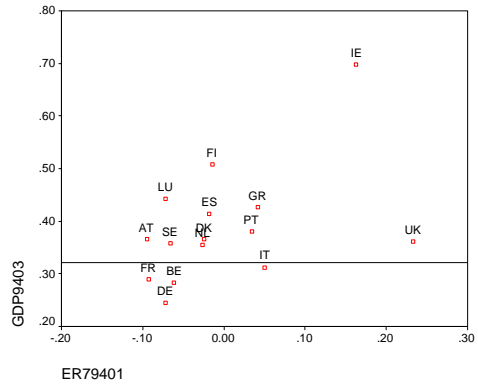
growth correlation : 0.178
correlation with indicator in 1995: -0.242

Figure 20 GDP pc growth (1994-2003) and Youth educational attainment level growth (1995-2001).



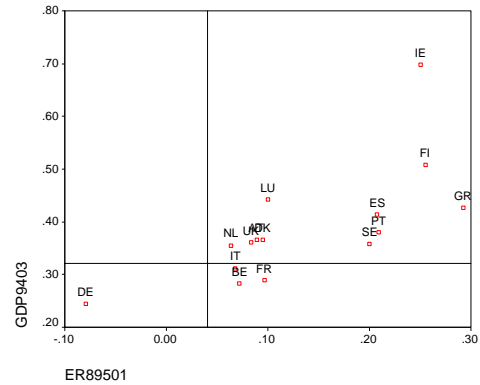
growth correlation : 0.517
correlation with indicator in 1995: -0.038

Figure 21 GDP pc growth (1994-2003) and Comparative price levels growth (1994-2001).



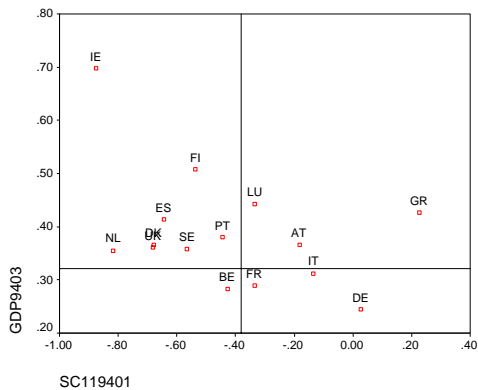
growth correlation : 0.388
correlation with indicator in 1994: -0.018

Figure 22 GDP pc growth (1994-2003) and Business investment growth (1995-2001).



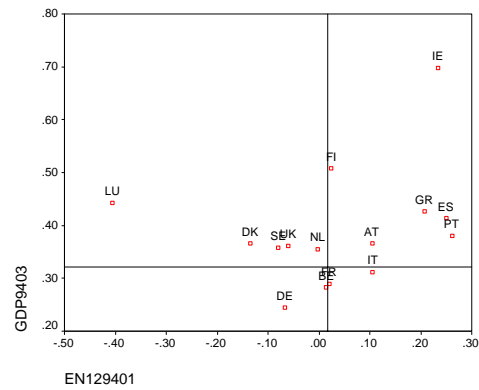
growth correlation : 0.768
correlation with indicator in 1995: 0.047

Figure 23 GDP pc growth (1994-2003) and long-term unemployment rate growth (1994-2001).



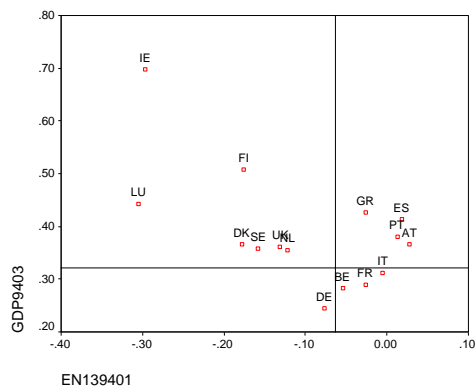
growth correlation : -0.611
correlation with indicator in 1994: 0.490

Figure 24 GDP pc growth (1994-2003) and total greenhouse gas emissions growth (1994-2001).



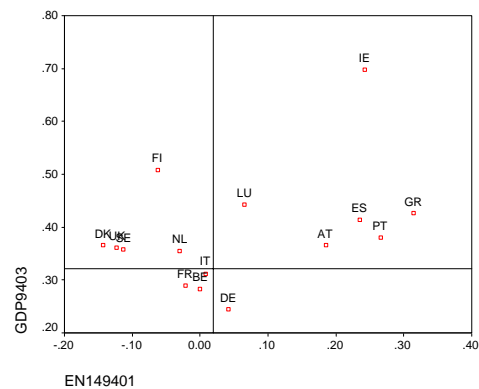
growth correlation : 0.506
correlation with indicator in 1994: 0.718

Figure 25 GDP pc growth (1994-2003) and Energy intensity growth (1994-2001).



growth correlation : -0.210
correlation with indicator in 1994: 0.714

Figure 26 GDP pc growth (1994-2003) and Transport-volume of freight transport relative to GDP growth (1994-2001).



growth correlation : 0.295
correlation with indicator in 1994: 0.584

From all these pictures, some conclusions can be drawn. First, and regarding the **Employment indicators** (employment rate and employment rate of older workers), it must to be said that they address the key aims of the Lisbon European Council, refined by the Barcelona European Council: to strengthen employment in the Union; the importance of equal employment opportunities for men and women; and the importance of an "Active Employment policy" such as focussing on life-long learning.

These indicators are expected to be positively related with the General Economic Background of the European economy. Here, three different results are seen from the analysis (tables 2 and 3 and figures

17 and 18). First, we see a positive and lagged relation between employment and GDP growth. This clearly confirms the interpretation of the structural indicators: higher growth implies more employment in the European economy.

The second result has to do with the negative correlation between employment and productivity. In our opinion, this result is not intuitive from a theoretical point of view, due to the fact that an increase in productivity should result in higher growth and finally higher employment. Nevertheless, as the structural indicator of productivity is defined as *labour productivity*, the final result shows that the improvements in productivity have been obtained at the expenses of a lower employment. In any case, a different measurement of overall productivity arises as a basic need from a future list of structural indicators.

Third, from figures 17 and 18, it seems that growth in GDP pc has run parallel with growth in the employment, both in terms of employment rate and employment rate of older workers. This is especially evident in the case of Ireland, Spain, Netherlands and Finland (Germany is in the opposite situation). However, Greece and Luxemburg are the exceptions, given that their high growth rates of GDP pc have been not supported by high growth rates of the employment.

With regards to **Innovation and Research** indicators (GERD and youth educational attainment level), they measure Lisbon's emphasis on the transition to a knowledge-based economy through better policies for R&D, education and the information society. These key indicators are clearly related with new endogenous growth theories that relate knowledge coming from research and development with permanently higher economic growth rates. This implies that investing today in R&D (detracting from other productive activities) is the key point to have a higher growth tomorrow. Thus, a non contemporaneous relation would be expected, although the long term positive relation is assured with a positive lagged correlation. On the other hand, we cannot forget that in many European countries a high proportion of R&D is developed to public research centres, such as Universities. This fact implies that within the cycle, when an economy is having a peak, and consequently having a public finance surplus, it can dedicate more resources to R&D. On the contrary, when an economy is experiencing a trough, public finances are expected to reduce non imperative expenditure. Thus, a (lagged) procyclical relation is expected due to the needed time to prepare this kind of investments.

What we finally see in table 2 is a positive correlation both Innovation and Research Indicators and GDP per capita and, if any, a positive correlation with productivity (especially at the end of the period). Besides, the serial correlations provide a lagged procyclical relation within structural R&D indicators and GDP growth rate. These results clearly enforce the idea of the positive relation between innovation and growth.

From figures 19 and 20, it can be seen that while countries as Finland, Greece or, to a certain extent, Portugal and Spain increased Gross Domestic expenditures on R&D during the period and also grew in terms of GDP pc, Ireland presented the highest GDP pc growth rates but a clear decrease in its expenditures on R&D (leading to a null correlation coefficient between both variables). In the case of youth educational attainment level, its growth during 1995 to 2001 is positively correlated with GDP pc growth rate for the last ten years.

As for **Economic Reforms** indicators (comparative price levels and business investment), they would respond to the Lisbon European Council's emphasis on product and capital market reform. They should look market integration, progress in liberalising the network industries and possible distortions in the functioning of product markets caused by public intervention.

The two structural indicators of Economic Reforms are expected to be very closely related with long term indicators of the General Economic Background of the European economy. Thus, what theory says about market efficiency is that in long term higher efficiency will result in a lower inflation (and consequently, lower price levels) and higher GDP per capita. Additionally, higher gross fixed capital formation will end in higher production possibilities and then higher GDP per capita and higher future consumption.

Nevertheless, in short run terms, we can observe, from tables 2 and 3, opposite signs in computed correlations, due to the fact that, for instance, with fixed production possibilities, a higher economic growth can produce a price level increase, or, alternatively, a higher gross fixed capital formation can result in future (not current) GDP growths. So, concerning price levels, what we finally find in data is that the crossed country correlation is positively related with the General Economic Background indicators, showing how richer countries exhibit higher comparative price levels. On the contrary, the temporal correlation of the European economy shows a negative correlation between inflation¹⁰ and GDP growth, reflecting a non general inflationist process of economic growth. Concerning the business investment indicator, we see a low but negative crossed correlation with the General Economic Background indicators. This fact shows us how countries with current higher or lower investment are not countries with a particularly higher or lower GDP per capita or productivity respectively. Nevertheless, the temporal correlation of the overall European economy shows a positive (and maybe lagged one year) figure, assuring that this indicator exhibits the formerly related long term relation.

