National Research and Innovation Policy the Case of Greece: A Benchmarking Exercise to Assist Evidence-Based Policies on Research, Innovation, and Technological Entrepreneurship

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Greece has made considerable effort to develop and implement a concise research and innovation policy during the last decades aiming at a knowledge-intensive economy. New legal frameworks and funding schemes are introduced, funding increased, but evaluation of impact is implemented marginally. The landscape in the early 2020ies has little in common with that in the late 1970ies. The active participation of Greece to the European Union's framework programs and the European institutions' prioritization of research and innovation increased the impetus for the policy makers at national level and for an informed policy in this field. Nevertheless, the data are relentless in the demonstration of the effectiveness of the policies. Despite the efforts deployed, Greece continues to lag most European countries, pairing mostly with its neighbors. This proves a strong need for improvement of the efficiency and effectiveness of the policies. It shows that politicians and policy makers are ill prepared to face the new challenges in global competitiveness. Greece is not the only case in this position.

Keywords: research policy, innovation policy, benchmarking

INTRODUCTION

The need to compare the progress of Greece with the progress of other countries which have been placed as models in the near past by influential political personalities, has been a strong motivation for the present document. Two eminent politicians, from different sides of the political spectrum, proposed at different but not distant moments, around 2010, Denmark and Ireland as role models or benchmarks for the Greek development effort. Both "model" countries have different cultural profiles, economic history, and socio-economic development levels. Both are distinguished for their success in accommodating in the same policy mix economic performance, reflected on their international competitiveness, and social welfare, reflected on the population's peaceful labor relations and high educational level. They are of quite similar size than Greece, positioned at the geographical periphery of Europe as Greece but differ from Greece to political and cultural history and many more parameters.

Nevertheless, they represent a challenge for the Greek politicians wishing to lead their country at the same pathway as one or the other of these two target countries. Their raising at the role of model is a challenge that should be analyzed and supported with evidence. Since this problem is much more complex than it may appear at first glance, continuous work is necessary in all the fields of public policy. The present document focuses on research and innovation, including entrepreneurship as an absolute complement to innovation and competitiveness. The document is based on a larger analysis with the support of a plethora

of hard data (Deniozos, 2013a), which complements the narration of the evolution of the Greek research and innovation policy through the decades from the beginning of the national state to 2010 (Deniozos 2023b and 2023c).

Moreover, the complexity of the phenomena led to the integration to the group of benchmarks some more countries which either show some similarities to Greece and/or diversify the profile of the first two models. From the group of the Nordics, Sweden and Finland were added to Denmark. Belgium, Austria and Portugal were added to Ireland from the group of medium-small size countries. In addition, Italy and Turkey were taken on board, despite their large size, for their Mediterranean culture and Bulgaria and Romania for their Balkan common historic background to Greece. Comparisons of Greece to EU or other average or median parameters is avoided because there are no such competitors as averages.

The document aims to be useful in other benchmarking exercises, helping decision makers and their staff who need data to make evidence-based decisions instead of intuitive or purely political decisions. It aims also to create a sustainable link among the proliferating politicians in Greece and the scarce professional policy makers. It starts with the most traditional data on RTD spending and personnel which nourished and continues to do so the research policies at national and European levels, based on the older "science push" concept of policy. Outputs of RTD, the publications, citations and intellectual property titles follow it. The latter bring in the discussion insights independent from research activity, closer to the economic and industrial competition. Specific sections on the quality of the secondary and tertiary education focus on the quality of the human potential which is the most crucial component of both research and innovation policies. Data on the participation of Greece to the European RTD programs, although of critical importance for policy evolution, often used in argumentation for some types of policy orientation, will be presented in future documents.

The innovation and entrepreneurship statistics and indicators proliferating in the last two decades are central to the document. The European Innovation Scoreboard offers a panorama of the relative positioning of the European Union member states and beyond. But what has been less used in the policy building is the attitudes and perceptions of the citizens and entrepreneurs on the various components of the research and innovation policy. Eurobarometer has been publishing data of surveys in this area that bring additional information on the table of the debate. Moreover, the behavior of entrepreneurs, particularly the younger ones, is of utmost importance for developing the type of modern entrepreneurship creating high and sustainable added values. The document closes with data on the general economic standing of Greece, particularly in the competitiveness landscape, that may have been directly or mostly indirectly impacted by the research and innovation policies applied so far.

The usual approach of examining the country's progress through the decades has been comparing the efforts and achievements of one year over the other. This is a fulfilling approach, because the progress is secured by continuous efforts, although with some discontinuities. But it ignores that the benchmarks of any RTDI policy are moving because the competitors continuously change the international economic landscape. Suppose the RTD and Innovation policies are expected to contribute to the economic and social progress of the country and to its competitiveness in the continuously changing world. In that case, a different approach has to be experienced.

Most politicians and scholars underscore the progress Greece has made during the recent decades in various aspects of the economy and social welfare, particularly in research and innovation, despite the financial crisis of the 2010s. Other, regret the sluggishness of the change, the fragility of the development model, and the trailing of the knowledge-intensive economy. Both sides have good arguments to support their views, the reality being somewhere in between but certainly not in mid-way. Since the country's future depends, among other, on a good understanding of the past policies' successes and failures, it is necessary to multiply efforts to understand the recent history and build new evidence-based policies, reducing the relative weight of intuition and spontaneity.

The present document is trying to analyze, hard data at hand, the evolution of research and innovation policy components, constrained mainly by the availability of reliable data and their comparability in time and among countries. Emphasis is given to entrepreneurship, which transforms the research produced knowledge into commercializable products and services, and the entrepreneurial culture, which leads the

motivations and behaviors of entrepreneurs and potential entrepreneurs toward innovation and technological change.

The general impression that emerges from the exercise is that Greece has made undeniable progress in the research and innovation fields, but this is insufficient to make the difference in the competitive position of the national economy. Other countries also try hard, and some obtain better results in shorter time. Many questions must be answered about the reasons for this laggardness relative to the benchmarked countries in our sample. One of the most important is whether research policy is appropriate for supporting economic development or if other factors are intervening and undermining whatever strengths have been built in the research area.

RESEARCH AND DEVELOPMENT

The more impressive outcome of the last decades has been the change of the GERD/GDP ratio from 0.15% in 1981 to 1.5% in 2020, while at the same time, the BERD/GDP ratio, a critical indicator for innovativeness, passed from 0.03% to 0.60%. On the other side, other countries maintained their advance in the field during this same period. Denmark increased the GERD/GDP from 1.01% to 2.97%, Austria from 1.09% to 3.22%, and Portugal from 0.34% to 1.62%. There were also slower-moving economies, such as Italy which passed from 0.83% to 1.51%, Spain from 0.39% to 1.41%, and Ireland from 0.65% to 1.08%. On the business contribution to the GERD, Denmark increased the BERD/GDP ratio from 0.43% to 1.79%, Ireland from 0.38% to 0.78% (2019), Austria from 0.55% to 1.52%, Italy from 0.41% to 0.80%, Portugal from 0.09% to 0.84% and Turkey from 0.11% to 0.62%. These figures show that Greece is closing the gap with some of the competing countries, particularly some southern ones, but remains at the tail of the ranking (with exceptions for the Balkan neighbors) after four decades of efforts[1].

Greece presents the second lowest percentage of BERD performed in the computer, electronic and optical industry in 2019, next to Romania, losing some tiny advantage Greece had in 2011 against Portugal, Spain and Turkey. The same indicator for the pharmaceutical industry was particularly favorable to Greece in 2011, outdistanced only by Belgium and Denmark, while degraded quickly in ten years, losing ground to Ireland and Spain. Most revealing data for the structure of BERD in Greece, the share of manufacturing in the total BERD was reduced from 56.6% in 2000 to 31.1%in 2020. Correspondingly, the share of services rose from 33.4% to 61.3%. The construction industry, an important vector of the economic development, also showed a radical reduction from 7.6% to 0.9%. The shrinkage of the BERD in manufacturing was born by all industries, including food, chemicals and machinery. The activities that had the largest rise inside the services sector were on one side the financial services (banks), growing up to 15.5% of the domestic BERD, the trade and repair services, rising to 11%, the information and communication services up to 17.6% and the transportation and storage (logistics) up to 6.8%[1].

