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Economic Geography and Regional Growth: An Empirical Evidence From Greece

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Economic Geography and Regional Growth: An Empirical Evidence from Greece

Abstract:

There is a huge literature regarding the main determinants and sources of economic growth. Most of the recent work emphasizes on the role of knowledge, and innovation activities typically produced by a specific sector of the economy, and furthermore in the role of entrepreneurship and analysing the implications and the importance for economic growth. Moreover, the socio-economic and public policies aim to distinguish the determining factors of growth, in order to enhance the regional cohesion and the convergence process. Much of the recent work on regional growth can be viewed as refining the basic economic insights of economic geography. There are two principal theories of why growth rates differ, the first is the theory of comparative advantage and the second is the theory of increasing returns to scale.

This paper attempts to examine the main sources of regional growth through an inter-and intra sectoral analysis. In particular, the paper attempts to investigate through an empirical inter-comparison study using statistical-data from several Greek regions, the determinant sectoral factors and the implications to growth process. We also employ the empirical non-parametric analysis. We find support for the existence of economic geography effects in several manufacturing sectors and moreover we find that these effects are economically very significant.

Key-words: Regional growth, sectoral analysis, local development

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1. Introduction

Regional differences remain the prime sources of competitive advantage. A long-term approach to development of regional knowledge economies must therefore combine local (regional) bottom-up approaches with global or European top-down approaches. There is no contradiction between global and local approaches to development of the knowledge economy. Regional policy should evolve from supporting general R&D efforts towards innovation promotion. It should also change the emphasis from a “technology-push” into a “demand-pull” approach, to identify and understand the demand for innovation in firms in the less favoured regions. Technological transfer is essential for regions which are lagging behind. It might even be more important than the development of indigenous R&D activities in the weaker regions.

This article argues that regional economic development ultimately depends on the technical change, social and human capital and civic entrepreneurship, among others. We would like to tackle the following four issues in this paper: (a) Why is innovation important for regional economic development? (b) Why is the regional dimension important for innovation promotion? (c) What has been our policy response so far and what lessons have we learnt from it? (d) Finally, what are our action lines for the future? In this paper, we will try to analyse the regional systems of innovation, and to estimate the effects of technical change in the convergence process. This paper also questions the regional policy in Europe and in particular in Greece. To do this, it examines critically the claims of regional disadvantage and examines the factors that influence regional economic and social conditions.

2. Regional Policy and the Regional Systems of Innovation

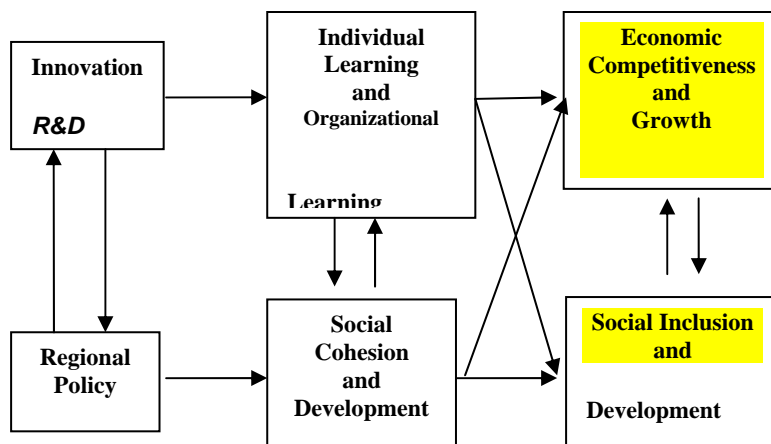
Regional policy should facilitate the identification, adaptation and adoption of technological developments elsewhere in a specific regional setting. It might be less costly, avoid duplicating previous errors and reinventing the wheel. Regional policy should facilitate technology transfer and the flow of knowledge across regions, maximising the benefit of the European dimension by facilitating access from less favoured region's economic actors to international networks of "excellence" in this field. They encourage regions to take actions such as: a) Promoting innovation, new forms of financing (e.g. venture capital) to encourage start-ups, specialised business services, technology transfer, b) interactions between firms and higher education/research institutes, c) encourage small firms to carry out R&D for the first-time, d) networking and industrial co-operation, e) developing human capabilities.

The first current originates in research on technological innovation, particularly that which refers to National Systems of Innovation and the second results from advances in theories of regional development. The discussion of National Systems of Innovation emphasizes the importance of innovations on national processes of development. These innovations are the result of the interaction between firms, clients, and government and research institutions, constituting an environment that is favourable to the learning of new ways of producing and of organizing production. One of the matters that is emphasized in this type of research are the processes through which this learning takes place and the roles carried out by the different actors that are involved. The concept of innovation that is used in this research is a broad one. It goes beyond new discoveries in activities and products on the frontiers of technological progress, to refer as well to changes in the production of less-elaborated products and to human behaviour, including changes in cultural values, routines and habits. At the same time, there are according to the authors several elements that indicate that the issues dealt with in this discussion can be better understood and analysed within a more restricted territorial environment, such as the region. This is where the second formative element of the concept of Regional Systems of Innovation enters the scenario. Evidently, a learning system that develops capability is much more onerous than one that merely supplies competence. Thus, a regional system of learning can not restrict itself to the mere transfer of competence coming from elsewhere.

This is all the more so due to the fact that all experiences are singular. From the perspective of economic development, we can not imagine that this whole framework to

increase the capability of countries/regions can dispense with intense action on the part of the State. To the extent that this regional learning system interacts formally or informally with universities, research institutes, vocational training agencies, technology transference, technological parks and firms in general, it tends to become a Regional System of Innovation. The OECD proposed a more general strategy set for all (not just less favoured) regions. Although this was not specifically focused on Information Society issues, it has clear and direct relevance for the Knowledge Economy. A territory's indigenous capacity for development is linked to the productivity of enterprises, their ability to join networks, the skills of the labour force and the strength of institutional resources. Such an approach stresses the (mainly) endogenous task of creating networks, partnerships and cooperation within the region, and five important strategies are recommended in this context: a). Use regional policies for human resource development. b) Give a demand-driven focus to human resource development. c) Base competitiveness on the development of partnerships. d) Reinforce economic efficiency by policies of equity. e) Develop regional governance to consolidate national policies. Strategies (a) and (b) were subsequently refined into one of the most important current policy and strategy approaches for developing regions in a Knowledge Economy context, the learning region. This emphasises the essential role of skills and competencies in enhancing innovative capacity and regional competitiveness. Figure 1 presents the regional and innovation policies for the learning economy.

Figure 1: Regional and Innovation Policies Towards the Learning Economy



Source: OECD (2001)

3. The European Regional Policy

The basic tendencies that prevail today and determine the future of Regional growth, they can be summarized in the followings:

- We should point out and confrontation the main global problems. For instance, we could say that the pollution of environment, the sources of energy and the dangers that they encompass, the demographic explosion in the third world, the revolutionary changes in the communications and the information technology, and finally the implications of the technological change in the international division of labor, that affecting the problems of unemployment and growth.
- Direct and continuous transformation of knowledge in action of policy planning. This orientation constitutes answer in the pressing problems that are presented in the territorial units, but also correspondence of social sciences in the development of technological sciences in the field of competition of international markets.
- Extended the analysis and the study in all levels of territorial units. The globalization of markets and the regard the economic and social changes in their global dimension impose the corresponding territorial analysis.

- Enlargement and confrontation the problems of region, as the basic problems of «geopolitical unit». The «regional identity» is strengthened at the same time with the economic completion and for this observes the constant course, even slow, to «Europe of regions».
- Research of phenomenon of «multi-centre networks» in the space and synergy that is developed among these networks. The new poles and the networks and their multidimensional relations are encouraged by the globalisation of economy and are altered in flexible means of confrontation of competition and facilitation of mobility of factors of production.

Table 1: Real GDP

Percentage change from previous year	Average 1979-89	1990	91	95	97	98	99	2000	01	02	03	04	2005	Fourth quarter 2003	Fourth quarter 2004	Fourth quarter 2005
Austria	2,1	4,7	3,3	1,6	1,6	3,9	2,7	3,4	0,8	1,4	0,8	1,6	2,4	0,6	2,1	2,5
Belgium	2,2	3,1	1,8	2,3	3,7	2,1	3,2	3,7	0,7	0,7	0,7	1,9	2,8	0,0	2,8	3,2
Czech Rep.	..	..	..	5,9	-0,8	-1	0,5	3,3	3,1	2,0	2,5	2,9	3,2	..	..	..
Denmark	1,4	1,0	1,1	2,8	3,0	2,5	2,6	2,9	1,4	2,1	0,5	2,4	2,8	1,3	2,6	2,8
Finland	3,6	-0,3	-6,4	3,4	6,3	5,0	3,4	5,1	1,2	2,2	1,0	3,4	3,8	0,6	4,2	3,5
France	2,2	2,6	1,0	1,8	1,9	3,6	3,2	4,2	2,1	1,3	0,1	1,7	2,4	0,4	2,2	2,5
Germany	1,9	5,7	5,1	1,8	1,5	1,7	1,9	3,1	1,0	0,2	0,0	1,4	2,3	0,2	1,8	2,5
Greece	0,8	0,0	3,1	2,1	3,6	3,4	3,4	4,4	4,0	3,8	4,0	4,1	3,6	3,9	4,9	3,5
Hungary	..	..	..	1,5	4,6	4,9	4,2	5,2	3,8	3,3	2,9	3,3	3,8	..	..	..
Ireland	3,1	8,5	1,9	9,9	11,1	8,6	11	10,1	6,2	6,9	1,8	3,6	4,8	2,2	3,4	5,9
Italy	2,4	1,9	1,4	3,0	2,0	1,7	1,7	3,3	1,7	0,4	0,5	1,6	2,1	0,5	2,0	2,1
Luxembourg	4,5	5,3	8,6	1,4	8,3	6,9	7,8	9,1	1,2	1,3	1,2	2,0	2,9	..	..	..
Netherlands	2,0	4,1	2,4	3,0	3,8	4,3	4,0	3,5	1,2	0,2	-0,5	1,0	2,0	0,1	1,1	2,4
Poland	..	..	..	7,0	6,8	4,8	4,1	4,0	1,0	1,4	3,3	3,5	4,5	..	..	..
Portugal	3,3	4,0	4,4	4,3	4,0	4,6	3,8	3,4	1,7	0,4	-0,8	1,5	2,6	0,7	2,1	2,8
Slovak Rep.	..	..	..	6,5	5,6	4,0	1,3	2,2	3,3	4,4	3,9	4,2	4,4	..	..	..
Spain	2,7	3,8	2,5	2,8	4,0	4,3	4,2	4,2	2,8	2,0	2,3	2,9	3,1	2,4	3,1	3,1
Sweden	2,2	1,1	-1,1	4,0	2,4	3,6	4,6	4,4	1,1	1,9	1,5	2,3	2,7	1,8	2,8	2,7
Turkey	4,0	9,3	0,9	7,2	7,5	3,1	-4	7,4	-7,5	7,8	5,0	4,9	5,4	..	..	..
U. K.	2,3	0,8	-1	2,8	3,3	3,1	2,8	3,8	2,1	1,7	1,9	2,7	2,9	2,0	2,8	3,0
Euro area	2,2	3,6	2,5	2,3	2,4	2,8	2,8	3,7	1,7	0,9	0,5	1,8	2,5	0,6	2,2	2,6
E. U.	2,2	3,1	1,9	2,5	2,6	2,9	2,8	3,7	1,7	1,1	0,7	1,9	2,5	0,9	2,3	2,7
Total OECD	3,0	3,1	1,3	2,6	3,5	2,7	3,1	3,9	0,9	1,8	2,0	3,0	3,1	2,4	3,1	3,1

Source: OECD: OECD Economic Outlook Sources and Methods (<http://www.oecd.org/eco/sources-and-methods>)