¹⁰ As this structural indicator was stated at level 100 for EU15 for each period, we compute serial correlation between GDP and the inflation rate for each year.

With regards to the evolution of economic reforms indicators (figures 21 and 22), it could be noticed that growth in GDP pc has been accompanied with a similar evolution in terms of growth in comparative price levels. So, in countries as Ireland, Greece, Portugal and, especially, in UK, the observed growth has been inflationary (in relative terms). On the contrary, Finland or Luxembourg grew but with a decreased on their comparative price levels during the period. In addition, data reveals that high growth rates in GDP pc during the period have been accompanied with significant high rates in business investments, specially in the case of Ireland, Finland, Greece or Spain (Germany is the only country that decreases its business investments during these years).

Concerning **Social Cohesion** indicators (at-risk-poverty rate, dispersion of regional employment rates and total long-term unemployment rate), they should provide measures of the degree and persistence of poverty and income dispersion and the associated risk of exclusion in accordance with the Lisbon European Council's high priority on social cohesion.

Social Cohesion can be considered as a political objective that could be more related with key political objectives than with clear short run economic processes. Nevertheless, there are two different situations that have to be considered. Firstly, there are different social negative processes that can be accounted as a natural result of the general economic growth of our economies: non-desirable income distribution, regional concentration of economic growth or simply intergenerational substitution of the labour force, with the expulsion of a group of labour force that hardly finds a job again. And secondly, we have to see that these situations, coming either from expansions or from recessions, are in long term pernicious to the General Economic Background, due to the bad influence in the social capital of a nation.

From the cross correlation analysis (table 2), it seems that, generally speaking, countries with lower GDP pc or, to a lower extent, minor labour productivity display a higher risk of exclusion, dispersion of regional employment rates and total long-term unemployment rate. In global European terms (table 3), these indicators are negatively related with GDP growth¹¹, exhibiting the expected long term relation sign (greater current growth, greater social cohesion in the future). Besides, this positive correlation appears with one and two years lead, which can be explained by the cyclical process of the European economy (current problems are expected to be solved in a two-years lapse).

It should be noted that the non availability of data for at-risk-poverty rate and dispersion of regional employment rates during the nineties, prevents us from computing the correlation between growth of GDP pc and growth of these two variables. In the case of evolution in total long-term unemployment

¹¹ Temporal correlation with dispersion of regional employment rates could not be computed due to the lack of complete data.

rate (figure 23), a negative correlation with the GDP pc growth rate can be observed, showing that countries with high increases in terms of GDP pc experienced also high diminishes in long-term unemployment rates (as, for instance, Ireland, Finland, Luxembourg and Spain). The opposite was detected in the case of Greece (which grew in terms of GDP pc but got worse in its long-term unemployment).

With respect to **Environment** indicators (total greenhouse gas emissions, energy intensity of the economy and transport-volume of freight transport relative to GDP), they would respond to the Gothenburg European Council Conclusions and they should measure concepts such as climate change, sustainable transport, threats to public health and managing natural resources.

As happened with the Social Cohesion objective, the Environmental objective exhibits a more politically focused profile, based on very long term relations with what can be summarized by GEB indicators. Thus, we could even expect opposite signs in crossed and temporal correlations compared with the political objectives and expectations of these indicators.

What we finally see from table 2 is that, roughly speaking, poorer countries (lower GDP per capita and lower productivity) exhibit a general worse behaviour in environmental indicators. In addition, countries with higher annual GDP growth show a positive correlation with all three environment structural indicators (see table 3). This last point is especially remarkable in what relates the transport-volume of freight transport relative to GDP indicator, and, although with lower absolute figures, also with the total greenhouse gas emissions indicator. On the contrary, the temporal correlation of the energy intensity of the economy presents a negative sign with GDP growth.

Besides, from figures 24, 25 and 26, it seems that growth in GDP pc during the nineties was accompanied with a relatively deterioration of sustainability, judged by the positive correlation between this variable and both the growth of total greenhouse gas emissions and the transport-volume of freight transport relative to GDP (especially in the case of Ireland, Greece or Spain). Despite of this, it seems that the improvements in terms of GDP pc have not involved a general increase in energy intensity (reflecting a more efficient use of energy). On the contrary, countries as Ireland, Finland or Luxemburg, with high growth rates of GDP pc, decreased their consumption of energy (the opposite of Portugal, Spain or Austria).

So, in general terms, GDP pc growth of EU15 countries during the nineties has been positively correlated with growth in terms of human capital and, especially, employment (total and for older workers) and business investments, that is, factors that reveal themselves as solid forces of economic growth. In addition, this growth has not implied a worsening in social cohesion, at least, on the lines

of evolution of long-term unemployment. On the contrary, this growth in GDP pc has been accompanied with relative growth in prices, and it seems quite low sustainable since it has led to a general increase in the greenhouse gases emissions (with the negative consequences in terms of potential impact on climate change) and in the general degree of congestion and pollution (as a consequence of rising volumes of traffic and a certain decouple of freight transport growth from real GDP growth).

Finally, it must be said that some countries that grew more in terms of GDP pc during the last ten years showed, at the beginning of the period, relatively low employment rates (Spain, Ireland and Greece), low levels of expenditures on R&D (Greece, Spain, Portugal or Ireland), youth educational attainment levels (Portugal, Luxemburg and Spain) and business investments (Ireland, Greece or Finland) or high levels of long-term unemployment levels (Ireland or Spain), reflecting a clear catch up process.

3.2 The state of play: Evolution during the period 1999-2003

Focusing now only on the four last years (1999-2003), it is worth analysing the evolution of the EU15 countries on the different dimensions considered by the Lisbon Strategy. So, figures in Annex 3 depicts the relation between growth of GDP pc and growth of the structural indicators during this period. In addition, these figures include information about the cross correlation between GDP pc growth and both the growth of structural indicators and the value of these indicators at the beginning of the period.

From these figures, some conclusions could be drawn. First, it can be seen that those countries that started from lower values of employment rate have experimented the highest growth rates. This is the case of Spain and Italy, which have successfully maintained relatively rapid job creation during this period (the opposite is found in the case of Denmark or Germany). In addition, these high employment growth rates have translated into remarkable GDP pc growth rates. However, countries as Ireland, Greece, Finland or Luxemburg, showed the highest GDP pc growth rates but with employment rate growth near to the EU15 average.

Second, and in general terms, countries that grew more (less) in terms of employment rate of older workers, also grew more (less) in terms of GDP pc.

Third, it can be seen that high growth rates during 1999-2001 in Gross Domestic expenditures on R&D have not obligatory lead to a similarly high GDP pc growth rates. This is the case of UK,

Sweden, Portugal or Belgium (with outstanding increases of GERD but relatively low GDP pc growth rates). Besides, although some countries, that started from worst positions in GERD, have significantly increased this variable (Portugal, Spain or Italy), other countries decreased their GERD (as Greece or Ireland).

Fourth, it seems that high rises of youth educational attainments during 1999-2002 have not been necessarily translated into great GDP pc growth rates (Denmark, Portugal, Belgium or Italy). On the contrary, countries as Luxembourg, Finland or Spain, with null or even negative growth rate of this R&D indicator, have showed the highest GDP pc growth rates.

Fifth, and concerning the evolution of economic reforms indicators, it could be noticed that growth in GDP pc has not been accompanied with a rather similar evolution in terms of growth in comparative price levels during the last years. However, there are some differences between EU15 members. So, countries as Greece have showed relatively high increments of GDP pc but improving their comparative price levels, while the opposite is found in the case of Ireland.

Sixth, it seems that high growth rates in GDP pc during the period have gone with significant high rates in business investments, especially in the case of Greece or Spain (showing in 1999 relatively high levels of this indicator). However, the opposite is found in the case of Portugal, Germany or Netherlands, which have decreased their business investments through 1999-2002 (showing comparatively low GDP pc growth rates).

Seventh, it must be said that in some cases elevated GDP pc growth rates have not supposed a worsening in social cohesion. So, Greece has shown one of the highest GDP pc growth rates but it has achieved reducing considerably its at-risk-poverty rate, its dispersion of regional employment rate or its long-term unemployment rate. A similar situation is detected for Spain, which jointly with Greece, displayed worse comparative conditions in 1999. Other countries as Finland, Luxembourg or in particular Ireland increased their GDP pc but with some costs in terms of social cohesion. So, Finland raised its dispersion of regional employment rate, Luxembourg increased its long-term unemployment and Ireland got worse in terms of at-risk poverty rate (especially preoccupant given that Ireland showed high values of this indicator in 1999). Finally, it is worth noting that long-term unemployment rate has presented the best evolution in comparison with the others social indicators (only Luxembourg presented a positive growth during 1999-2002).