The presence of large and numerous companies investing important amounts on RTD was explored by the EU statistics from 2004 to 2022. No Greek company is placed among the 200 highest RTD investors throughout all the period, which is also the case for Portugal and Turkey. Depending on the year, one to three Greek firms rank from 201 to 700 and a similar number among 701 and 1000. All other countries show a continuous increase, in particular Portugal, Ireland and Turkey. In the second decade (2011-2021) the ranking found one to three Greek companies per year between 1001 and 2500 with one exception. They have fallen to zero in the last two years (European Commission, Joint Research Centre 2004-2019). No Greek company appears on the tables of the 2500 bigger spenders in the word in 2020 and 2021. Portugal ends the period with two companies in the list, while Ireland ends with 34 companies and Denmark with 25. All this hardly explains the rise of the Greek BERD in 2016-2017 and stabilized since (European Commission 2004-2022 Industrial investment scoreboard).

The source of funding with the stronger rise between 1980 and 2020 has been the organizations from "abroad", mainly the European Union through the Framework Programme for Research (FP/Horizon) and the Regional Development Fund (ERDF). The funding line from abroad passed from 0% to 14.4% of the GERD, having attended also 21% in the early 2000nds[1]. Here Greece competes for the highest shares with Austria, Belgium, Finland and Ireland but its share seems to have suffered more than the Nordics, Belgium

and Italy from integrating the eastern countries into the Union and the Framework Programs in the early 2000nds. The relative dominance of EU funding on the Greek research contributes to the alignment of the best research teams to the EU priorities. Still, it has not helped focusing on identified national or regional priorities.

These national priorities always suffered from the difficulty of focusing frugal resources on specific areas of socio-economic interest, contributing to the fragmentation of the RTD funding. The stronger factors leading the thin allocation of public funds had been the lack of strategic thinking on the government's side and the persistent small size of the research entities both in the government and the business sectors. The allocation of government funds to the socio-economic fields shows a strong specificity for Greece, spending from 2008 onwards an impressive and unexplainable share of the GBAORD to the social sciences, close to 20% (followed by Portugal to 9% and Denmark 8%), shrinking slightly in 2020-21. The shares of transport and telecommunications RTD are increasing over time while those for agriculture are decreasing significantly, despite the importance of this field for the economy. The main result of this analysis is that the priority sectors of socio-economic activity had not been taken seriously when determining the budgets for funding programs and institutions[3].

One of the weaknesses of the structure of the Greek GERD is the low contribution of the defense and security research despite the high public expenditures on defense equipment (Deniozos 2013a). The share of defense RTD budget in the Total Government Allocation on RTD was reduced in the examined four decades from 2.23% to 1.55% despite the repeated political declarations for allocating a minimum of 1% of the budget for purchasing military equipment to defense RTD. Greece has been apparently a tiny player in the field, far behind Turkey, and even Romania, and the then "neutral" Sweden and Finland.

As to the research personnel, the related statistics are less homogeneous across countries and contain many discontinuities at national level due, probably, to statuses' changes. Nevertheless, some observations could be useful. Greece, Italy and Spain show the lowest share of researchers per thousand total employment, except for Romania and Turkey, confirming the performances of the same countries on the financial field[1]. Greece and Portugal have started in 1989 from very low level, but Portugal moved faster in the three decades considered. Countries like Austria, Belgium, Denmark and Sweden demonstrated an impressive growth of both researchers and research personnel in this period, although starting from higher points at the end of the 1980ies. A marked trend in the examined period is the rise of the share of researchers to the RTD personnel, even above 80%, which can be attributed to the radical reduction of the share of administrative personnel in all countries (except Romania and Turkey).

On the very positive side of the policy one needs to consider the organizational and legal changes, introduced by the 1985 reform and other that followed for recalibrating the system in the government research centers, the universities and the relations between industry and the public sector.

PUBLICATIONS AND CITATIONS

A first effort to assess the value of the research and technological development financed by all sources has been expressed through indicators related to the outputs of the RTD activity. The available Web of Science (WoS) data show an uninterrupted increase of Greek publications from 2,654 in 1993 to 18,557 in 2020, a sevenfold rise in 27 years. The growth looks less dramatic with the Scopus data, a tripling is secured between 1996 and 2012. Similarly, the growth of citations is paramount from 35,044 in the 1993-1997 period to 707,087 in 2016-2020. Of the Greek publications only 0.6% were classified among the 1% with the highest impact internationally in 1993-1997, while this share rose to 2% in 2016-2020 (National Documentation Center 2010 - 2022).

Greece stood behind the more developed countries of EU in the number of publications per 1 million inhabitants in 2020, but in 2007 was ahead of Italy, Spain, Portugal and Turkey; despite this favorable initial condition of Greece, the countries in the sample had tremendously increased this indicator in the following years, Greece showing the lowest rate of change. The result is that at 2020 Greece stands ahead only of Turkey (no data available for Bulgaria and Romania). The situation looks much worse in the field of

productivity per researcher and the efficiency of the RTD funding, a finding that should have rung the alarm by policymakers. Still, it seems not to be noticed when debating about researchers' performances.

The E. Commission proceeded in 2022 to the comparison of publications and citations data for the member states and third countries for the years 2000 and 2020. Greece is classified in the group of countries with a share above 2% of the EU scientific publications, with a slight increase in 2020, while is found in the group with lower than 2% share of the EU member states for the top 10% most cited scientific publications. Greece is improving its position from 2018 to 2020 compared to 2000. Nevertheless, the ranking of Greece on the basis of the number of the top 10% highly most-cited scientific publications in 2018 places the country one position behind Estonia and Portugal and ahead of all ex-eastern European countries.

From 1996 to 2020 the publications in the field of engineering and technology constituted 21-26% of the total, varying slightly from one year to the other. The agricultural sciences had also a more or less stable but quite low participation share in the sum of all Greek publications. On the other hand, the publications in the natural sciences field diminished their share from 60% to 40%. The medical and health science increased their share from 30% to 40%, the social sciences from 4% to 11% and the humanities from 1% to 3% approximately.

The field normalized citation score is the more significant indicator of the various disciplines weight in the country's scientific and technological development. The highest score in the natural sciences for the period 2010-2014 was attributed to nuclear physics, which is a field of limited interest for the economic development policy (nuclear power reactors are banned from the national grid) but has attracted many well motivated researchers in the previous decades. On the other side, polymer science, a champion in the 2004-2008 period, and genetics championing in 2006-2010 could be more linked to industrial and health dynamics respectively. On the side of Scopus, the 2006-2010 period gave atmospheric science and oceanography the highest scores, while for 2008-2012 nuclear physics and astronomy were winning the first positions.

PATENTS AND OTHER INDUSTRIAL PROPERTY TITLES

The industrial property has long ago become an indicator of measuring inventive activity, a proxy for the output of applied RTD and an input to innovation. While the annual patent applications oscillated around 3,000 until 1987, dropped to 660 in 1988 after the adoption of the new legislation introducing the control of applications, continued shrinking until the mid-2000nds and started increasing since to reach 920 in 2021.

The volume of the patent applications in the Greek Patent Office was the fourth lowest in 1980 among the studied countries and remained the fifth lowest in 2021. Ireland and Portugal trailed behind, while Turkey lip-frogged to join the Italian performances. This happened in a context where the number of applications in most technologically developed EU countries demonstrated a downwards trend in the 40-year examined period. In 2020 Greece presented the lowest number of patents in force, except for Bulgaria; even Ireland, which was granted low numbers of patents in the previous years has a much larger stock of patents in force, due probably to the fact that holders of Greek patents abandon them before they expire, because they do not represent any commercial interest[3].

In the number of residents' applications per 100 billion US$ GDP Greece was in better position than Portugal and Turkey at the beginning of the 1980ies. The advantage was lost later; at the end of the 2020ies, Bulgaria and Romania lagging Greece. A similar pattern is mirrored in the number of residents' applications per million population, with very few divergencies. All these findings show that Greece's position in patenting has declined in these four decades faster than for most of the other countries of the sample despite the measures taken for the modernization of the national patent system, the awareness campaigns to potential beneficiaries and the membership in the EPO and all international related institutions.

The patents granted by each national patent office of the selected countries are analyzed by 35 technology fields and to a much larger number of subfields, according to WIPO. Greece presents the highest shares in grants in the fields of organic fine chemistry (14.4%) and pharmaceuticals (11.6%) in a total of

25,167 patents granted from 1980 to 2021. Ireland and Portugal presented higher shares in the same fields. Many other countries of the sample show relatively high shares in these industries (between 5% and 10%), such as Denmark, Finland, Belgium, Spain, Bulgaria and Romania. The finding is an indication that countries of different development levels put their inventive effort into the same technological fields or similar industries, increasing the pressure of competition.