Table 2: Output gaps

Deviations of actual GDP from potential GDP as a per cent of potential GDP	1986	1987	1990	1991	1993	1994	1995	1997	1998	1999	2000	2001	2002	2003	2004	2005
Belgium	-3,0	-2,1	2,5	1,7	-2,3	-1,5	-1,2	-0,7	-0,4	0,8	2,5	0,8	-0,8	-1,9	-2,1	-1,4
Denmark	3,4	1,8	-0,8	-1,2	-3,5	-0,3	0,0	0,9	1,0	1,3	1,7	0,6	0,4	-1,2	-1,0	-0,4
Finland	-0,5	1,4	3,5	-4,3	-11	-9,0	-7,3	-2,9	-1,2	-1,0	1,2	-0,5	-1,0	-2,6	-1,5	-0,3
France	-3,9	-3,2	1,7	0,7	-2,5	-2,3	-2,4	-3,8	-2,5	-1,5	0,5	0,3	-0,4	-2,4	-2,8	-2,6
Germany	1,0	0,8	5,4	2,3	-1,9	-1,4	-1,1	-2,0	-1,6	-1,1	0,3	-0,4	-1,7	-3,3	-3,5	-2,9
Greece	-1,1	-4,2	-0,1	0,6	-4,1	-4,0	-3,9	-2,8	-2,8	-2,6	-1,7	-0,6	0,0	0,8	1,3	1,3
Ireland	-4,6	-3,5	3,9	0,5	-4,4	-4,7	-2,3	1,0	0,5	3,7	6,8	6,1	6,4	2,9	1,2	1,3
Italy	-2,0	-1,3	1,3	0,6	-3,2	-2,3	-1,0	-1,1	-0,9	-0,9	0,5	0,5	-0,9	-1,8	-1,7	-1,0
Netherlands	-0,8	-1,2	2,7	2,3	-0,7	-0,3	0,2	1,0	2,0	3,1	3,7	2,4	0,3	-1,6	-2,8	-2,4
Norway	3,5	2,2	-4,3	-3,4	-2,1	-1,2	-0,5	2,0	3,0	2,8	2,5	1,7	0,7	-0,7	-0,1	0,0
Portugal	-8,3	-4,8	3,5	4,7	-2,2	-3,7	-2,0	0,3	1,8	2,4	2,5	1,1	-1,1	-3,4	-3,5	-2,7
Spain	-3,2	-1,1	3,0	2,5	-3,5	-3,7	-3,9	-3,3	-1,8	-0,5	0,5	0,3	-0,4	-0,8	-0,6	-0,1
Sweden	2,6	3,9	3,6	0,3	-6,2	-4,3	-2,6	-2,8	-1,4	0,7	2,3	0,6	0,3	-0,5	-0,4	0,1
U. K.	-0,5	2,0	2,7	-1,4	-3,8	-2,0	-1,6	-0,6	-0,1	0,0	1,2	0,5	-0,5	-1,1	-0,9	-0,4
Euro area	-1,5	-1,0	3,2	1,6	-2,5	-2,1	-1,7	-2,0	-1,3	-0,6	0,9	0,3	-0,8	-2,2	-2,4	-1,9
E. U.	-1,4	-0,6	2,9	1,0	-2,9	-2,2	-1,7	-1,8	-1,0	-0,4	0,9	0,4	-0,7	-2,0	-2,1	-1,5
Total OECD	-1,1	-0,5	1,9	-0,3	-2,1	-1,3	-1,1	-0,2	0,1	0,5	1,2	-0,5	-1,2	-1,7	-1,2	-0,6

Source: OECD: OECD Economic Outlook Sources and Methods (<http://www.oecd.org/eco/sources-and-methods>)

Table 1 shows the Real GDP for most of the European member states indicating the existing inequalities and differences between the member states. Whereas, Table 2 illustrates

the Output Gaps between members states in the E.U. The «Output Gap» is calculated using the «production function method», as indicated by the OECD. The decade 1980 appears the diffusion of innovation in the space and the equipment of regions with advanced systems of telecommunications and innovation activities. The decades of 1990 and 2000 shape a more complicated strategy, that her main component of is the appointment of forces of synergy among all these factors that promote the developmental process, the organization of networks institutional, sector-based and territorial form and the constitution of completed parcels of strategic drawings, that serve medium and also long-term developmental scenarios.

4. The European Innovation Policy

The EU has played a major role in disseminating good practice in R&D policy by helping to create a «European Research, Technology, Development and Innovation Community», where decision-makers, researchers, and other interested parties can communicate and work together, in both formal and informal ways, in official advisory committees, specific R&D programmes and policy exchange initiatives. By assisting in this, and through its influence on policy formulation and implementation, EU policy has indirectly contributed to closing the R&TD and innovation gap between member states and regions, and, by changing the culture, it has, in some respects, improved the policy planning process. To improve the quality of regional development strategies the Commission intends to support the latest ideas, which have not yet been adequately exploited. They are expected to provide the regions with the scope for experimentation, which they sometimes lack but need to meet the challenges of the information society and to make their economies more competitive. The Commission has laid down three working topics for ERDF innovative actions in 2000-2006: (1) the regional economies based on knowledge and technological innovation; (2) information society at the service of regional development and (3) regional identity and sustainable development. The E. U. is increasingly becoming a knowledge-based economy and society. The development of knowledge has a direct effect on competitiveness and employment.

Table 3: Basic Research and Development Data, 2000

	Gross Expenditure on R&D (GERD)			Per capita
	% of GDP	% finance by Gov.	% finance by Ind.	
Australia	1.51	47.42	45.51	346
Austria	1.80	38.82	41.00	486
Belgium	1.96	23.16	66.19	484
Canda	1.84	31.84	42.55	515
Czech Rep.	1.35	44.51	51.21	193
Denmack	2.09	32.55	57.95	577
Finland	3.37	26.23	70.25	848
France	2.15	36.94	54.11	518
Germany	2.48	31.44	66.11	643
Greece	0.67	48.70	24.16	107
Hungary	0.81	49.54	37.76	100
Ireland	1.21	21.81	64.12	313
Italy	1.04	50.81	42.98	249
Japan	2.98	19.58	72.42	774
Netherlands	2.02	35.75	49.66	536
NewZealand	1.11	52.29	30.48	203
Norway	1.70	42.55	49.53	492
Poland	0.70	63.44	32.62	67
Portugal	0.75	69.68	21.32	128
Slovak Rep.	0.69	42.61	54.42	80
Spain	0.94	38.64	49.73	189
Sweden	3.78	24.48	67.76	888
Switzerland	2.64	23.24	68.96	797
Turkey	0.63	47.71	43.32	38
United Kingdom	1.86	28.91	49.27	453
United States	2.70	27.33	68.23	963
G7	2.47	27.89	65.31	730
EU-15	1.88	35.00	55.33	458
OECD Total	2.24	28.89	63.90	535

Source: Main Science and Technology Indicators, OECD (2002).

Tables 3, 4 and 5 illustrate the basic research and development data, research and development indicators and also the science and technology data for the European members states and the OECD' countries. Accordingly, the European Commission has concluded that a genuine «European Research Area» needs to be created to improve the situation. Member States need to consider policies on finance, human resources, the relationship between the public and private sectors, the creation of a common reference framework and values, and regional aspects. Regional and local authorities already support research, technological development and innovation. It is estimated that the finance they provide amounts annually to almost 1½ times the total appropriation of the EU Framework Programme (EUR 4.5 billion compared with EUR 3 billion), over 90% of which is allocated on a regional basis. The authorities concerned are best placed to form the links with companies necessary for innovation and, therefore, the generation of economic wealth and employment. Creating networks of knowledge, clusters of companies, linking the scientific system to the needs of industry and services are all easier to organise at local and regional level.

Table 4: Basic Research and Development Indicators

	Researchers, Full time eq.	Per 1000 total employment	% GDP
Australia	62 790	7.2	0.44
Austria	18715	4.7	0.53
Belgium	30 219	7.8	0.47
Canada	90 810	6.1	0.57
Czech Rep.	13 852	2.9	0.19
Denmark	18 438	6.7	0.42
Finland	26 162	11.4	0.60
France	160 424	6.8	0.36
Germany	259 214	6.7	0.40
Greece	14 828	3.8	0.33
Hungary	14 406	3.7	0.19
Ireland	8 217	5.1	0.26
Italy	64 886	2.9	0.33
Japan	647 572	9.7	0.43
Netherlands	40 623	5.1	0.53
Norway	18 295	8.0	0.49
Poland	55 174	3.7	0.22
Portugal	15 752	3.3	0.29
Slovak Rep.	9 955	4.7	0.07
Spain	76 670	4.9	0.28
Sweden	39 921	9.6	0.81
United Kingdom	157 662	5.5	0.38
United States	1 114 100	7.9	0.37
EU-15	919313	5.6	0.39
OECD Total	3 235 631	6.6	0.38

Sources: OECD.

In summary, we can state that there is a widening tendency for differences between European regions in the fields of innovations and new technologies and in particular in the subjects of Research and Development Expenditures per inhabitant. According to econometric evidence, we can also state that the European Union should improve the distribution of regional funds for research and development, in order to diminish these differences and to support researchers in the less favored regions, and consequently to affect the socio-economic and regional growth and convergence of member states (Guisan, Canelo and Diaz-Vazquez, 1998). By pursuing their own interests, therefore, regional authorities can increase the momentum towards the establishment of a European Research Area as well as ensuring its effectiveness and consistency.

Table 5: Science and Technology, 2000: Balance and Patents.

	Foreign Receipts	Foreign Payments	Foreign Balance	«Triadic» patent Total	% of foreign co-inv.	Apply EPO ICT	Bio-technology
Australia	103	225	- 122	191	26	84	60
Austria	2430	2426	4	189	36	58	25
Belgium	5642	4235	1407	368	36	92	117
Canada	1995	1409	586	379	30	267	155
Czech Rep.	287	574	- 287	8	33	1	2
Denmark				205	21	83	82
Finland	107	413	- 305	296	14	440	26
France	2 755	3169	-414	1912	15	984	250
Germany	12994	17754	-4760	4807	13	1878	445
Greece				4	33	4	1
Hungary	216	504	- 288	23	33	8	0
Iceland				2	0	7	1
Ireland				25	70	29	5
Italy	2805	3503	- 698	728	14	194	53
Japan	8435	3602	4833	9903	3	3159	416
Korea				388	5	268	29
Luxembourg				9	78	2	0
Mexico	64	454	- 390	8	44	2	5
Netherlands				722	22	620	127
NewZealand	8	4	4	20	31	10	10
Norway	1057	1284	- 227	102	22	32	12
Poland	136	813.4	- 677	4	100	2	1
Portugal	294	677	-383	7	67	1	1
Slovak Rep.	23	64	-41	6	100	1	1
Spain	191	1025	- 834	86	33	48	19
Sweden	397	45	352	782	15	424	61
Switzerland	1563	1756	- 194	657	29	168	52
Turkey				2	100	4	0
UK	16096	8923	7173	1583	25	830	374
US	38030	16106	21924	12682	8	5078	2359

Sources: OCDE

The establishment of a European Research Area, however, is not confined to the most central and competitive regions. The instruments available - the Framework Programme, the Structural Funds and action at national and regional level - should be used together in a more coherent way, each according to its objectives, in order to enable all regions to participate fully in the area

5. The Geographic Sources of Regional Growth and Regional Disparities

Regional policy aiming to reduce the existing inequalities and to enhance the cohesion. In order to measure the existing disparities at regional and sectoral levels, we can use the component-quotient indexes. Industry clusters were classified by the location quotients measured by both industry employment and by establishment counts. The Location Quotient (LQ) based on employment is defined as:

$$LQ = \frac{L_{ir}}{L_{in}} / \frac{L_r}{L_n}$$

where: L_{ir} : is the number of employees in industry (i) in the region (n)

L_{in} : is the total number of employees in all industries in location-region (r),

L_r : is the total employment in the region (r)

L_n : is the total employment in the whole regions of the country

In order to compare the performance of firms located within the industry clusters versus those outside clusters, the sample firms are classified into clustered and non-clustered groups based on the criteria and in particular, if a location has a L Q equal to or greater than unity, then there is a high concentration of the particular

activity and those firms located in this area or location are classified as clustered. More simply, the clustered group has a LQ >1, and the non-clustered group has a LQ <1.

