The system of innovation in Greece: structural asymmetries and policy failure

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Abstract: This paper attempts to shed light on the Greek innovation system which is characterised by a number of asymmetries that have been prevalent over time. This paper is structured as follows: Following a brief presentation of the analysis framework (Section 2), we examine the Greek innovation system and identify four important asymmetries prevalent in the system which affect its operation (Section 3). We then turn to the government technology and innovation policies adopted over the last 15 years to examine their apparent failure to address the low performance of the Greek innovation system in an effective way, pointing out weaknesses in the design and the implementation stages (Section 4). The last part (Section 5) attempts to bring the two elements together (innovation system versus. policies) and outline some directions for future innovation policy that would better fit the characteristics of the country's innovation system, taking into account its asymmetries, strengths and weaknesses.

Keywords: systems of innovation; technology policy; innovation policy; innovative sectors; Greece.

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1   Introduction: innovation and development in Greece – two unrelated stories?

There is almost no single study or report examining the competitiveness of the Greek economy that does not point to the country's weak innovation capacity and its poor performance in most of the indicators/metrics that describe research activity, knowledge creation and technology and innovation development (EC, 2003, 2004, 2006a; Technopolis, 2006; Tsipouri and Papadakou, 2005). The country occupies the last positions in the Innovation Scoreboards rankings, something that did not change even after the enlargement of the EU with 10 new Member States from Central and Eastern Europe.

This has happened at the same time that Greece has for the last 10 years experienced GDP growth rates at 1–2% higher than the European average and improved its labour productivity by 3.5% over the period 1995–2004, 2% points higher than the EU-15 average (OECD, 2006). Further support for this apparent discrepancy is provided based on the Innovation Scoreboard 2003 (EC, 2003). A simple linear regression of GDP/capita (rescaled from 0 to 1) on the Regional Summary Innovation Index (RSII) 2003 for a total of 173 EU regions produces a positive and strongly significant ($p = 0.001$) coefficient between the RSII and GDP per capita levels with the model explaining 41% of the variation of per capita income (see Figure 1). This positive correlation is not replicated when examining the 13 Greek regions' subgroup separately. The regression coefficient is not significant ($p = 0.438$) and very close to zero (0.065) and the variation explained only 5.5%. While the model does not control for other important variables, it provides another evidence that the economic performance of the Greek regions does not seem to be connected with their respective (low) innovation activity.

Hence, there seems to be a limited correlation between the country's overall economic performance and the respective performance on knowledge creation and innovation. Arundel and Holladers argue that, 'Greece's economic strategy appears to have little if anything to do with innovation' (Arundel and Hollanders, 2005, p.62).

A number of issues arise from the above picture:

- Why does the economic development of the country not coincide with an improvement in its innovation performance? Is Greece locked on a permanent pathway of low innovation and technology creation?

- What are the reasons and parameters that obstruct the development of innovation activity in the country?

- What has been the nature and role of innovation policies, institutions and support structures? Have they been moving towards readdressing the apparent weaknesses and supporting the change towards a knowledge-based trajectory?

Figure 1 RSII and GDP/capita (EU and Greek regions)
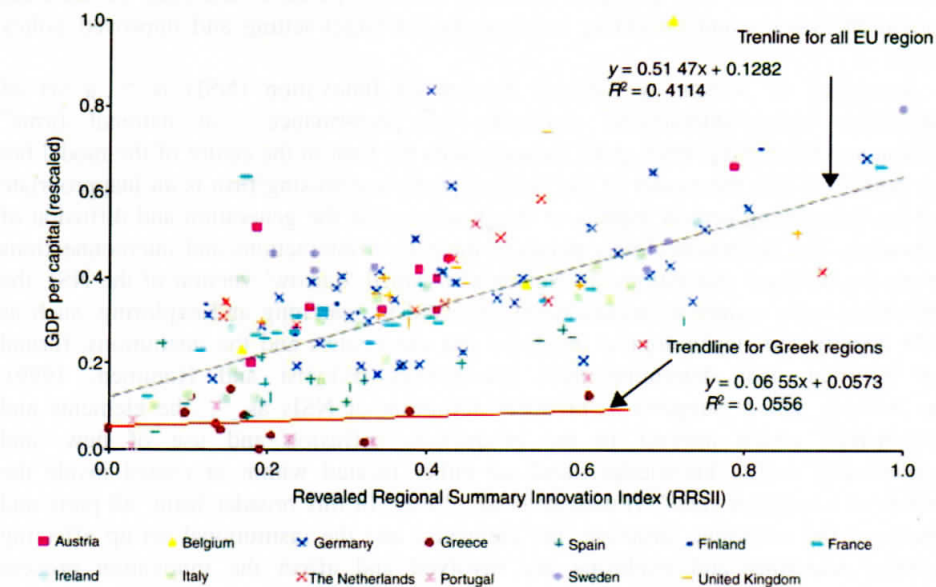
Source: EC (2003).

We argue in this paper that an important part of the problem of the Greek system of innovation is the presence of important asymmetries and the failure of innovation policy to properly address them. Based on existing data and indicators we identify four such asymmetries in the system that characterise the operation of the Greek innovation system. They include:

1 the dominance of public sector R&D activity compared to the private sector

2 an asymmetry between innovation creation and absorption / adoption activity

3 an imbalance between few and small innovative sectors and the remainder of the economy

4 a very strong spatial concentration of innovation-related activities.

Subsequently, examining the research, and technology and innovation policies implemented over the last 15–20 years we identify important weaknesses, both in the design and the implementation stage. We conclude that there is a need for a more appropriately targeted, consistent and effective innovation policy that would recognise the presence of these strong asymmetries, address their persistence, and lead to a change of trajectory towards more informed technology and innovation policies.

2   A framework of analysis: systems of innovation

Our framework of analysis is based on a systemic approach to the innovation framework as developed in parallel from Lundvall, Nelson and Rosenberg (Edquist and Lundvall, 1993; Nelson, 1993; Nelson and Rosenberg, 1993) and its subsequent variances. It provides a holistic, pragmatic and flexible way of analysing the specific setting of a country and identifying why and how knowledge and innovations emerge. Furthermore, as the systemic approach is becoming more widely accepted as a basis for government policies, more data are available allowing for comparative analyses of different innovation systems and providing benchmarks for target-setting and improved policy design.

According to Nelson, a National System of Innovation (NSI) is "…a set of institutions whose interactions determine the performance… of national firms" (Nelson and Rosenberg 1993, p.4). Nelson's puts the firm in the centre of the model but also points out that the model of the isolated profit-maximising firm is an inappropriate tool for interpreting certain aspects of the processes for the generation and diffusion of innovation. The definition clearly points to the role of interactions and interconnections among the different institutions. In Nelson's so-called 'narrow' version of the NSI, the institutions refer mainly to organisations involved in searching and exploring, such as R&D departments, technological institutes and universities and the institutions, formal and informal, that determine their interactions (Edquist and Hommen, 1999). The Aalborg school suggests a 'broader' definition of NSIs as, "…the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge…and are either located within or rooted inside the borders of a national state", (Lundvall et al., 2002). In this broader form, all parts and aspects of the economic structure (the elements) and the institutional set-up affecting learning, searching and exploring are involved and affect the innovation process (Figure 2).