Finally, growth in GDP pc during the last four years has been accompanied with a relatively deterioration of sustainability in terms of total greenhouse gas emission, making more difficult to achieve the Kyoto Protocol. This is the case of Ireland, Greece, Finland or Spain, countries that

showed high levels of this indicator in 1999. Besides, there has been a certain decoupling of freight transport growth from real GDP pc growth during the period (for instance, in Spain, Luxembourg and Ireland, while other countries as Greece or Finland have decreased the ratio of transport-volume of freight transport relative to GDP). However, the opposite situation is detected in the evolution of energy intensity, due to all the EU15 members, in particular Ireland, which grew but reducing their consume of energy (Austria is the exception).

4. A KNOWLEDGE BASED ECONOMY: WHAT HAVE WE ACHIEVED?

4.1. Overall discussion on economic growth

The key objective of the Lisbon Strategy is economic growth. This growth is expected to be sustainable in social and environmental terms. But, why growth? Let's remember what Robert Lucas (1988) said almost twenty years ago:

Annual rates of growth of real per capita GNP: India, 1.4%; South Korea, 7.0%. Then Indian incomes will double every 50 years; Korean every 10. An Indian will, on average, be twice as well off as his grandfather; a Korean 32 times. The consequences for human welfare involved in questions like these are simply staggering: once one starts to think about them, it is hard to think about anything else.

The initial thinking about economic growth comes from Adam Smith, David Ricardo and Schumpeter, and was firstly formalised by Roy Harrod and Evsey Domar in the latest 1930's and first 1940's. In their model, economic growth is due to the balanced growth of physical productive capital, in a way which implies that if population grew faster than capital there would be unemployment and if capital grew faster than its own balanced path, there would be overinvestment.

Later on, in 1957 Robert Solow assumed a more flexible model in which long run per capita growth is determined by exogenous technology (something not explained in the model indeed). The implications of that model are known: income levels in all countries should be identical unless countries differ in their savings rates, population growth rates, depreciation of physical capital rates and capital shares. Thus, convergence arises and the principle of policy neutrality is stated: changes in policy (i.e. taxation) may affect the steady state level of an economy, but not its growth rate. Thus, only income levels may differ, not growth rates, no matter what the country characteristics are.

After identifying that most of the growth is unaccounted for by the growth of conventional factors, many economists attempted to reduce Solowian residual by adjusting (augmenting) both labour and capital input measures to take into account improved education of labour and changes in age and

quality of machinery and equipment. Progressively, other determinants of economic growth were included. Prominent among these is the catching-up effect that describes the advantage of being a follower country. They enjoy opportunities of backwardness, which means that over a considerable range of technologies they can emulate the leader and, through diffusion of technology, achieve a given rate of growth with less expenditure for R&D. Structural change is another source of aggregate growth. As labour is moving from low productivity sectors and industries (agriculture, old, labour intensive manufacturing industries) to high value added industries and services, the overall productivity of the economy increases.

According to implications of Solow's model, one should observe a pattern of convergence of the rate of growth: advanced countries should experience a deceleration, developing countries an acceleration. The neoclassical assumption of a freely and universally available technology is contradicted by the industrial reality of sharp technological rivalry; technology is far from being a public good and its creation is increasingly costly. A series of articles published by Paul Romer (1986,1990) and others in the mid 1980s recognize that technological change is an endogenous, i.e. a byproduct of economic activity, as well as one of the fundamental sources of growth. New knowledge and new technology (the two concepts are often used as being interchangeable and loosely defined) is an output resulting from investing in human capital (education and training), employment of specialised labour (R&D personnel), equipment and material inputs.

The endogenous growth model that includes a rather realistic knowledge and technology creation mechanism assumes simply that the aggregate output of an economy depends not only on the amount of inputs employed by firms (labour, human capital, capital and R&D inputs) but also on the stock of results from research and development undertaken by all firms in the economy. These "spillovers" of new knowledge and technology are assumed to be freely available (scientific discoveries, and information in general are nonrival goods; many peoples and/or firms can use them at the same time). Contribution of these spillovers explains why in the model the total output of the economy grows faster than would indicate the use of inputs. In contrast to microeconomic studies where a similar model has been used since the 60s, the endogenous growth theory is concerned with a formal structure of relationships determining the long term growth of the whole economy.

The second important step towards more realism involved abandoning the unrealistic assumption that knowledge and technology are free and universally available. Important innovations are at least temporarily excludable. A good is said excludable if the owner has the power to exclude others from using it. Patenting and trade secrets are the common means to exclude others from using the new product or process in order to ensure that the innovator can appropriate benefits from his innovation. This gives the owner of the proprietary knowledge and technology a competitive advantage that can be

turned into a higher price and monopolistic profits. This step towards competitive reality has been taken by endogenous growth models in which monopoly profits motivate innovation. The ongoing investment in R&D and resulting flow of innovations leads to steady improvements of quality of goods, and productivity increases keep the economy growing at a pace determined by the rate of investment into R&D.

The endogenous character of innovation means that the process is rooted within each country or region. Firms are the important actors in generating new technologies and their behavior is determined on the one hand by the national environment and on the other hand by the increasingly global competition.

In that model a bigger size of the final market is also seen as a way to generate more advantages to create technology spillovers. The consequences are clear: larger countries and larger economic unions grow faster; international trade leads permanent higher growth; and higher proportions of human capital leads to permanent higher growth rates.

Nevertheless, several papers (Jones, 1995, among others) have criticized those consequences after revising historical data. Actually an amount of work is developed trying to harmonize data versus theory and intuition: technology matters for growth.

In the following sections we focus on the relationship between economic growth and the improvements made in the area of innovation and research. This is seen as one of the main engines for growth in the Lisbon strategy and a base for modernizing the European model.

4.2. Empirical discussion of correlations between innovation and research indicators

Several economists (for instance, Pavitt, 1982 and Griliches, 1990) have been debating about the issue of measuring innovative and research activity and technological progress, but no universal solution has been found. Starting from the concept of knowledge production function two types of indicators are usually identified: technology input measures and technology output measures. R&D expenditures measure the value of inputs, alternatively, the labour input may be measured by number of scientists and technicians employed in R&D. The difficulty is how to measure outputs of research and development. Since most of new knowledge and technology is not sold on the market, there is no way to assign it a price. However, among the variables most commonly used to measure the output of the innovation process we can think of patents and new product announcements.

The main drawback of the former indicators is that they embrace firms' efforts for invention and innovation together with imitation activities. Moreover, they do not take into account for informal technological activity and, as a consequence, tend to underestimate the amount of innovative activity of medium and small firms. On the contrary, patent and product announcement represent the outcome of the inventive and innovative process. The fact that there are inventions that are never patented and many patents are never developed into innovations marks the shortcomings of this measure. However, the patenting procedures require that innovations have novelty and usability features and imply relevant costs for the proponent. Therefore innovations which are patented, especially those extended in foreign countries, are expected to have economic value, although highly heterogeneous.

The problems of measurement are recognized, their existence can not, however, invalidate the economic character of activities creating new knowledge and technology. Specifically, for the case of the innovation and research area, the Lisbon strategy outlines 20 indicators for innovation (Table 4). Some of them are innovation indicators from the input side (spending on human resources, gross domestic expenditure on R&D, venture capital investments, ICT expenditure), others are from the output side (patents) whereas some others are related to the level of human capital achieved among the population (science and technology graduates, youth education attainment level) or related to the use that population and firms make of technology (level of internet access, e-commerce).

Therefore, despite the measurement problems encountered when analyzing the innovation and research process, since economic literature points it as one of the most important growth factors, as a first stage, we compute several correlation measures to analyze the link between economic growth and the level and growth of the innovation and research indicators.

Table 5 shows the correlation coefficients between economic growth measured by GDP per capita and the different indicators. The first two columns offer a measure of the correlation between growth of GDP per capita in the period 1994-2003 and the level of the innovation and research indicators in 1994 in the first column, and the growth of the indicators in the period 1994-2001 in the second column. This way we leave a time lag between the indicator growth and economic growth in the country under consideration, since it is believed and well documented that the effect of the innovation effort does not have an immediate result in the development of the economy. The two last columns offer the same idea although concentrated in the period of the Lisbon strategy (1999-2003).

It can be observed that many of the correlations show low values, against a first intuition we expected of high correlations among these indicators and growth. First, increases in patents, both in the EPO and USPTO cases, in youth education attainment level and in science and technology graduates have run parallel to growth rates in the whole period although several comments are in order. On the one

hand, this positive relation is observed for the increases in the indicator but not for the level, which would indicate that the important issue is the effort made in patenting and getting higher education levels more than the initial level. And in the other hand, this positive relationship is not observed for the Lisbon period in terms of Patents, which the correlations are not significant.

