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CHAPTER 1
MACROECONOMIC PROCESSES AND REGIONAL ECONOMIES MANAGEMENT

Technological Development in the Context of the European Integration: The Case of Greece

Ioanna Kastelli[1]

Abstract

In this paper we study technological development of the Greek industrial system in the context of European integration.

Greece is a typical case, which during the last twenty years deals with specific imperatives: European integration, technological catch-up and macro-economic stability. These processes are envisaged under the pressure of the opening the economy, which is supposed to facilitate dissemination of new technologies on the one hand but might constrain the development of national capabilities on the other one.

The objectives of trade liberalization and nominal convergence with the EU were compensated by financial support provided in the context of EU regional policy. European policy initiatives seem to be an important leverage for upgrading national technological capabilities.

The main argument of the paper is that in intermediate countries depending on technology transfer there is need for active development policies that will not simply imitate the "best practices" of other developed countries but will take into account national specificities.

1. Introduction

Until 1973 the Greek economy experienced a spectacular rate of growth and high performance based on the development of an important range of heavy industrial activities as well as on the flourishing of a spectrum of traditional industries (textile, food and beverage). After the first oil shock and with the gradual opening the economy to international pressures, the Greek economy entered a phase of economic recession that was reflected on a wide range of economic indicators.

Circumstances seem to change again after 1995, a period which has all the characteristics of macro-economic recovery in terms of growth rates, investment, inflation, public debt.

The case of Greece as an intermediate country that passed from a transition phase to a full member of the European Union and then the Economic and Monetary Union, presents some specific characteristics that support the importance of structural factors in the performance of the industrial system.

In this paper we study the evolution of the Greek industrial system in the context of the European Integration with specific emphasis on its technological development. Some important elements of this process had considerable implications for industrial dynamics and the competitive position of the industrial system: integration of markets for goods and services, trade liberalization, monetary integration and regional development.

R&D performance is often seen as a key element of economic growth and industrial competitiveness. However, as the experience of many countries shows, wealth and impressive industrial performance do not necessarily follow huge R&D investments and any impressive R&D activities. More precisely, for small intermediate countries like Greece, imported technology, foreign

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investment and licensing keep a more prominent role than the domestic production of technology. In such cases absorption and diffusion of knowledge and technology seem to be more influential factors in industrial dynamics.

The paper is structured as follows. The first section presents the specificities of the Greek industrial system with special emphasis on protectionist regime and public intervention. In the second one, we focus on technological development and the evolution of the S&T system in Greece. Emphasis is given on efforts that might improve the catching-up process and the country's absorptive capability. The third section investigates the role of the European Regional Policy. The last section summarises the main points with regard to the technical change and the competitive position of Greece.

2. The Relaxation of Protectionist Regime and Trade Liberalisation

From the mid-1950's the development of the Greek industrial system demonstrated two main structural deficiencies: first, the specialisation in traditional, (unskilled) labour intensive and natural resource intensive sectors; second, the dependence of its performance on high protectionism, which was demonstrated in different economic policy measures (financial assistance, low loans and taxes, subsidies) but also in political issues such as unions' oppression.

For a long time industrial policy in Greece was focused on the level of protectionism, incentives and subsidies taking the form of a deal between political power and private interests for the distribution of economic benefits expected from public intervention (Vaïtsos, Giannitsis, 1987). High protectionism and state intervention not only offered conditions for high profits for Greek firms by the exploitation of monopolistic positions but also created a misleading picture of the situation in the Greek industry and oriented corporate behaviour towards practices that resulted in de-industrialisation (turn to commercial activities, limp "investment behaviour" etc.) (Kastelli, 2000).

The Affiliation of Greece to the European Community in 1961, pointed to the elimination of tariff protection regarding imports from EC member states. The protectionist regime preserved the traditional structures of the Greek productive system as it offered high protection to traditional goods that were domestically produced and not to other categories that were not produced in Greece but were more advanced technologically.

The Affiliation Agreement required a gradual dismantling of tariff protection until 1974 for products that were not produced in Greece and until 1984 for products for which domestic production existed. This was of great importance for technological development in Greece as technologically more sophisticated activities that were not developed in Greece were exposed to international competitive pressures from the early 70's. The absence of protection to infant industries explains to some extent the limp investment behaviour in technologically more advanced activities.

However, there was a delay of the adjustment to this new status and even in 1985 the amount of taxes and duties on the taxed value of goods remained important.

It should be mentioned here that although the percentage of import duties decreased after 1983, the total amount of charges remained important for a number of categories as taxes represented almost the total charge on the imported value.

In the context of industrial policy a number of policy tools have been used in addition to tariff protection to support growth of production and income. Different tools distinct from the duties such as advance payments on imports, quotas, indirect taxation or administrative forms of intervention, discriminative treatment of Greek firms in the public procurement, privileges to FDI, all constituted the complex of protection for firms producing in Greece. State aids and public intervention (subsidies, bank loans, nationalisations, pricing policy, tax exemptions, returns of interest payments etc.) especially to specific manufacturing sectors such as shipbuilding and the fertilizer industry remained relatively high until the end of 80s. State intervention was supported and facilitated by financial / banking institutions that were largely controlled by the state, and this delayed any restructuring until the cost became too high and could no longer be absorbed by public banks and until international pressures became very strong (Caloghirou et al., 2000). In fact until the late 80s there were no real strategies designed to accomplish the adjustment of the Greek in-

dustrial system to the new situation, but instead efforts were made to preserve the status quo and attenuate external constraints and pressures.

A change in policy from favouring state intervention towards a more open market approach occurred at the end of 80s and in the early 90s, first, because there were no more degrees of freedom with regard to the EC requirements and second, because the benefits from the EC regional policy persuaded economic actors to speed up Greece's integration into the EC (ibid). Since 1990 there has been a gradual decline in total State aids, following the general trend of relaxation of public intervention in the EU (European Commission, 1999).

During the same period of relaxation of the protectionist regime we observe a deterioration in a number of performance indices.

Particular attention should be paid to trade performance for the different categories of goods. Greece fell behind (especially in the period of 1989-93) in terms of export / import ratios in categories for which the relative specialization ratio was relatively high, and in terms of international competitiveness in categories for which the competitiveness index was higher than the average for all goods. For example in the category of animal and vegetable oils and fats the relative specialization ratio decreased by 36%, in food and live animals 28% and in beverages and tobacco 59%. The Balassa index deteriorated for most of the categories (Table 1).