Figure 2   A generic view of a national innovation system
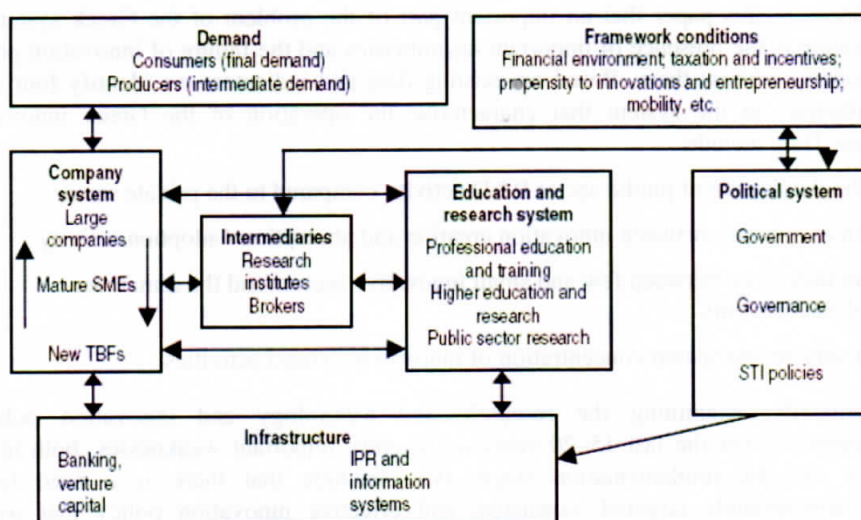
Source: Arnold and Kuhlmann (2001) cited in OECD (2005a).

The development of innovation systems approaches brings together different theories of innovation, including interactive learning and evolutionary theories (Edquist and Hommen, 1999). Interactions are at the core of the systems approach, rejecting a linear-model, where new technology is assumed to develop directly on the basis of scientific efforts in the research laboratory and materialise thereafter in new marketed products. Success in innovation has to do with knowledge flows and interactions – traded and untraded – among different agents through complex relations characterised by reciprocity and feedback mechanisms where cooperation and competition coexist. The agents may be other firms (suppliers, customers or competitors), public and private research institutes, universities or transfer institutions. The 'locus' of the critical knowledge for innovation varies depending on the relevant/expected 'rents' (Von Hippel, 1988). The importance of interaction between users and producers and the feedback loops also introduces the role of the demand side – consumers and public sector – both in quantitative terms (home market size) and also in qualitative terms concerning the presence of early adopters and preference for innovative products (Lundvall et al., 2002).

An additional element of the NSI framework is the recognition that the interactions among different agents do not occur in a vacuum but in the context of established institutions including the governance system, laws and regulations and also norms and cultural habits which tend to differ among different environments. The institutions play a major role in how people and firms learn and use their knowledge, as a result affecting the final outcome. Different national contexts with different norms and institutions provide different possibilities for establishing the processes of interactive learning (Edquist and Hommen, 1999). The distinction between the short-termism characterising corporate governance in Anglo-Saxon countries, and long-termism in Japanese investment decisions, is a typical example of how differences in culture and institutions can affect the conduct and performance of innovation activities at national level (Lundvall et al., 2002). Going back to Nelson's national firms, their capacity to create and utilise knowledge for developing own innovation depends both on its external environment but also on its own capacity to interact with it and derive the appropriate resources, capabilities and knowledge.

Besides the interactive nature of innovation, a systemic approach also adopts an evolutionary view to innovation. Instead of understanding technical change as a profit-maximising exercise – implying some form of optimal solution – Nelson and Winter (cited in Edquist and Hommen, 1999) see it is an open-ended and path-dependent cumulative process with no single optimal solution. Uncertainty and asymmetry of knowledge are essential elements of the process, providing profit-making opportunities and the drive for further innovation. For the system it means that the prior resource base and accumulated knowledge influence the pattern (path) of the innovation process while at the same time there is considerable randomness and uncertainty concerning its future evolution. A variety of options provide sufficient diversity, and a selection process allows the system to exploit good trajectories as well as the capacity/opportunity to escape from possible technological lock-ins (Bach and Matt, 2005).

So far, we have implicitly set the boundaries of the innovation system at national level mainly. Other scholars/studies, however, argue for sectoral boundaries – focusing on systems of innovation defined by specific technology fields or product areas. In such cases the market requirements, the capabilities and interactions among agents are

technology–specific and in many cases they may extend beyond national borders (Carlsson and Jacobsson, 1997). Another important strand points to the importance of subnational, regional or local systems focusing on the tacitness of knowledge as well as the role of role of norms and institutions (mainly informal) that are more apparent at regional levels (Cooke et al., 1997). Following Edquist (1999), our view is that there is no real contradiction among the different approaches. "Whether a system should be spatially or technologically delimited – or both – depends on the object of the study. Generally, the approaches complement each other rather than exclude each other" (p.13). Hence, any analysis at national level needs to consider how specific elements of it interact at a broader scale (e.g. multinational firms), the role of the external environment and external agents and institutions (e.g. in the case of Greece this clearly includes the EU and its policies), how external knowledge is (or is not) integrated and utilised in the system and consider the operation of specific regional or sectoral subsystems and their integration at national level.

From a policy perspective, understanding innovation as a systemic process has important implications for policy-makers and for identifying effective innovation policy measures. The linear approach to innovation directed policy intervention towards correcting market failure – mainly in the form of providing incentives to firms (grants, tax cuts, intellectual rights protection) that would otherwise be expected to under-invest in research and technology development due to inappropriability concerns. While such measures are still of importance, the systemic approach directs attention to a broader set of parameters that may impede/obstruct innovative performance and support for efficient interaction and knowledge exchange/flows among the different elements of the system. Hence, innovation policy should go beyond supply-side instruments and include legislation on consumer safety and the environment, the use of tools/instruments affecting choices among alternative technologies as well as public procurement policies that can create new markets or trigger innovation (Edquist and Hommen, 1999). A systemic approach – especially in its 'broader' form – points to the need of more integrated view where other policies (macroeconomic, employment, education, environment) are recognised as parts of the innovation policy and possible conflicts of direction are examined and addressed.

Due to the evolutionary approach adopted, the 'failures' of the system do not refer to the deviation from the 'optimal situation' – as in neoclassical economics – but rather to dysfunctions, gaps or traps in the system (Bach and Matt, 2005). Misallocation of efforts to one or few activities, technologies, practices and firms early eliminated or maintained too long, lack of coordination and absence of appropriate institutions, constraints in knowledge processing and diffusion are all possible failures that lead to lock-in or bad trajectories and difficulties in shifting to new paradigms. Hence, the policy-maker's role is to facilitate the progress of the innovation system through supporting increase and/or change of the available knowledge base, reinforcing cooperation and diffusion of knowledge and facilitating transition and change to new paradigms. However, in contrast to the neoclassical optimising role based on full/perfect information, policies are constrained by what is known about the system and the inherent uncertainty of future technological changes. The policy-maker should be 'adaptive', experiment with policies and instruments and – crucially – be able to use past experiences, feedback and other examples to learn and adopt (Bach and Matt, 2005; Metcalfe, 2002).

3 The Greek innovation system: performance and asymmetries

In the great majority of existing relevant studies/reports, Greece and its innovation system has been characterised as a 'laggard' country, placed at the bottom in most rankings and with rather limited improvement/progress evident over recent years (MERIT and JRC, 2006). Presenting the Greek innovation system in a recent OECD report, Tsipouri and Papadakou (2005, p.13) state that it is, "…among the least developed [in the OECD area] in terms both of actors and of linkages. The productive sector relies on traditional activities, market mechanisms do not trigger change and the economy remains dependent on low cost for competitiveness".