Table 4. List of innovation and research indicators

Spending on Human Resources (public expenditure on education) as a percentage of GDP
GERD (Gross domestic expenditure on R&D) - As a percentage of GDP
GERD (Gross domestic expenditure on R&D) by source of funds - industry - Percentage of GERD financed by industry
GERD (Gross domestic expenditure on R&D) by source of funds - government - Percentage of GERD financed by government
GERD (Gross domestic expenditure on R&D) by source of funds - abroad - Percentage of GERD financed by abroad
Level of Internet access - households - Percentage of households who have Internet access at home
Level of internet access - enterprises - Percentage of enterprises who have Internet access
Science and technology graduates - total - Tertiary graduates in science and technology per 1000 of population aged 20-29
Science and technology graduates - females - Female tertiary graduates in science and technology per 1000 of female population aged 20-29
Science and technology graduates - males - Male tertiary graduates in science and technology per 1000 of male population aged 20-29
Patents EPO - Number of patent applications to the European Patent Office (EPO) per million inhabitants
Patents USPTO - Number of patents granted by the United States Patent and Trademark Office (USPTO) per million inhabitants
Venture capital investments - early stage - relative to GDP, breakdown by investment stages
Venture capital investments - expansion & replacement - relative to GDP, breakdown by investment stages
ICT expenditure - IT expenditure - Expenditure on Information Technology as a percentage of GDP
ICT expenditure - Telecommunications expenditure - Expenditure on Telecommunications Technology as a percentage of GDP
E-commerce - Percentage of enterprises' total turnover from e-commerce - Share of turnover sold via the internet by enterprises with 10 or more persons employed
Youth education attainment level - total - Percentage of the population aged 20 to 24 having completed at least upper secondary education
Youth education attainment level - females - Percentage of the female population aged 20 to 24 having completed at least upper secondary education
Youth education attainment level - males - Percentage of the male population aged 20 to 24 having completed at least upper secondary education

Table 5. Correlations between Innovation and Research indicators and GDP pc growth

Knoweldge indicators		Growth GDP pc 94-03		Growth GDP pc 99-03	
		indicator 94	indic growth 94-01	indicator 99	indic growth 99-01
IR010	Spending on Human Resources	0.336	-0.105	0.038	-0.142
IR021	Gross domestic expenditure on R&D	-0.242	0.178	-0.440	0.071
IR031	Level of Internet access - households			-0.180	-0.190
IR032	Level of internet access - enterprises			-0.639	0.545
IR041	Science and technology graduates	0.052	0.398	0.345	0.407
IR051	Patents EPO	-0.433	0.599	-0.672	-0.305
IR052	Patents USPTO	-0.465	0.577	-0.513	-0.067
IR061	Venture capital investments - early stage	0.086	0.008	-0.470	0.218
IR062	Venture capital investments - expansion & replacement	0.229	0.088	-0.138	0.115
IR071	IT expenditure			-0.298	-0.011
IR072	Telecommunications expenditure			0.186	-0.135
IR080	E-commerce			0.053	
IR091	Youth education attainment level	-0.038	0.517	0.156	0.435

Second, increases in the spending on human resources seem not to run parallel to growth rates or even the contrary, since we obtain a negative correlation which is even more exacerbated in the period of the Lisbon strategy. These results come to contradict which would be expected if considering endogenous economic growth theories.

Thirdly, concentrated in the Lisbon period, the increases of the level of internet access in enterprises is positively correlated with GDP growth (although a negative correlation would be encountered with the level of the indicator). Additionally, it seems that IT expenditures are not correlated with growth.

Finally, for the cases of evolution of both gross domestic expenditure on R&D and venture capital no relationship is observed.

However, in order to get a deeper insight into the influence of each country in the value of the correlation we have depicted a scatter plot for each innovation and research indicator, so that growth in GDP per capita is plotted in the Y-axis against the growth of the indicator in the X-axis (Figures 27 to 38).