The Urban Space Concentration Index (CI) based on employment is defined as:

$$CI = \frac{1}{2} \sum_{i=1}^k \left| \frac{L_{ir}}{L_{in}} / \frac{L_r}{L_n} \right|$$

where: L_{ir} : is the number of employees in industry (i) in the region (n)

L_{in} : is the total number of employees in all industries in location-region (r),

L_r : is the total employment in the region (r)

L_n : is the total employment in the whole regions of the country

k: is the number of regions in the country

Table 6: Location Quotient Component Index for Regions & Activities in Greece, 1999

Regions \ Sectors	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Agriculture	0,006	0,017	2,039	2,978	1,200	1,973	1,328	2,117	1,555	0,043	2,198	1,120	0,416	1,926
Fisheries	0,128	0,297	0,914	2,362	0,347	0,589	2,223	0,844	3,851	0,326	1,650	6,550	5,333	0,669
Mining	0,201	0,099	1,664	1,315	11,689	0,430	0,465	0,352	4,038	0,275	1,967	0,667	1,604	0,247
Manuf. Industries	1,194	1,595	0,797	4,038	0,972	0,690	0,484	0,616	1,172	1,227	0,588	0,569	0,483	0,427
Electricity	1,237	0,609	0,529	1,331	5,018	0,625	0,442	0,627	0,943	1,239	1,001	1,188	1,237	0,683
Construction	0,842	0,780	0,774	2,569	1,274	1,011	1,254	1,212	1,195	0,941	0,992	1,517	1,701	0,842
Retail Services	1,221	1,375	0,779	3,273	0,759	0,841	0,997	0,765	0,738	1,208	0,739	0,936	0,947	0,796
Hotels – Restaurants	0,685	0,905	0,823	3,068	0,829	0,827	2,587	0,704	0,780	0,724	0,754	1,032	4,123	1,927
Transportations	1,486	0,993	0,631	2,311	0,605	0,547	1,169	0,764	0,750	1,447	0,712	1,485	1,098	0,633
Financial Organizations	1,822	1,123	0,433	2,398	0,557	0,505	0,455	0,503	0,412	1,697	0,620	0,690	0,521	0,586
Real Estate	1,659	1,598	0,411	3,063	0,611	0,537	0,562	0,456	0,587	1,570	0,488	0,719	0,763	0,521
Public Services	1,383	0,966	0,888	2,304	0,826	0,825	0,581	0,754	0,790	1,351	0,633	1,147	1,011	0,740
Education	1,232	1,381	0,807	2,973	1,031	0,988	0,636	0,804	0,861	1,175	0,764	0,891	0,532	0,912
Health Services-Social Protection	1,454	1,390	0,754	2,760	0,730	0,687	0,624	0,687	0,452	1,393	0,613	0,826	0,638	0,906
Other Activities	1,359	1,255	0,725	2,865	0,729	0,770	0,862	0,601	0,715	1,330	0,812	0,789	1,305	0,614
Private Households	1,847	1,027	0,373	2,633	0,452	0,560	0,817	0,584	0,307	1,767	0,245	0,276	0,393	0,436
Other Organizations	2,369	0	0	0	0	0	2,553	0	0	2,119	0	0	0	1,374

Source: Our Estimations

Note: 1 = Capital – Region of Athens

2 = Region of Thessalonica

3 = Region of East Macedonia and Thrace

4 = Region of Central Macedonia

5 = Region of West Macedonia

6 = Region of Thessaly

7 = Region of Ionian Islands

8 = Region of West Greece

9 = Region of East Main / Sterea Greece

10 = Region of Attica

11 = Region of Peloponnesus

12 = Region of N. Aegean

13 = Region of S. Aegean

14 = Region of Crete

A location quotient greater than unity, indicates a higher clustering in location s relative to the whole country. When the CI is greater than unity there is a specialization for this particular activity – concentration index in the region that accounts the most of the employment in this specific region. From the other hand, when the CI is equal to a unity there is non-specialization in this particular activity – concentration in the region and the employment in this specific activity in the region is more or less the same with that of the national level. Likewise, a location quotient less than unity indicate that an economic activity is relatively less concentrated. We can use the location quotients to measure the level of clustering of industry clustering and trace the changes of economic development using location quotients at county level over the past three decades.

Table 7: Urban Space Concentration Component Index of Regions-Activities in Greece, 1999

Regions	Urban Space Concentration Index
Agriculture	0,0000008
Fisheries	0,0000015
Mining	0,0000022
Manufacturing Industries	0,0000007
Electricity	0
Construction	0,0000018
Retail Services	0,0000133
Hotels – Restaurants	0
Transportations	0
Financial Organizations	0
Real Estate	0,0000024
Public Services	0
Education	0,0000103
Health Services & Social Protection	0,0000046

Source: Our Estimations

We have used the available data-set from Greece derived from National Statistic Search of Labour Force, in order to investigate at a sectoral and regional analysis the ranking of cohesion and disparities. Tables 6 and 7 illustrate the results of indexes component analysis.

6. Modelling the theoretical framework of productivity, technical change and regional growth

There are many different productivity measures. The choice between them depends on the purpose of productivity measurement and, in many instances, on the availability of data. Broadly, productivity measures can be classified as single factor productivity measures (relating a measure of output to a single measure of input) or multifactor productivity measures (relating a measure of output to a bundle of inputs). Another distinction, of particular relevance at the industry or firm level is between productivity measures that relate some measure of gross output to one or several inputs and those which use a value-added concept to capture movements of output.

Table 8: Overview of main productivity measures

Type of output measure	Type of input measure			
	Labor	Capital	Capital and labor	Capital, labor and intermediate)
Gross output	(a). Labor productivity (based on gross output)	(c). Capital productivity (based on gross output)	(e). Capital-labor MFP (based on gross output)	(f). KLEMS multifactor productivity
Value added	(b). Labor productivity (based on value added)	(d). Capital productivity (based on value added)	(g). Capital-labor MFP (based on value added)	-----
	Single factor productivity measures: (a), (b), (c), (d).		Multifactor productivity (MFP) measures: (e), (f), (g).	

Note: Intermediate goods includes: energy, materials and services. Other approaches consider intermediate factors of production more complementary than substitutive for primary inputs (labor and capital) and thus they are considered outside the production function as in the three regimes growth approach suggested by Guisan(1980) and (2004).

Table 8 uses these criteria to enumerate the main productivity measures. The list is incomplete insofar as single productivity measures can also be defined over intermediate inputs and labor-capital multifactor productivity can, in principle, be evaluated on the basis of gross output. However, in the interest of simplicity, Table 1 was restricted to the most frequently used productivity measures. These are measures of labor and capital productivity, and multifactor productivity measures (MFP), either in the form of capital-labor MFP, based on a value-added concept of output, or in the form of capital-labor-energy-materials MFP (KLEMS), based on a concept of gross output. Total factor productivity is defined as the change in output after taking account of growth in physical capital and changes in the quantity and quality of labor input. These measures are not independent of each other. For example, it is possible to identify various driving forces behind labor productivity growth, one of which is the rate of MFP change.

We can also adopt the index number approach in a production theoretic framework. This «growth accounting» technique examines how much of an observed rate of change of an industry's output can be explained by the rate of change of combined inputs. Thus, the growth accounting approach evaluates multifactor productivity (MFP) growth residually. To construct an index of an industry's output, different types of outputs have to be weighted with their share in total output. To construct an index of combined inputs, the rates of change of different inputs (labor, capital, intermediate inputs) have to be weighted appropriately.

The econometric approach to productivity measurement is only based on observations of volume outputs and inputs. Furthermore, it is possible to investigate forms of technical change other than the Hicks-neutral formulation implied by the index number based approach; and there is no *a priori* requirement to assume constant returns to scale of production functions. The literature about the econometric approach is large, and examples of integrated, general models can be found in Morrison (1986) or Nadiri and Prucha (2001). Hulten (2001) points out that there is no reason why the econometric and the index number approach should be viewed as competitors. Econometric methods are used to further explain the productivity residual, thereby reducing the ignorance about the «measure of our ignorance».

6.1. The Growth Accounting Approach: Growth accounting and most other approaches to measuring productivity are firmly rooted in a standard neo-classical equilibrium concept. Equilibrium conditions are very important because they help to guide measurement of parameters that would otherwise be difficult to identify. An obvious example is the use of cost shares instead of output elasticities - the former are observable, the latter are not, but theory shows that, in competitive equilibrium, one must equal the other. Although it's usefulness is generally recognized, it has been argued that an equilibrium approach sits uneasily with the notion of innovation and productivity growth. Evolutionary economists, in the tradition of Schumpeter, argue that innovation and technical change occur as a consequence of information asymmetries and market imperfections. In a quite fundamental sense, innovations and information asymmetries are one and the same phenomenon. Indeed, such asymmetries can scarcely be termed market imperfections when they are necessary conditions for any technical change to occur in a market economy. The point made by evolutionary economists is that equilibrium concepts may be the wrong tools to approach the measurement of productivity change, because if there truly was equilibrium, there would be no incentive to search, research and innovate, and there would be no productivity growth.

6.2 The Index Number Approach: Accounting is not explaining the underlying causes of growth. Growth accounting and productivity measurement identifies the relative importance of different proximate sources of growth. At the same time, it has to be complemented by institutional, historical and case studies if one wants to explore the underlying causes of growth, innovation and productivity change. Because the technology parameter cannot be observed directly, MFP growth is derived as the difference between the rate of growth of a Divisia index of output and a Divisia index of inputs, as shown below. The Divisia index of inputs is made up of the logarithmic rates of change of primary and intermediate inputs, weighted with their respective share (s_X, s_M) in overall outlays for inputs:

$$\begin{aligned} \text{Percentage (\%)change of gross-output based MFP} &= \\ &= \frac{\partial \ln H}{\partial t} - \frac{\partial \ln A}{\partial t} = \frac{d \ln Q}{dt} - s_X \frac{d \ln X}{\partial t} - s_M \frac{d \ln M}{\partial t} \end{aligned}$$

Alternatively, one could define a *value-added function*. A value-added function presents the maximum amount of current-price value added that can be produced, given a set of primary inputs and given prices of intermediate inputs and output. Such a value-added function is an equivalent ("dual") representation of the technology described by a production function. For the present purpose, call the value-added function $G = G(A(t), X, P_M, P)$. Dependence of the value-added function on intermediate input prices P_M and on gross-output

prices P signals that producers adjust the level of intermediate inputs when relative prices change. Just as the measure of technical change for the production function was defined as the shift of that function over time, productivity change could be defined as a shift of the value-added function, *i.e.* as the relative increase in value added that is associated with technical change. Parallel to the earlier statement regarding the production function, this can be formulated as $\frac{\partial \ln G}{\partial t}$.

Again, this change cannot be directly observed but it can be shown that it corresponds to the difference between the growth rate of the Divisia volume index of value added (called VA) and the growth rate of the Divisia index of primary inputs:

$$\begin{aligned} \text{Percentage (\%)} \text{ change of value-added based MFP} &= \\ &= \frac{\partial \ln G}{\partial t} = \frac{d \ln VA}{dt} - \frac{d \ln X}{dt}. \end{aligned}$$

6.3. The Approach of Cost Function: A cost function shows the minimum input cost of producing a certain level of output, given a set of input prices. Under relatively weak regularity conditions, cost functions can be derived foregone to provide the amount of savings needed to permit capital accumulation. In practice, this would imply the use of a private consumption deflator in the perpetual inventory method. The effect is to relegate all advances in knowledge (embodied and disembodied) explicitly to the productivity residual. See also Durand (1996) on this point from production functions, and vice versa - there is duality. To illustrate this point, one expresses a simple cost function C as $C = B Q^{-c(w_1, w_2, \dots, w_N)}$, where C is total cost that varies as a function of the level of output, Q , of unit costs c (themselves dependent on input prices w_i) and of a parameter B . This parameter plays a role similar to the productivity parameter A in the production function $Q = A \cdot F(X_1, X_2, \dots, X_N)$. It can indeed be shown that $\frac{d \ln A}{dt} = -\frac{d \ln B}{dt}$.

Thus, the MFP productivity residual can be measured either as the residual growth rate of output not explained by the growth rate of inputs or as the residual growth rate of average costs not explained by change in input prices:

$$\frac{d \ln C}{dt} - \frac{d \ln Q}{dt} = \sum_i s_i \frac{d \ln w_i}{dt} - \frac{d \ln A}{dt}.$$

This expression states that the rate of growth of average costs equals the rate of growth of aggregate input prices, reduced by advances in multifactor productivity. A slightly different formulation is that productivity growth equals the diminution in total costs that is neither explained by a fall in output nor by substitution of inputs that have become relatively more expensive for those whose relative price has fallen.

This formulation of MFP in terms of average costs lends a richer interpretation to technological change. It is intuitively plausible that total and average costs can be reduced by many means including technological innovations in an engineering sense but also by organizational innovations, learning-by-doing, and managerial efforts. The cost approach also shows how average cost can decline as a consequence of embodied technological change only: suppose that one of the inputs exhibits falling prices (user costs) relative to other inputs as a consequence of (embodied) technical change. Most likely, a substitution process will take place where computer services replace other factors of production.