This bleak picture can be illustrated and analysed based on data and studies/reports available from the European Innovation Scoreboard (EIS), OECD and the Community Innovation Surveys (CIS). All studies available since 2001 place Greece at the bottom of the ranking of the EU and OECD Member states in almost all respects. In 2001 – the year when the first scoreboard was published – Greece was placed last among the 15 EU Member states in the Summary Innovation Index (SII) as well as in the great majority of the individual indicators referring both to innovation inputs (R&D activity, R&D personnel) and outputs (patents, innovative firms). Despite the fact that the enlargement of EU in 2004 brought 10 new Member states into the European Union which all – bar Cyprus and Slovenia – had GDP/capita levels below 80% of that of Greece (EUROSTAT, 2005a), the country again ranked at the bottom of the 2006 EIS (Table 1), with a SII at 40% of the EU-15 average[1] (MERIT and JRC, 2006). The cluster analysis based on the available indicators for 2006 places Greece in the laggards group with its peer countries including Portugal and 3 new Member states – Estonia, Poland and Latvia (Arundel and Hollanders, 2005). The 2006 scoreboard (MERIT and JRC, 2006) placed Greece in the catching up cluster due to a marginal increase in the SII score (from 0.21 to 0.22).

Table 1 Greece's rank in the innovation scoreboard SII

	2001	2002	2003	2004	2005	2006
Greece	−7.9	n.a	0.13	0.20	0.21	0.22
EU15 Score	0	n.a	0.44	0.44	0.46	0.50
Position	14th	n.a.	19th	23rd	24th	25th
Number of countries	15	n.a.	19	27	27	27

[a]This is the SII-2 index which is based on indicators for which there are data available from all countries.

Note: The SIIs were not comparable across years until 2005 as they were based on different definitions (indicators included and relative weights).

Source: EISs (2001–2006).

This poor performance of the Greek innovation system is replicated at regional and sectoral level. The 2006 Regional Innovation Scoreboard places all 13 Greek regions (NUTS2) at the very bottom of the relative ranking of 203 regions, with the region of the South Aegean (Notio Aegeo) being very last, 10 of the 13 being in the bottom 20 and only the capital region of Attica having a relatively good performance (86th) (Hollanders, 2006). At sector-level, the results of the Sector Innovation Scoreboard for

2005 place all manufacturing sectors at the lower-end of the rankings based on the composite Innovation Sector Index (ISI). Services show an overall better performance based on ICT and the computer services subsector which shows an exceptionally high relative performance (1st in the respective ranking) (Hollanders and Arundel, 2005).

While the above composite indexes give a general view of the country's overall performance in comparison to other Member states, there are important variations in the country's performance among the different indicators (see EIS Graph 2). More specifically:

- Greece has an above-average performance in areas related to public funding of innovation, university R&D financed by the business sector, innovation expenditure shares, youth education levels and non-technology innovation.

- It is closer to the EU average (60–90%) in tertiary education levels of the working population, new to firm products sales, ICT expenditure and innovative SMEs (in-house or through collaboration). According to OECD data (STI indicator), it also has a moderate level of scientific publications per million population, around 55% of the EU15 average.

- It has a wide group of indicators in the 'red zone' (below 50% of the EU average) including patenting activity, business sector R&D expenditure, high tech sector employment and value-added shares, innovative activity (new-to-market) in manufacturing services, ICT penetration, life-long learning and innovation financing.

One general observation made – see 2004 Scoreboard report (EC, 2004) – is that there is a general tendency for better performance in indicators measuring innovation inputs and worse performance in output-measuring indicators, a picture indicating a possible absence of appropriate links and interactions among the knowledge-creating and knowledge-utilising elements of the system.
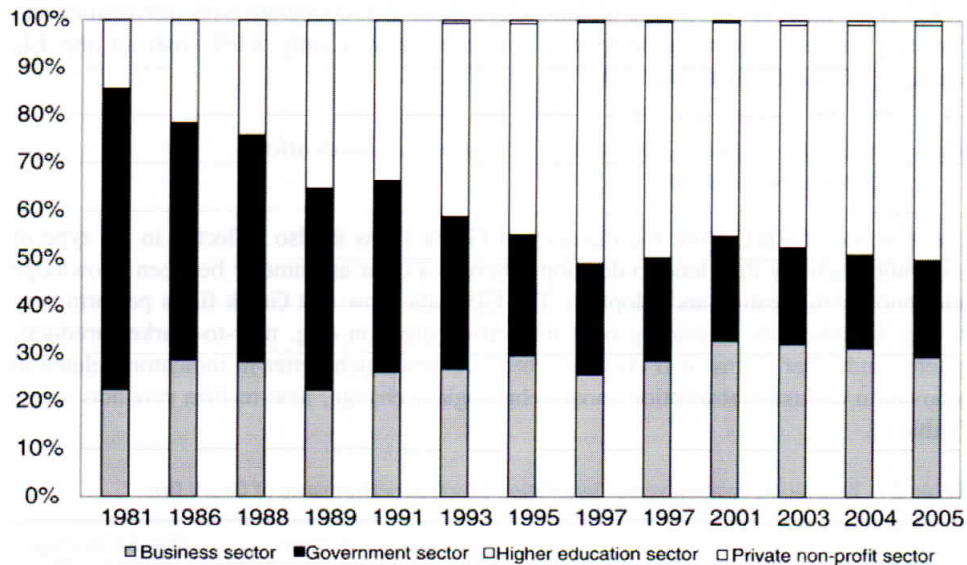
Our data analysis points to four main *structural asymmetries*, which have been persistent overtime and which we analyse below examining how they influence the function of the innovation system in the creation of knowledge, its diffusion among the different players and its use for the development of innovation.

3.1 Asymmetry between public and private R&D activity

Greece's distribution of total national R&D expenditure reveals a reverse profile from almost all other countries in the EU. Business sector expenditures on R&D are continuously less than 30% of total R&D expenditures, at around 15% of the respective EU average (EUROSTAT, 2005b). A disproportionate share of R&D activity in the country takes place in the public sector – around 50% at universities and 20% at government research centres (Figure 3). This trend has been prevalent overtime despite policy measures and incentives in the form of grants and subsidies focusing explicitly on the promotion/support of business R&D. As shown in the CIS (2–4), Greek firms do not invest in R&D activity and a very low share has owned R&D facilities and research personnel performing continuous R&D. According to the most recent innovation survey (CIS-4), among the firms with some form of innovative activity, around half engaged in intramural R&D and 30% on a continuous basis (EUROSTAT, 2007). In addition, the country has very few companies with large-scale, strong R&D

performance around which important supplier networks and technology demand could develop. The 2006 European Industrial R&D Investment Scoreboard reporting the top 1000 firms with R&D activity in Europe included only 6 Greek firms (2 in manufacturing and 4 in services) all ranked below the 300th position (EC, 2006a).

Figure 3   Distribution of R&D expenditure in Greece by source of funding (1981–2005)

□ Business sector   ■ Government sector   □ Higher education sector   □ Private non-profit sector

Source: EUROSTAT (2007, #50).