In Greece, the shares of organic fine chemistry and basic materials chemistry have declined strongly (from 15.3% to 1% and from 10.1% to 2% correspondingly), that of pharmaceuticals slightly (from 8.6% to 6.9% after rising to 14% in 1987 and since declining). Conversely, the shares of "other special machines" and civil engineering rose (from 6.3% to 9.9% and from 3.5% to 9.9% correspondingly. Increases we observe also in the fields of medical technology (from 1.7% to 7.9%), food chemistry (from 1.9% to 7.4%), handing (from 4.5% to 6.9%) and furniture and games (from3% to 5.4%).

In an OECD analysis on patenting in high technology sectors (applications filed under the PCT), Greece had 32.7 patent applications in 2019, only ahead of Romania, far behind the championing Sweden and Finland. The situation is quite similar in biotechnology, with Romania keeping the last position and Greece the second last. In nanotechnology the situation appears more alarming, Greece, together with Ireland, Bulgaria and Romania remained at zero throughout the examined period and Austria and Portugal with one patent. The champions in the field were Finland, Spain and Turkey. Greece seems to have made stronger progress in the pharmaceuticals field, passing from 8.4 to 19.7 patent applications under PCT, but the figure is the third lower performance behind Bulgaria and Romania. The pattern is similar in the food technology field, Greece oscillates between one and five patent applications per year, third from the bottom again.

In industrial design applications, Greece started in 1997 at the last position among the countries studied and finished with the highest reduction among all these countries in 2020, placing the country to an even more disadvantaged position. The applications for the registration of industrial designs were strongly reduced in two decades in all considered countries except Turkey but Greece suffered particularly from this reduction. After a strong rise in the 1990ies, the applications for trademarks started shrinking in most countries. Among the sample countries, there are notorious exemptions for Italy, Portugal and Turkey, but also Bulgaria and Romania. Other countries resisted the pressure to find their applications in 2020 at the level of 1980. This included Greece, which suffered mostly from the reduction of the applications from the non-residents, that is the international companies and investors.

INNOVATION AND INNOVATIVENESS

The E. Commission introduced measurements of the innovation phenomenon by 2001. During the 2000-2020 period, the concept was grasped gradually, and more parameters were taken on board for seizing all aspects of general acceptance. The Summary Innovation Index (SII) and the European Innovation Scoreboard (EIS) have been powerful instruments for evaluating national, supranational and regional performances.

The first published SII in 2001 referred to 15 indicators. Eight member states show a negative index compared to the EU average; the group in the "negative" included all southern countries, from Greece to Portugal, including France, with Greece keeping the penultimate position ahead of Portugal. In 2003, Greece was ahead of Portugal, Bulgaria, Romania, and Turkey. By 2007, Portugal overtook Greece and at the end of the period, Greece was ahead only of the three other countries[4].

FIGURE 1
THE SUMMARY INNOVATION INDEX FOR 2005

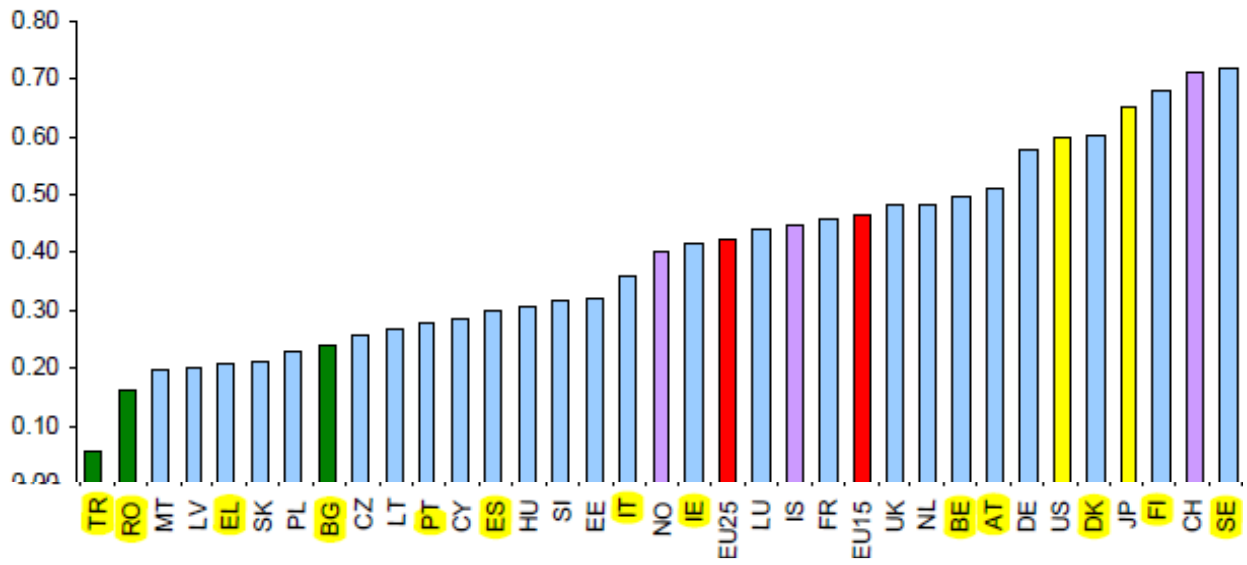
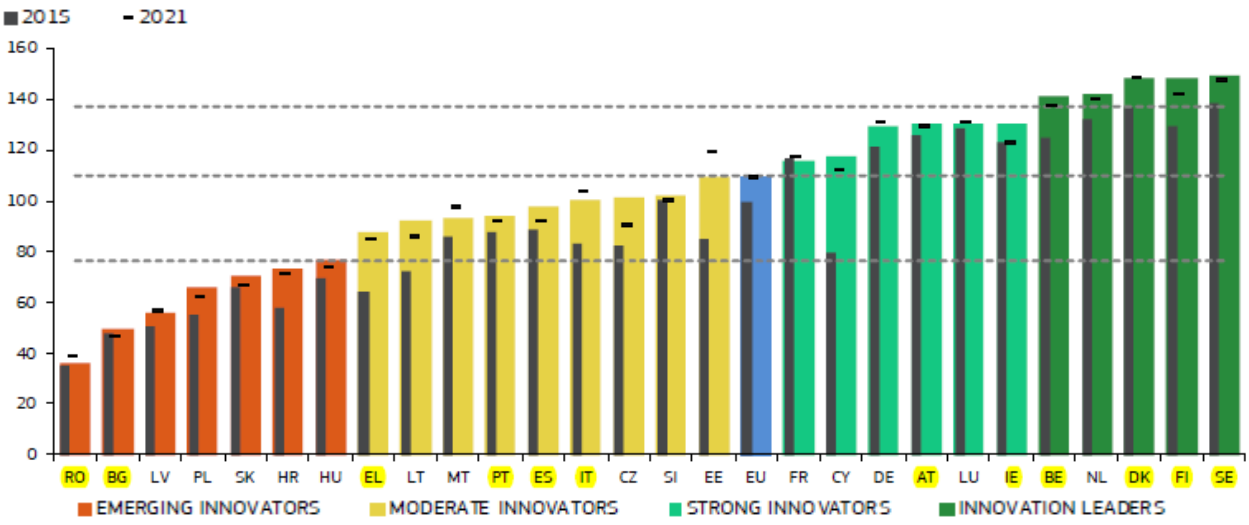


FIGURE 2
EU MEMBER STATES INNOVATION PERFORMANCE - EIS 2022



Greece showed a continuous rise of its SII but, as in many other cases, its rate of growth was slower than that of other countries. The increase of the SII between 2006 and 2022 is of the order of 33%, lower than those of Portugal, Bulgaria and Turkey, close to that of Italy but higher than those of Spain, Ireland and Austria. Significantly, the SII of the Nordics remains more or less stagnant. At the beginning of the period, the Greek SII was estimated at 64% of the EU average, at the end at 80% (not including the UK) leaving a mixed feeling on the progress of Greece in the field.