Table 1

Relative Specialisation and Competitiveness by sector of activity (revised SITC classification)

	Relative specialisation (X/M)			Competitiveness (Balassa ratio X-M/X+M)		
	82-88	89-93	94-99	82-88	89-93	94-99
Total	0,47	0,42	0,40	-0,36	-0,41	-0,43
0	0,77	0,72	0,60	-0,14	-0,17	-0,25
1	2,82	1,35	1,17	0,47	0,15	0,08
2	0,52	0,57	0,80	-0,32	-0,28	-0,11
3	0,22	0,33	0,43	-0,65	-0,50	-0,42
4	8,19	4,98	5,27	0,64	0,57	0,66
5	0,20	0,16	0,18	-0,67	-0,73	-0,70
6	0,76	0,48	0,45	-0,14	-0,35	-0,38
7	0,06	0,06	0,11	-0,89	-0,89	-0,80
8	1,93	1,04	0,7	0,31	0,02	-0,18
9	1,35	3	3,1	-0,02	0,47	0,41

Source: calculations on data from Statistical Yearbooks ESYE
(0)food and live animals
(1)beverages&tobacco
(2)crude materials, inedible, except fuels
(3)mineral fuels, lubricants etc.
(4)animal and vegetable oils and fats
(5)chemicals
(6)manufactured goods by material
(7)machinery & transport equipment
(8)miscellaneous manufactured articles
(9)commodities and transactions not classified by categories

However, it should be mentioned that the share of exports of high-tech products on total exports has shown an improvement over recent years although it stands somewhat behind other countries of the EU and its competitiveness is very low in comparison with other countries of Southern Europe and Ireland (Tables 2, 3).

Table 2

Exports of high-tech products (% share on total exports)

	EL	E	IRL	I	P	EU15
1992	1,2	5,7	25,3	7,7	3,1	15,4
1993	2,1	6,4	27,4	7,7	2,4	14,7
1994	2,2	6,5	29,7	7,5	3,2	14,7
1995	3,1	5,6	35	7,4	4,6	15,3
1996	3,0	6,0	36,7	7,2	3,6	15,5
1997	3,1	5,2	37,5	6,9	3,6	16,3
1998	4,8	5,5	37,7	7,4	4	17,6
1999	5,5	5,9	39,4	7,5	4,3	18,9
2000	6,7	6,4	41,3	8,4	5,6	19,8

Source: Eurostat – Key indicators, Europa website 2001.

Table 3

Relative specialization and competitive position in high-tech products*

	X / M	X-M / X+M	Average annual growth of exports	
			1990-1994	1995-1998
EL	15.7%	-72.9%	15.3%	15.8%
P	23.6%	-61.8%	1.3%	-1.8%
E	44.9%	-38.0%	15.8%	9.3%
I	67.9%	-19.1%	6.8%	6.4%
IRL	157.5%	22.3%	11.8%	24.1%
EU-15	81.3%	-10.3%	10.8%	12.0%

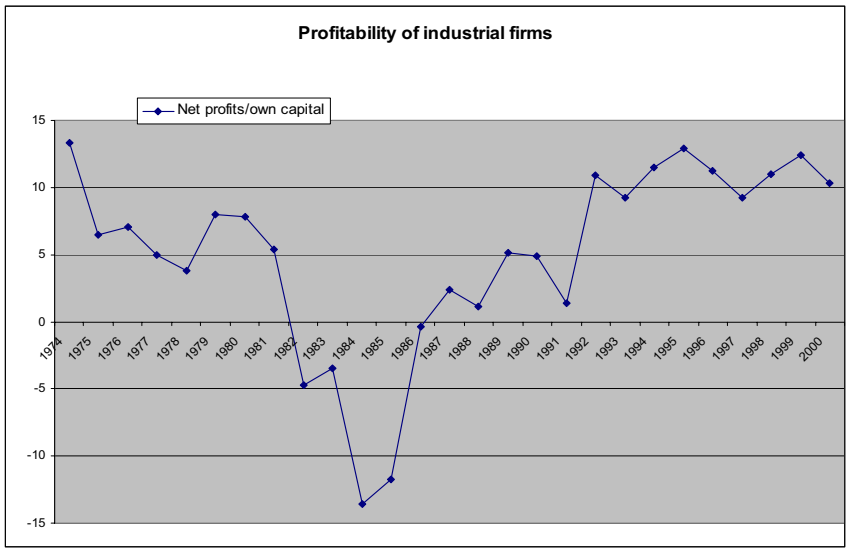
Source: Eurostat, Key Figures 2000.

*High-tech products: Aerospace, computers and office machinery, electronics and communications, pharmaceuticals, scientific instruments, electrical machinery, chemicals, non-electrical machinery, armaments.

The move from protective to competitive conditions affected profitability of industrial firms, which was squeezed during the period of 1982-1988. A reversal of the downward trend was achieved through restrictive income policies mainly after 1989 (Figure 1).

The weak technological capabilities of most industrial firms imposed severe limits on their possibilities of facing competitive pressures by improving productivity rather than depressing labour cost (Giannitsis, Mavri, 1993).

The unification of the European Market and the European Monetary Integration made obsolete many of the state practices that involved public intervention in industrial development. At the same time they revealed the strategic role of knowledge and technological and organisational characteristics at the micro level. As the relaxation of public intervention intensified, there was more pressure for the private actors (national and international) to improve their competitive position in terms of technological and organizational capabilities.



Source: The Greek Industry, Confederation of Greek Industries, many years.

Fig. 1. Profitability of industrial firms

3. Technological Characteristics of the Greek Industrial System and Greek S&T System[1]

The discussion of industrial development in Greece is to a great extent related to the inadequacies of the Greek industrial system over technological issues. The Greek industrial system specialises in low or medium technological areas, where it confronts competition from countries whose competitiveness lies in low labour costs, whereas it stands well behind as far as high technology activities are concerned.

A basic element of Greek industry evolution has been relying on technology transfer. Technology transfer was considered as one of the main tools for improving competitiveness of Greek firms, although it had some characteristics that were not always beneficial for the recipient country. In such a context absorptive capability, defined as the capability to absorb the transferred technology, to diffuse it within the productive system and transform it into new technological solutions becomes an important determinant of the country's potential to reduce technological gaps with more advanced countries. It is then crucial for an intermediate country to accumulate skills, create an R&D system with adequate immaterial and material infrastructure and improve its knowledge stock as prerequisites for catching-up. However, low export intensity of recipient firms, the weak performance of Greek manufacturing, the import penetration and the deterioration of the competitive position of Greece, raise serious questions about the extent to which Greek firms succeeded in exploiting technology transfer in order to upgrade their technological and organisational capabilities (Giannitsis, 1991). This aspect is discussed in the following section where we present the main dimensions of the technology transfer process in Greece.

3.1. Technology Transfer

Technology transfer has taken place through imports of capital equipment, foreign direct investment and licensing.