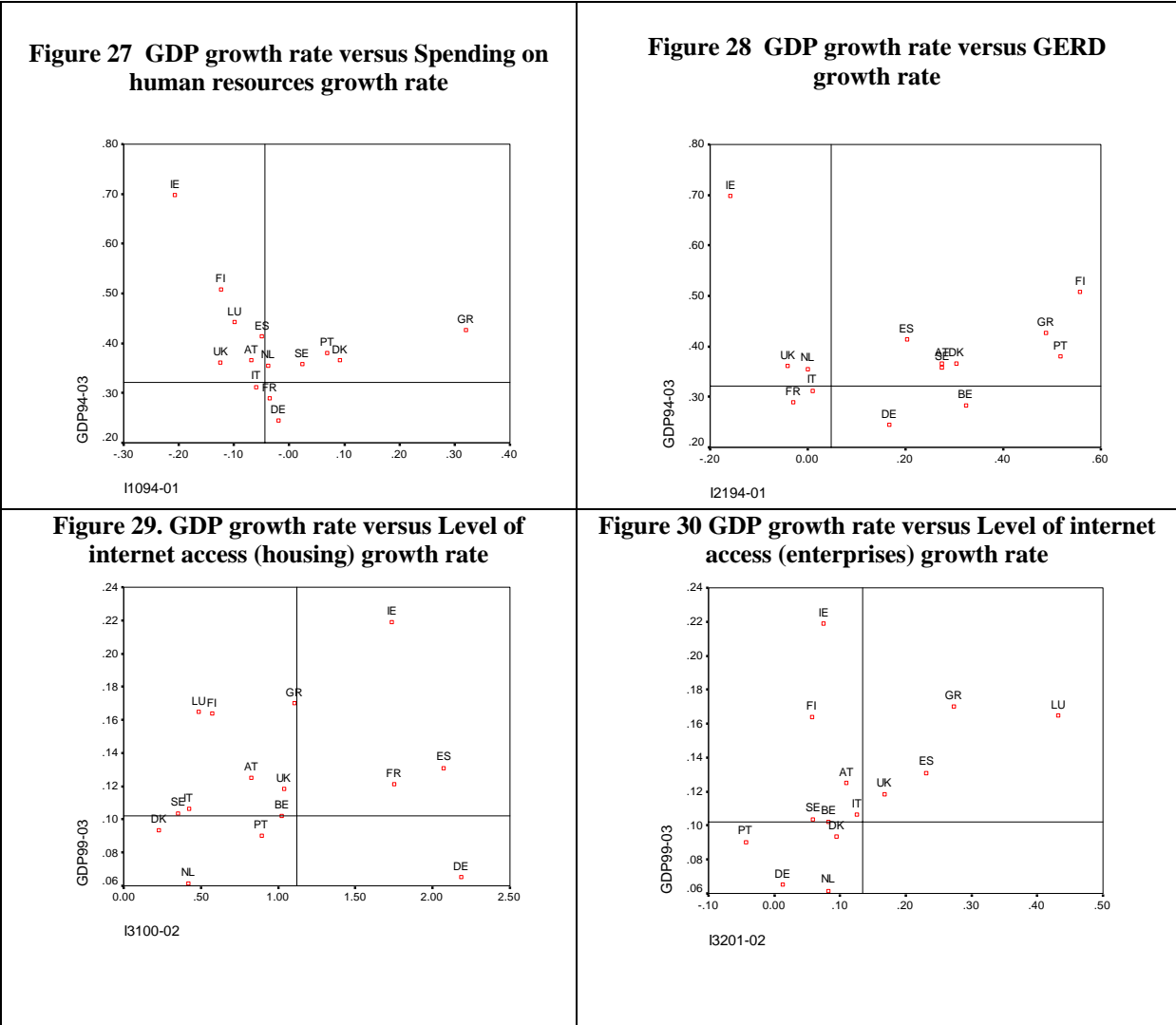


Figure 31 GDP growth rate versus Science and technology graduates growth rate

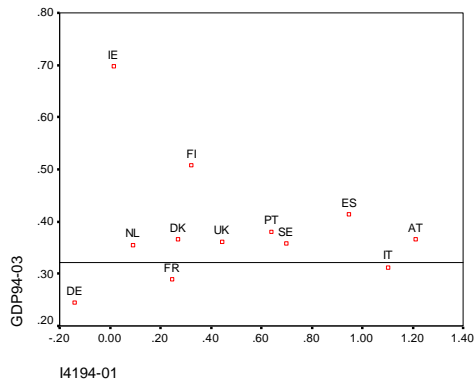


Figure 32 GDP growth rate versus Patents EPO growth rate

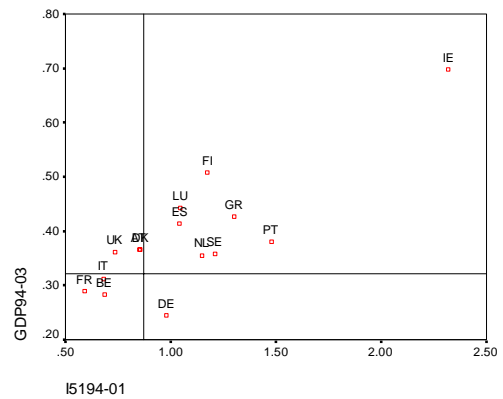


Figure 33 GDP growth rate versus Patents USPTO growth rate

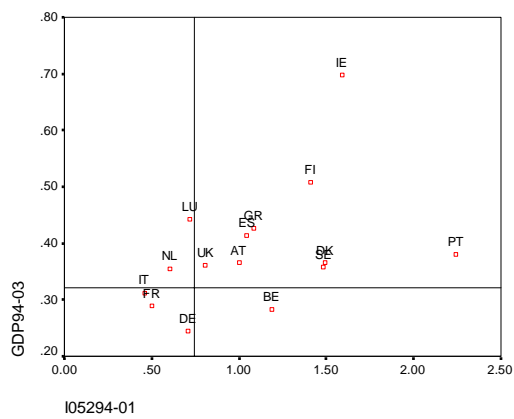


Figure 34 GDP growth rate versus Venture capital investment growth rate

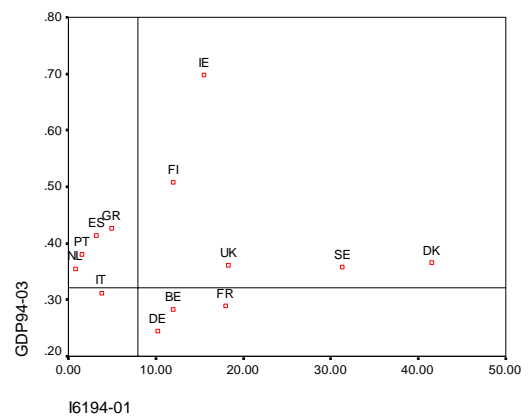


Figure 35 GDP growth rate versus Venture capital investment growth rate

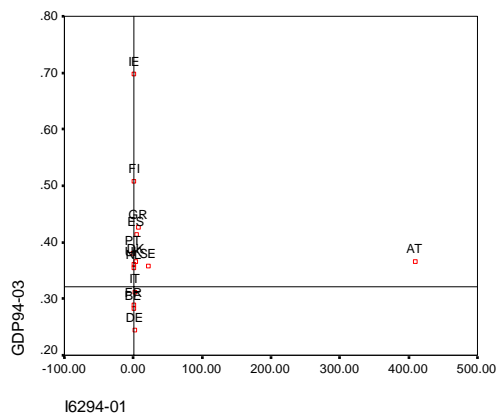
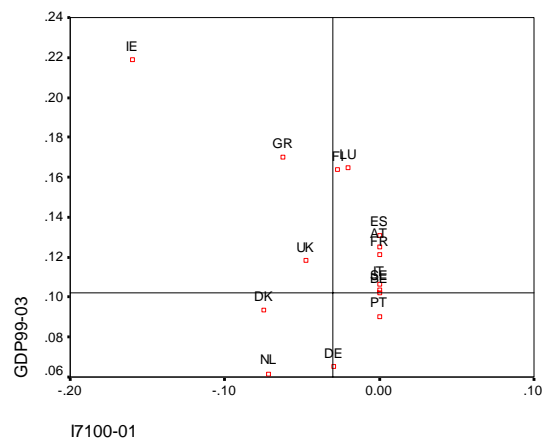
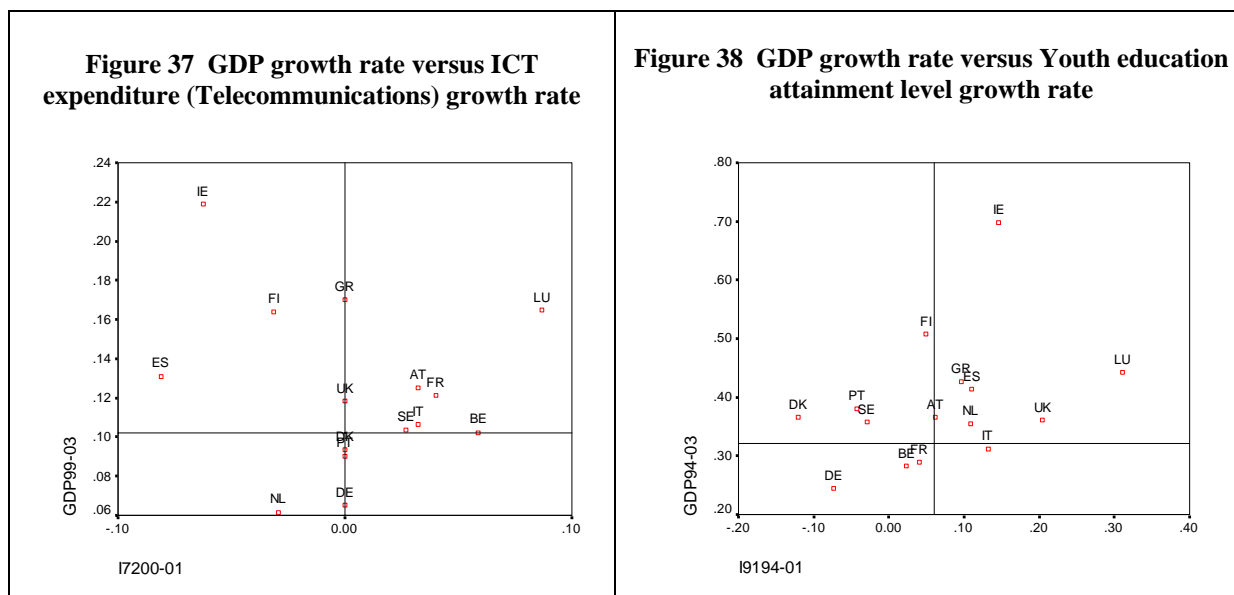


Figure 36 GDP growth rate versus ICT expenditure (IT) growth rate





4.3. How knowledge based economy indicators influence convergence

As it has been seen above growth theories have been classified either in a neoclassical or endogenous growth group. In what is related to predictions for convergence, the neoclassical model (Solow, 1956; Swan, 1956) supports a convergence process based on the existence of decreasing returns in capital accumulation. Increases in capital lead to increases less than proportional in product. This circumstance explains the existence of a steady state level for the main magnitudes, such as product per unit of employment, to which the economy will tend after any transitory shock. These being the case, poor economies will grow at higher rates than rich ones, guaranteeing convergence across all of them.

On the other hand, endogenous growth models are characterized by giving mechanisms that determine the absence of convergence. In a first step, the fact of not imposing decreasing returns to capital (Romer, 1986; Lucas, 1988) and some ulterior mechanisms in which technological growth is a non-decreasing function of some factors (among others, the resources devoted to R&D), lead to models in which there is not a steady state or long run equilibrium. In other words, these models would not impose any limits to growth. Both mechanisms, although through different ways, allow economies which are initially rich to keep this condition the same as poor economies. In fact, an important part of the efforts in endogenous models have been motivated on the notable persistence observed in the differences in the levels of income and welfare across economies.

However, the implications in terms of convergence derived from both types of models are not straightforward. As can be easily deduced from the assumptions of neoclassical models, the convergence predicted can not be directly translated to the disappearance (of a great part) of the differences across economies. This will also be true when all the economies share the same steady

state. Also, in the scope of the endogenous growth models it is possible to design mechanisms that will allow approaching the development levels across economies through, for instance, technological diffusion processes.

These comments above point that the same word convergence can be used to denote different concepts in the area of growth, which are not necessarily equivalent. In fact, we could find convergence without having convergence. How? If we understand the first one as an approximation of each economy to its steady state, with different steady states.

A simple growth equation for a discrete period can be expressed as (Barro and Sala-i-Martin, 1995):

$$g_{GDP} = a - (1 - e^{-\beta T}) \log(GDP_{i0}) + u_i \quad (4.3.1)$$

that includes a random error term which proxies the transitory shocks, where g_{GDP} is relative growth of GDP between periods 0 and T. The subscript i denotes the country, T is the final year under consideration and 0 the initial one. This way, the intercept would reflect all the factors influencing the steady state. Then T is the whole time period considered and β is the convergence rate. This is why these concepts are named β -convergence.

With respect to the steady state, if we can just consider it to be proxied by the intercept, we would be imposing the existence of the same steady state in all the economies under consideration, which is known as absolute convergence. However, we can think of some specific factors that have a real influence in it and consider them explicitly. These factors can be introduced *ad-hoc* through the consideration of additional explanatory variables, in a way that has been called growth equations à la Barro.

The empirical evidence, which has mostly estimated the convergence rate using cross-section samples, shows that convergence is estimated to be around an annual 2% for very different samples. A value which is observed for samples without conditioning for the determinants of the steady state.

In our case, we estimate a growth equation for the sample of 15 countries of the EU for which we can get information for the whole period between 1994 and 2003. Specifically, in order to avoid heteroskedasticity problems we estimate by the method of weighted least squares in which the weighted variable is population. In order to check the type of convergence, if existing, that is present in the sample under consideration, we start by estimating model (4.3.1) in which we can test the existence of absolute convergence as predicted in neoclassical models, and in a second stage we aggregate it with some variables that could be affecting the steady state. These factors are introduced *ad-hoc* in the way à la Barro as follows:

$$g_{GDP} = a - (1 - e^{-\beta T}) \log(GDP_{i0}) + \gamma Service_{i0} + \rho g_{INNOVATION} + u_i \quad (4.3.2)$$

where the variable *Service* is the share of value added in service sectors as a proxy of the sectorial structure of the economy and $g_{INNOVATION}$ is the growth rate of each one of the indicators in the area of “Innovation and Research” of the Lisbon Strategy. The growth rate of GDP is obtained for the period 1994-2003, whereas the growth rate of the innovation and research indicators are given for the period 1994-2001.