Looking in more detail the indicators composing the SII, Greece lagged Bulgaria Romania and Turkey in several items in 2010 and 2022, particularly the "*medium and high-tech product exports*". Greece lagged Romania and Turkey in 2010 in "*new doctorate graduates"* and Bulgaria in "*population having completed tertiary education*" and" *youth with upper secondary education*". Comparing the Greek indicators to those

of Portugal, Spain and Italy, Greece is excelling in "*non-RTD innovation expenditure*", the "*percentage of SMEs introducing marketing and organizational innovations*" or "*business process innovations*". Greece developed its advantage in 2022 in the "*exports of knowledge intensive services'*, in "*innovation expenditure per employee"* and "*RTD expenditure in the public sector"* (the latter for Portugal, Spain). There had also been several other advantageous indicators for Greece, i.e., for the human capital compared to Portugal and Italy. These data show the pronounced non-technological character of the innovativeness in the Greek economy.

Greece demonstrates some advantages even against the Nordic countries. These refer to the "*sales of new products*", "*non-RTD innovation expenditures*" (2010, 2022), the "*exports of knowledge intensive services*" (2010), the "*percentage of product and business process innovating SMEs*" (2022) and "*SMEs introducing marketing and organizational innovations*" (Sweden-2010). Similarly, Greece presents better scores than Ireland in "*non-RTD innovation expenditure*", "*SMEs introducing marketing and organizational innovations*" (2010) or "*product and business process innovations*" (2022) as well as in "*public RTD expenditure*". These data may not confirm the widely diffused approach in the country that Greece excels in human capital.

Large enterprises in Greece proved more innovative to SMEs than other member states in 2016-2018. The Greek SMEs rank 9th in innovativeness while the larger ones are found among the top five, at more or less equal footing with those of Belgium, Germany or Austria and ahead of Italy and Sweden. On the other side, the Greek SMEs precede those of Denmark, Ireland, Portugal, Spain etc. When considering the type of innovative activity, Greece ranks 7th for all types of innovation, but lags far behind many member states in strictly product innovation.

Summing up the Greek strengths in 2022, the E. Commission includes "product innovators", "innovative SMEs collaborating with others", "employment in innovative enterprises", "sales of innovative products" and "business process innovators". In the relative weaknesses it includes "foreign doctorate students", "lifelong learning", "employed ICT specialists", "government support for business R&D" and "medium and high-tech goods exports".

The World Intellectual Property Organization (WIPO) has produced its own "Global Innovation Index" (GII). In this framework Greece in 2022 ranks 44th behind Portugal, Bulgaria and Turkey and ahead only of Romania. Romania even precedes Greece, according to this classification, in *infrastructures*, *market and business sophistication*, *knowledge and technology outputs*. In *creative outputs* Turkey ranks 15th while Greece 54th. The weakest indicator for Greece refers to the *market sophistication*, followed closely by *business sophistication* and *creative outputs*. These are issues of wider government policy, that may not be considered as independent from other parameters such as the quality of institutions and the human capital (WIPO 2022).

Another organization, the Startup Genome, studies innovation and entrepreneurship and focuses on the innovation ecosystems. The 2020 Fintech report did not identify a Greek city among the top 20 in the world. Among them are found Milan and Madrid and 5 more European cities from the north of the continent. In the 2021 report the Startup Genome presents the ranking of the top 30 and "runners-up" of the global ecosystems among which Dublin and 7 more European cities. A second ranking presents the 100 emerging ecosystems, among which Athens ranks in the 71-80 positions. preceded by Barcelona, Madrid, Lisbon, Milan, Roma, Istanbul, Bucharest and even Cairo (Global Entrepreneurship Network 2021-2023).

The 2022 report of Startup Genome considered 72 cities of which 17 are in Europe. The top 40 include 8 participants from Europe all from the north. The top 100 emerging ecosystems ranking is more balanced geographically. Athens ranks among the 91-100 positions, preceded by a large number of other European cities: Dublin in the 3rd position, Barcelona 9th, Istanbul 14th, Lisbon (41-50), Bucharest (51-60) etc. The following year, the report continues to rank the top 100 emerging ecosystems, but none is in Greece. Instead, Nicosia in placed in the 51-60 range, Barcelona 4th, Istanbul 16th, Lisbon (31-40), Bucharest (61-70), Kiev (71-80), Zagreb (91-100) etc. Some cities are considered as "strong starters", i.e., Istanbul in the 1st position, Barcelona 2nd, Madrid 5th, Dublin 22nd, and Cairo 13th.

Even more discouraging for the Greek policy was the finding of the 2022 "blue economy" edition. No Greek city or conurbation appears on the 35 top cities, on which are present Oslo, Amsterdam, London,

Copenhagen, Hamburg, and five more coastal cities and conurbations, but also Munich and Paris. This is an indication of the types of economic activities developed in Piraeus or other Greek coastal cities and the corresponding added value produced. These activities lack the necessary depth for becoming global front runners while the policies suggested for developing such activities have not yet yielded any results.

UNIVERSITY EXCELLENCE AND INTERNATIONAL COMPETITIVENESS

Building a knowledge-intensive economy in Greece is often suggested as a national goal by ambitious politicians, but forgotten quickly after, until another one, unaware of the challenges' difficulties, raises the issue again. In the knowledge intensive economy universities may not but having a central and critical role. The ubiquitous position of the universities in the modern economy is a reason for several institutions producing in the recent years international rankings of universities using various criteria to respond to the multiple missions of the tertiary education in the 21st century. On their side, the Greek universities, as loosely integrated institutions, have shown limited sensitivity to the missions latently assigned by the global competition. Their response to the challenges was expressed for many decades through demands for more public funding and more administrative autonomy, having already secured their autonomy in teaching and research. Institutional growth strategies were impossible to establish against individual academic freedom.

One of the older university ranking efforts, the Shanghai approach, was introduced in 2003-04. The data show that Greece lagged well behind the Scandinavian and central EU countries, as was expected and Ireland. Greek higher education stands ahead of other Balkan countries and Portugal during the earlier years of the examined period. However, the Greek universities were losing positions through the years, a phenomenon that is also observed in the cases of other southern EU countries. This is probably owed to entering the ranking table of additional universities, mainly from Asian countries; nevertheless, the Nordic countries defend more effectively their ranks[5]. The poor position of the Greek universities is obvious also in the other Shanghai ranking of CWRU, even compared to Portugal[6].

The Times of Higher Education (THE) rankings at the beginning of the 2010ns and the 2020ies confirm the weakening of the position of the Greek universities while the stronger partners in the EU are effectively defending theirs[7]. It is interesting to notice that one old and one young Greek university, ranked in the third and fourth hundreds internationally, keep the first two positions at national level. The government policies in creating new institutions to bypass the rigidity and senility of the older ones was probably working also to benefit the rejuvenation of the older universities. The older university, that of Athens, was defending its first position throughout the years, accompanied by the young University of Crete. On the other side, older universities, such as Thessaloniki and the Technical of Athens are found in medium-low ranks (600-1000) together with younger ones (Giannina, Thessaly), while Patras and Thrace are positioned in even lower ranks.

The THE elaborates on rankings in individual activities, such as teaching, research, citations, industrial income. These rankings do not offer much different information than the overall one. The rankings by discipline for THE also follows the general ranking of the corresponding university to the greatest extent. Two universities are active in all fields, Athens and Thessaloniki, even in fields where they do not operate relevant departments (i.e. engineering and agriculture for the University of Athens). In addition, in these departments the University of Athens scores better than the "competent" institutions for engineering (Technical University of Athens).

The ranking of Shanghai ARWU by discipline seems more informative on the disciplines but considers only the first 500 institutions. It gives the 5th position to the civil engineering and 48th to the naval engineering departments of the National Technical University of Athens. In the range 51 to 100 are identified the dentistry of Athens, the transport S&T and the electrical and electronic engineering of Thessaloniki. In the range 101-150 are positioned the clinical medicine and telecommunications engineering of the University of Athens, the public health, veterinary science, telecommunications and food sciences of the University of Thessaloniki and the public health of the University of Crete. More disciplines are found in the range of 151-200 also involving the universities of Patras (civil engineering), Thessaly (veterinary and tourism management), the Technical University of Athens (energy S&T), University of

Athens (physics), atmospheric science in Thessaloniki and Crete. It is noticeable how some units or teams of excellence survive and grow in poorly managed institutions, securing their proper administrative support.