In 1953 the Greek Government in order to attract foreign investors enacted law 2687. Its objective was to offer constitutional protection to foreign investors and to establish exchange, tariff and tax privileges for them. This legislative framework has been progressively supplemented

[1] Some of the material of this section is taken from Kastelli (2000).

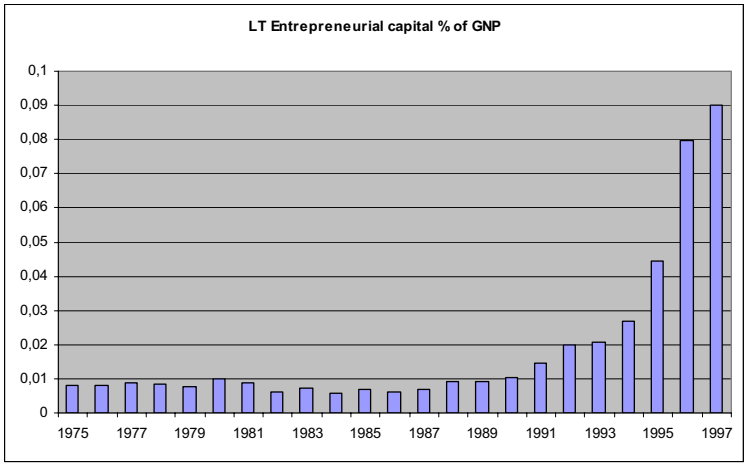
with specific agreements between the Greek State and foreign investors when important investing initiatives were concerned. Public policy was very open towards FDI until 1974. Changes have been introduced since 1974 in an effort to rationalise foreign investment. Some criteria for the performance of the foreign investors have been established.

The characteristics of FDI in Greece pointed to an important restructuring of the Greek industrial system (Vaïtsos, Giannitsis, 1987, pp. 64-65):

1. FDI resulted in the creation of large units in Greek industry and in totally new activities for the Greek productive system (petrochemicals, electrical materials, pharmaceuticals, etc.). An important part of the FDI concentrated on intermediate sectors and on the production of capital goods.
2. Most FDI aimed at penetration of the Greek market. Only in the first period of their establishment in Greece they did realise exports, probably because the internal market could not absorb all their production. This in combination with foreign companies which aimed to the exploitation of raw materials (vertical direct investments) resulted in an increase of industrial exports.
3. There was however an important part of FDI directed to the final phases of the production process and thus making a low contribution to the industrial value-added.

According to Vaïtsos and Giannitsis (1987), FDI has played a very important role in the formation of the industrial structure, in the establishment of entirely new industrial activities (as above), in shaping the characteristics of Greek industry (size, turnover) and in the restructuring of Greek exports, from almost exclusively agricultural goods to a combination of agricultural and manufacturing products. However it is worth mentioning that the most important reasons for foreign investments were the exploitation of the Greek market and Greek natural resources, and to take advantage of the specific privileges.

The picture changed following the oil crisis. Foreign capital inflows decreased after 1975 and turned to sectors of consumer goods or traditional sectors (food and beverages, textiles). In Figure 2 we observe that inflows of entrepreneurial capital remained at very low levels as percentages of GNP until 1991 and increased considerably after 1992.



Source: Bank of Greece, Monthly Statistical Bulletin, many years.

Fig. 2. LT Entrepreneurial capital % of GNP

One would expect that the reduction of exchange rate risk and the general stabilization of the monetary variables played an important role in the increase of entrepreneurial capital inflows[1].

[1] There is a break in the data collection for FDI after 1993 because of a change in the Balance of Payments system. In order to follow the trend for a long period we used long-term entrepreneurial capital inflows without real estate investment.

However, a survey carried out by Thompson Financial on mergers and acquisitions (OECD, 2001) shows a stable weak interest of foreign investors for the Greek productive system. The value of deals realised during the period of 1990-99 is one of the lowest among OECD countries, confirming the weak interest of foreign investors (OECD, 2001). In addition, most of the mergers and acquisitions in the 90s took place in the sectors of food and beverages, chemicals and paper material.

The only exception were the years 1992 and 1996 where we observe a slight increase of the deal value as a percentage of the total inward cross-border mergers and acquisitions in OECD countries (0,57% and 0,25% respectively) (Table 4), probably explained by the opening the capital market and modernisation of the Stock Market.

Table 4

Inward cross border M&As in Greece. Deal value as a % of OECD total

	% deal value GR / deal value OECD total
1990	0,08
1991	0,09
1992	0,57
1993	0,07
1994	0,01
1995	0,03
1996	0,25
1997	0,04
1998	0,004
1999	0,03

Source: "New Patterns of Industrial Globalisation. Cross-Border Mergers and Acquisitions and Strategic Alliances", OECD 2001.

Loans are the other component that could explain the increase in foreign capital inflows but no data are available for studying their evolution. We can only suspect that this is the main reason of the increase in the long-term entrepreneurial capital inflows as there was a period during which interest rates were lower in foreign banks than in Greek ones.

As a general remark, we should underline that unfortunately, FDI has not geared into a realignment between foreign and domestic technology and thus any expansion of industrial activities still remains vulnerable to competition from countries offering lower wages.

Regarding licensing, although the Greek government considered it as a tool for upgrading Greek firms' performance and competitiveness, it failed to turn into a mechanism of knowledge flows and development of in-house technological capabilities. The licensing agreements most of the time imposed important export restrictions and thus did not function as a tool for improving industrial competitiveness (Giannitsis, Mavri, 1993). In addition, an important part of the royalty payments concerned payments of subsidiaries to the mother company that chose licensing as a way of penetration in the Greek market.

The protectionist regime in Greece played an important role in FDI and licensing. Investing in Greece gave the opportunity to foreign firms to penetrate a protected market. Regarding licensing, the high level of protectionism ensured to domestic producers a monopolistic rent that was reflected to prices. Foreign providers of technology were taking a part on this monopolistic rent as they were negotiating for higher royalties as a percentage of the product price. European integration and the relaxation of protectionism made exports a more attractive (in economic terms) way of penetration of foreign producers into the Greek market as the price of the products on which the royalties were calculated diminished. That is probably one of the reasons why royalties as percentage of Greek industrial exports and of invisible payments diminished until 1992 (Figure 3). After 1992 there is again an

increase of both ratios probably relating to an increase of gross investment over the gross productive value.