The limited R&D activity from firms has a number of important implications. Firstly, it is in general recognised that business sector R&D activity brings a higher level of economic returns (GDP growth) than public sector R&D activity, and that influence of the latter is higher in countries with high business R&D intensity (Tsipouri, 2001). More important for the operation of the innovation system, a less skewed distribution of public and private R&D activity could facilitate the flows of knowledge and interactions. The performance of internal R&D from firms not only increases the probability of developing innovative products and processes internally but also increases their absorptive capacity (Cohen and Levinthal, 1990) – the ability to search, identify and absorb external knowledge – and the propensity to interact with the external environment (Fritsch and Lukas, 1998; Veugelers, 1997). Hence, the limited number of firms with own R&D activity in Greece plays a restrictive role on the development of flows of knowledge and the interactions inside the system. Any increase of public R&D activity that is not followed by a respective increase from the private sector can end up under-utilised.

The low investment of Greek firms in R&D activity can be at least partly explained by the dominance of small or even very small firms (Tsipouri, 1991) which in many cases lack the resources for continuous R&D activity. An alternative strategy could be based on outsourcing of R&D and use of technology services developed from semi-private research centres (such as the technology centres in Spain) or the public sector research institutes. Few centres of the first type have been developed in Greece, while the public sector – and especially universities – have maintained a rather negative

attitude towards direct cooperation and funding of R&D activities by the private sector. They focus on basic research activity that in many cases does not fit with the needs of the market. On the other hand, the low demand for technology services from firms has not helped the creation of a market for research services from public organisations and the necessary incentives for a more market-oriented structure – a shift already evident in many public research organisations at a global scale (Howells, 1999). The results from CIS-4 show that the percentage of innovative firms that cooperate with universities and research centres in innovation-related programmes was only 8.9%, half of the EU average (18.5%)(EUROSTAT, 2007).

3.2   Asymmetry between innovation creation and innovation diffusion/absorption

The absence of R&D from the majority of Greek firms is also reflected in the type of innovation activity they tend to develop. There is a clear asymmetry between knowledge and innovation creation and adoption. The CIS data show that Greek firms perform very poorly in indicators measuring own innovation creation (e.g. new-to-market products, patents and other forms of IPO) while they perform much better in indicators related to innovation diffusion/absorption (non-technological change, new-to-firm products sales) (Table 2).

Table 2   Innovation creation versus innovation adoption performance of Greek firms

	Greece	*% of EU average*
Innovation creation indicators		
– New to market product sales	2.9	48
– EPO patents (per million population)	8.1	6
– Community trademarks (per million population)	24.9	29
Innovation adoption indicators		
– SMEs using non-tech change (% of SMEs)	59	139
– New to firm products sales	8.9	74

Source: EIS (2005).

This diffusion/adoption-oriented strategy is also highlighted by Greek firms' attitude towards innovation. The country ranks low (13th of 19) in the share of firms that consider innovation as an important part of their competitive strategy (strategic and intermittent innovators)[2] while it has a rather better performance (9th) in the technology adopters category, "firms that only innovate through adopting technology developed by other firms" (Arundel and Hollanders, 2005). Still, 72% of firms did not report any innovative activity (non-innovators).

From the demand side, there is again a preference for and support for adoption strategies. That includes customer demand that is not supportive of innovation: 56% of customers have a negative attitude towards innovation according to the 2005 Innobarometer (EC, 2005).

Clearly an adoption/diffusion-focused strategy is a rational approach for a small country which in most sectors is far from the technological frontier. For most of its lagging regions and firms, it is clearly the only option – at least in the long term.

A properly developed adoption strategy means linkages and interaction with the various technological resources (inside and outside the country) and a skilled and continuously reskilled human capital able to absorb and use existing knowledge and technology in the most efficient and effective way. In the long term, this path can also lead to an increase in own innovation capacity.

This is, however, not the case in Greece. Greek firms' adoption strategy has traditionally relied on imports of machinery and equipment (embedded technology) as the main form of technological upgrade and productivity improvement (Deniozos, 1993; Tsipouri and Papadakou, 2005), a form that provides for the minimum possible form of interaction, knowledge exchange and learning. As revealed by the 3rd CIS, more than 40% (44% in manufacturing and 49% in services) of stated innovation expenditures were directed towards the purchase of equipment and machinery. External R&D (1.9% in industry and 9.1% in services) or use of other forms of external knowledge (19.8% in industry and 7.2% in services) are much less important for the majority of Greek firms. As far as human capital is concerned, the respective investment in life-long learning and training is among the lowest in Europe (39% of EU average) and the relative progress has also been very limited (EC, 2006b). The absence of continuously learning personnel – combined with absence of internal R&D activity – limits the potential effect from capital imports and embedded technology and the quality of the knowledge flows inside and outside the country.
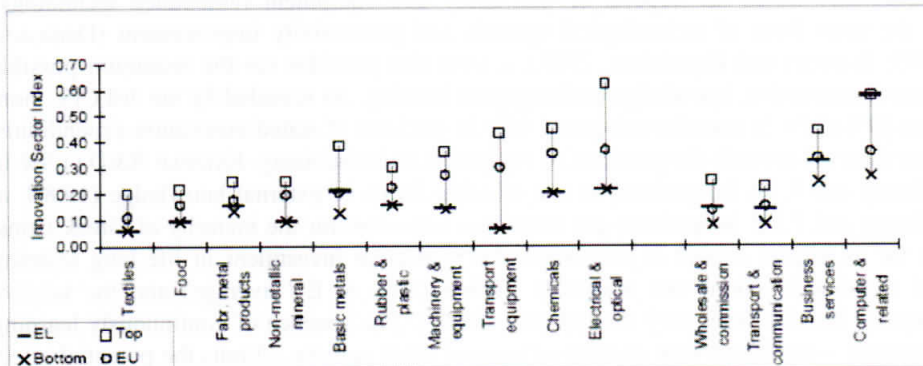
3.3 Sector asymmetry

A third asymmetry identified is related to the structure of industry and its focus on activities with limited innovative content. The Sector Innovation Scoreboard provides a ranking of industry and services sectors for each country based on a composite indicator. Based on this indicator we see that all manufacturing sectors in the country have innovative performances well below the EU–15 average – a result of very low R&D expenditures as well as limited innovative activity. Among the manufacturing sectors, none shows high or even medium innovation performance. The dominance of manufacturing sectors with low technological and innovation intensity that are based on imported technology has, of course, a clear result and impact on the level of demand for knowledge and technology intensive products and services, the opportunities for innovative products and the flows and interactions inside the system.

On the contrary, the services sectors reveal more positive results with some ranked close or above average (transport and communication and wholesale and commission trade) while the computer services firms have the best overall performance among all 15 Member states. Analysis of the composite indicator shows that this high performance is based on a combination of high innovation and R&D expenditure levels, a high rate of skilled personnel usage along with continuous training (life-long learning), good innovative performance (new-to-market products) and increased levels of cooperation with other firms in the innovation process (Hollanders and Arundel, 2005) (Figure 4).

This gap between innovation in services and manufacturing is much wider than in almost any other country. More important though is that in Greece the more innovative sectors have very small shares in the total economy, while the increase of their share in the economy is lower than that of the EU-15. The most innovative sector, computer

services, participated with only 0.3% in the total added value (in current prices) in 2003 – more than 6 times less than the respective EU average. The absolute increase of its share in the period 1990–2003 was only 0.2% when in the EU-15 the figure was 0.9% (GGDC, 2005).