6.4. Modeling a Flexible Functional Form: The starting point of this model is the *translog function*. The objective is to characterize the distribution of the value of output between capital and labor inputs and changes in this distribution over the time. To do this we must describe capital and labor inputs in terms of the value shares. The aggregate cost (or production) function is based on a cost function (or a production function), which is characterised by constant returns to scale:

$$C = F(P_K, P_L, Y, T)$$

where: P_K , P_L , Y , T indicate the price of capital input, labor input, the value added and time. If the cost function C is increasing then the value shares are nonnegative. To be able to check these restrictions for particular values of capital and labor prices and time, we can compute the value shares and verify that they have the right sign. Similarly, the share elasticities can be expressed in terms of the second order partial derivatives of the cost function with respect to capital and labor prices. The translog cost function can be written, (where $ij=K,L$):

$$\ln C(P_K, P_L, Y, T) = \alpha_0 + \alpha_Y \ln Y + \frac{1}{2} \alpha_{YY} (\ln Y)^2 + \sum_{i=1}^n \alpha_i \ln P_i + \frac{1}{2} \sum_{i=1}^n \sum_{j=1}^n \gamma_{ij} \ln P_i \ln P_j + \sum_{i=1}^n \gamma_{iy} \ln P_i \ln Y$$

$$\gamma_{TT} + \frac{1}{2} \gamma_{TT} T^2 + \sum_{i=1}^n \gamma_{iT} \ln P_i T + \gamma_{YT} \ln Y T$$

We use aggregate data and assuming that input prices are endogenous, in order to estimate the *translog share equation system* and to avoid the simultaneous equation problems, we employ three stage least squares with an instrumental variable estimator provided that appropriate instruments are available. Output is measured as value added. Labor is measured as the number of employees and capital is measured as the capital stock. As the price of capital we use the long-term interest rate and as the price of labor wages and salaries.

The σ_{LL} , σ_{KK} have to be negative because of the *demand law* for inputs (as actually they are negative in the following results). That implies downward slopping demand curves for the inputs. If σ_{KL} (the substitution elasticity between K and L) is positive then K and L are complements (otherwise they are substitutes). Finally, we can derive *technical change* into neutral (related only to time) and non neutral (related to the time path inputs of capital and labor respectively: γ_{KT} and γ_{LT}). The parameters α_K and α_L can be interpreted as the average value shares of capital and labor inputs. The parameters γ_T and α_Y indicate the average (negative) rate of technical change and the average share of output in total cost and the parameter γ_T can be also interpreted as the average rate of productivity growth.

7. An empirical estimation of productivity, technical change and growth

Once productivity measures are conceptualised on the basis of economic theory, there are several ways to go about their empirical implementation. From a broad methodological viewpoint, parametric approaches can be distinguished from non-parametric ones. In the first case, econometric techniques are applied to estimate parameters of a production function and so obtain direct measures of productivity growth. In the second case, properties of a production function and results from the economic theory of production are used to identify empirical measures that provide a satisfactory approximation to the unknown «true» and economically defined index number. The growth accounting approach to productivity measurement is a prominent example for non-parametric techniques.

All estimations are based on national data derived from OECD's data bank. We use aggregate data and assuming that input prices are endogenous, in order to estimate the *translog share equation system* and to avoid the simultaneous equation problems, we employ three stage least squares with an instrumental variable estimator provided that appropriate instruments are available. Output can be represented as a function of two inputs and the time as an indicator of the level of technology. Substitution possibilities among intermediate inputs and primary factor input can be incorporated explicitly. Output is measured as value added. Labor is measured as the number of employees and capital is measured as the capital stock. As the price of capital we use the long-term interest rate and as the price of labour wages and salaries. To estimate the above model of the average cost functions along with the share of one input and the rate of technical change, we adopted the three stage least squares (using instrumental variables with endogenous lag variables, such as lag shares, lag prices of capital, labour and output and some exogenous variables, such as export and import prices and consumer prices). Table 9 shows the aggregate developments of output, employment and

productivity growth in the US, EU and Japan, as well as the growth rates for individual EU countries.

Table 9: Recent trends in productivity growth, 1980-1999 (percentage change at annual rate)

	Trend growth in GDP per hour worked		Trend growth in multi-factor productivity	
	1980-90	1990-99	1980-90	1995-99
Canada	1,1	1,3	0,5	1,3
Mexico	..	-0,6	..	..
United States	1,3	1,6	0,9	1,2
Australia	1,2	2,0	0,5	1,5
Japan	3,2	2,5	2,1	0,9
Korea	6,3	5,1	..	..
New Zealand	..	0,7	0,7	0,7
Austria	..	..	..	..
Belgium	2,4	2,3	1,7	1,6
Czech Republic	..	..	..	..
Denmark	1,7	1,8	0,9	1,5
Finland	2,8	2,9	2,3	3,6
France	2,7	1,8	1,8	1,1
Germany	2,3	2,0	1,5	1,1
Greece	1,3	1,4	..	..
Hungary	..	2,7	..	..
Iceland	..	1,5	..	1,4
Ireland	3,6	4,3	3,6	4,6
Italy	2,6	2,0	1,5	0,8
Luxembourg	..	5,1	..	..
Netherlands	2,9	1,8	2,3	1,5
Norway	2,6	2,6	1,2	1,2
Portugal	..	2,3	..	..
Spain	3,2	1,4	2,3	0,5
Sweden	1,2	1,7	0,7	1,3
Switzerland	..	0,8	..	..
United Kingdom	2,3	1,9	2,2	1,0

Source: Calculations based on data from the OECD Economic Outlook.

Comparing the EU with Japan and the US, the Table 9 shows that during the 1980s, real GDP growth was fastest at 4.0 per cent per year on average in Japan, followed by 3.2 per cent in the US. Growth was slowest in the EU at only 2.4 per cent. During the early 1990s GDP growth slowed in all three regions, but both the US and the EU saw a substantial recovery during the second half of the 1990s. However, the recovery was much faster in the US than in the EU. In contrast, the EU realized a substantial expansion in labor input but productivity growth slowed down to a rate that was substantially lower than that achieved during the 1980s. These growth rates can also be seen in conjunction with estimates of the distance between countries in levels of GDP, labor productivity and employment rates. Starting from a higher level in 1980, and continuing through to the early 1990s, the EU GDP level fell below that of the US in the second half of the 1990s. Moreover the labor productivity gap between the EU and the US also widened at this time. This has been the first time since World War II that the productivity level in the EU did not converge to the US level for a sustained period.

Some European countries, per capita income levels are lower due to lower labor intensity levels in the EU. In contrast to the US position, however, there is as yet less evidence that this productivity slowdown is of a structural nature. Firstly, it should be noted that the productivity growth rates experienced in recent years in the EU are no less than those in the US

in the 1980s and so recent experience may largely be driven by the end of catch-up growth, before any benefits from the new technology were manifest. Many EU countries are still in the midst of an adjustment process towards a new arrangement of their economies, with less emphasis on capital intensive manufacturing, and a greater emphasis on technology use and diffusion in services. Secondly, there is still a much greater potential in terms of underutilized resources to be employed in the EU. This latter view is consistent with the notion that the EU is merely lagging the US in the adoption of new technology and that the EU will see the benefits within the next decade.

As the most advanced European countries were approaching the US productivity level, the benefits of technology borrowing got gradually exhausted. The joint process of European economic integration and more intensive global capital flows (including foreign direct investment) required these countries to find new ways to increase efficiency and develop new markets domestically and internationally. At the same time, lower income countries in the EU, for instance Finland, Ireland, and to a lesser extent Spain and Portugal) have continued to benefit from their catch-up potential, but the realization of that potential has been very much dependent on their specific initial conditions.

It can be seen from Table 10 that the major contributors to EU labor productivity growth in the 1980s are Germany, France, the UK and Italy. By the end of the 1990s, the slowdown can be seen to be chiefly the result of the decline in all of these large nations, excepting the U.K. Many of the smaller EU-15 nations have seen modest reductions over this period, and a number of the Southern European nations have seen slight increases. But the fortunes of Germany and Italy in particular have had a large impact on the EU growth slowdown. The EU is considerably less competitive than the US in the manufacture of high technology equipment. In many traditional manufacturing industries, however, the EU is now competitive relative to the US.

Table 10: Contributions of member states to EU-15 annual labour productivity growth 1979-2001

	1979-1990	1990-1995	1995-2001
Belgium	0.08	0.09	0.03
Denmark	0.04	0.05	0.02
Germany	0.59	0.68	0.22
Greece	0.01	0.02	0.05
Spain	0.18	0.15	0.22
France	0.40	0.27	0.22
Ireland	0.02	0.04	0.10
Italy	0.27	0.36	0.18
Luxembourg	0.01	0.01	0.01
Netherlands	0.14	0.13	0.11
Austria	0.07	0.09	0.04
Portugal	0.02	0.02	0.04
Finland	0.05	-0.01	0.04
Sweden	0.06	0.03	0.06
UK	0.31	0.38	0.39
EU-15	2.26	2.31	1.72

Source: Data derived from OECD.

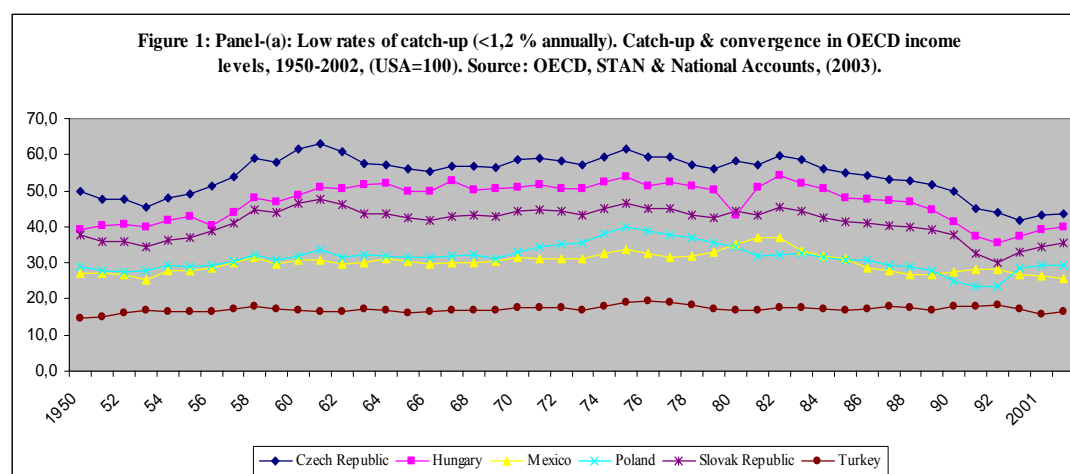
Table 11 illustrates the labor productivity in EU manufacturing industries. But comparisons with the US are less relevant here, since both the EU and US are likely to have high unit labor costs relative to their main competitors in developing countries. Japan is the country with the highest labor productivity slowdown across the two periods, losing ground to both the EU and the US.

Average labor productivity growth decreased from a rate of 3.02% in the period 1992-1995 to a negative - 0.5% in 1996-2001. The service sector experiences the most severe deceleration with growth rates going from 3.97% to -1.09%. These trends are not surprising given the economic difficulties the Japanese economy had to face since the late 1980s. In fact, labor productivity growth at the aggregate economy level has been decreasing since 1985.