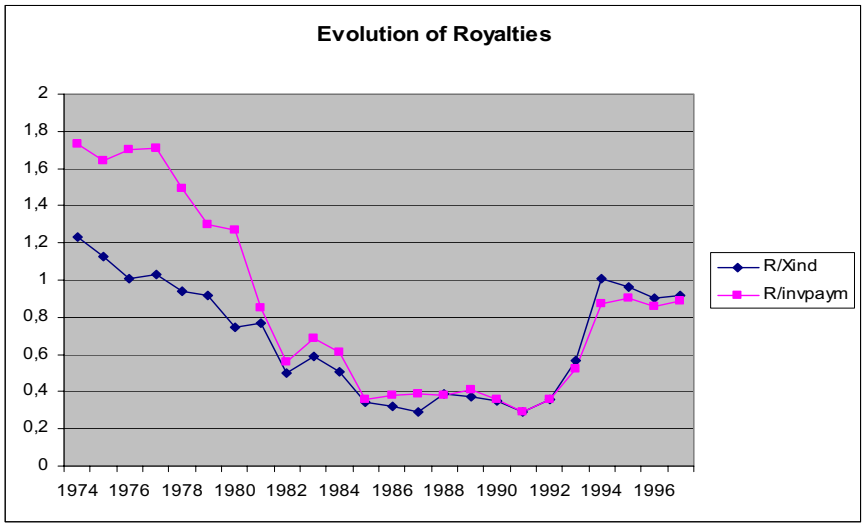


Fig. 3. Evolution of royalties

3.2. The S&T System in Greece

Until mid- 80s, relatively little attention was paid to endogenous technological development and the institutional set up with related to research and technological activities was rudimentary. In the end of the 80s and in the line with European S&T policy some important changes have occurred.

1. There was a general consensus that issues regarding technological development and modernisation of industrial structures should be approached in a systematic way. In this context many changes and new elements were introduced into the institutional set-up.
2. Application of austerity policies and macro-economic stabilisation was expected to constrain the ability of the State to intervene and actively promote technological development. In addition, competition policy reduced the possibilities for traditional direct intervention that might distort competition (e.g. support of infant industries). However, European initiatives for the improvement of European competitiveness through Framework Programmes and support to less favoured regions through Structural Funds formed a new modality of public intervention for the development of the S&T system in Greece.
3. The objectives of the Science and Technology Policy derive essentially from the European Technology Policy. During the last fifteen years the main orientation of the Greek S&T policy has been shaped according to European priorities. In this line emphasis has been put to the linkages of productive and research activities, to facilitation of knowledge flows, to networking and cooperation, to the development of research infrastructure, adoption and assimilation of new technologies (ICTs, biotechnologies etc.) and the development of human resources.
4. Recently, there is a growing interest at a policy level in linking research to industrial activities and needs. This is reflected to the initiatives of the General Secretariat of Research and Technology (GSRT) that try to turn financial support towards “useful” research and stress to the inclusion of users in funded research projects.

As we already pointed out, intermediate countries need to build a sustainable potential of skills, knowledge stock, infrastructure and R&D capability in order to exploit knowledge flows

and transform technology that has been imported from abroad. Thus what is interesting to present is the level of the scientific and technological system and its characteristics not only in a technology supply perspective but also in a catching-up one. In that perspective the R&D efforts, the education efforts, the scientific and research personnel are indicative of the capability of the country to better exploit knowledge and technology created from foreign actors.

R&D Efforts

As observed in Figure 4, gross domestic expenditure on R&D (GERD) as a percentage of GDP is one of the lowest among EU countries.

The business sector failed to make systematic efforts in R&D and innovation activities, while the linkages of the productive and scientific system proved to be very weak. Taking into account the increased exposure of Greek industry to foreign competition, especially from the early 80s, this problem hastened the deterioration of the Greek position in international trade (increased import penetration and low export market shares). The evolution of business expenditure on R&D (BERD) as a percentage of GDP, as it appears in Figure 5, shows the weak level of Greek firms' expenditure on R&D compared with other EU countries.

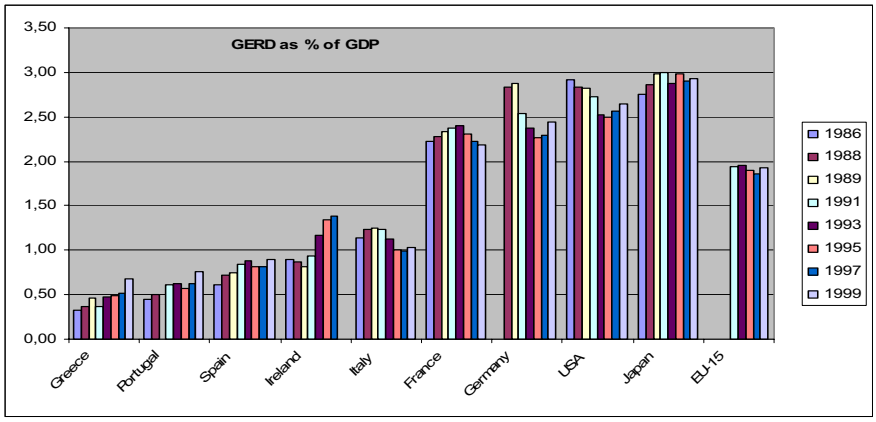


Fig.4. GERD as % of GDP

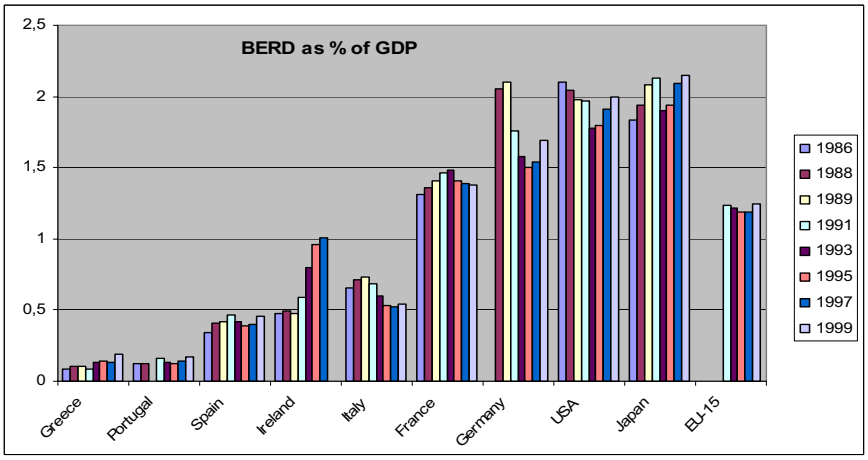


Fig. 5. BERD as % of GDP

The breakdown of R&D expenditures by source of financing and performing sector, as appears in Tables 5 and 6, reveals that by the mid-90s, firms financed half of EU R&D and per-

formed more than two-thirds. However, in Greece the breakdown shows the relatively small contribution of the business sector (public and private firms) to funding of R&D. At the same time we observe the significant contribution of government to R&D funding as well as of sources from abroad, which mainly consist of EU Framework Programmes, Structural Funds and other foreign sources (from 1995 Structural funds are considered as public funding). According to the figures the performance of the Greek business sector in R&D was well below the European respective average. The Government (PRIs) and the Higher Education sector performed the rest, which is highly compared with other European countries.