The results for the estimation of models 4.3.1 and 4.3.2 are depicted in table 6. Thus, as it can be observed in column 1, absolute convergence is shown, given the negative value of the level of GDP in the initial year.

In column 2 we condition this regression model including the sectoral composition of the countries in order to proxy the role that the sectoral specialization may be playing in the convergence process. As observed, convergence is maintained and services are highly significant.

However, our interest is focus on the effect that innovation and research may have in the growth process which is the ultimate objective of the Lisbon Strategy. With this aim in mind, we introduce the growth rate of each one of the indicators in the area of Innovation and Research. Several conclusions are interested to highlight.

First, only 3 indicators present significant parameters in the growth equation. Increases in “Spending on human resources” (column 3) seem to affect negative and significantly GDP growth rates, whereas “Patents in the European Patent Office” (column 6) as well as “Youth educational attainment level” (column 10) present a positive effect on economic growth rate. The rest of innovation indicators (Gross domestic expenditure in R&D, Science and technology graduates and Venture capital investments) are not significant.¹²

Second, the convergence process which was observed before introducing the innovation indicators is not maintained in the 3 cases in which these indicators are significant. This fact points to the ideas expressed by endogenous growth models in which decreasing returns seem not to operate probably due to technological growth which will not be putting general limits to growth. As a consequence convergence is not observed in general terms.¹³

¹² It has not been possible to estimate the growth equation for the case of the indicators referred to Access to internet, ICT and E-commerce, since the information provided for them starts in 2000 for these two first indicators and 2002 for the last one.

¹³ The estimation of the growth equation is repeated for a panel data set consisting of the annual growth rates of GDP between 1996 and 2002 for the 15 EU members, with two main regressors, namely GDP in the original

4.4. Composite Measurements for Innovation and Research

As has been formerly stated, an inherent difficulty in measuring knowledge exists. However, a list of indicators can be built in order to have a wide map of the innovation and research axis of the Lisbon strategy. As has been also seen, this variety of different indicators offer opposite results on the European growth and convergence process, what drives to a problem in terms of interpreting the effect of innovation and research on growth.

In order to see if the final list of 20 indicators is quite heterogeneous or if they are much related between them, we have computed correlation coefficients between all indicators and the two of them chosen as structural indicators (Gross Domestic Expenditure on Research and Development (GERD) and Youth Education Attainment Level). See Table 7 for cross sectional correlations between 15-MS in different periods of time.

What we see is that GERD is particularly related with Spending on Human Resources, Patents, Venture Capital Investment and Level of Internet Access, while Youth Education Attainment Level is much correlated with Science and Technology Graduates. Of course, additional correlations between all indicators arise, like the high one between GERD and Youth Education Attainment Level, showing the richness of multidimensionality in the Innovation and Research vector.

These points drive us to think on the possibility of building composite indicators on the knowledge-based economy, as is stated in the Communication from the Commission COM-2003 585 final.¹⁴ In order to build the composite measurement, here we have followed a double strategy for reducing the multidimensionality. Firstly, we considered a set of composite measurements based on principal components or on cluster analysis procedures. Normally they are developed by minimizing the loss of relevant information after the construction of the indicators, and components are weighted with the proportion of variance in the original set of variables explained by first principal components (up to consider a significant amount of total variance) of that particular vector of information. Thus, the composite index requires weights that are usually based on the statistical properties of the data used for the analysis.

year and annual growth rate of the innovation and research indicator with one lag with respect to growth rates, that is, from 1995 to 2001. Among the results of the fixed effect estimation we highlight two: a convergence process is observed in all the cases, and only the indicator Venture capital (early stage) is significant and positive at 5%, and the one referred to Youth education attainment level is significantly positive at 10%.

¹⁴ The computation of composite indices in the Innovation and Research dimension has been already developed by the European Commission in the recent past. See “*Towards a European Research Area. Key Figures 2002. Science, Technology and Innovation*”, European Commission (2002).

Table 6 Estimation of the growth equation.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Constant	4.356*** (0.812)	4.530*** (0.579)	-1.289 (0.946)	3.891*** (0.648)	-1.187 (0.729)	-1.867*** (0.577)	-2.727*** (0.606)	3.364*** (0.621)	3.517*** (0.627)	-1.817** (0.593)
Ln GDP ₀	-0.415*** (0.083)	-0.484*** (0.582)	0.249* (0.122)	-0.372*** (0.053)	0.277*** (0.082)	0.273*** (0.086)	0.461*** (0.672)	-0.354*** (0.059)	-0.364*** (0.059)	0.339*** (0.071)
Service		0.748*** (0.245)	-1.149** (0.387)	0.48 (0.457)	-1.707*** (0.170)	-0.848** (0.383)	-2.001*** (0.222)	0.569* (0.281)	0.487 (0.270)	-1.707*** (0.175)
Spending			-0.310* (0.162)							
GERD				-0.118 (0.101)						
Science and technology graduates					-0.045 (0.025)					
Patents EPO						0.125** (0.041)				
Patents USPTO							-0.053 (0.0043)			
Venture capital (early stage)								-0.000 (0.001)		
Venture capital (expansion)									-0.001 (0.004)	
Youth education attainment level										0.244*** (0.076)
R ²	0.655	0.860	0.938	0.838	0.969	0.899	0.896	0.830	0.828	0.942
Log likelihood	18.398	20.769	25.322	24.888	22.979	26.925	23.273	23.017	22.939	25.537

Note: Endogenous variable: growth rate of GDP.
Standard errors in brackets
***, **, * significant at 1%, 5% and 10%, respectively
Weighted LS. Weight variable is population.

Table 7 Cross correlations between Innovation and Research indicators and Structural R&D indicators

		5. GERD: Gross Domestic Expenditure on Research and Development			6. Youth educational attainment level*		
		1994	1997	2001	1994	1997	2001
IR010	II.1: Spending on Human Resources	0,777	0,538	0,728	0,539	0,445	0,275
IR021	II.2.1: GERD (Gross domestic expenditure on R&D)	1,000	1,000	1,000	0,796	0,744	0,612
IR022	II.2.2: GERD (Gross dom. expend. R&D)-industry	0,620	0,776	0,802	0,795	0,602	0,421
IR023	II.2.3: GERD (Gross dom. expend. R&D)-government	-0,689	-0,629	-0,679	-0,493	-0,497	-0,699
IR024	II.2.4: GERD (Gross dom. expend. R&D) - abroad	0,023	-0,403	-0,350	-0,527	-0,202	0,192
IR031	II.3.1: Level of Internet access - households	n.a.	n.a.	0,549	n.a.	n.a.	0,290
IR032	II.3.2: Level of internet access - enterprises	n.a.	n.a.	0,558	n.a.	n.a.	-0,055
IR041	II.4.1: Science and technology graduates - total	0,686	0,486	0,217	0,363	0,427	0,603
IR042	II.4.2: Science and technology graduates - females	0,351	0,190	0,062	-0,052	0,187	0,465
IR043	II.4.3: Science and technology graduates - males	0,351	0,190	0,062	-0,052	0,187	0,465
IR051	II.5.1: Patents EPO per million inhabitants	0,805	0,881	0,889	0,850	0,663	0,410
IR052	II.5.2: Patents USPTO per million inhabitants	0,825	0,931	0,941	0,839	0,694	0,485
IR061	II.6.1: Venture capital investments - early stage	0,224	0,191	0,858	-0,162	-0,009	0,547
IR062	II.6.2: Venture capital investments - expansion & replacement	0,544	0,155	0,216	-0,109	-0,224	0,028
IR071	II.7.1: ICT expenditure - IT expenditure	n.a.	n.a.	0,811	n.a.	n.a.	0,601
IR072	II.7.2: ICT expenditure - Telecommunications exp.	n.a.	n.a.	-0,388	n.a.	n.a.	-0,484
IR080	II.8: E-commerce - % of enterprises' total turnover from e-commerce	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
IR091	II.9.1: Youth education attainment level - total	0,796	0,744	0,612	1,000	1,000	1,000
IR092	II.9.2: Youth education attainment level - females	0,685	0,575	0,454	0,981	0,944	0,965
IR093	II.9.3: Youth education attainment level - males	0,860	0,819	0,695	0,986	0,970	0,984

Note: n.a. = Non Available

The second methodology that we considered, based on structural index methodologies, as in Royuela, Suriñach and Reyes (2003), tries to pick up *all* the information belonging to the variables considered, while the other methodology considers, generally speaking, the information *common* to all variables. This second alternative can be considered more appropriate than the common information one in order to assume a multidimensional framework: if there are several dimensions of innovation and research that are not statistically correlated, the principal components approach could not lead to any reasonable solution, while that second approach can be perfectly reasonable. Nevertheless, we see one major disadvantage with the structural index strategy: the subjectivity that emerges from the choice of specific weights in all partial indexes and subindexes. As Morris (1979) and Gwartney et al. (1996) say, there is no weighting system above criticism. Following Babbie (1995), we finally decided to attribute the same weight to all the variables.

Table 8. Matrix components of first two principal components. 1995 and 2001 estimates.