Figure 4   Innovation performance by industry sector, Greece

ISI scores per sector shown by •, highest ISI score in country sample depicted by •, lowest ISI score in country sample depicted by x, EU average depicted by • .

Source: EIS (2005).

3.4 Regional asymmetry

Besides the general poor performance of all regions of the country, the Scoreboards point out the uneven innovation potential of the country's 13 regions. Two regions (Attica, Central Macedonia) concentrate the bulk of the country's innovative activities while two additional regions (Crete, Western Greece) have important shares in public sector R&D and human capital only – a result of the establishment of Universities and public research institutes in these areas during the 1980s. The region of Attica has – in the majority of variables – shares much higher than the respective population and GDP shares (see Figure 5). Patenting activity and business R&D expenditures in particular are above 60% of the total while all other parameters are 50% or higher. The capital region concentrates the highest part of the most innovative sectors and activities – replicating the sectoral asymmetry at a regional level. The second pole in Central Macedonia – around the city of Thessaloniki – is much more limited – following to a great degree the relative GDP shares and with important weaknesses evident concerning the business sector activities. The public-private sector R&D asymmetry and the sectoral concentration in high-tech services is replicated here as, in relative terms, the remaining 11 regions have higher shares in indicators related with the public sector role (public R&D activity and knowledge workers/university students) and very low shares in knowledge intensive business services (measured by employment).

To the extent that this strong geographical concentration would signify the creation of strong R&D and innovation poles, that could be considered a positive element. However, even with this strongly uneven distribution of innovative inputs and outputs, the region of Attica is only 85th in the respective EU ranking based on the Summary Regional Innovation Index, much lower than the capital regions of most enlarged

countries (e.g. Prague region-15th, Budapest region-34th, Bratislava region-27th, Warsaw region-65th) and only higher than Lisbon-108th. Central Macedonia ranks only 164th (Hollanders, 2006).

Figure 5 Regional distribution of innovation factors and activities
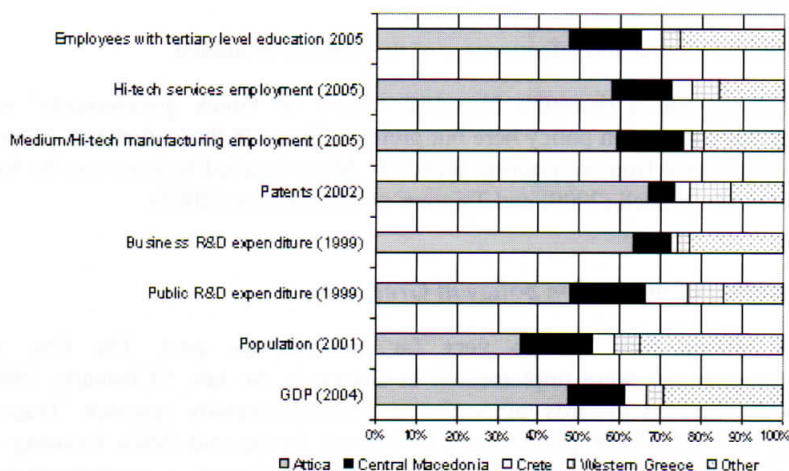
Source: EUROSTAT (2007 #50).

The presence of minimum level of absorption capacity in the remaining regions is a necessary condition for the development of knowledge flows and technology absorption. Its absence means that a large part of the country remains outside the technology development process. As well as that, an important share of existing human resources (an indicator where the regional distribution is less skewed) is left outside the innovation process of Greece.

Brought together, the four asymmetries reflect an innovation system characterised by weak/not-sufficiently developed elements and the absence of the necessary flows and interactions between the more and the less dynamic parts. Knowledge creation is predominantly a public sector venture which in large part remains under-utilised (or unutilised) inside its boundaries instead of being diffused to the broader system. Under-investment in knowledge capacity from the private sector reduces the demand for technology and the capacity for knowledge exchange and interactive learning inside the system. Sectoral and regional asymmetries show that innovation-related activity concerns a small number of business entities and spaces inside the country while the remaining part of the economy cannot participate and contribute towards a more knowledge-based structure.

4   Innovation policy and its failures

The innovation systems approach recognises an important role in the political system (government and governance) and the innovation policies in avoiding critical lock-ins. What have been the responses of the political system and the innovation policy of governments implemented so far? Is it moving towards addressing its apparent weaknesses and supporting its evolution?

To answer the above questions we examine key dimensions of the innovation policy that has been implemented over the last 15–20 years, and in particular:

- the innovation policy design process

- the policy concept

- the implementation and effectiveness of the policies promoted.

We do not provide a thorough historical review of Greek governments' science, technology and innovation policy here but prefer to focus on those elements we consider of prime importance from a systemic approach. More detailed reviews can be found in Deniozos (1993), Kasteli (2000) and Tsipouri and Papadakou (2005).

4.1   Evolution of innovation policy in Greece

Innovation policy does not go very far back in the past. The first support measures/programmes were implemented in Greece in the late 1970s/early 1980s and were mainly directed towards supporting academic/university research. Traces of a technology and innovation policy were introduced in the mid-1980s focusing on the creation of research infrastructures and relevant organisations (e.g. government research centres, sector technology centres, technology transfer organisations) and the creation of a more supportive legal framework (tax incentives and subsidies for R&D investments). More important changes took place in Greece with the implementation of the 1st Community Support Framework (CSF) (1989–1993) that provided the opportunity for the first time for longer-term Science and Technology policy through the implementation of the Operational Programme for Research and Technology (EPET-I) and STRIDE community initiative (Deniozos, 1993). The subsequent programme in the 1994–1999 period followed a rather similar logic. Emphasis was placed on the creation of research infrastructures for many of the organisations created in the previous period, the development of intermediary actors/organisations and the development of technology services (e.g. technology parks, agency for the protection of industrial property). There were also measures/activities targeting the development of cooperation between the public and private sector, which had been identified as an important deficiency of the system (Kasteli, 2000). During the same period, EU programmes (Research framework programme, EUREKA, Community Initiatives) acquired an increasing role in the total financing of R&D activity in Greece (Deniozos, 1993).

The 2000–2006 period saw a continuation of such efforts-based predominantly on the 3rd CSF – together with the introduction of some new measures, such as the PRAXE programme for the support of spin-offs, ELEFTHO supporting the creation of incubators and S&T parks from the private sector and more recently the creation of regional innovation poles, still at the very early stages of its implementation. According to Tsipouri and Papadakou (2005), it is only during this last period (2000–2006) that an explicit connection/integration of research, technology and innovation measures with the country's overall competitiveness strategy was attempted, as expressed through the Competitiveness Operational Programme. R&D activity was for the first time considered as an input for innovation rather than as a target.

4.2   Innovation governance

A very important deficiency in the innovation design process is the fragmented nature of innovation design and the absence of coordination among the different government entities whose activities are related to innovation (Tsipouri and Papadakou, 2005). Improvement in financial coordination achieved during the last programming period (2000–2006) has not yet been accompanied by thematic coordination and there is loose governance in terms of priority setting among the different responsible entities.