The sectoral distribution of BERD shows an important concentration in five sectors, namely food and beverages, chemicals (including pharmaceuticals), machinery and equipment, radio/television and communication equipment, computer related activities and business services which add up to 60% of BERD.

Table 7

Sectoral distribution of BERD

	1995	1996	1997
Computer and related activities	23,26	26,13	26,12
Food and beverages	5,41	5,9	5,17
Chemicals (including pharmaceuticals)	8,46	7,26	7,63
Machinery and equipment	5,01	4,78	5,25
Radio/television and communication equipment)	15,95	15,23	17,21
	58,09	59,3	61,38

Source: GSRT 2001, "Research in Greece".

R&D Expenditure and Innovative Activity

However, low R&D expenditure is not an indicator that alone could evaluate innovative efforts in Greece. As empirical evidence from OECD countries indicates, only 30-50% of all innovation costs relate to R&D expenditure (OECD, 1998). The rest are expenditure on product design, market analysis, outsourcing and expenditure on patents and licenses. The breakdown of innovation expenditures, according to CIS I data, shows however that in Greece, the major sum spent by Greek firms is on R&D and very low amounts are spent for patents, licenses and market analysis (ibid, p.58).

Innovation is increasingly recognised to rely on interactive processes and knowledge flows. A major problem in the Greek S&T system is the limited linkages between economic actors and the weak infrastructure for diffusion of information and knowledge. Interaction among firms as well as between firms and the scientific community is weak (Deniozos, 1996). This can be observed in the structure of GERD inflows and outflows, according to which private firms in 1997 financed only 3,6% and 0,4% respectively of the Universities' and Public Research Institutes' (PRIs) expenditure on R&D (GSRT, 2001a).

In Greece there have been three surveys on innovative activity (conducted in the context of the Community Innovation Surveys) that cover the periods of 89-91, 94-96, 97-98. Although there are methodological issues that do not allow reliable comparisons between the first period and the other two ones, we however observe an improvement between the periods of 94-96 and 97-98 as the number of innovative firms relative to the total number of manufacturing firms increases from 16,9% to 18,4% (GSRT, 2001b). During the 90s we also observe an increase in the patent applications to the EPO per million inhabitants from 3,3 to 7,7 (Eurostat, Key indicators, 2003).

Table 5

% Distribution of GERD by source of financing

Country	Government			Firms			Abroad			Other		
	1993	1995	1997	1993	1995	1997	1993	1995	1997	1993	1995	1997
EC	40	39	37,2	52,5	52,5	53,9	5,9	6,7	7	1,5	1,8	1,9
Austria	48	47,1	43,9	49	49,2	51,7	2,6	3,3	3,9	0,4	0,4	0,4
Belgium	32,5	26,4	-	62,7	64,2	-	3,9	6,9	-	1,3	1,7	-
France	43,5	41,9	40,2	47	48,3	50,3	8,1	8	7,9	1,3	1,7	1,6
Germany	36,5	36,8	35,9	61,5	61,1	61,4	1,6	1,8	2,4	0,3	0,3	0,3
Denmark	37,7	39,6	36,1	50	45,2	53,4	7,3	11	6,4	5	4,2	4,1
Greece	49,3	54	54,9	20,2	25,5	21,6	30,4	19,8	23,3	0,1	0,7	0,2
Ireland	27,9	21,6	22,2	62,3	68,5	69,4	7,9	8	6,7	1,9	1,8	1,7
Spain	51,6	43,6	43,6	41	44,5	44,7	6,4	6,7	6,7	1	5,2	4,9
Italy	51,3	53	51,2	44,3	41,7	43,3	4,4	5,3	5,5	-	-	-
UK	32,5	33,2	31,1	51,5	48	49,6	11,9	14,4	14,5	4,1	4,4	4,8
The Neth.	48,5	42,2	39,1	44,1	46	45,6	5,3	9,3	12,8	2,1	2,6	2,6
Portugal	-	65,3	68,2	-	19,5	21,2	-	11,9	6,1	-	3,3	4,4
Sweden	33	28,8	25,2	61,2	65,6	67,7	2,9	3,4	3,4	3	2,2	2,1
Finland	39,8	35,1	30,9	56,66	59,5	62,9	1,8	4,5	5,3	1,8	1	0,9

Table 6

% Distribution of GERD by performing sector

Country	Public Research Institutes			Firms			Higher Education			Private non-profit organisations		
	1993	1995	1997	1993	1995	1997	1993	1995	1997	1993	1995	1997
EC	16,5	16,2	15,3	62,2	62,1	62,9	20,4	20,8	20,9	1	0,9	0,9
Austria	8,9	-	-	55,9	-	-	35	-	-	0,3	-	-
Belgium	6,2	3,8	-	63,8	67,4	-	28,7	27,3	-	1,3	1,5	-
France	21,1	21	20,2	61,7	61	61,2	15,8	16,7	17,3	1,4	1,3	1,4
Germany	15	15,4	14,6	66,9	66,4	67,5	18,1	18,1	17,9	-	-	-
Denmark	17,8	17	15,4	58,3	57,4	61,4	22,8	24,5	22,2	1	1,1	1
Greece	32	25,5	23,4	26,8	29,5	25,6	40,6	44,3	50,6	0,6	0,7	0,4
Ireland	10,2	8,8	7,4	67,9	71,2	73,3	21,1	19,3	18,6	0,8	0,7	0,7
Spain	20	18,6	17,4	47,8	48,2	48,8	31,3	32	32,7	1	1,1	1,1
Italy	21,4	21,1	20,7	53,7	53,4	53,2	25	25,5	26,1	-	-	-
UK	14,2	14,4	13,7	67	65,3	65,4	17,1	19	19,6	1,7	1,3	1,3
The Neth.	18,1	18,1	17,1	49,4	52,1	54,6	30	28,8	27,3	2,5	1	1
Portugal	-	27	24,2	-	20,9	22,5	-	37	40	-	15	13,3
Sweden	4,1	3,7	3,5	69,6	74,3	74,8	25,7	21,9	21,5	0,7	0,2	0,1
Finland	20,5	16,6	13,6	58,4	63,2	66	20,5	19,5	20	0,7	0,6	0,5

However, the innovative performance of Greece remains worse except for Portugal among EU countries (the share of firms that have introduced a product innovation in the period of 1994-96 is 26,5% in Greek manufacturing firms). Interaction between firms and other organizations in innovative efforts is partly represented by the share of innovative firms that have cooperated. This share reaches 17% of innovative firms in 94-96 and 20,6% in 97-98 and to some extent is related to the conditions of funded programmes (mainly EU Framework Programmes requiring cooperation). In 1994-96 42% of innovative firms were funded and additionally funded firms demonstrated a higher intensity of innovative efforts. These facts point to an important presence of the financial support in the innovative process.