	1995		2001	
	First Component	Second Component	First Component	Second Component
IR010	0.683	0.044	0.639	-0.099
IR021	0.883	0.329	0.940	-0.203
IR022	0.795	0.063	0.781	-0.091
IR023	-0.756	0.065	-0.699	-0.060
IR024	-0.153	-0.532	-0.361	0.239
IR031	--	--	0.758	-0.084
IR032	--	--	0.454	-0.260
IR041	0.28	-0.559	0.305	0.858
IR042	--	--	0.184	0.883
IR043	--	--	0.184	0.883
IR051	0.882	0.386	0.882	-0.184
IR052	0.771	0.52	0.920	-0.264
IR061	-0.106	0.662	0.910	-0.057
IR062	0.089	0.272	0.516	-0.239
IR071	--	--	0.615	-0.402
IR072	--	--	-0.348	-0.319
IR080	--	--	0.260	0.661
IR091	0.871	-0.371	0.499	0.415
IR092	0.803	-0.435	0.287	0.423
IR093	0.887	-0.312	0.615	0.295
Proportion of total variance	47.20%	16.30%	37.30%	18.96%

We understand that both techniques are complementary, and consequently we have worked with both.¹⁵ In first place, in order to get indices to be considered in the whole temporal sample (1995-2001), we could not consider the whole list of indicators due to the lack of statistical information, excluding Level of Internet Access, ICT Expenditure and E-commerce. After choosing the list of final variables, we have computed the principal component analysis. The two first principal components consider a 64% of the total variance of the 13 indicators.¹⁶ Table 8 exhibits the components matrix of both first two principal components, jointly with their proportion of the total variance.

The second strategy computed indices of two composite measurements of innovation and research, and considered the ad hoc separation of the indicators. The selection of the final structure was made after the inspection of the former correlations between structural indicators and the global list of Innovation and Research indicators (see table 7). These correlations drove us to grouping Education indicators against Innovation indicators, following, indeed, the Commission selection of the two structural indicators: GERD (say, Innovation) and Youth Education Attainment Level (say, Education). Thus, we finally considered on the one side Education indicators: Science and technology graduates and Youth education attainment level; and on the other vector we had the Innovation indicators: Spending on human resources, Gross domestic expenditure on R&D, Patents EPO and Patents USPTO, and Venture capital investments.

The statistical method of the composite indices has to meet five requisites:

1. The index has to be able to aggregate indicators calculated with different units of measurement.
2. The aggregation process has to be able to compare indicators with a high level of different relative dispersion.
3. The index has to allow the construction of a scale that *lets the data talk*, i.e., that reflects the statistical characteristics of the data.
4. The final index has to allow for a comparison over time: when a system's basic variables rise, the final index has to increase.
5. If the relative size of the systems changes over time, the index has to condense this information without overvaluing (undervaluing) the result for a specific country.

These criteria are the basis for our index, I , as a linear function of K attributes, X . Each attribute measures Innovation and Research, indicating the extent to which a country is above (below) the European average, which is equal to 100 in the base year. The structure of the final index reduces the dimensions at each level. Every attribute, X_j , is originally measured in its own units (percentage,

¹⁵ Additional techniques were considered, as hierarchical clustering of variables with different measurements of distance (Euclidean, Pearson correlations, and so on), being discarded due to the little theoretical interpretation of the results.

¹⁶ We did not consider either the desegregation of gender of Science and Technology graduates.

patents per million inhabitants, etc.), but needs to be redefined in terms of the final index. We do so taking a relative measure, which converts the result into a percentage. If country i has a value in the f attribute equal to X_f^i , then we say that we can measure how far country i differs from the European average in terms of Innovation and Research merely by computing:

$$Y_f^i = X_f^i / \bar{X}_f$$

Then, the final index, I''^i , is a linear function of the attributes' vector Y^i , $Y^i = (Y_I^i, \dots, Y_K^i)$:

$$I''^i = Y^i W, \tag{4.4.1}$$

where $W = (w_I, \dots, w_K)$ are the weights given to every attribute.

Differences between countries can be expressed in a dispersion measurement, for example the variance

$$\text{VAR}(I'') \text{ from } i=1 \text{ to } N,$$

where N is the total number of countries.

We understand that this variance is useful information about attribute Y_f . If we only had *one* Innovation (Education) attribute, then the measurement of Innovation (Education) would be defined by this particular variance. But as there is more than one attribute in each index, a general measurement for each aggregate index needs to be defined. Following (4.4.1), the total amount of information provided by the final index is:

$$\text{VAR}(I'') = \text{VAR}(YW) = W' \text{VAR}(Y) W. \tag{4.4.2}$$

So, the index information is equal to the weighted variance and covariance matrix of the attributes. This is the measurement of Innovation (Education) that we will use in the final index I'' , and it allows us to say that, considering all attributes, a country is above or below the European average – and also by how much, since it was measured in relative terms.

Nevertheless, if the final index is simply $I'' = YW$, then the attributes with greater variance are overweighted. This effect can be seen in one example. If in the Innovation (Education) index a country has a good position in four of the five indicators, but is badly placed in the other (perhaps due to the fact that this attribute has a much higher variance than the others) the final result will be poor. In order to avoid this, we should compute the index as:

$$I' = ZW,$$

where Z_f are the standardised variables: $Z_f = (X_f - \bar{X}_f) / SD(X_f)$. We can expect the variance of that index to be equal to one. But if there is information common to these attributes, we have:

$$VAR(I) = W' R W,$$

where R is the correlation matrix between the standardised indicators. This is the reason for computing the final standardised positions (number of standard deviations away from the trend) of the countries as:

$$I = ZW / (W' R W). \tag{4.4.3}$$

As we built the final index measurement in (4.4.2), now we only have to add it to the standardised positions of all countries defined in (4.4.3). In order to make it more comprehensible we have included a level to the final measurement (100 in the base year). So, the final index is:

$$Index = 100 (1 + I * [W' VAR(Y) W]).$$

Any interpretation of this index has to be done in relative terms. So, if $Index_i = 102$, country i is 2% above the European mean in terms of this component of Innovation and Research. Thus, this composite index is the result of summing up several indicators.

The final results of both strategies offer an index or principal component for every country, both for 1995 and 2001. In order to compare both strategies, the correlation matrix is computed, and is shown in table 9. What we see is that the first principal component is highly correlated with the Education index, while the second principal component is much more correlated with the Innovation index. These figures show us that the indices aggregation strategy of Innovation and Research variables can be appropriate to summarize an important amount of the overall information of that vector of Innovation and Research of the Lisbon Strategy.

Table 9. Correlation Coefficients between Composite Measurements of Innovation and Research: Indices and Principal Components (computations for 2001).

	Index 1 (Education)	Index 2 (Innovation)	Principal Components factor 1	Principal Components factor 2
Index 1 (Education)				
Index 2 (Innovation)	0.352			
Principal Components factor 1	0.738	-0.218		
Principal Components factor 2	0.526	0.955	0.000	

Finally, figures 39 to 43 show the standardized results of both indices and factors of principal components for every UE-15 Member State both in 1995 and 2001. We can then develop a rank of every Innovation and Research component for every year. Belgium, Denmark, Germany, France, Ireland, Finland and Sweden exhibit a good relative position in the Education component in 1995, while Greece, Spain, Italy, Luxembourg and Portugal have a worst position, being the rest in an average position. Nevertheless, this picture is somehow different in 2001: Belgium, Denmark, Germany have lowered their relative good position to a medium one, being the United Kingdom the country with a higher increase in the Index. On the contrary, Greece and Spain have abandoned the relatively bad positions of 1995.

The Innovation component of Innovation and Research presents a graph with high relative positions in 1995 for Luxembourg, the Nederland, Finland and Sweden, and a bad relative position for Greece, Spain, Portugal and Ireland, being the rest of the countries in a more intermediate situation. That situation changes in 2001, especially for Luxembourg and the Netherlands, which exit the good positions of the composite measurements. Denmark experiences an increase in its relative position, while Finland and Sweden increased their relative good former positions.

Figure 39 Results of Composite Measurements of the Education Component for UE-15. 1995.

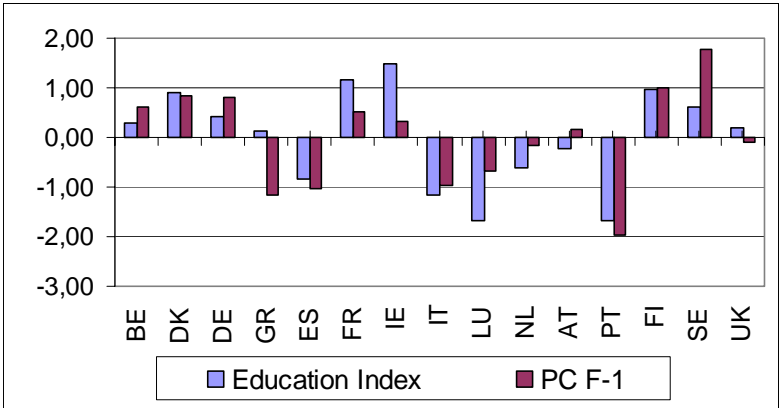


Figure 40 Results of Composite Measurements of the Education Component for UE-15. 2001.