Furthermore, stakeholders' involvement (business, academia) has also been rather limited and at the same time uneven. Through informal linkages (responsible government positions, advisory boards composition) academia primarily has a much stronger role in the policy design process which is reflected in the research orientation of past programmes. The other main stakeholder – the private sector – has a limited role in the formation of innovation policy – a result of the limited number of modern, dynamic and innovation-oriented firms and reluctance to participate. Employers and industry federations remain focused on general economic incentives – favouring the reproduction of the current industrial structure – and labour market (de)regulation. Innovation and knowledge-intensive investments are seen as exceptional cases (Tsipouri and Papadakou, 2005).

At a regional scale, there were no innovation measures in the 2nd CSF regional operation programmes. In the 3rd CSF the focus of the limited funds dedicated was on research infrastructures rather than broader innovation-oriented measures. More important, the capacity of the regional authorities to design and implement has remained extremely limited. Illustrative of this is that early during the 3rd CSF period the responsibility for the implementation and monitoring of the innovation measures included in the regional programmes was transferred back to the central government (General Secretariat for Research and Technology) (Technopolis, 2006).

4.3   Dominance of linear rather than systemic approaches

The majority of Research, Technology Development and Innovation (RTDI) policies implemented have been based on the principle of cofinancing of private R&D, where the public sector participation attempted to leverage private sector participation. Over 80% of 3rd CSF Structural Funds (in the 2000–2006 period) directed to innovation went either directly to firms (PAVET programme) or through intermediaries in the form of subsidies but did not support extensive interactions. They promoted short-term R&D projects instead of long-term relationships (Technopolis, 2006). The programmes followed a linear approach, supporting R&D activity in the initial premarket stages but not the later stages of product development closer to the market.

Furthermore, an important part of the interventions subsidised the acquisition of embodied technology through investments in equipment. Technological breakthroughs and investments related to innovation were with few exceptions not a prerequisite for support (Technopolis, 2006). Hence, in practice the largest part of the measures reinforced the existing trends of low investment in innovation creation and the passive technology adoption of embedded technology.

4.4   Limited funding of R&D and innovation

While the Structural Funds brought a substantial absolute increase of government funding towards activities related to R&D and innovation, the relative share dedicated is still rather limited. Government budget appropriations or outlays for R&D have increased from €162 million in 1993 to €418 million in 2001 but the share in the government budget is 0.6% (from 0.4%), much lower than the respective EU-15 average (1.5%), and below almost all other countries in the laggards group.[3] In addition, instead of concentrating in a few specific areas, this budget is disproportionately allocated to general advancement of knowledge through university funds (>40% of total budget for the last 15 years) and thinly allocated to all other sectors. No other socio-economic area has a share over 10%. While similar to the EU-15 average, small but innovation-strong countries such as Finland and Ireland, as well as less innovation-developed countries such as Spain and Portugal, tend to concentrate their investments in one or two areas, the main one being industrial production and technology, instead of thinning it out among many areas (EUROSTAT, 2007).

Furthermore, while it increased in comparison to the previous CSF programmes, only 2.4% of the 3rd CSF for the period 2000–2006 was dedicated to activities related to RTDI-defined in a broader sense. At a regional scale, on average less than 1.1% of the respective Operational Programmes was dedicated to RTDI[4] with an important part directed towards the transfer of embodied technology (Technopolis, 2006).

4.5   Absence of demand side policies

Demand side policies also have a role in supporting the innovation system. Public procurement in a country where the public sector has such a large weight in the economy has clearly an important role in promoting innovation and technology. However, up till now public procurement has almost never been used as such. Efficiency and rationalisation is the main priority during public procurement framework design while innovation is not – at least explicitly – considered (FISIR, 2006). Most characteristic of all is the case of defence-related procurement. Greece has among the highest levels of defence expenditures as a share of its GDP in NATO (over 4% of the country GDP). However, in 2001 R&D-related expenditures coming from the Ministry of Defence were only 0.7% of the total government appropriations for R&D. Procurement of advanced defence systems comes almost exclusively from foreign suppliers in an embedded form minimising the technology transfer results and providing little support for the development of local defence-related R&D and innovation activity (Deniozos, 1993).

4.6   Ineffective implementation with no policy feedback

An important weakness of the innovation policy process in Greece is the absence of proper ex-post evaluation of the measures implemented that would serve a policy-learning process. The R&D support programmes were never analysed to assess their effectiveness in leveraging private R&D. Current EU Regulations require ex-post evaluation studies but in many cases this has followed an 'accounting' approach limited to the absorption of the available funds – a priority issue for the governments – and has not focused on the actual results and impact of the programmes nor their weaknesses and opportunities for improvement (Tecnhopolis, 2006).

Here we focus on two measures implemented before 2000, which at the design level had a systemic character, but poor implementation deducted most of their innovative characters. They were the Cluster programme in the 1994–1999 period, and the creation of Science and Technology Parks (STPs) that were implemented in the 1989–2000 period.

The cluster support programme under the Operation Programme for Industry supported 51 clusters with a total of 475 SMEs – which received funding of € 75.5 million and focused predominantly on traditional sectors (basic metals, food and beverage, textiles). However, this measure was poorly implemented due to the very small size of the clusters supported – in terms of firm's numbers and size – and the absence of a knowledge-creation element. As a result the clusters never become self-sustainable and at the end of the supporting period not even one remained in operation. According to the Economic and Social Council of Greece, implementation of the 1994–1999 cluster policy should be considered as an 'example to avoid' because the selection of the clusters was not the result of market demand (OKE, 2006, p.37). As innovative, holistic and systemic policy tools they were rather poorly implemented and were subsequently dropped.

The establishment of STPs was another policy measure with a potential systemic character focusing on technology transfer through spin-off creation and increasing university-industry cooperation. In total 7 STPs parks were established next to the most important public research centres of the country in the period 1989–2000. While no formal evaluation of their operation ever took place, the existing academic work (Bakouros et al., 2002; Souitaris and Daskalopoulos, 2000) shows that the only successful elements of the parks operation so far has been the development of R&D activity through research centres. On the contrary, the elements of technology transfer and incubation of new technology-based firms have provided rather poor results while linkages among tenants and with the institutes has remained rather limited. The few research institutes that have important interactions with industry cooperate mainly with foreign firms while the structures created to support technology transfer (park management units and liaison offices) are not considered as important by researchers (EC, 2006b). The incubator structures ended up providing only physical infrastructure (offices, space, low rents) and not the necessary financial (risk capital provision through VCs and seed funds), management/coaching and technology support services (Souitaris and Daskalopoulos, 2000). Once more, a complex model for innovation support based on colocation of university and industry, interactions and development of flows and entrepreneurship was downgraded to a real-estate project.

5   Towards selective future policies

Bringing together the existing structure of the innovation system and the actual policies, we observe that in many respects the latter did not take into account the main characteristics of the country's innovation system. In some aspects there was an inability to address the gaps identified within the system, while in other aspects the policies implemented largely ignored its characteristics, strengths and weaknesses. At least four areas of mismatch may be identified.

5.1   Leverage of private R&D funding

While being recognised as a critical weakness by Greek policy-makers, the measures designed and implemented since the late 1980s have failed to leverage private R&D activity and address the imbalance between the public and private sector. R&D support through grants and subsidised programmes for R&D and innovation activities have been in general limited and many of them were actually channelled towards capital investment in machinery and equipment not supporting a break with the existing pattern. Furthermore, as far as R&D supported projects are concerned, their short-term and rather ad hoc nature did not create the incentives for the development of more permanent R&D structures inside firms. The subsequent very low response to the programme promoting employment of researchers and investment in R&D labs in firms (HERON programme) could be seen as a confirmation of a continuing negative attitude (Technopolis, 2006).