THE QUALITY OF THE SECONDARY EDUCATION'S OUTPUT

Past research in American universities has shown that the quality of higher education depends more on the quality of the enrolled students than on any other factor. Therefore, the international competitiveness of the universities needs to maintain a high qualitative production at secondary level. The OECD introduced 2000 a methodology for assessing the quality of secondary education known as the Programme for International Student Assessment (PISA) which offers serious indications on the capabilities of secondary education and their evolution through time (OECD 2001-2022 Education at a glance, OECD 2011, 2019, 2021).

PISA started as an exercise covering the domains of reading, mathematical and scientific literacy, and important knowledge and skills needed in adult life. The Programme "*focuses on things that 15-year-olds will need in their future lives and seeks to assess what they can do with what they have learned"*. A few figures should alarm the Greek policymakers in the secondary education area. In the group of 11 studied countries Greece shows the lowest performance next to Turkey in the field of science and in problem-solving in technology-rich environments. Such a performance emerges as a major hindrance for technological development. A more in-depth investigation is required to specify the weaknesses leading to downgrading Greece's competitiveness.

Greece performed below the OECD average in all subjects in every year it participated in PISA. Mean reading performance shows a steady decline since its peak in 2009. Performance in mathematics showed a spike in PISA 2009, remaining stable in the following years. Mean science performance declined steadily since 2006, by an average of 5.9 score points per 3-year period, even though changes from one round to the next were not always statistically significant. Performance amongst the highest-achieving students declined by 6.4 percentage points and that amongst the lowest-achieving students fell by 5.3 percentage points per 3-year period.

The 2018 PISA exercise, having further analyzed reading literacy, Greece shows low scores in all components with higher among them in "*evaluating & reflecting*", a finding for further investigation. The 2021 PISA focused on *extracting and processing pre-coded, carefully curated information*, *constructing and validating knowledge*. The corresponding report is exploring how 15-year-old students are developing reading skills to navigate the technology-rich 21st century. It also explores what teachers can do to help students *navigate ambiguity* and *manage complexity*. In these areas Greece shows positive signs for closing the gap with the other southern European countries, Italy, Spain, and even Ireland, although remaining behind the northern and central ones and Bulgaria. The Greek students perform better in the "*use of keywords in search engines*", "*comparing web pages and select the relevant ones*", "*detecting biased information*," or "*phishing and spam emails"*.

PERCEPTIONS AND ATTITUDES FOR SCIENCE, RESEARCH AND INNOVATION

In addition to the "objective" or rational elements entering the decision-making process, subjective elements, cultural features and embedded beliefs play their role in orienting the political and business decisions on science, research, and innovation. The European Union uses the Eurobarometer to analyze and monitor the elements intervening in the transfer of knowledge from the latent to the explicit sphere of policymaking. The Eurobarometer data are collected in the various participating countries, but it has been impossible to establish a reliable time series of various identified parameters.

Most data place Greece in a median position among the other countries it is compared with, while several deviations may support the arguments of cultural barriers to the acceleration of the technological progress. For example, in most sample countries, science and technology are perceived positively or very positively, and Greece lays among them. From 2013 to 2021 the data show an improvement of the overall influence of S&T on life. Greek and Portuguese youth demonstrated the highest *interest in S&T* among the

investigated countries. But considering the *power of S&T in determining the status of the host country in the world*, the Greeks were less appreciative for S&T, positioning it at the same level with military might, as do Finland and Romania. Turkey has the highest consideration for S&T (European Commission DG Research, DG Communication 2005-2021).

The Greek youth estimated in 2008 that *science was too much influenced by profit and much less by reducing poverty and hunger in the world or in creating new jobs in the future*. For most of the Greek youth, "*scientific research should above all serve the development of knowledge*," while the lowest minority among other investigated youths supported in 2008 that "*research should above all serve economic development*" (together with the Danes and Spaniards) or "*above all serve businesses and enterprises*". The high percentages supporting the idea of *science above all for knowledge development* is also found in the Scandinavian countries but there, the weight of knowledge is counterbalanced by the higher percentage of respondents in favor of the *science supporting economic development and businesses*.

In 2008, a majority of the young citizens in the investigated countries believed that the scientists were "*devoted and working for the good of the humanity*" with the lowest majority depicted for Greece and the highest for Denmark and Portugal. On the other side, again, most youth believed that "*because of their knowledge, scientists have the power that can make them dangerous*". The Greeks were the most numerous to believe on the potential danger of scientific knowledge, followed by the Portuguese. This apparent contradiction of good and evil may come either from fear of the potential uses of knowledge or ignorance of scientific ethics and knowledge management practices.

In 2010 the Greeks presented the third lowest share, after Italy and Bulgaria, of those believing that *S&T makes our lives healthier*, the highest share held by Turkey. Greeks presented the highest share of those believing that "*scientists have the power making them dangerous because of their knowledge"*, followed closely by Portuguese and Spaniards. Moreover, most Greeks (64%) considered that "*we depend too much on science and not on faith"*. Bulgarians, Romanians, and Turks followed them with much lower majorities (51-52%). The Greeks are also most critical among the respondents considering that scientists do not put enough effort into informing the public about new developments in S&T. A decade later, the perplexity of Greeks facing science is expressed through the large majority, above any other country of the sample, on the statement "*science is so complicated that I do not understand much about it*". At the same level are found the Bulgarians, while Irish and Belgians are at the other side of the spectrum.

The involvement of the Greeks is particularly low when they consider more technologically advanced activities like providing personal data for scientific research, taking part in clinical trials, or lending own computer's processing power to contribute to the research on complex scientific questions. Bulgaria, Romania, and Spain are found on the same stage, instead, Turks are demonstrating a much more intense S&T involvement.

Greeks were in 2005 particularly distrustful to innovation, believing that "*innovations are most often gadgets and a matter of fashion"*. At the same time, they stated that innovations often simplify everyday life. Greeks were the most numerous among the people of the investigated countries in stating that "*purchasing innovations is risky for the consumer"* and their advantages are often exaggerated. The Greeks were in 2005 the most numerous in "*never willing to purchase an innovative product or service*", followed by the Portuguese. On the other side, Italians and Turks were the most numerous in *replacing a product or service by an innovative one "even if it is significantly more expensive"*. This finding raises questions on an established belief on the propensity of the Greeks to adopt quickly consumer addressed innovations.

With these data, the Eurobarometer scholars produced a typology of innovation adopters: enthusiasts, attracted, reluctant and anti-innovation. In this typology, the Greeks present the highest share of anti-innovation followed by the Bulgarians. Nevertheless, the Greeks also show a relatively high share of enthusiasts, but far behind the Turks and the Romanians.

According to the Eurobarometer surveys, the group with a larger influence on decisions on spending money for research in 2008 should be the citizens themselves. The citizens received high shares of preference in all countries while in Greece, Austria and Ireland, citizens made the highest score as a first choice. In general, for Greece, the distrust to governing bodies gives preference to the citizens or the scientific community, which are diffuse entities without established formal representation. In the 2021

survey, for the majority of the questioned Greeks, the decisions about S&T should be made by scientists, engineers and politicians, the general public should stay simply informed. The Greek dominant attitude was then aligned with the attitude of quite all other participant countries.

Quite half of Greeks supported in 2005 that "*scientists should be held accountable for the misuse of their discoveries by other people*", which increased to two-thirds in 2021 the highest percentage among the investigated countries. The percentages of Greeks were very high also in supporting that "*we can no longer trust scientists to tell the truth about controversial S&T issues because they depend more and more on money from industry*". Their attitude on the issue was loosened from 2010 to 2021, but the percentage remained among the highest again. The Greeks were more numerous to believe in 2021 that "*scientists should intervene in political debate to ensure that decisions take into account scientific evidence*" and at the same time, quite one on two to support that "*scientists should not intervene in political debate when decisions ignore scientific evidence*", a position also shared in Bulgaria, Italy and Spain. These perceptions are rather a strong warning signal about the future of science, particularly for the economy, industry and knowledge intensive services.

The position of government representatives and industry is even worse for the Greek respondents, with less than one third of them believing that these actors "*try to behave responsibly towards society by paying attention to the impact of their S&T related activities*". Nevertheless, when we come to identifying the people and organizations who try to "*behave responsibly towards society by paying attention to the impact of their S&T related activities*" it is the scientists in the universities, government and industry laboratories that are trusted in 2013.

The Eurobarometer has also performed surveys of the entrepreneurs in the member states, who are invited to assess their innovative performance as well as their competitiveness at national and global levels. The Greek entrepreneurs considered in 2001 their innovativeness far above average, higher than any other in the group of the selected countries, equaling the Swedes in the matter. Given more "objective" data from the Innovation Scoreboard, Greeks held a misunderstanding or misinterpretation of the concept of innovation. Focusing further on the problem, we conclude that the Greek entrepreneurs were keener in introducing organizational innovations than launching new products or services.