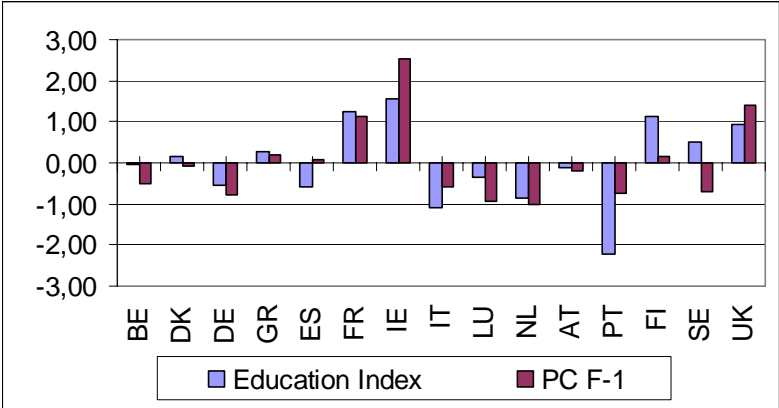


Figure 41 Results of Composite Measurements of the Innovation Component for UE-15. 1995.

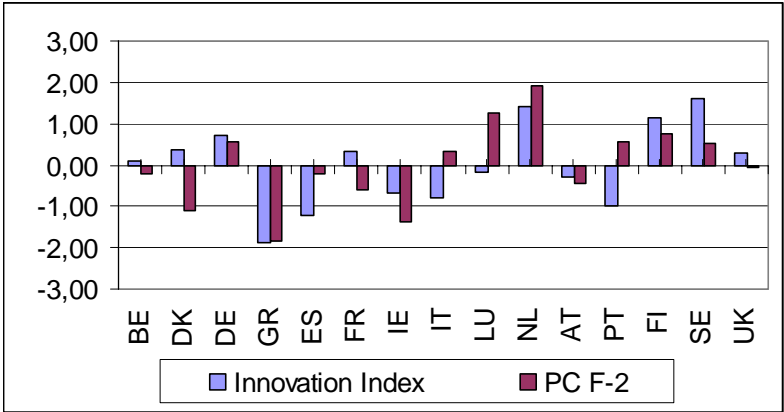
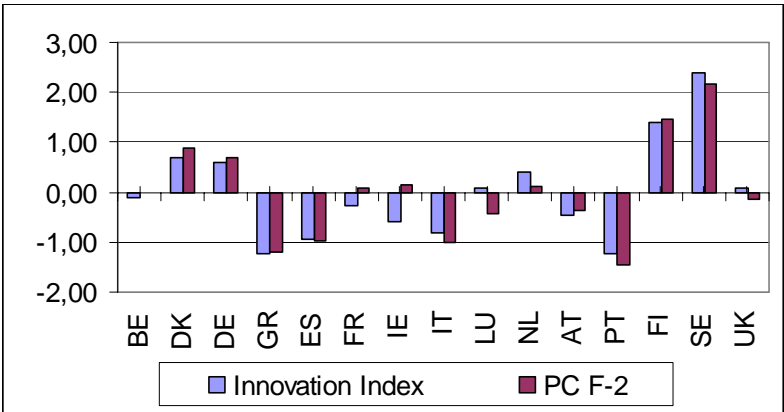


Figure 42 Results of Composite Measurements of the Innovation Component for UE-15. 2001.



An additional advantage of the computed ad hoc indices is that, following Royuela, Suriñach and Reyes (2003), we can compute the 2001 index based on 1995=100, and allowing for temporal comparisons. This property allows us for computing the increase of every country in both the Education and Innovation components. Figures 43 and 44 show the scatter plots of GDP per capita growths and against the growth of both Innovation and Research indices.

With all these results into consideration we have computed again the convergence equation, against growth of Innovation and Research indicators, but now being they computed as composite measurements. What we finally find (see table 10) is a positive influence of both Education and Innovation on GDP per capita growth, although, as obtained in several former estimates, no overall convergence process is found.

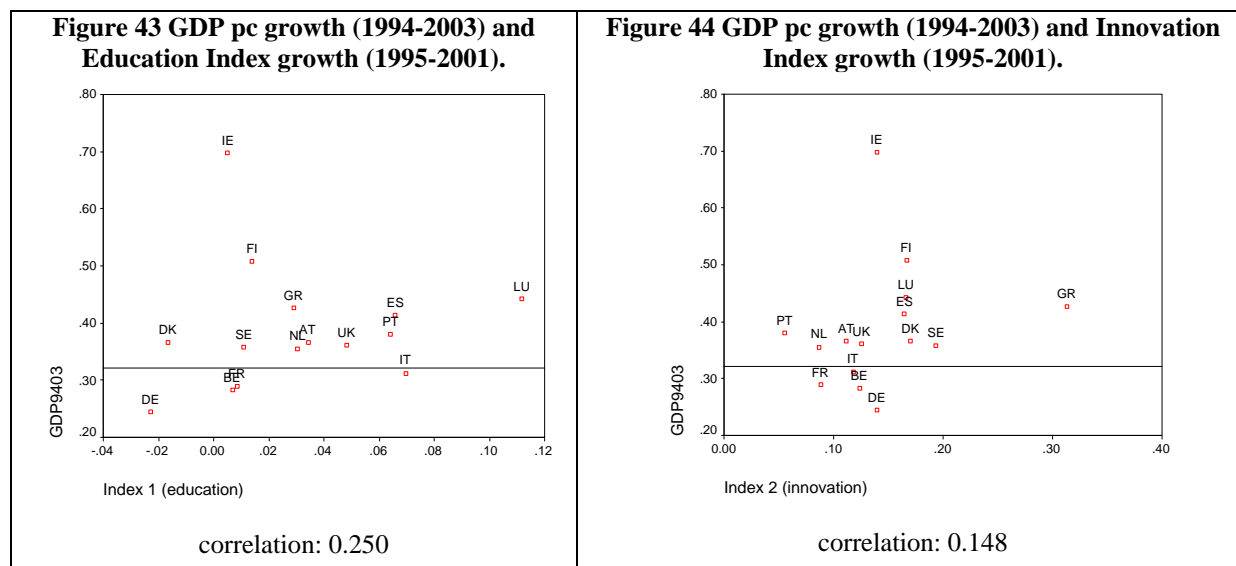


Table 10. Estimation of the growth equation with composite R&D indices

	(1)	(2)
Constant	-2.142** (0.784)	-4.467** (0.596)
Ln GDP ₀	0.415*** (0.089)	0.663*** (0.0739)
Service	-3.303 *** (0.231)	-2.520 *** (0.237)
Education Index Growth	0.0669 ** (0.026)	
Innovation Index growth		0.0482 ** (0.016)
R ²	0.911	0.922
Log likelihood	21.619	22.611

Note: Endogenous variable: growth rate of GDP. Standard errors in brackets. ***, **, * significant at 1%, 5% and 10%, respectively. Weighted LS. Weight variable is population.

Summing up this brief analysis of the composite indices of Innovation and Research, what we see is that sometimes a good strategy to incorporate all dimensions of complex and multidimensional information can be the use of aggregate measurements. Thus, although it can never obliterate the use of original data in order to get a right understanding of the reality, we have already seen that it can be a useful tool for economic analysis.¹⁷

¹⁷ As in the case of the original indicators, the estimation of the growth equation with the composite indicators is repeated for a panel data set. This way, the annual growth rates of GDP between 1996 and 2002 for the 15 EU members is regressed to GDP in the original year and annual growth rate of the composite indicator with one lag with respect to growth rates, that is, from 1995 to 2001. GDP per capita presents a significant and negative parameter, whereas only the indicator related to education is significantly positive at 10%. The innovation index does not present a significant parameter.

5. Preliminary conclusions

In this paper the monitoring of the Lisbon Strategy is analysed. In order to do that, in a first stage a summary of the Lisbon Strategy is made, with an analysis of its objectives, list of structural indicators (linked to the targets pursued in the LS) and an overall evaluation. In a second stage, we develop an analysis of the structural indicators evolution against general economic background indicators both at cross section and temporal dimensions, focusing on economic growth. Related to this point, we would like to stress the fact that the annual reports of the Commission only review the evolution of the different indicators, without a deeper analysis. In our opinion, this analysis can be complemented with a discussion about the implications that the evolution of these indicators may have on economic growth. This would provide a richer explanation on the role that these aspects are having in EU development and growth.

Related to the former analysis, we focus both at a theoretical and empirical level on the relationship between economic growth and the improvements made in the innovation and research area, which in our opinion can be considered as a key dimension in assuring to become the most competitive and dynamic knowledge-based economy in the world. Finally, we also believe that a system of composite indicators is a good approach to gather the multidimensionality of objectives of the Lisbon Strategy and at the same time we also put special stress on the innovation and research dimension, we build a composite indicator system of this dimension as a complementary measure to the set of structural indicators selected by the Commission. The evolution of this system of composite indicators is in a last step related with economic growth.

Finally, we have observed certain deficiencies in the statistical information provided by the Eurostat. Besides the lack of a long time span for some variables, some inconsistencies have been detected after a revision of the information of the structural indicators. Undoubtedly, these problems with data may be affecting the results provided in this paper.

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