One issue that is partly indicative of the extent of interaction between S&T actors is the synergies and links developed among firms and between firms and Universities located in the incubator of a science park that may prove to be critical for innovative activity. According to a survey undertaken in March 2000 (Bakouros *et al.*, 2002), involving 24 firms located in three Greek science parks, there is no strong formal interaction between companies located in these parks. Besides, research synergies between on-park companies are completely absent and only commercial transactions and social interaction are taking place. Informal links are also developed between firms and the local University. Although informal interaction and socialization are not without importance for knowledge and information flows no research-based synergy in terms of joint research or shared equipment has been established in the science parks that have been studied.

Some recent studies[1] point to some interesting trends suggesting that there is a part of Greek firms which in the light of EU membership and European Monetary Union have made important steps towards modernization in terms of competitive strategy, organizational structure and management processes. These firms initiated change irrespective of size. The findings of these studies show that some firms have managed to succeed by drawing on their own initiatives and compete in the context of European integration. Especially regarding innovation, some firms appearing as "hidden champions" have relied on better satisfying their customers' needs and on close cooperation with their suppliers. These findings may justify a degree of optimism for the future of Greek firms and their technological development in the context of European integration. Perhaps one positive impact of European integration on Greek innovation system is the pressure for modernisation on domestic firms (Liagouras *et al*., 2002)

Human Resources

The development of human resources, investment on education and training and efforts for upgrading research personnel are an indicator for evaluating learning and knowledge transfer capability. To implement foreign knowledge and technology requires that skills are built up in the domestic economy.

In Greece there is some improvement in that respect.

In the following table we observe that although below the level of other European countries, researchers increased over the period of 1991-1997 as % of the labour force. European Framework Programmes played an important role in that respect as many scientists were hired either in companies or in Universities and Public Research Centres for the needs of research projects financed by the EC.

[1] Three recent research studies give some interesting information on the Greek firms: a) Makridakis S., Y. Caloghirou, L. Papagiannakis, P. Trivellas "The dualism of Greek firms: Problems and alternative strategies of a country in transition", Athens 1998, b) Voudouris I., S. Lioukas, S. Makridakis, Y. Spanos "Greek Hidden Champions: Lessons from Small, Little-known Firms in Greece", European Management Journal 2000, vol. 18(6), pp. 663-674, c)Spanos Y., G. Prastacos, V. Papadakis, "Greek Firms and EMU: Contrasting SMEs and Large-Sized Enterprises", European Management Journal 2001, vol. 19(6), pp. 638-648.

Table 8

Researchers in Europe (man years / 000 labour force)

	1991	1993	1995	1997
EU15		9,3	9,4	9,5
France	12	12,5	12,6	12,3
Germany	13,2	12,3	11,6	11,6
Denmark	8,8	9,5	10,8	11,9
Greece	2,7	3,5	4,1	4,7
Ireland	6,1	5,6	6,6	7,8
Spain	4,7	4,9	5	5,3
The Netherlands	9,5	10,5	10,7	10,9
Portugal	2,4*	2,9	3,2	3,6
Sweden	11,9	13,1	14,5	15,4
Finland	11,6	12,2	13,3	16,4

*: 1990.
Source: GSRT 2001, "Research in Greece".

Regarding the supply of human capital in Greece, we should point out that there is not only a lack of high-quality researchers but many PhD holders wait for a long time to be employed by Universities or Public Research Institutes (Liagouras *et al.*, 2002). At the same time the business sector lacks the capability to absorb them.

Besides, public expenditure on education as % of GDP increased from 2,7 to 3,5 (Table 9) showing the growing importance attributed to learning from Greek public actors. However, these indicators still remain below the levels met in other European countries.

Table 9

Public expenditure on education as percentage of GDP

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
DK	..	..	..	7,7	8,1	7,9	8,2	8,0	..	..
D	..	..	..	4,7	4,8	4,7	4,7	4,7	..	..
EL	..	2,7	3	2,9	3,1	3,4	3,5	3,7	3,5	3,5
E	4,8	4,9	4,7	4,7	4,7	4,5	4,5	4,5	4,5	4,4
F	5,6	5,9	5,9	6,0	5,9	6,0	5,9	5,9	5,8	5,7
IRL	5,6	5,9	5,9	5,5	5,3	5,2	4,9	4,6	4,5	
I	5,4	5,4	5	4,9	4,9	4,6	4,6	4,5	4,6	4,5
NL	5,4	5,2	5,1	5	5	4,8	4,9	4,8	4,9	4,9
P	..	..	..	5,4	5,5	5,6	5,6	5,7	..	..
FIN	7,3	6,9	6,7	6,9	7	6,5	6,2	6,2	6	..
S	..	7,6	7,5	7,5	7,6	7,9	8	7,7	8,4	8,3
UK	5,2	5,2	5,2	5	4,8	4,7	4,6	4,6	4,9	..
EU15	..	5,5	5,3	5,2	5,2	5,1	5	5	5,1	..

Source: EUROSTAT 2002, General Statistics, Structural Indicators, EUROPA < http://europa.eu.int/comm/eurostat/Public/datashop/print-product/EN?catalogue=Eurostat&product=1-ir010-EN&mode=download>

Scientific and technological Output: A Missing Link

There is a divergence in the performance of the scientific compared to the techno-economic system in Greece. This is reflected to several indicators as presented in the tables below.

The scientific performance of Greece measured by its world share in publications is very satisfactory compared to other southern European countries and tends to increase. At the same time its world share in citations although less important, is improving (Table 10).

Table 10

Scientific performance in Southern Europe and in Ireland

	Publications			**Citations**		
	World share* 1998	Ave. growth of share		World share* 1996	Ave. growth of share	
		1990-95	1995-98		1990-93	1993-96
GR	0.60%	6.6%	7.6%	0.40%	2.8%	13.9%
P	0.32%	9.0%	11.6%	0.21%	7.2%	10.5%
SP	0.77%	8.9%	5.6%	0.61%	12.4%	8.6%
I	0.79%	4.8%	3.4%	0.77%	5.8%	7.4%
IRL	0.84%	4.0%	5.9%	0.56%	-1.4%	6.1%
EU-15	1.05%	2.8%	1.7%	1.07%	2.8%	2.1%

Source: European Commission (2000)
* : weighted by population

When we measure the technological output we get another picture. The number of patent applications per million inhabitants deposited by residents to EPO is very low compared to other European countries.