In services, the situation was presented slightly better than in products, Greece exceeded Austria and Italy, Belgium, Finland and Sweden for several years. But the relative position of Greece is rather worsening, the shares of positive developments falling significantly through the years, except in two types of innovation: the new services and new production or distribution processes. In 2020 Greece and Italy presented the lowest shares of enterprises performing all types of innovation. The analysis of the innovations in the services shows that their largest part belongs to the less intensive "knowledge-intensive services". They are followed by the low and medium technology manufacturing. The Greek segment contains the lowest share in knowledge-intensive services with Italy and the highest share in low and medium-low technology, peering with Italy and Bulgaria.

The entrepreneurs that have ever had at school or university a course or activity about entrepreneurship (i.e. turning ideas into action) were in 2012 a small minority in Greece and Italy, half the percentage of Sweden and Finland, and much smaller than Bulgaria, Romania and Turkey. Similarly, school education has been of limited help in developing a sense of initiative and a sort of entrepreneurial attitude and to better understand the role of entrepreneurs in society for Greeks, Italians and Irish, compared to the other. The situation was better presented for these countries compared to the Scandinavian and even the other Balkan countries for transferring skills and know-how to enable the entrepreneurs in running a business. On the other side, the surveyed entrepreneurs, and managers in 2011 confirmed that their employees held a university degree at higher percentages in Greece and Romania and to some extent in Bulgaria, Turkey and Ireland. Greece and Turkey showed the lower rates of zero employment of non-university graduates, confirming the mismanagement of human resources in some Mediterranean countries.

Focusing on the obstacles to innovation affecting most enterprises in 2001, identifying and mobilizing human resources proved to be most important, followed by the access to innovative customers and markets. Human resources were also seriously concerning Greeks, behind Swedes and Irish, at similar levels as Finland and Austria. This is a rare finding, Greeks usually pretending benefit from the availability of

adequate human resources, with excess expatriating for meeting labor demand in western Europe. Greece and Portugal were experiencing the scarcity of cash and bank credits, which culminated with the financial crisis of the 2010ns. With respect to the availability and access to new technology, a little more than one third of the Greek entrepreneurs stated they had problems, third to Ireland and Finland.

The 2020 and 2021 Eurobarometer reports found that the main obstacles for most countries were the "*prediction of market responses"*, the "*lack of adequate financial resources"* and the "*administrative environment*". The percentage of Greek firms suffering from these problems was not particularly high. For the market response prediction Greeks and Italians showed some of the lowest percentages, an indication of the market segments behavior they addressed to. For the administrative environment, Greeks, Italians, Irish, Fins and Swedes were the least concerned among the group. This has to be examined concerning the types of innovations promoted and the rigor of applying the regulatory environment. The Greek firms felt the financial barriers more extensively, but were also important in Turkey, Spain and Bulgaria. According to their entrepreneurs, the lack of skills comes back as an obstacle, for which Greece and Italy suffer less than any other. Summing up, the sources of obstacles and the barriers to innovation during the two decades depended in a great part on the types of innovations promoted and/or supported in each economy.

The Eurobarometer report in 2020 gave a picture of the entrepreneurs' perception of the quality of the support services supplied by the government or assimilated services. The Italians and Danes are the least satisfied for the quality of services to businesses, leaving the Greeks, Spaniards, Austrians, and Bulgarians at the next level of dissatisfaction. On the collaboration of the companies with various partners Greece, Italy, and Spain make up the smaller group of satisfied entrepreneurs. Overall, in 2020 the business environment was poor for Italians, Spaniards and Greeks, while Portuguese and Turks were more likely to be satisfied on all four assessed criteria.

In 2016 the Eurobarometer asked the entrepreneurs once more about the types of supporting measures for commercializing the companies' products or services. *Training staff in promoting and marketing innovative goods-services was expected to be the most helpful measure by* entrepreneurs in quite all countries except for Greece. The Greek entrepreneurs presented the lowest interest for training the staff in commercializing innovative products and services. For *testing of products or services before launch in the market* the Greeks manifested a relatively high interest, behind the Portuguese, the Belgians and the Swedes. Here again, the Greeks are demonstrating their preference for direct impact measures like testing and exhibiting innovative products rather than training staff or conforming to regulations.

ENTREPRENEURSHIP, INNOVATIVENESS, AND COMPETITIVENESS

We can claim that the parameters characterizing the economy interact with RTD and innovation factors, although research has not established direct and univocal relations between the two parts. These parameters are used for measuring the economy's status and its transformations. Such a parameter is productivity, whose link to technology is indisputable. Four decades ago, Greece belonged to a group bringing together Portugal, Ireland, Finland while at around 2020 Greece was left behind all countries of the sample. The productivity/GDP ratio rose in Greece between 1983 and 2021 by 27%, while that of Turkey rose by 218%, Ireland by 368% and Portugal by 78%. Italy increased in the same period by 43% and Spain by 49%[8].

In the field of inward foreign direct investment (FDI), one of the proxies for inward technology transfer, the available data on the 2000nds show the very low level of investment activity in Greece, despite the push expected from the 2004 Olympic Games in Athens[9]. The Greek performance started rising after 2016, while approaching 3.5% in 2022. In 2022, Greece was found at the same level as Portugal ahead of all other countries but Sweden. As to the investment on intangible fixed assets, Greece shows much lower ratios of such investments to the GDP during the whole period than other countries, confirming that the prevalence of embodied technology transfer. Italy presents a similar profile for this indicator.

The introverted character of the Greek economy is shown by the ratio of the sum [imports+exports] to the GDP. Greece has the lowest ratio, except for Turkey, which has a much larger internal market with eight times the population of Greece, although of lower income per capita. All smaller countries of the sample show high ratios, with Belgium championing the group, followed by Ireland and the Nordics.

Global competition in the industry has been too fierce for the Greek companies bound to increase substantially their technological might. Nevertheless, this change in the Greek share moves in the opposite direction than the shares of all other countries (except Turkey), which see their penetration to the global markets shrinking. The share of high technology exports to the total exports of Greece varied between 4.2% in 2007 and 4.8% in 2021, marking a tiny increase and creating some optimism. Portugal shrunk from 6.8% to 4.7%, Finland from 17.5% to 6.8% and Sweden from 13.3% to 11.4%. The other countries recorded increases as limited as from 6% to 7.7% for Italy, from 4.2% to 6.8% for Spain, or as large as 25.7% to 43.4% for Ireland and 6.6% to 17% for Belgium. Bulgaria and Romania have also seen their shares increasing significantly. Based on the OECD data, Greece doubled its world export market share in the pharmaceutical industry from 1981 to 2020. Nevertheless, the countries that had a high market share in this industry in 1981 continue to maintain their supremacy in 2020 over Greece, apart from Portugal and Finland. In the computer, electronic and optical industry, Greece doubled its share in the world market, but this share remains quite insignificant and lower than that of any other country in the sample (OECD 1997, Prodromidis K.P. 1976, European Commission 2022).

The situation presents a better look for Greece when exports of knowledge-intensive services are considered. But the knowledge intensity of these services is based more on experience and less on scientific research and technical knowledge, which may become a competitive weakness in the long run. The competitive pressure of economies of similar or even lower technological level and lower labor cost cancel the competitive advantage of Greece in experience-based service industries.