Simultaneously, while increasing public sector R&D activity, the policies did not focus on the development of the necessary structures and services that would fit the needs of firms and promote a greater use from the firms' side. Intermediary organisations should address issues of communication and coordination between the two sectors, build mutual confidence and gradually lead to an increase of private sector investment in R&D activity. As we saw very few of them have managed to operate along these lines.

5.2   Enhancing the creation of innovation

Even more important is the failure of the policies implemented to enhance the innovation activity of Greek firms. As most of the measures ended up supporting machinery and equipment upgrade, they actually reinforced the existing trends of low investment in innovation creation and the rather passive technology adoption of embedded technology.

At the same time, the schemes implemented were rather one-dimensional while the SME-dominated structure of the economy requires more hands-on-guidance. Financial instruments should have been complemented with business and technical support to overcome the documented limited capacity of firms and to help them develop the necessary networks. Again, the role of intermediaries is important. The public sector agencies/organisations have not covered appropriately the absence of private sector firms specialised in innovation and product development services – leaving an important gap in the necessary innovation creation support infrastructure. Their creation was not properly supported with funds and the necessary skilled personnel, the services provided have remained rather soft and of low added-value and many of them remain in hibernation.

5.3   Creating strong sectors

The innovation policies designed and implemented have so far never adopted an explicit sectoral focus promoting the innovative – but still limited in size – sectors of the economy and the restructuring and diversification of more traditional firms towards new and innovation-intensive activities. Innovation policy and governance largely avoided such choices with a distribution of the limited public R&D funding among a wide range of different socio-economic sectors. The business community has – for its part – also supported sector-neutral and innovation-neutral policies.

The only sector-specific measures identified were the sectoral technology centres which had a rather marginal impact and the clusters programmes which focused on traditional sectors and were – as we saw – a clear implementation failure.

Ignoring the sector-specific elements of the system, the policy so far has neither supported the development of any strong highly innovative sector nor the restructuring and diversification of the less technology-intensive ones.

5.4   Creating strong innovation poles

Together with the absence of a sector specific policy there was also a weak focus on the regional elements of the innovation system. The regional dimension and concentration of innovative activity – and the need to act accordingly – has not been adequately integrated into innovation policy design and the implementation process. A more region-specific policy should attempt to strengthen the existing high concentrations of innovative activity in the metropolitan regions of Attica and Thessaloniki addressing their particular weaknesses in order to transform them into dynamic and leading innovation poles for the country. Similarly, it should focus on strengthening the limited absorption capacity of the less developed regions – with significant diversity in their character. A homogeneous innovation policy and the limited capacity of the regional authorities to design and implement focused policies has largely ignored the regional imbalances and asymmetries of the system and the special needs of each specific region.

However, within the rather dark landscape of the Greek innovation system there are some bright spots indicating that alternative trajectories are also feasible. We refer to a number of sectors, mainly in services, showing a good level of innovation performance, as well as to the geographical agglomeration of technology and innovation resources in certain regions. These sectoral and regional trends are landmarks for a better future and the reorganisation of the national innovation system needed. They document that besides the asymmetries in R&D, innovation creation, and intermediary institutions, certain hubs may escape the overall backwardness and operate as 'islands of innovation' following local norms and regulations. We consider them as *weak signs*, to use a term from the foresight literature, in favour of sector/region-specific innovation systems.

What then would be the lessons for future technology and innovation policy? Though this question should be the subject of another paper, we attempt here to put forward some proposals on a more selective and system-based innovation policy.

Firstly of all, technology and innovation policies should be more *selective* focusing on fewer, large and long-term strategic projects, characterised from programming and continuity instead of thinning into a wide range of small interventions with limited impact capacity. Policies should focus more on supporting institutions, interactions and linkages among the different elements compared to the direct provision of funds to firms for R&D projects. At this level, selectivity goes together with the development of proper evaluation mechanisms providing feedback on results achieved based on clearly predefined goals and objectives that will serve for future policy design. In the case of organisations supported, for instance, increased efficiency will also mean increased consideration of past performance and credibility against the future intentions.

Secondly, it is necessary that the innovation policies implemented take a more *sector-specific* orientation. The previous and current policies have largely avoided either prioritising among the different manufacturing and services sectors or focusing on specific areas of research and technology development activity. For a small country such

as Greece the development in parallel of many R&D areas is not feasible and results only in the fragmentation of activities and loss of the necessary critical mass. The analysis of the example of Finland – a country with one of the most successful innovation systems – shows that it is explicitly focusing on a few selected technology areas (Kostoff et al., 2006).

In the case of Greece, what should the priority sectors be? The scoreboard of sectoral innovation performance provides some indications, but this it is not a sufficient criterion for selection. A more comprehensive view is given in the recent study of Logotech (2007) on the sectoral and technological specialisation of the Greek economy. Specialisation is determined by the performance of manufacturing and service sectors on five sets of criteria: added-value, employment, exports, R&D spending and patent applications. A sixth appraisal factor concerns the positive or negative trends of sectors on the same five criteria, during the period 1993–2003. ICTs are defined as a sector of strong technological specialisation, as are other services including health, while in manufacturing the food industry, chemicals and the building industry prevail.

Thirdly, the sectoral focus should be combined with reinforcing existing *regional innovation systems*. Based on detailed mapping exercises, they should identify strengths and weaknesses (e.g. missing links, structures), focus on improving their operation, increasing knowledge and effective diffusion inside the system, developing linkages and integration in broader national and international networks and creating new products and processes. Such a case appears to be the recently scheme for Regional Innovation Poles. The specific measure support selected sectors within selected regions having a critical mass of production, R&D and innovation. It provides a combination of support mechanisms and financing tools for the creation of new knowledge and development of learning linkages and interactions among firms, research organisations and intermediaries that can include joint ventures, innovation networks, spin-off firms, training and exchange of personnel.

References

Arundel, A. and Hollanders, H. (2005) *Innovation Strengths and Weaknesses*, MERIT European Trend Chart on Innovation.

Bach, L. and Matt, M. (2005) 'From economic foundation to the S&T policy tools: a comparative analysis of the dominant paradigms', in P. Lerrena and M. Matt (Eds). *Innovation Policy in a Knowledge-based Economy - Theory and practice*, Springer.

Bakouros, L., Mardas, C. and Varsakelis, N. (2002) 'Science park, a high tech fantasy? An analysis of the science parks of Greece', *Technovation*, Vol. 22, No. 2, pp.123–128.

Carlsson, B. and Jacobsson, S. (1997) 'The technological system for factory automation', in B. Carlsson (Ed). *Technological Systems and Industrial Dynamics*, Kluwer Academic Publishers, pp.37–60.

Cohen, W. and Levinthal, D. (1990) 'Absorptive capacity: a new perspective on learning and innovation', *Administrative Science Quarterly*, Vol. 35, No. 1, Special Issue: *Technology, Organisations, and Innovation*, pp.128–152.

Cooke, P., Uranga, M.G. and Etxebarria, G. (1997) 'Regional innovation systems: institutions and organisational dimensions', *Research Policy*, Vol. 26, pp.475–491.

Deniozos, D. (1993) 'Τεχνολογική Πολιτική', [Technology policy] in T. Giannitsis (Ed). *Βιομηχανική και Τεχνολογική Πολιτική στην Ελλάδα*, [Industrial and Technology Policy in Greece] pp.209–261, Athens, Themelio.