Table 11

Patent applications to the EPO per million inhabitants in Southern Europe and Ireland

	No of patent applications / million inhabitants, 2001	%Average annual growth rate, 1991-2001
EL	7,7	8,2
E	24,1	11,4
P	5,5	25,7
IRL	85,6	17,5
I	74,7	6,7
EU-15	161,1	7,4

Source: Eurostat, Yearbook 2003.

The same applies for the competitive position of high technology industries, even though high-tech activities are not the critical factor for long - term development, especially in intermediate countries. Irrespective of which indicator we use, the Greek industry demonstrates a very weak position among the EU countries (see Table 3).

EU financial support raised considerably the amount of resources directed to the S&T system. However, the conditions required to have access to these resources do not correspond to the specific needs of the Greek industrial system. The impact from the implementation of the S&T policy during the last 15 years was mainly on the employment and training of Greek researchers rather than on innovative performance (Liagouras *et al.*, 2002).

If we consider on the one hand the relatively improved position of the scientific base in Greece (supply of researchers, performance of the scientific system, participation in international

research projects) and on the other hand the poor performance of the business sector in terms of R&D expenditure, patents and innovations, we are led to the conclusion that there is a missing link between the 'S' and the 'T'. In other words, the industrial system lacks the capability to exploit its scientific potential successfully.

4. The Role of the EU Transfers

European Union policy has been in favour of balanced regional growth. European Integration has revealed the importance not only of nominal but also of real convergence, the latter expressing the approximation of the levels of economic welfare, the social cohesion and the improvement of the competitive base of member states.

Policy priorities aimed at economic and technological convergence of the different European regions and to improve their S&T bases in order to increase their competitiveness. In this respect considerable transfers have been realised from more to less developed regions through two types of mechanisms: the EU Structural Funds and the EU Framework Programmes. The latter constitute a tool of RTD policy while the former is considered as a tool of broader macroeconomic policy.

The application of austerity policies in the preceding 10-15 year period seriously constrained the ability of the state to intervene and actively promote technological development. Particularly the objective of meeting Maasticht criteria was in an opposite direction of that of a policy aiming to support endogenous technological development. In addition competition policy has reduced the possibilities for traditional direct intervention that might distort competition (e.g. support of infant industries). Thus, the proportion of R&D activities that have been publicly funded fell from 74.4% of the total funding in 1986 to 57% in 1991 and 55% in 1997. At the same time the funding of R&D activities from European financial resources has risen considerably. The evolution of the r indicator (government financing of R&D as a percentage of GDP) appears in Table 12, showing a slight increase after 1992. However it should be taken into account that most of the public funds were directed to projects co-financed by EU funds, the Greek Government and private actors and could not be considered as an independent growing interest in R&D activities. EU regional policy and inflows of EU funding came to have a significant influence and to some extent offset internal austerity.

Table 12

Evolution of the r indicator (including Structural Funds for the years before 1995)

	Greece	Portugal	Spain	Ireland	EU15
1986	0,20	0,27	0,34	0,43	
1988	0,20	0,29	0,43	0,38	
1989	0,26	0,31	0,52	0,38	
1991	0,24	0,40	0,54	0,44	
1993	0,30	0,50	0,49	0,33	0,90
1995	0,31	0,46	0,49	0,36	0,84
1997	0,33	0,53	0,48	0,31	0,77
1998	0,29	0,56	0,56	0,31	0,76
1999	0,29				

Source: GSRT 2001, "Research in Greece".

S&T policy in Greece has been influenced to a great extent by the priorities of the European S&T policy, especially after 1989. At the same time important transfers in the context of EC regional policy and European S&T policy were directed either at R&D activities or at upgrading infrastructures in order to improve competitiveness.

After 1983, there was an increasing participation of Greece in the European Commission's activities. This constituted a basic change for the Greek economy because of the drastic increase of the resources available for R&D funding. The participation of Greek organisations in the European Programmes was very important with the Research Laboratories taking a more active role. Participations in EU Framework Programmes increased considerably after 1996 until 1998 and 49% of all participations came in the period of 1996-1998 (Tsakanikas, 2002). A survey carried out during winter 1999 in Greece[1], studied the R&D collaborations funded by European or National programmes. For EUREKA projects it was observed that in most of the cases Greek participants had not finally implemented the project, as they did not find the necessary funds from national sources. This can be considered as evidence that even in cases for which the R&D project was positively evaluated, Greek firms were not willing to take the risk of implementation without funding. The same survey showed that "additionality", which is an objective of EU intervention, has been achieved to a considerable extent as 65% of the research activity undertaken in the context of the Framework Programmes would not have been performed in the absence of funding (Tsakanikas, 2002). This becomes more crucial if we take into account that for almost half of the Greek firms of the sample this activity represents the only R&D effort undertaken.

In the context of European regional policy, a large amount of receipts from the Structural Funds were directed at investment.

EU transfers (net receipts) reached the level of 5% of the GDP in the year 2000 (Table 13). Receipts from Structural Funds, that are mainly oriented to investment purposes, represent 14% of the Gross Fixed Capital Formation (GFCF) and 50% of the public GFCF.

Table 13

Evolution of net receipts from EU and of the trade balance as % of GDP and GFCF

	ECrecpts/GDP	SF/GFCF	SF/pubGFCF	TB/GDP	TB-fuels/GDP
1981	0,37	1,24	5,92	-7,44	-8,5
1982	1,31	1,66	6,93	-10,16	-8,2
1983	1,99	2,15	8,39	-10,46	-8,3
1984	1,82	2,88	8,57	-10,13	-7,8
1985	2,18	3,29	9,93	-11,32	-9,6
1986	2,72	5,22	19,69	-10,72	-9,2
1987	3,23	5,65	24,34	-10,47	-9,2
1988	2,83	5,84	27,09	-11,41	-9,7
1989	3,24	6,92	32,00	-12,56	-11,1
1990	3,61	7,10	37,36	-14,52	-12,2
1991	3,74	8,33	38,92	-14,11	-11,5
1992	4,35	11,66	48,87	-13,30	-12,4
1993	4,98	14,23	56,20	-13,42	-12,1
1994	4,64	14,37	57,25	-11,92	-12,3
1995	3,95	13,01	49,42	-12,19	-13,3
1996	4,70	15,16	58,85	-13,24	-13,1
1997	3,92	12,72	49,76	-13,81	-13,4
1998	3,84	12,96	53,54	-15,12	..
1999	4,84	15,15	57,67	-13,90	..
2000*	4,86	14,34	54,88	-14,91	..