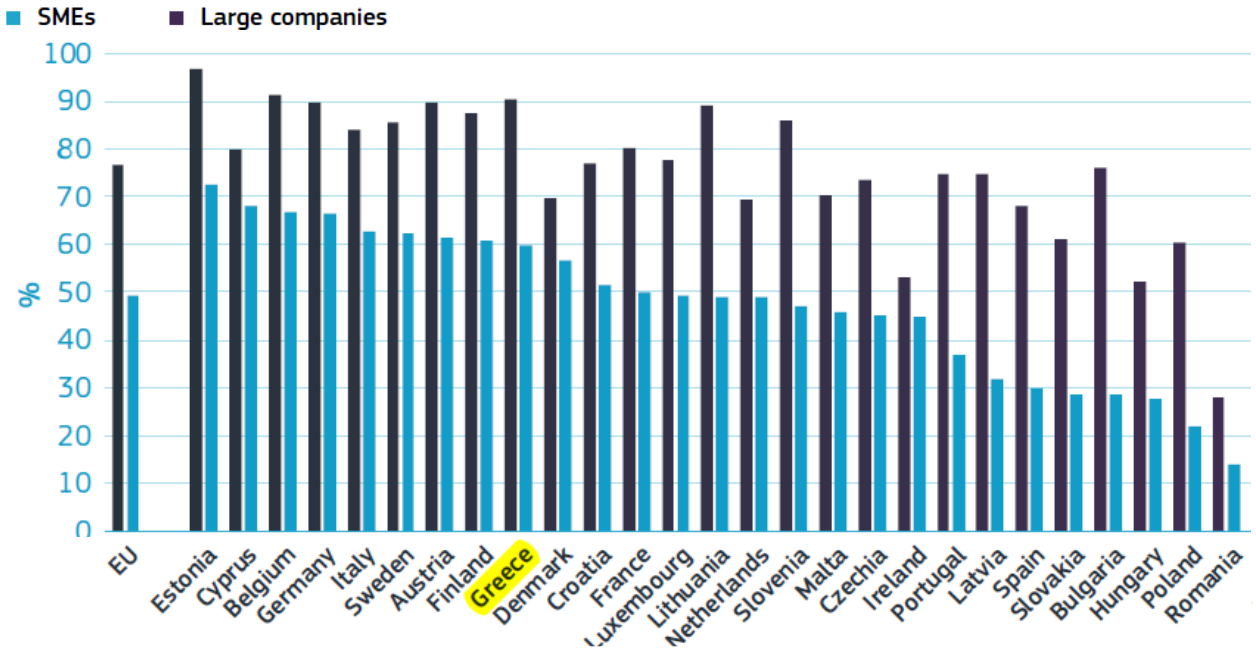
Scholars and politicians have often underscored the dominance of small companies in Greece which need special protection for their paramount contribution to employment. Very few notice the absence of very large companies inside Greece that would lead value chains and offer their financial and commercial potential for facing global competition and enhancing exports (figures 3, 4). The number of companies employing 500 staff or more in Greece is estimated to about 80. In comparison, those employing more than 2000 staff are less than ten, but even with the +250 staff companies Greece shows the lowest share of large enterprises to the total number of companies. The countries with the highest share of large companies are Austria, Denmark, Finland, Sweden, Ireland and also Romania. In absence of effectively large firms in Greece, analysts call, not ironically, the rather unstructured mass of SMEs as the "backbone" of the economy.

The puzzling structure of the Greek business sector becomes more intriguing when examining the demography of the firms (Eurostat-OECD 2008). The available data on "all firms" (active employers or not) starting in the years of deep financial crisis (the 2010ns) show deaths of Greek firms more numerus than births. The situation reverses by 2018 on. Portuguese firms seem to have better resisted to the crisis of their national economy. Considering only the Greek firms with active employers, the data appear much more optimistic, since the births are considerably higher than the deaths. The question raises here concerns on the zombie firms, to which several scholars refer for their blurring role in the economy[10].

One more feature of modern economies is the emergence of high growth enterprises, contributing to restructuring the national economies and raising competitiveness. Greece presented in the 2014-2016 period some of the lowest shares of this type of firms to the total number of active enterprises with at least 10 employees[11]. Greece presented the second lowest percentage after Romania in some significant selected sectors, like ICT, computer programming and S&T activities.

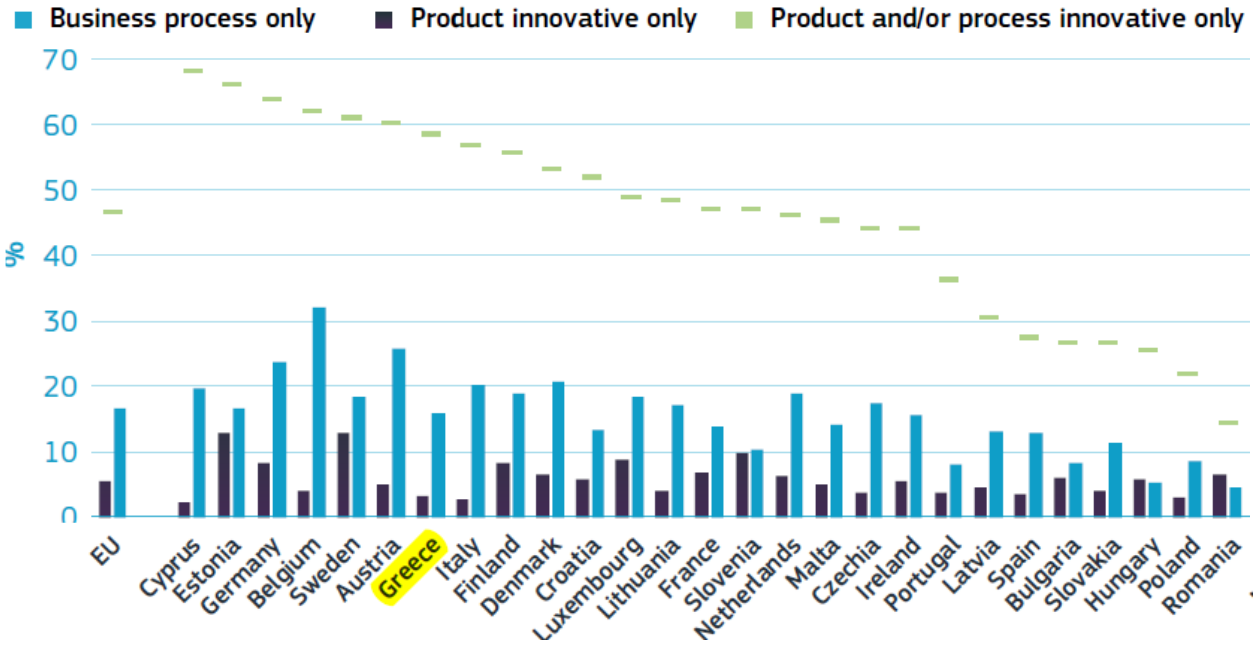
On the other side, Greece demonstrates in 2018 and 2019 the highest percentage of high-growth firms. Greece is seconded only by Spain, Denmark and Finland. The sudden rise of the ratio in 2018 could be explained by the approval of the third Rescue Programme (memorandum) of the Greek finances, the approaching end of the financial crisis, and the disillusionment of youth on the government's role in creating new jobs. Reducing the number of high-medium growth firms in 2021 in only four of the studied countries, among which is Greece, raises questions on the sustainability of this trend.

FIGURE 3
SHARE OF INNOVATIVE ENTERPRISES BY SIZE CLASS, 2016-2018



Source: SRI Performance 2022

FIGURE 4
SHARE OF INNOVATIVE ENTERPRISES BY TYPE OF INNOVATION ACTIVITY, 2016-2018



Source: SRI Performance 2022

The Global Entrepreneurship Monitor (GEM 2004- 2021/2022) is investigating the business dynamics, entrepreneurial opportunities and capacities and other parameters of entrepreneurial activity. A central

concept to the GEM is the Early-stage Entrepreneurial Activity (TEA) in which Greece held the 49th position among 60 countries in 2015 and the 38th in 2018 with only 49. In 2022 Greece fell to the third from the end position, lower than all other sample countries. Greece scored relatively high in the beginning of the 2000nds (2003-04) but then started losing ground, not only compared to Ireland and Portugal but also to Sweden, Romania and Turkey. Other countries, such as Spain, Austria, Belgium, Denmark and Finland suffered from a kind of stagnation, which can be seen as a sign of resilience.

In 2005, Greece presents a low *opportunity-to-necessity ratio* in creating an enterprise, leaving behind Italy and Ireland, staying at level with Sweden; In 2007, a period of euphoria, the improvement driven entrepreneurial activity is for Greece lower only from the Nordics, Italy and Austria. In 2014-2016 Greece presents the highest necessity-driven and the lowest opportunity-driven entrepreneurship as a share of TEA. Nevertheless, in 2018 this positioning is reversed, and the Greek entrepreneurship seems to become more sensitive to opportunities.