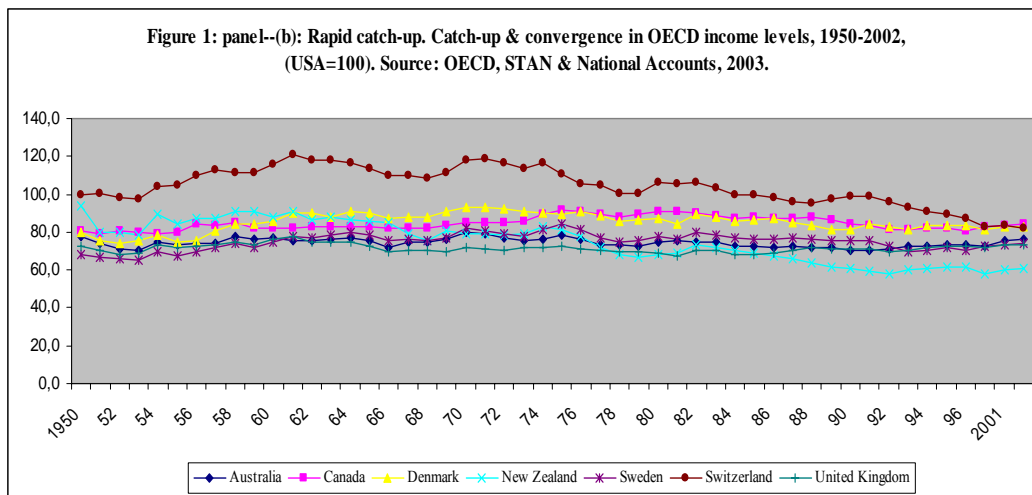
Table 11: Labor productivity in EU-14 manufacturing industries relative to the US (US=100)

	ISIC rev 3	1979-81	1994-96	1999-01
Food, drink & tobacco	15-16	64.5	79.7	100.6
Textiles	17	103.4	99.1	100.8
Wearing apparel	18	66.1	67.7	61.0
Leather	19	95.2	88.0	89.9
Wood products	20	63.0	86.8	101.3
Pulp and paper products	21	76.8	104.9	120.0
Printing & publishing	22	67.0	120.3	134.5
Chemicals	24	54.7	70.5	78.4
Rubber & plastics	25	180.2	145.8	127.0
Non-metal mineral products	26	121.2	142.6	148.8
Basic metals	27	65.1	109.1	107.8
Fabricated metal	28	108.9	108.5	111.4
Machinery	29	66.5	97.4	110.8
Computers	30	133.3	89.8	71.9
Insulated wire	313	87.3	93.7	77.6
Other electrical machinery	31-313	79.7	91.3	112.1
Semiconductors	321	47.8	31.8	41.6
Telecommunication eq.	322	71.9	63.9	65.7
Radio and television receivers	323	44.0	62.8	63.1
Scientific instruments	331	114.4	106.9	103.2
Other instruments	33-331	42.8	49.2	47.3
Motor vehicles	34	30.0	44.9	43.7
Ships and boats	351	59.2	95.8	88.7
Aircraft and spacecraft	353	46.7	71.1	71.8
Railroad and other transport	352+359	68.8	76.4	80.4
Furniture, miscellaneous goods	36-37	110.5	100.8	94.4
Total manufacturing	15-37	84.6	88.0	80.3

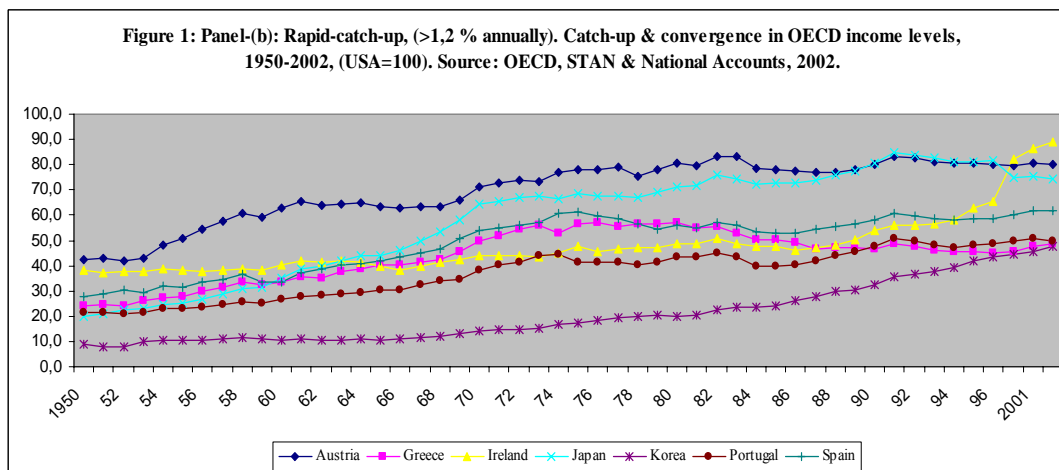
Sources and data derived from OECD.



MFP is commonly defined as the portion of output growth left after accounting for growth in capital and labor, where both capital and labor are expressed in quality-adjusted terms. This measure captures disembodied technological and organizational improvements that increase output for given amount of inputs. Dale Jorgenson, in particular, argues that this is the only identifiable component of technological progress. The other procedures to calculate MFP that use different measures for the capital aggregate, for instance capital stock at acquisition prices, are likely also to pick up changes in the composition and quality of the capital stock due to other reasons than technological change. Other researchers have recently focused on the identification of the «embodied» part of technological progress. Greenwood (1999) and Hercowitz (1998) have suggested a way to tackle the «embodiment» controversy by adding an additional source of information (and in fact mixing the primal and dual approach). On the one hand they suggest the estimation of the disembodied component as the residual of a production function.



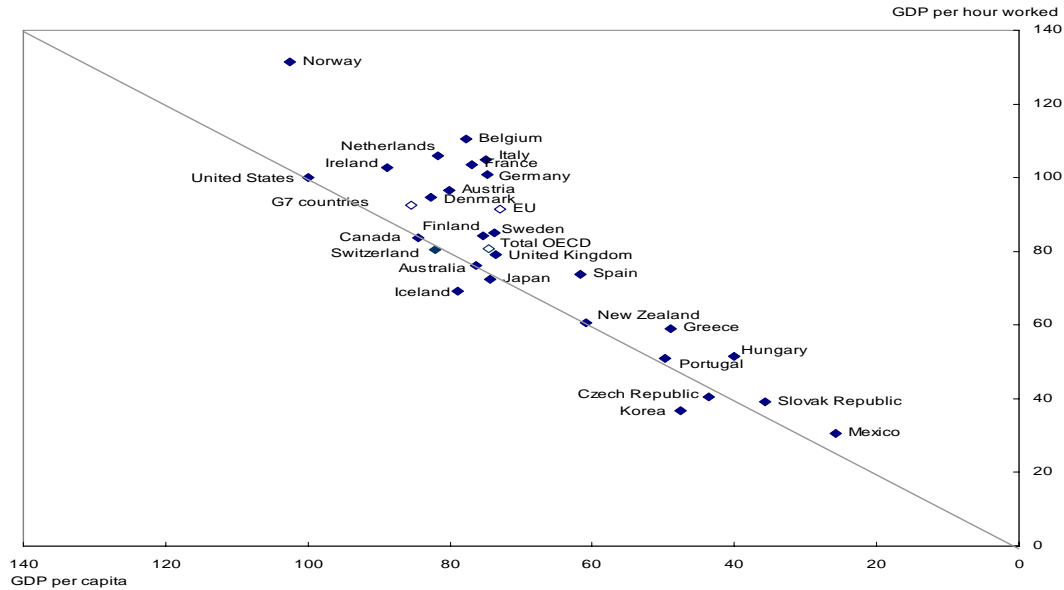
Low starting point, low rates of catch-up In the European area, cross-country differences in GDP per capita and labor productivity have eroded considerably since the 1950s. Over the 1950s and 1960s, income levels of European countries except the United Kingdom that was catching up with those of the United States. In the 1970s, this phenomenon was less widespread and the rate of catch-up had fallen, Korea being the main exception. In the 1980s, there was even less catch-up, as GDP per capita grew more slowly than in the United States in 19 OECD countries.



The same was true for 20 OECD countries in the 1990s. Japan and Korea had the highest rates of catch-up over the 1950-99 period, with GDP per capita growing more rapidly, by 2.7% and 3.2%, respectively, than in the United States. Most of Western Europe had much lower rates of catch-up, typically below 1% a year. Countries such as Australia, New Zealand, the United Kingdom and Canada were already at relatively high income levels in 1950 and have since done little catching up with the United States. Switzerland had a marked decline in relative income levels.

From the estimation of a flexible functional form, namely the translog function, we can summarise that the σ_{LL} , σ_{KK} have to be negative because of the *demand law* for inputs (as actually they are negative in the following results). That implies downward sloping demand curves for the inputs. If σ_{KL} (the substitution elasticity between K and L) is positive then K and L are complements (otherwise they are substitutes). Finally, we can derive *technical change* into neutral (related only to time) and non neutral (related to the time path inputs of capital and labor respectively: γ_{KT} and γ_{LT}).

Figure 2: GDP per capita and GDP per hour worked , (USA=100), 2002.



Using the translog cost function, we can estimate the appropriate parameters indicating the average value shares of capital and labour inputs. In addition, we can estimate the parameters showing the average rate of technical change, the average share of output in total cost, and also the average rate of productivity growth. Finally, we can estimate the constant share elasticities describing the implications of patterns of substitution for the relative distribution of output between capital and labour. The bias estimates describing the implications of patterns of productivity growth for the distribution of output. An alternative and equivalent interpretation of the biases is that they represent changes in the rate of productivity growth with respect to proportional changes in input quantities.

Summarizing the main econometric results for a selected number of member states using a flexible functional form, namely the translog cost function, we can conclude the following points:

- The results of multivariate regression include the countries of France, Germany, Italy, Netherlands and United Kingdom (the first category of more advanced member states) and Greece, Ireland and Spain (the second category of less advanced member states).
- The estimate parameter, indicating the average value share of output in the total cost, has a positive value which for all member states, except for Britain and Ireland. There is an estimation of the parameter of *the rate of technical change or the acceleration rate*, indicating how time affects the growth of output, appearing a negative value for both Ireland and the United Kingdom.
- We assumed a two factor cost function, indicating the substitution patterns between the two factors (capital and labour), whereas, capital and labour are substitute except the case of France where it is positive but not statistically significant.
- The parameter of *flexibility cost* indicating that the marginal cost will change with a change in the level of output, whereas for three countries, namely England, Germany and Ireland, indicate that the marginal cost will increase as the output expands.
- The share of capital (or in other words, it show how an input's share would be affected by a change in the level of output) showing that increases with an increase in output for Britain, Germany, Greece, Italy and Ireland, while in the other countries namely France, Netherlands and Spain, it decreases. Exactly the opposite estimated for labour input and for the share of labour.
- Looking for the impact of technical change on the growth of output, the estimated parameter suggests that the technical change is biased and they represent a change of factor share with respect to time. This parameter indicates that the technical change in England and Ireland decreases aggregate the output.

- Finally, we can estimate the *multifactor productivity MFP*, or the rate of technical change, that is decomposed into three parts, pure technology, non- neutral technology and scale augmenting technology. The *multifactor productivity* is negative for all countries, except Spain, which means technological change reduces total costs.

Table 12: Parameter estimations, time-series translog-cost function, Greece (1959-90)