Excerpts: net receipts from EC, SF: receipts from Structural Funds, pub GFCF: public Gross Fixed Capital Formation, TB: trade balance, TB-fuels: trade balance without fuels.

Source: National Accounts, ESYE.

It is reasonable to suggest that in a period during which restrictive macro-economic policies have squeezed the possibility of spending on the improvement of infrastructures and the tech-

[1] The survey has been carried out in the context of the STEP TO RJVs project funded by the TSER EC programme.

nological basis of the industrial system, European transfers play a role of counterbalance, which relates with a long-term perspective. European transfers have played the role of attenuating restrictive policies and raised the level of public funding without the negative effects that might result from intervention with national funds. European funding has also raised the level of economic activity (a multiplier effect). However as trade performance still remains very problematic (the trade deficit is increasing as a percentage of GDP) and innovative performance very weak, it is still to be shown in the years to come whether the impact of the European support will really play a restructuring role in the industrial system or will exert pressure to the trade balance through the increase of domestic consumption. The key element to this question is the ability of the Greek industrial system to exploit European financial resources in improving its absorptive capability and building a dynamic process of catching up.

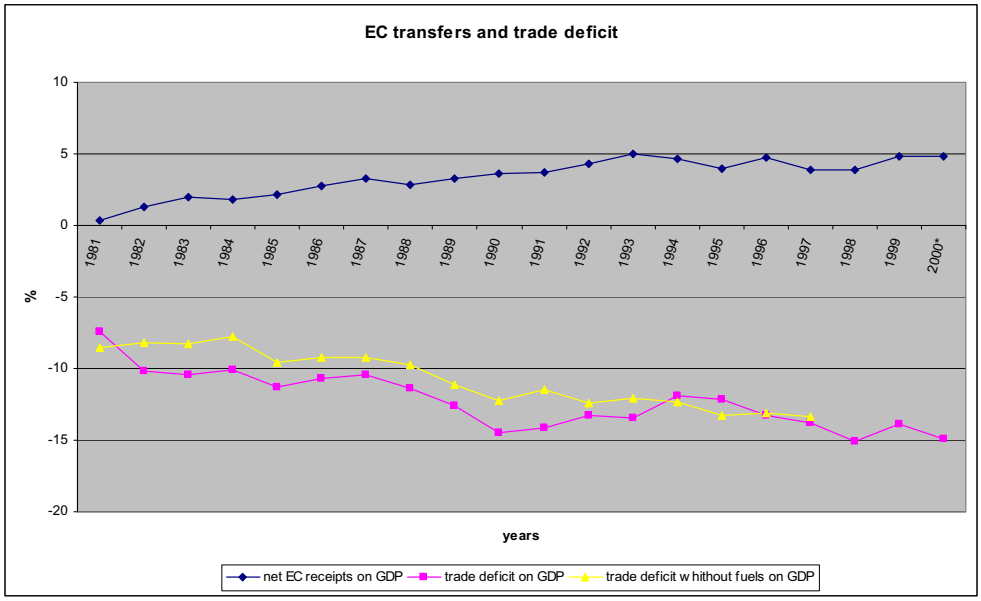


Fig. 7.EC transfers and trade deficit

5. Discussion

In the context of the European Integration, Greece moved from a protectionist regime of state intervention towards greater openness and economic liberalisation. European macroeconomic policies were pointing to this transition from the time of the Affiliation agreement and more strongly from the Accession of Greece to the EC (in 1981). However, before 1992 there was a disassociation between the national macroeconomic policy and the needs for adjustment in the context of European policy requirements. National priorities delayed the adjustment to the new status and it is after 1992 that European Integration and preparation for Economic and Monetary Union have been treated as national priority.

The gradual dismantling of the protectionist regime, which occurred after the end of 80s, had some negative effects on:

a) the profitability of industrial firms;
b) the competitive position of many of the Greek products that remained exposed to international competition;
c) licensing agreements, as exports became a more attractive way of penetration of foreign producers into the Greek Market.

The transition to greater openness and economic liberalisation made obsolete many of the state practices in favour of industrial and technological development and required new strategies

from the private actor's side. As the relaxation of public intervention intensified there was more pressure for private actors to improve their competitive position in terms of technological and organisational capabilities and the strategic role of knowledge was more and more recognised.

European Integration influenced technological development through the process of trade and market liberalisation and through the implementation of regional and technology policies. In the context of restrictive macroeconomic policies that were implemented during the 90s, national public intervention and spending on the improvement of the Greek S&T system were reduced but inflows of financial support from the European Union counterbalanced this effect and established a new context for inducing local technological development.

What appears to be most important for catching-up in intermediate countries is the need to build a sustainable potential of skills, knowledge stock, technological infrastructure and R&D capability in order to absorb knowledge flows from abroad and efficiently transform them into new products, services or processes. Although Greece presents very low performance in terms of R&D indicators (the lowest after Portugal in the EU), we can observe a slight improvement over the last 15 years. Financial support from the European Union played an important role to that respect as it proved to be beneficial in raising R&D efforts and improving the level of scientific personnel in the business and academic sectors. National initiatives followed the same priorities with the EU technology policy. The recent orientation of the Greek S&T policy to support research that is close to market needs to have a positive impact on technology performance and innovative capabilities of the Greek industry, although it encompasses a risk of restrictive effects on basic research, as the Ministry of Development and particularly the General Secretariat of Research and Technology is responsible for research policy in Greece, not only as far as firms are concerned but also Universities and Public Research Institutes.

Additionally, a small part of Greek firms (hidden champions) introduced some important changes towards modernisation of their competitive strategy, organisational structure and management practices in order to compete under the new conditions set in the context of European Monetary Union.

However, we should also underline that the competitive position of Greek products was not improved over the last twenty years and import penetration increased. This seriously questions the ability of the Greek industrial system to convert investment in new knowledge and R&D into innovative products and commercial success. Despite the issue of how much R&D spending there is also an issue of efficiency of R&D spending that involves public and private actors.

Probably the missing link from the side of economic policy remains at the integration of all policy measures into a more dynamic perspective of industrial development that would consider real demand needs on the one hand but also the necessity of upgrading the capacity of all economic actors involved in the productive and innovative process to create and / or exploit knowledge and information flows.

What is clear from the Greek experience and could be of interest for accession countries as well, is that once macroeconomic imperatives point to restrictive policies, the challenge remains to keep developing domestic capabilities that would support a catching-up process. EU regional and technology policy could support and complement this effort under condition of on the one hand orienting financial resources towards developing a critical mass of R&D capabilities and skills and on the other hand adapting policy objectives and tools to national specificities.

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