What impressively characterizes Greek entrepreneurship is the *fear of failure*. The ranking of Greece among all countries participating to the GEM survey among the first two or six in *fear of failure* raises serious questions on the attitudes of potential entrepreneurs and their needs for managerial, technical and psychological support by specialized institutions. One more motivational parameter for entering entrepreneurship is the *high status afforded to successful entrepreneurs*. The gap between the Mediterraneans and the Nordics is remarkable in this respect. It is interesting to notice that Ireland and Turkey are aligned to the Nordics in this case as in several others. Regarding *media attention to entrepreneurship*, Greece marks one of the lower percentages of respondents to the survey for assessing the media attention, on the opposite to Finland, Sweden, Ireland, Turkey and even Italy, Spain and Portugal.

Other private organizations offer more rankings of national economies and links to innovation. IMD (Institute for Management and Development World Competitiveness Online 1995 – 2021) is probably the older among them. IMD's data show a continuous deterioration of the relative competitiveness of Greece from 2001 to 2019. In 2021-22 the ranking of Greece is again on the rise but not decisively. While Denmark and Sweden show a net improvement, climbing to the first ranks, Austria, Belgium, Finland and Ireland demonstrated a deterioration in the 2000nds but followed afterwards by stabilization. On the other side, Spain and Turkey have lost ground.

An IMD ranking exercise addressed the field of the digital competitiveness of 63 countries in 2022 (IMD World Digital Competitiveness Ranking 2022). The data show that Greece was lacking talent, behind Turkey and ahead of Bulgaria and Romania, trailing in education and scientific concentration. But the worst performance of Greece was on *future readiness* and in particular, *adaptive attitudes* and *business agility*, ranking behind all other countries. As the weakest factor in digital competitiveness emerges the *use of big data & analytics*, followed by *smartphone possession*, the *highly skilled foreign personnel*, the *pupil-teacher ratio in tertiary education*, *banking and financial services*, and the country's *credit rating*. These parameters refer mostly to the business sector's characteristics, dominated by the scarcity, if not lack of large and internationally exposed firms.

The World Economic Forum (WEF) is another private organization elaborating competitiveness rankings. The competitiveness index worsened between 2008 and 2019 for the Nordics, Austria and Turkey while improving for Italy, Spain, Portugal, Bulgaria and Romania. Greece demonstrates a net downfall in 2008-10, then improves after adopting the third Rescue Programme (2016-17) and starts falling again in the following two years (2017-19). This pattern is observed also with other parameters for Greece, in entrepreneurship, business RTD, innovation and innovation capability etc. Among the Nordics, Denmark and Sweden keep stable and Turkey is improving considerably. Bulgaria and Romania mark notable improvements in their rankings.

In *business sophistication/dynamism*, the loss of ground for the Greek economy is continuous, as it is for Italy, Spain, Austria and Belgium, On the opposite, the Nordics, Ireland, Portugal, Bulgaria, Romania improve their scores. Italy and Spain lose ground. Greece scores particularly good in *diversity* and *creativity* but ranks behind Italy, Spain and Turkey. The positioning of Greece is neither enviable in the *education and skills* area nor in the *financial market development*. The *technological readiness* indicator shows an improvement for Greece, but its reformation between the two periods does not allow safe comparison.

In a more detailed analysis of the Greek rankings, based on the individual parameters composing the synthetic indicator, the loss of ground in most sub-indicators reveals either the deficient efforts or the limited effectiveness of the policy measures enforced in Greece (World Economic Forum 2009-2019). *Intellectual property protection*, a component of the institutional strength, Greece is clearly losing positions for obscure reasons. In the *education and skills* domain, the difference between quantitative characteristics, such as the *duration of the studies* and the qualitative ones is striking. It ranks 1st for *tertiary enrolment* in 2008-2009 but 49th in q*uality of math and science education*, 80th in the *quality of management schools* and 82nd in the *quality of the educational system*. In 2019, Greece passes 55th for the "*mean years of schooling*", and 82nd for the *skills of the current workforce*, with the "*quality of vocational training"* at the 109th position and the *extent of staff training* at the 108th. This situation cannot be sweetened with the best position of the "*future workforce*" which is based on a quantitative indicator, neither by the "*pupil to teacher ratio in primary education*" (5th) while skills of the workforce suffer from low "*critical thinking in teaching*" (122nd).

The above demonstrate the national policy's difficulty in designing and implementing an effective intervention for impacting the multiple facets of the innovation phenomenon, mobilizing the various stakeholders on the correct timing, and making the maximum benefit out of the available human and financial resources. The effectiveness of government efforts is not dependent only on governmental decisions. Entrepreneurial culture and general public awareness play a critical role in the parameters influencing innovativeness and competitiveness on a global scale.

CONCLUSIONS

We may wonder whether all the data included in this article can make up a cohesive set and lead to safe findings. It is quite unusual to find these data types on the same document; research and innovation are processed in different contexts than productivity, entrepreneurship, education, and attitudes. Nevertheless, the rise of the weight of the knowledge-intensive productive activities and the integration of the knowledge producing and transferring organizations into the economic value chains has changed the "competitiveness game". Greece's efforts to respond to the challenges prove of limited effectiveness until the beginning of the 2020ies.

The obstacles and barriers in building a knowledge-based economy show that the Greek practice of delegating all competencies for designing and implementing an effective research and innovation policy in one government body with limited visibility in the society and the political system proves limited impact. Transferring this unique body from the ministry to ministry (Economic development/Industry and Education in the case of Greece) for increasing synergies with neighboring sectors has not enhanced its effectiveness. Experience from successful countries in the north of Europe, i.e. Denmark, shows that there is a need for convergence and coordination of many policies to common objectives, set at the top of the government and shared by the involved units and their head officers as well as by the stakeholders. This includes economic development and secondary and tertiary education but also sectors of critical importance like industry, agriculture, health, environment protection, tourism and leisure services, financial services, defense and other, depending on the government priorities.

The data on the quality of education show that lack of excellence at the various levels may constitute a serious barrier to understanding scientific evolution and technological changes, as well as "translation" processes of science to technology and of technology to innovation. The inertia of a centrally controlled educational system by the government and the trade unions raises additional barriers. Moreover, the necessary sophistication in policy design and implantation requires appropriate training and skills. The international "competitiveness" of the education system, measured by the competitiveness of its graduates in the labor market, proves a critical factor for attracting investment in knowledge-intensive activities and for the resilience of the labor supply in the frequent changes of the demand.

The entrepreneurial culture is conditioned partly by the education the entrepreneurs and managers receive. The understanding of the economics of innovation by these actors has become critical in modern societies. The capability to assess one's position in the national and global business environment may play

a critical role in defining business models and reducing the fear of failure, that proves a burden in the case of Greek SME world. Of equal importance proves the integration of continuous training in business practices and the enhancement of staff's skills.

The necessary changes in education and business culture require raising social awareness on the future of science and innovation and their impact on society. This is incompatible with the current education of opinion makers and what is currently called "influencers". The ambivalent attitudes of the Greek population towards science and technology, due to deficient training and information, raise the mistrust of researchers and innovating entrepreneurs. The role of schoolteachers needs to be assessed continuously in this respect. In the education system, a cultural revolution seems necessary to promote creativity, individual initiative and cooperative capability, accountability and continuous learning, instead of memorization and seeking formal credentials.

Most importantly, society's deeply rooted beliefs in kinship need to be balanced with the search for merit in professional accomplishment.

Large firms' role in advanced economies has only recently been highlighted, receiving criticism from various political sides for which SMEs were the "backbone of the national economy." In practice, traditional SMEs contribute to keeping productivity at relatively low levels and innovation addressing the needs of final consumers. The lack of large firms exposed to international competition deprives the economy of the real backbone of healthy value chains aiming at innovation at a global scale. Continuous training is also better supported in larger firms than short-term planning small companies.

The paradigms of Denmark and Ireland suggested by political leaders could be more operational if explained to the society in their very components and the role of the citizen in each of these societies. Most urgent action of the government would be the implementation of a campaign explaining to the public, and more specifically to the small and medium entrepreneurs and the politicians of all boards, of the content and challenges of the knowledge base economy and the role of all levels of education in its development

ENDNOTES

1. Source OECD.Stat, data extracted on 09/11/2022
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4. European Innovation Scoreboard for 2003-2005 edition 2007, for 2006 ed. 2010, for 2007 ed. 2015, for 2008-2013 ed. 2016, for 2014 ed 2021, for 2015-2022 ed. 2022.
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6. www.cwur.org/2022-23.php; www.cwur.org/2021-22.php
7. https://www.timeshighereducation.com/world-university-rankings
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10. OECD.Stat Data extracted on 20/3/2023
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