	α_0	α_ψ	$\alpha_{\psi\psi}$	α_K	α_L	γ_T	γ_{KK}	γ_{LL}	γ_{TT}	$\gamma_{\psi T}$	$\gamma_{K\psi}$	γ_{KL}	γ_{KT}	$\gamma_{L\psi}$	γ_{LT}
20	2.0 (7.0)	2.6 (5.0)	-1.4 (-1.8)	0.51 (6.9)	0.49 (6.6)	-0.1 (-2.8)	0.01 (0.4)	0.01 (0.4)	-0.03 (-1.4)	0.21 (1.5)	-0.1 (-2.1)	-0.01 (-0.4)	0.17 (2.6)	0.10 (2.1)	-0.1 (-2.6)
21	-0.60 (-1.3)	4.59 (4.4)	-2.28 (-1.2)	0.80 (8.4)	0.20 (2.1)	-0.42 (-2.2)	0.017 (0.8)	0.017 (0.8)	-0.05 (-0.8)	0.34 (0.9)	-0.06 (-1.6)	-0.01 (-0.8)	0.013 (2.3)	0.062 (1.6)	-0.01 (-2.35)
22	0.63 (0.5)	1.98 (1.5)	-0.5 (-0.7)	0.40 (2.6)	0.60 (4.0)	-0.05 (-0.3)	-0.03 (-0.1)	0.090 (2.7)	-0.02 (-1.7)	0.094 (0.9)	-0.10 (-2.5)	0.03 (0.1)	0.015 (3.4)	-0.03 (-1.8)	-0.086 (-1.7)
23	0.710 (1.7)	3.195 (4.4)	-1.19 (-1.2)	0.64 (5.4)	0.36 (3.1)	-0.24 (-2.0)	-0.03 (-0.1)	-0.03 (-0.1)	-0.01 (-0.5)	0.132 (0.7)	-0.10 (-2.5)	0.037 (0.1)	0.015 (3.4)	0.104 (2.5)	-0.015 (-3.4)
24	3.42 (22)	0.91 (2.5)	-1.10 (-2.5)	0.16 (5.7)	0.84 (32)	0.055 (0.6)	0.096 (7.7)	0.096 (7.7)	-0.03 (-1.9)	0.201 (2.1)	-0.05 (-0.3)	-0.09 (-7.7)	0.012 (3.8)	0.05 (0.3)	-0.012 (-3.8)
25	3.84 (37)	0.55 (0.9)	-0.49 (-0.5)	0.18 (3.8)	0.82 (17)	0.049 (0.5)	0.088 (3.8)	0.088 (3.8)	-0.02 (-0.7)	0.101 (0.6)	-0.04 (-1.6)	-0.08 (-3.8)	0.19 (5.3)	0.044 (1.6)	-0.019 (-5.3)
26	2.93 (27)	1.566 (4.7)	0.057 (0.6)	0.24 (5.8)	0.76 (18)	-0.03 (-0.1)	0.042 (1.9)	0.042 (1.9)	0.060 (0.2)	-0.04 (-0.2)	-0.08 (-3.4)	-0.04 (-1.9)	0.019 (3.9)	0.089 (3.4)	-0.019 (-3.95)
27	1.906 (2.6)	1.558 (1.2)	0.179 (0.1)	0.01 (0.7)	0.99 (9.8)	-0.06 (-0.3)	0.130 (4.9)	0.130 (4.9)	0.019 (0.4)	-0.07 (-0.3)	0.166 (0.4)	-0.13 (-4.9)	0.104 (1.8)	-0.01 (-0.4)	-0.010 (-1.8)
28	3.24 (5.4)	-0.10 (-0.9)	0.849 (0.6)	0.19 (1.5)	0.81 (6.7)	0.169 (1.0)	0.107 (3.1)	0.10 (3.1)	0.163 (0.4)	-0.12 (-0.6)	0.064 (1.2)	-0.10 (-3.1)	0.071 (0.7)	-0.06 (-1.2)	-0.071 (-0.7)
29	2.240 (5.4)	1.832 (3.4)	0.511 (0.9)	0.15 (2.9)	0.85 (18)	-0.04 (-0.7)	0.055 (2.7)	0.05 (2.7)	0.253 (1.7)	-0.14 (-1.7)	0.010 (0.4)	-0.05 (-2.7)	0.069 (2.0)	-0.01 (-0.4)	-0.069 (-2.01)
30	3.124 (14)	1.146 (1.4)	-0.23 (-0.7)	0.25 (3.2)	0.75 (10)	-0.01 (-0.7)	0.120 (4.0)	0.12 (4.0)	-0.01 (-0.1)	0.080 (0.1)	-0.16 (-2.7)	-0.12 (-4.0)	0.043 (3.6)	1.60 (2.7)	-0.043 (-3.6)
31	4.214 (5.8)	-0.13 (-0.1)	-0.16 (-0.4)	0.51 (6.0)	0.49 (5.7)	0.515 (0.4)	0.058 (1.8)	0.05 (1.8)	-0.01 (-1.6)	0.070 (1.2)	0.015 (0.2)	-0.05 (6.0)	0.022 (0.1)	-0.01 (-0.2)	-0.022 (-0.1)
32	0.98 (0.9)	3.609 (2.3)	-2.92 (-1.3)	0.76 (6.0)	0.24 (1.9)	-0.19 (-0.7)	(*)	(*)	-0.11 (-1.6)	0.555 (1.4)	-0.16 (-3.0)	(*)	0.032 (3.6)	0.160 (3.0)	-0.032 (-3.6)
33	2.056 (5.4)	1.726 (2.0)	0.786 (0.5)	0.36 (5.9)	0.64 (10)	-0.05 (-0.4)	0.052 (3.2)	0.052 (3.2)	0.039 (0.9)	-0.19 (-0.8)	-0.06 (-2.4)	-0.05 (-3.2)	0.017 (5.4)	0.060 (2.4)	-0.017 (-5.4)
34	3.259 (13)	0.324 (0.5)	-0.21 (-0.2)	0.22 (2.2)	0.78 (8.3)	0.132 (1.2)	0.167 (5.4)	0.167 (5.4)	-0.01 (-0.4)	0.075 (0.3)	-0.06 (-1.4)	-0.16 (-5.4)	0.031 (4.0)	0.060(1) (.4)	-0.031 (-4.0)
35	2.419 (12)	2.543 (5.7)	-0.56 (-0.5)	0.30 (4.2)	0.70 (10)	-0.18 (-2.8)	0.086 (3.5)	0.086 (3.5)	0.036 (0.1)	0.027 (0.1)	-0.05 (-1.6)	-0.08 (-3.5)	0.021 (3.4)	0.054 (1.6)	-0.021 (-3.43)
36	0.582 (1.1)	5.707 (5.6)	-5.09 (-3.8)	0.30 (3.7)	0.70 (8.7)	-0.69 (-4.4)	0.079 (3.1)	0.079 (3.1)	-0.12 (-3.4)	0.777 (3.6)	-0.03 (-1.2)	-0.07 (-3.1)	0.014 (3.0)	0.038 (1.2)	-0.014 (-3.0)
37	1.562 (1.4)	3.072 (0.9)	-0.03 (-0.7)	0.62 (5.3)	0.38 (3.3)	-0.22 (-0.4)	0.103 (2.9)	0.103 (2.9)	0.030 (0.2)	0.028 (0.3)	-0.23 (-5.1)	-0.10 (-2.9)	0.051 (6.8)	0.239 (5.1)	-0.051 (-6.8)
38	2.332 (7.3)	3.414 (4.4)	-2.39 (-1.5)	0.40 (5.2)	0.60 (8.0)	-0.29 (-2.5)	0.084 (4.6)	0.084 (4.6)	-0.05 (-0.8)	0.342 (1.1)	-0.05 (-1.2)	-0.08 (-4.6)	0.023 (2.5)	.2 (.2)	-0.023 (-2.5)
39	1.809 (7.2)	1.629 (9.0)	-0.33 (-6.0)	0.40 (6.7)	0.60 (10)	(*)	0.026 (1.3)	0.026 (1.3)	(*)	0.077 (0.4)	-0.02 (-1.3)	(*)	-0.07 (-0.4)	(*)	(*)
20-	5.560 (6.94)	-1.61 (-1.6)	1.04 (1.5)	1.27 (1.6)	0.87 (11.4)	-0.23 (-2.4)	0.155 (4.68)	0.155 (4.68)	0.010 (1.71)	0.128 (2.93)	0.020 (0.31)	-0.15 (-4.6)	0.004 (0.09)	-0.02 (-0.3)	-0.0042 (-0.09)

Note: The numbers in the brackets indicating the t-statistic. Note:(*) The parameters in sector (32) are not presented due to the convexity restrictions, while the parameters in sector (39) by definition there is no technical change in the 39 sector (miscellaneous).According to the ISIC classification, we have the branches (the brackets show the categories): (20) food, (21) beverages, (22) tobacco, (23) textiles, (24) footwear and wearing apparel, (25) wood and cork, (26) furniture, (27) paper, (28) printing -publishing, (28) leather, (30) rubber and plastic products, (31) chemicals, (32) petroleum, (33) non-metallic mineral products, (34) basic metal industry, (35) metal products, (36) machinery & appliances (37) electrical supplies, (38) transport equipment (39) miscellaneous industry.

More complete measures of productivity at the economy-wide level relate output growth to the combined use of labor and capital inputs. This measure is called multi-factor productivity (MFP). Growth in MFP is a key to long-term economic growth, as it indicates rising efficiency in the use of all available resources. It is also a better reflection of technological progress than the increase in labor productivity, since the latter can also be achieved through greater use of capital in the production process and the dismissal of low-productivity workers. Estimates of MFP growth are available for fewer countries than estimates of labor productivity growth, primarily because of the limited availability of data on capital stock. The estimates show that Ireland and Finland experienced the most rapid MFP growth over the 1990s. In countries such as Ireland, Finland, Belgium, Australia, Canada, the

United States, France and the United Kingdom, MFP growth accelerated during the 1990s. In other countries, such as the Netherlands, Norway, Spain and Japan, MFP growth declined.

Table 13: Substitution, price elasticities, technical change and scales:(1959-1990)

	σ_{LL}	σ_{KK}	σ_{KL}	P_{LL}	P_{KK}	P_{LK}	P_{KL}	c/l	TCH1	TCH2	TCH3	MFP	Scale
Foodstuffs (20)	-0.839	-1.101	0.957	-0.44	-0.51	0.44	0.51	c.u	-0.812	-0.00058	0.745	-0.0679	0.858
Beverages (21)	-4.222	-0.184	0.875	-0.72	-0.15	0.72	0.15	c.u	-1.385	0.017460	1.233	-0.1348	0.655
Tobacco (22):	-1.699	-0.102	0.412	-0.33	-0.08	0.33	0.08	c.u	-0.450	0.010289	0.383	-0.0561	0.724
Textiles (23):	-1.077	-0.963	1.014	-0.52	-0.49	0.52	0.49	c.s	-0.518	0.008332	0.480	-0.0299	1.545
Footwear & wearing (24):	-0.267	-1.177	0.554	-0.22	-0.28	0.22	0.28	c.u	-0.668	-0.00399	0.600	-0.0721	1.182
Wood & cork (25)	-0.299	-1.228	0.596	-0.17	-0.37	0.17	0.37	c.u	-0.305	-0.00866	0.301	-0.0124	1.298
Furniture (26):	-0.278	-2.207	0.777	-0.20	-0.57	0.20	0.57	c.u	0.0994	-0.02033	-0.13	-0.0533	0.964
Paper (27):	-0.347	-0.639	0.459	-0.19	-0.26	0.19	0.26	c.u	0.2635	0.008485	-0.30	-0.0361	1.501
Printing-publishing (28)	-0.676	-0.483	0.564	-0.30	-0.25	0.30	0.25	c.u	0.4473	0.000461	-0.43	0.00994	1.366
Leather (29):	-0.285	-1.855	0.723	-0.20	-0.51	0.20	0.51	c.u	0.3845	-0.00143	-0.45	-0.0751	2.076
Rubber & plastics (30):	-0.416	-0.645	0.508	-0.22	-0.28	0.22	0.28	c.u	-0.344	0.001361	0.276	-0.0667	0.644
Chemical (31)	-1.383	-0.427	0.731	-0.46	-0.26	0.46	0.26	c.u	-0.248	0.001290	0.272	0.02507	4.445
Petroleum (32)	-2.631	-0.403	1.000	-0.17	-0.28	0.17	0.28	c.s	-2.133	0.058802	2.048	-0.0255	0.209
Non-Metallic products (33):	-0.697	-0.904	0.789	-0.36	-0.42	0.36	0.42	c.u	0.6072	0.009445	-0.66	-0.0498	0.941
Basic metal industries (34):	-0.307	-0.129	0.189	-0.11	-0.07	0.11	0.07	c.u	-0.1874	0.023929	0.264	0.10102	1.579
Metal products (35):	-0.587	-0.738	0.653	-0.30	-0.34	0.30	0.34	c.u	-0.1273	-0.00067	0.0916	-0.0363	1.228
Machinery & appliances (36):	-0.486	-0.952	0.672	-0.28	-0.39	0.28	0.39	c.u	-2.7787	0.001201	2.7022	-0.075	1.986
Electrical supplies (37):	-1.070	-0.275	0.529	-0.34	-0.17	0.34	0.17	c.u	-0.172	0.000704	0.0999	-0.065	0.464
Transport equipment (38)	-1.214	-0.339	0.615	-0.40	-0.21	0.40	0.21	c.u	-1.1805	0.008928	1.1000	-0.071	3.947
Miscellaneous Manuf/ind. (39)	-0.634	-1.265	0.890	-0.36	-0.52	0.36	0.52	c.u	(*)	(*)	(*)	(*)	1.582
All manufacturing:	-0.285	-0.385	0.309	-0.14	-0.16	0.14	0.16	c.u	-0.126	0.0009419	0.12283	-0.00227	0.8977

Note: σ_{LL} , σ_{KK} , σ_{KL} = indicate the substitution elasticities, P_{LL} , P_{KK} , P_{KL} =indicate the price elasticities, TCH1, TCH2, TCH3=indicate the technical change, MFP, Scale = indicating the multifactor productivity and scale, respectively. Finally, c/l = indicate the capital-labour saving (where c.u. is the capital-using (or labour saving)); according to David and Van De Klundert, (1965) the technical progress is capital-saving if and only if the elasticity of substitution between capital and labour is less than unity in absolute values.