EC (2003) *European Innovation Scoreboard 2003. Technical paper 3. Regional Innovation performances*, European Commission - Directorate General Enterprise, Retrieved from http://trendchart.cordis.lu/scoreboard2003/index.html.

EC (2004) *European Innovation Scoreboard 2004*, European Commission - Directorate General Enterprise, European Trendchart on Innovation.

EC, (2005) 'Eurobarometer 236 - Population innovation readiness'

EC (2006a) *The 2006 EU Industrial R and D Investment Scoreboard*, European Commission - Directorate General Joint Research Centre, Retrieved from http://iri.jrc.es/ research/ scoreboard_2006_data.htm

EC (2006b) *Annual Innovation Policy Trends and Appraisal Report – Greece*, European Commission - Directorate General Enterprise, European Trendchart on Innovation.

Edquist, C. (1999) 'Innovation policy - a systemic approach', Retrieved from http://www.druid.dk/ uploads/tx_picturedb/ds1999–55.pdf

Edquist, C. and Hommen, L. (1999) 'Systems of innovation: theory and policy for the demand side', *Technology in Society*, Vol. 21, pp.63–79.

Edquist, C. and Lundvall, B.A. (1993) 'Comparing the Danish and Swedish systems of innovation', in R.R. Nelson (Ed). *National Innovation Systems - A Comparative Analysis*, Oxford: Oxford University Press.

EUROSTAT (2005a) 'General and Regional Statistics', EUROSTAT, Retrieved from http:// epp.eurostat.cec.eu.int/portal/page?_pageid=0,1136162,0_45572073&_dad=portal&_schema= PORTAL.

EUROSTAT (2005b) *Science and Technology Statistics*, EUROSTAT, Retrieved from http://epp.eurostat.cec.eu.int/portal/page?_pageid=0,1136250,0_45572552&_dad=portal &_schema=PORTAL.

EUROSTAT (2007) *Science and Technology Statistics*, EUROSTAT, Retrieved from http://epp.eurostat.cec.eu.int/portal/page?_pageid=0,1136250,0_45572552&_dad=portal&_sc hema=PORTAL.

FISIR (2006) *Innovation and Public Procurement. Review of Issues at Stake*, Study for the European Commission, Fraunhofer Institute for Systems and Innovation Research, No ENTR/03/24.

Fritsch, M. and Lukas, R. (1998) 'Who cooperates on R&D?', *Research Policy*,Vol. 30, No. 2, pp.297–312.

GGDC (2005) *60-Industry Database - October 2005*, Groningen Growth and Development Centre, Retrieved from http://www.ggdc.net.

Hollanders, H. (2006) *2006 European Regional Innovation Scoreboard*, European Commission - Directorate General Enterprise.

Hollanders, H. and Arundel, A. (2005) *European Sector Innovation Scoreboards*, European Commission - Directorate General Enterprise, European Trendchart on Innovation.

Howells, J. (1999) 'Research and technology outsourcing', *Technology Analysis* and *Strategic Management*,Vol. 11, No. 1, pp.17–29.

Kasteli, I. (2000) *Science and Technology Policy in Greece - Policy initiatives for R&D Cooperation*, Fondazion Eni Enrico Matei, Retrieved from http://www.feem.it/NR/rdonlyres/ 5131EEE1-AABC-41B3-9BC1-C5AF7DCB5A56/264/6900.pdf

Kostoff, R.N., Tshiteya, R., Bowles, C.A. and Tuunanen, T. (2006) 'The structure and infrastructure of the Finnish research literature', *Technology Analysis* and *Strategic Management*,Vol. 18, No. 2, pp.187–220.

Logotech (2007) Investigation of priority sectors for the promotion of research and technology in the programming period 2007-2013, Athens, General Secretariat for Research and Technology.

Lundvall, B., Johnson, B. Andersen, E.S. and Dalum, B. (2002) 'National systems of production, innovation and competence building', *Research Policy*, Vol. 31, (2002) pp.213–231.

MERIT and JRC (2006) *European Innovation Scoreboard 2006. Comparative analysis of innovation performance*, Maastricht Economic Research Institute on Innovation and Technology and Joint Research Centre (Institute for the Protection and Security of the Citizen),

Metcalfe, J.S. (2002) 'Equilibrium and evolutionary foundation of competition and technology policy: new perspectives on the division of labour and the innovation process', *Paper presented at the Conference: Frontiers and trends: Frontiers of Innovation Research and Policy, Instituto de Economia and the ESRC Centre for Research on Innovation and Competition*, Manchester, September, pp.25–27, 2002.

Nelson, R. (Ed) (1993) *National Innovation Systems: A Comparative Analysis*, Oxford: Oxford University Press.

Nelson, R. and Rosenberg, N. (1993) 'Technical innovation and national systems', in R. Nelson (Ed). *National Innovation Systems: A Comparative Analysis*, Oxford: Oxford University Press.

OECD (2005a) *Governance of Innovation Systems: Synthesis Report*, Vol. 1, Paris: OECD Publishing.

OECD (2005b) 'OECD science, technology and industry scoreboard 2005 - Towards a knowledge-based economy', Retrieved from http://caliban.sourceoecd.org/vl=11334902/cl=18/nw=1/rpsv/scoreboard.

OECD (2006) 'OECD Productivity Database', OECD, Retrieved from http://www.oecd.org/dataoecd/25/44/2109316.pdf.

Souitaris, V. and Daskalopoulos, T. (2000) 'Managing science and technology parks in low-tech environments - a resource based strategic mapping framework', *International Journal of Manufacturing Technology and Management*, Vol. 2, Nos. (1/2/3/4/5/6/7).

Technopolis (2006) *Strategic Evaluation on Innovation and the Knowledge Based Economy in Relation to the Structural and Cohesion Funds for the Programming Period 2007-2013. Country Report: GREECE*, The European Commission - Directorate-General Regional Policy.

Tsipouri, L. (1991) 'The transfer of technology revisited: some evidence from Greece', *Entrepreneurship and Regional Development*, Vol. 3, pp.145–157.

Tsipouri, L. (2001) 'Can we benchmark the contribution of research and development investment to growth and competitiveness?', *Science and Public Policy*, Vol. 28, No. 4, pp.295–302.

Tsipouri, L. and Papadakou, M. (2005) 'Profiling and assessing innovation governance in Greece: do increased funding and the modernisation of governance co-evolve?' in OECD (Ed). *Governance of Innovation Systems: Case Studies in Innovation Policy*, pp.13–42.

Veugelers, R. (1997) 'Internal R&D expenditures and external technology sourcing', *Research Policy*, Vol. 26, No. 3, pp.303–315.

Von Hippel, E. (1988) *The Sources of Innovation*, Oxford University Press.

Notes

[1] Greece SII is 0.20 and the average for the EU is 0.44.

[2] Strategic innovators are characterised those firms that perform R&D on a continuous basis to develop new products and processes and are the main source of innovation. Intermittent innovators perform R&D and develop new products when necessary, but it is not a core strategic activity and some of them adopt new technology developed by other firms.

[3]In comparison, Portugal GBAORD is around 1.5%, and increased from 0.9% in 1997. Similarly, all new Member States – with the exception of Latvia – have higher levels than Greece.

[4]Only two regions had RTDI measures shares over 2% of the total budget, Central Macedonia and the North Aegean region.

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