Tables 12-16 illustrate the estimated results, using a flexible functional form – a translog cost function, in order to measure the technical change, productivity, parameter estimations and elasticities for Greek industrial sectors in time-series and cross-section analysis.

Table14: Parameter estimations cross-section of translog-cost function in Greece 1959-1990

	α_0	α_Y	A_{YY}	α_K	α_L	γ_T	γ_{KK}	γ_{LL}	γ_{TT}	γ_{YT}	γ_{KY}	γ_{KL}	γ_{KT}	γ_{LY}	γ_{LT}
59	5.5 (6.9)	-1.6 (-1.6)	1.04 (1.5)	0.127 (1.67)	0.87 (11.4)	-0.23 (-2.4)	0.155 (4.68)	0.15 (4.68)	0.105 (1.71)	0.128 (2.93)	0.202 (0.31)	-0.15 (-4.6)	0.004 (0.09)	-0.20 (-0.3)	-0.0042 (-0.09)
60	5.40 (6.7)	-1.15 (-1.1)	0.608 (0.92)	0.125 (1.73)	0.874 (12)	-0.24 (-2.6)	0.143 (5.06)	0.143 (5.06)	0.101 (1.84)	0.124 (2.88)	0.57 (1.03)	-0.14 (-5.0)	0.006 (0.15)	-0.05 (-1.0)	-0.0061 (-0.15)
61	4.01 (5.3)	0.682 (1.02)	-0.45 (-0.9)	0.217 (3.48)	0.782 (12)	-0.08 (-0.7)	0.197 (5.83)	0.197 (5.83)	-0.01 (-0.1)	0.048 (1.36)	-0.07 (-1.1)	-0.19 (-5.8)	-0.01 (-0.4)	0.072 (1.19)	0.016 (0.438)
62	4.18 (5.9)	-0.27 (-0.4)	0.268 (0.68)	0.239 (4.16)	0.760 (13)	0.033 (0.35)	0.227 (10)	0.227 (10)	-0.09 (-1.8)	0.031 (0.99)	-0.10 (-2.5)	-0.22 (-10)	-0.01 (-0.6)	0.108 (2.55)	0.019 (0.64)
63	3.89 (2.2)	-0.17 (-0.8)	0.132 (0.10)	0.171 (1.9)	0.828 (9.4)	0.059 (0.39)	0.177 (6.57)	0.177 (6.57)	-0.01 (-1.6)	0.055 (0.84)	0.021 (0.03)	-0.17 (-6.5)	0.028 (0.81)	-0.02 (-0.3)	-0.028 (-0.819)
64	3.72 (2.2)	0.49 (0.25)	-0.38 (-0.3)	0.122 (1.34)	0.877 (9.63)	0.010 (0.07)	0.159 (6.14)	0.159 (6.14)	-0.08 (-1.1)	0.061 (1.0)	0.047 (0.80)	-0.15 (-6.1)	0.051 (1.48)	-0.04 (-0.8)	-0.051 (-1.48)
65	5.214 (2.24)	-0.77 (-0.3)	0.221 (0.17)	0.086 (0.67)	0.913 (7.04)	-0.12 (-0.7)	0.142 (5.1)	0.142 (5.1)	-0.02 (0.32)	0.102 (1.55)	0.092 (1.28)	-0.14 (-5.1)	0.075 (1.81)	-0.09 (-1.2)	-0.075 (-1.81)
66	2.873 (1.44)	0.941 (0.48)	-0.32 (-0.3)	-0.17 (-1.7)	1.173 (12)	0.083 (0.56)	0.167 (9.92)	0.167 (9.92)	-0.08 (-1.4)	0.017 (0.30)	0.190 (4.2)	-0.16 (-9.9)	0.083 (2.9)	-0.19 (-4.2)	-0.083 (-2.97)
67	2.644 (0.87)	1.652 (0.56)	-0.73 (-0.5)	-0.04 (-0.3)	1.045 (7.54)	-0.04 (-0.2)	0.178 (5.46)	0.178 (5.46)	-0.01 (-0.2)	0.030 (0.52)	0.123 (1.77)	-0.17 (-5.4)	0.032 (0.87)	-0.12 (-1.7)	-0.032 (-0.87)
68	3.124 (1.19)	1.202 (0.48)	-0.51 (-0.4)	-0.06 (-0.8)	1.069 (12)	-0.07 (-0.5)	0.182 (10)	0.182 (10)	0.002 (0.03)	0.030 (0.66)	0.142 (3.63)	-0.18 (-10)	0.013 (0.59)	-0.14 (-3.6)	-0.013 (-0.59)
69	3.057 (0.74)	1.235 (0.32)	-0.64 (-0.3)	0.047 (0.45)	0.952 (9.0)	-0.02 (-0.1)	0.165 (8.4)	0.165 (8.4)	-0.03 (-0.5)	0.043 (0.78)	0.082 (1.62)	-0.16 (-8.4)	0.060 (2.46)	-0.08 (-1.6)	-0.060 (-2.46)
70	-5.47 (-0.9)	8.003 (1.6)	-3.21 (-1.5)	-0.04 (-0.2)	1.041 (7.07)	0.137 (0.75)	0.129 (5.52)	0.129 (5.52)	-0.05 (-0.9)	-0.02 (-0.5)	0.173 (2.66)	-0.12 (-5.5)	0.023 (0.85)	-0.17 (-2.6)	-0.0231 (-0.85)
71	-2.24 (-0.4)	5.343 (1.23)	-2.03 (-1.1)	0.126 (0.78)	0.873 (5.42)	-0.43 (-0.3)	0.205 (6.85)	0.205 (6.85)	-0.01 (-0.3)	0.029 (0.6)	0.075 (1.04)	0.126 (0.78)	0.034 (1.55)	-0.07 (-1.0)	-0.0346 (-1.55)
72	-9.60 (-1.8)	11.19 (2.81)	-4.25 (-2.8)	0.407 (1.88)	0.592 (2.74)	-0.04 (-0.4)	0.245 (7.51)	0.245 (7.51)	0.031 (1.0)	0.013 (0.37)	-0.39 (-0.4)	-0.24 (-7.5)	0.054 (1.96)	0.039 (0.44)	-0.0548 (-1.96)
73	16.99 (1.70)	-8.05 (-1.2)	2.658 (1.17)	0.017 (0.07)	0.982 (4.25)	-0.15 (-0.6)	0.161 (4.74)	0.161 (4.74)	-0.09 (-0.1)	0.060 (0.91)	0.140 (1.62)	-0.16 (-4.7)	0.020 (0.73)	-0.14 (-1.6)	-0.0204 (-0.73)
74	2.149 (0.21)	1.699 (0.26)	-0.56 (-0.2)	-0.23 (-1.1)	1.233 (6.3)	-0.03 (-0.1)	0.152 (8.55)	0.152 (8.55)	-0.09 (-1.8)	0.046 (0.62)	0.226 (3.59)	-0.15 (-8.5)	-0.05 (-0.1)	-0.22 (-3.5)	0.00051 (0.019)
75	9.261 (6.22)	-1.65 (-0.2)	0.245 (0.11)	-0.67 (-2.5)	1.678 (6.22)	-0.57 (-1.7)	0.122 (4.9)	0.122 (4.9)	-0.02 (-0.5)	0.180 (1.90)	0.360 (4.3)	-0.12 (-4.9)	-0.01 (-0.5)	-0.36 (-4.3)	0.01719 (0.57)
76	49.11 (2.81)	-22.6 (-2.2)	5.89 (1.98)	-0.08 (-0.2)	1.089 (3.26)	-1.28 (-4.1)	0.154 (6.28)	0.154 (6.28)	0.014 (3.51)	0.314 (3.82)	0.168 (1.76)	-0.15 (-6.2)	-0.0 (-0.6)	-0.16 (-1.7)	0.1541 (6.28)
77	15.98 (1.37)	-5.78 (-0.8)	1.57 (0.87)	0.350 (5.65)	0.649 (10)	-0.05 (-0.6)	0.209 (53.2)	0.209 (53.2)	0.006 (1.11)	0.014 (0.60)	0.038 (2.28)	-0.20 (-53)	0.006 (0.15)	-0.03 (-2.2)	-0.0006 (-0.15)
78	25.27 (0.97)	-11.2 (-0.8)	3.112 (0.86)	0.090 (0.02)	0.990 (2.30)	0.387 (0.69)	0.198 (6.59)	0.198 (6.59)	-0.02 (-0.4)	-0.09 (-0.7)	0.131 (1.24)	-0.19 (-6.5)	-0.01 (-0.8)	-0.13 (-1.2)	0.0188 (0.88)
79	-98.8 (-0.8)	43.45 (0.82)	-8.92 (-0.7)	-1.04 (-0.8)	2.048 (1.73)	1.987 (2.23)	0.180 (3.64)	0.180 (3.64)	-0.11 (-0.2)	-0.45 (-2.2)	0.368 (1.35)	-0.18 (-3.6)	0.003 (0.10)	-0.36 (-1.3)	-0.0003 (-0.01)
81	-56 (-3.5)	27.57 (3.94)	-6.14 (-3.8)	-0.84 (-1.3)	1.840 (3.02)	-0.24 (-1.0)	0.142 (3.18)	0.142 (3.18)	-0.05 (-2.0)	0.064 (1.42)	0.321 (2.50)	-0.14 (-3.1)	0.013 (0.38)	-0.32 (-2.5)	-0.0012 (-0.38)
82	-36.7 (-1.5)	17.01 (1.7)	-3.42 (-1.6)	-1.28 (-2.1)	2.28 (3.8)	0.34 (0.9)	0.98 (2.37)	0.98 (2.37)	-0.01 (-1.8)	-0.04 (-0.6)	0.386 (3.19)	-0.09 (-2.3)	0.035 (0.93)	-0.38 (-3.1)	-0.0355 (-0.933)
83	-9.61 (-0.3)	7.037 (0.54)	-1.56 (-0.5)	-1.60 (-3.2)	2.609 (5.29)	-1.09 (-1.7)	0.081 (1.94)	0.081 (1.94)	0.098 (1.20)	0.210 (1.84)	0.441 (4.69)	-0.08 (-1.9)	0.058 (1.92)	-0.44 (-4.6)	-0.0581 (-1.9)
84	-51.7 (-4.5)	22.76 (5.16)	-4.50 (-5.1)	-1.33 (-3.2)	2.336 (5.74)	-0.51 (-2.1)	0.110 (3.91)	0.110 (3.91)	-0.02 (-0.8)	0.114 (2.76)	0.369 (4.82)	-0.11 (-3.9)	0.069 (2.14)	-0.36 (-4.8)	-0.0693 (-2.14)
85	-124 (-6.4)	51.15 (6.6)	-10 (-6.4)	-2.41 (-7.1)	3.413 (10)	-1.49 (-2.9)	-0.01 (-0.8)	-0.01 (-0.8)	-0.01 (-1.7)	0.305 (3.62)	0.544 (8.5)	0.011 (0.81)	0.026 (0.81)	-0.54 (-8.5)	-0.0260 (-0.81)
86	-85.4 (-5.7)	34.96 (6.41)	-6.63 (-6.5)	-0.48 (-1.0)	1.483 (3.12)	-0.91 (-2.6)	0.151 (6.43)	0.151 (6.43)	0.004 (0.11)	0.167 (3.0)	0.215 (2.60)	-0.15 (-6.4)	0.037 (1.0)	-0.21 (-2.6)	-0.0377 (-1.02)
87	-61.3 (-2.7)	25.5 (3.15)	-4.77 (-3.1)	-0.63 (-1.1)	1.633 (2.92)	-1.33 (-2.7)	0.163 (4.7)	0.163 (4.7)	0.092 (1.39)	0.223 (2.90)	0.249 (2.64)	-0.16 (-4.7)	0.038 (1.06)	-0.24 (-2.6)	-0.0381 (-1.06)
88	-40.8 (-1.8)	16.73 (2.20)	-2.93 (-2.2)	-0.46 (-0.7)	1.461 (2.24)	-0.86 (-1.8)	0.144 (3.47)	0.144 (3.47)	0.067 (0.99)	0.140 (2.04)	0.205 (2.05)	-0.14 (-3.4)	0.041 (1.20)	-0.20 (-2.0)	-0.0410 (-1.20)
89	-22 (-0.6)	9.64 (0.83)	-1.61 (-0.8)	-0.59 (-0.7)	1.598 (1.97)	-0.60 (-1.1)	0.117 (2.30)	0.117 (2.30)	0.038 (0.47)	0.098 (1.26)	0.219 (1.83)	-0.11 (-2.3)	0.035 (1.0)	-0.21 (-1.8)	-0.0358 (-1.05)
90	20.36 (0.54)	-4.42 (-0.3)	0.73 (0.37)	-1.48 (-1.5)	2.486 (2.52)	-0.98 (-1.8)	0.060 (1.07)	0.060 (1.07)	0.013 (1.85)	0.141 (1.86)	0.341 (2.42)	-0.06 (-1.0)	0.040 (1.18)	-0.34 (-2.4)	-0.0402 (-1.18)

Note: The numbers in the brackets indicating the t-statistic. This analysis indicate all industries by each year, (the variables are weighted shares)

Table 15: Substitution & price elasticities, technical change and scale for period 1959-1990

	σ_{LL}	σ_{KK}	σ_{KL}	P_{LL}	P_{KK}	P_{LK}	P_{KL}	c/l	TCH1	TCH2	TCH3	MFP	Scale
1959	-0.285	-0.385	0.309	-0.142	-0.166	0.142	0.166	c.s	-0.126	0.00094	0.128	-0.00255	0.189
1960	-0.409	-0.411	0.368	-0.185	-0.187	0.181	0.187	c.s	-0.138	0.00139	0.133	-0.00352	-2.995
1961	14.605	-0.150	0.553	-0.488	-0.064	0.488	0.064	c.s	-0.093	-0.0037	0.066	-0.03094	-7.709
1962	5.8562	-0.013	0.277	-0.279	0.0027	0.279	-0.0027	c.s	-0.0697	-0.0043	0.046	-0.02797	3.108
1963	-0.226	-0.212	0.215	-0.111	-0.103	0.111	0.1038	c.s	-0.0777	0.00573	0.078	0.006551	2.519
1964	-0.371	-0.286	0.294	-0.157	-0.137	0.157	0.137	c.s	-0.0890	0.00957	0.094	0.015205	7.379
1965	-0.461	-0.379	0.375	-0.196	-0.178	0.196	0.178	c.s	-0.1481	0.01151	0.173	0.036977	-2.99
1966	-0.276	-0.273	0.256	-0.128	-0.127	0.128	0.127	c.s	-0.0044	0.01364	0.032	0.041807	1.271
1967	-0.265	-0.220	0.224	-5.039	-4.194	4.270	-0.117	c.s	-0.0588	0.00567	0.058	0.005280	2.094
1968	-0.190	-0.189	0.183	-0.092	-0.090	0.092	0.0902	c.s	-0.0679	0.00225	0.061	-0.00351	1.713
1969	-0.245	-0.247	0.242	-0.123	-0.118	0.089	0.0882	c.s	-0.0694	0.01020	0.097	0.038471	2.057
1970	-0.524	-0.355	0.398	-0.212	-0.180	0.218	0.180	c.s	0.07531	0.00316	-0.06	0.009342	-35.9
1971	0.0462	-0.082	0.058	-0.019	-0.038	0.019	0.038	c.s	-0.0613	0.00384	0.076	0.018688	1.933
1972	0.231	0.0714	-0.08	0.058	0.0311	-0.05	-0.03	c.s	-0.0168	0.00488	0.036	0.024108	0.149
1973	-0.38	-0.224	0.260	-0.14	-0.113	0.146	0.113	c.s	-0.1671	0.00173	0.182	0.017306	-0.87
1974	-0.45	-0.276	0.308	-0.17	-0.135	0.173	0.135	c.s	-0.1391	-0.0002	0.151	0.012476	2.613
1975	-0.61	-0.466	0.455	-0.24	-0.210	0.245	0.210	c.s	-0.6081	-0.0004	0.598	-0.01030	0.319
1976	-0.39	-0.319	0.321	-0.16	-0.153	0.168	0.153	c.s	-1.1302	-0.0002	1.112	-0.01809	-0.54
1977	-0.02	-0.081	0.067	-0.02	-0.038	0.028	0.038	c.s	-0.0520	0.00005	0.052	0.000384	0.518
1978	-0.03	-0.136	0.124	-0.05	-0.067	0.057	0.067	c.s	0.38514	-0.0001	-0.38	0.000020	-2.76
1979	-0.29	-0.20	0.229	-0.12	-0.103	0.125	0.103	c.s	1.97499	-0.0006	-1.96	0.011265	-0.31
1981	-0.45	-0.39	0.385	-0.20	-0.183	0.201	0.183	c.s	-0.2967	-0.0011	0.291	-0.00613	0.152
1982	-0.51	-0.80	0.559	-0.25	-0.305	0.254	0.305	c.s	0.22542	-0.0039	-0.20	0.019652	5.761
1983	-0.69	-0.80	0.639	-0.31	-0.324	0.314	0.324	c.s	-0.9872	-0.0007	1.101	0.022614	-0.49
1984	-0.53	-0.54	0.488	-0.24	-0.248	0.240	0.248	c.s	-0.5470	-0.0008	0.576	0.021308	0.932
1985	-1.08	-1.69	1.054	-0.49	-0.558	0.496	0.558	c.s	-1.6270	-0.0040	1.593	-0.03803	0.008
1986	-0.41	-0.28	0.331	-0.17	-0.153	0.178	0.153	c.s	-0.9117	-0.0052	0.908	-0.00870	-0.10
1987	-0.35	-0.25	0.283	-0.15	-0.132	0.150	0.132	c.s	-1.2344	-0.0058	1.245	0.005730	0.149
1988	-0.47	-0.35	0.011	-0.19	-0.167	0.193	0.167	c.s	-0.7942	-0.0068	0.812	0.011590	-0.851
1989	-0.63	-0.48	0.488	-0.26	-0.227	0.260	0.227	c.s	-0.5666	-0.0064	0.587	0.014652	0.705
1990	-0.84	-0.84	0.739	-0.37	-0.366	0.372	0.366	c.s	-0.8402	-0.0008	0.865	0.016348	2.812

Note: σ_{LL} , σ_{KK} , σ_{KL} = indicate the substitution elasticities, P_{LL} , P_{KK} , P_{KL} =indicate the price elasticities, TCH1, TCH2, TCH3=indicate the technical change, MFP, Scale = indicating the multifactor productivity and scale, respectively. Finally, c/l = indicate the capital-labour saving (where c.u. is the capital-using (or labour saving)); according to David and Van De Klundert, (1965) the technical progress is capital-saving if and only if the elasticity of substitution between capital and labour is less than unity in absolute values.

Table 16: Comparison of the elasticities of substitutions

ISIC:	σ_{KL}	$\sigma_{KL}(1)$	$\sigma_{KL}(2)$	$\sigma_{KL}(3)$	$\sigma_{KL}(4)$
Foodstuffs (20):	0.957	0.944	0.460	0.663	-10.11
Beverages (21):	0.875	0.877	0.745	0.503	2.457
Tobacco (22):	0.412	0.676	0.990	0.462	2.278
Textiles (23):	1.014	0.162	0.592	1.279	1.420
Footwear and wearing(24):	0.554	0.635	0.753	0.012	1.277
Wood and cork (25)	0.596	0.448	0.981	0.350	2.899
Furniture (26):	0.777	1.017	0.545	0.246	200.0
Paper (27):	0.459	0.851	-----	-----	1.852
Printing-publishing (28)	0.564	-----	0.177	-----	1.656
Leather (29):	0.723	0.852	0.625	0.775	1.855
Rubber & plastics(30):	0.508	0.855	0.772	0.588	1.608
Chemicals (31)	0.731	0.885	-----	-----	3.953
Petroleum (32)	1.000	1.027	0.545	0.342	12.658
Non-Metallic products (33):	0.789	-----	0.421	-----	2.571
Basic metal industry (34):	0.189	1.002	0.464	0.532	15.873
Metal products (35):	0.653	0.440	0.558	1.425	3.922
Machinery & appl.(36):	0.672	0.719	0.401	0.220	1.751
Electrical supplies (37):	0.529	0.191	0.736	0.387	-9.804
Transport equipments (38)	0.615	0.325	0.933	-----	-----
Miscellaneous manf/ind (39)	0.890	-----	-----	-----	-----

8. Implications and Conclusions

The Regional Policy, supported through Structural Funds and a Cohesion Fund has created objectives that have thus far been moderately successful in reducing disparities between the regions of the EU15. Greece, Portugal, Ireland and Spain, the 4 countries, which qualified for the Cohesion Fund, witnessed almost an 11% average increase in per capita GDP from 1988-1998. The poorest EU regions on average saw

the per capita GDP rise by almost 7% over the same 10 years. The funding provided through Regional Policy contributed significantly to these GDP increases.

Moreover, the European research and innovation policy has adopted an approach oriented more towards innovation than technological excellence as such, better addressing the deficiencies of less favoured regions as a result. An improvement in the interaction between the deployment of the Structural Funds and research policy is important to accelerating the «catching up» of lagging regions. The Structural Funds can provide the necessary support for firms and research institutes in the latter to participate on equal terms in future research programmes.

Finally, in this article we have attempted to present the main milestones regional authorities should keep in mind when undertaking a foresight process. There are three sets of reasons: (1) Over the last decade, most regions throughout Europe have built their legitimacy as policy makers in the RTD & innovation development field. There is now a need to develop the next round of policies via a mobilization of regional stakeholders. Foresight approaches are very well suited to vision building activities of this type. (2) Because of the change in pace, this next round of policies should be quite different, moving from planning approaches toward more flexible and shared approaches. Here again, foresight processes, because of their mobilization and scenario building potential can be very valuable. (3) Last but not least, the need to root research and innovation policies in a regional social and territorial vision calls for policy tools capable of integrating different foci in one process; we have tried to present various examples of the foresight approach potential to develop such integrated policies.

More generally, the new directions of Regional Policy can be summarized in four basic principles:

- Looking the concentration on efforts of growth.
- Programming the partnership between the member states of E.U.
- Planning the national and Community actions
- Enforcing the complementarity of resources from various sources of financing.

In the literature there are various explanations for the slow-down in productivity growth for OECD countries. One source of the slow-down may be substantial changes in the industrial composition of output, employment, capital accumulation and resource utilization. The second source of the slow down in productivity growth may be that technological opportunities have declined; otherwise, new technologies have been developed but the application of new technologies to production has been less successful. Technological factors act in a long run way and should not be expected to explain medium run variations in the growth of GDP and productivity. The countries that are technologically backward have a potentiality to generate more rapid growth even greater than that of the advanced countries, if they are able to exploit the new technologies which have already employed by the technological leaders.

Furthermore, conclusions cannot be easily drawn from simple summary measures of the extent or the rate of compositional structural change, without having some additional information regarding the direction of change, the path followed from the previous industrial structure and associated and institutional factors. Therefore, we have applied and implemented a new method for the measurement of technical progress and the economic growth; this is based on the *translog function*, (using time series data for selected member states). Our estimates indicate that technical progress is capital augmenting for Greece, Germany, Italy, Ireland, Netherlands and Spain, (where the

elasticity of substitution between capital and labor has been found to be less than unity); the opposite result holds for France.

Finally, this paper argues that the European slowdown in growth is a reflection of an adjustment process towards a new industrial structure, which has developed more slowly in the EU than in the US. Rapid diffusion of new technology will facilitate the adjustment process in the future. However, an institutional environment that slows down change may hold up the structural adjustment process in Europe and inhibit the reallocation of resources to their most productive uses.

- Labor productivity is a useful measure: it relates to the single most important factor of production, is intuitively appealing and relatively easy to measure. Also, labor productivity is a key determinant of living standards, measured as per capita income, and from this perspective is of significant policy relevance.
- Multifactor productivity measurement helps disentangle the direct growth contributions of labor, capital, intermediate inputs and technology. This is an important tool for reviewing past growth patterns and for assessing the potential for future economic growth.
- However, one has to be aware that *not all technical change translates into MFP growth*. An important distinction concerns the difference between embodied and disembodied technological change. The former represents advances in the design and quality of new vintages of capital and intermediate inputs and its effects are attributed to the respective factor as long as the factor is remunerated accordingly.
- Further, in empirical studies, measured *MFP growth is not necessarily caused by technological change*: other non-technology factors will also be picked up by the residual.

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