The developmental university in the time of crisis. The case of Greece

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1. Introduction

The global financial crisis that began in September 2008 reached Greece in the form of a sovereign fiscal and debt crisis. Since then, Greece has experienced in the 2010s a rapid deterioration of macroeconomic indicators. Therefore, the Greek State has engaged an ongoing economic adjustment that entailed fiscal consolidation that contributed to the vast reduction of the General Government deficit, from 15,2% of GDP in 2009 to 3,5% of GDP in 2014 (OECD 2016). At the same time, however, even if the ambitious medium-term fiscal targets established in the 2015 MoU between Greece, the ECB, the EU and the IMF were met and growth was to recover, the debt-GDP ratio would remain high in the foreseeable future (European Commission 2015a).

Nevertheless, from the mid-1990s and for almost a decade, economy has achieved significant –but unsustainable– growth performance, which was not driven by innovation or knowledge-intensive production. As a matter of fact, nor state intervention in Greece used to follow strategic, long-term goals for growth, paying little attention to factors that contribute to sustainable growth, such as well-educated human capital and new technology's integration within the production process (Caloghirou 2008). On the contrary, national priorities had to do with achieving high growth rates in the short-run, although experts highlighted the need for changes in productive structure and national growth model.

In this context, the manner in which universities, research centers and the industry interact in terms of knowledge- and technology-coproduction, as well as human capital education and flow has been standing as a hot topic of (policy) attention for a long time, in part because such co-habilitation sustains economic growth. While the issue of achieving an optimum interaction remains an open question, given the divergent institutional mandates between the public and private sector and a variety of country-specific characteristics, the purpose of this paper is to show off the R&D context in Greece amidst crisis, and to analyze linkages between universities and the business sector before and after crisis. For this reason the paper examines quantitative and qualitative data; the latter mainly dealing with respective institutional settings and mechanisms employed to boost (and, sustain) such a collaboration, laying emphasis on the impact that current economic crisis has on academia-business sector linkages. Quantitative analysis is based on data produced mainly by the National Documentation Centre (Greece).

2. Theoretical concept

The concept of triple helix appears to offer an insightful mechanism to map and understand the various processes and flows as well the respective tribulations pertaining such a nexus, while the construct of knowledge triangle has gained legitimacy both in OECD and EU circles followed by numerous and recurring national- and regional-level analyses. According to the

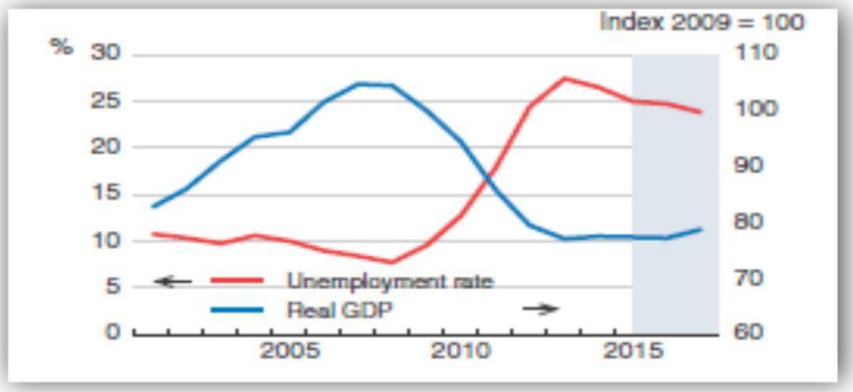
triple helix, a main triadic relationship emerges between university, industry and the state, forming or contributing to knowledge society. The paper relies mostly on the so-called neo-institutional approaches of the triple helix, examining triple helix configurations, in parallel to mechanisms in national and regional contexts (Etzkowitz 2003, Etzkowitz et al. 2005, Boardman and Gray 2010). Actually, *t*riple helix goes beyond the relationship of university, industry and government, taking also into account the internal transformations within each of these institutional forms. As Etzkowitz and Leyersdorff (2000) mention, "*a knowledge infrastructure is defined in terms of overlapping spheres, with hybrid organisations emerging at the interfaces".* According to them, the system is perennially incomplete and in flux, the sources of innovation do not fit together in a pre-given order, and the unidirectional causal relation between input and output is modified by taking into account interactions and recursivity (non-linearity of innovation).

The reason for choosing the triple helix approach deals with one of its points, according to which the potential for innovation and economic development lies in a more prominent role that the university may play within the university-industry-government nexus, generating new formats for the production, transfer and application of knowledge. This point is directly related to higher education institutes' (HEI) third mission. Moreover, the concept of knowledge triangle goes one step beyond, merely acknowledging the relevance of R&D, education and innovation: not only are these policy areas important, but there are important positive externalities *between* them. Thus, the need for improving the societal relevance of investment in these three areas calls for a systemic and continuous interaction (Hervás Soriano and Mulatero 2010). For the purposes of the article we rely on output deliverables, such as co-production of scientific articles, R&D synergies, collaboration for innovation and mobility of human capital between the sector of HEIs and businesses. Furthermore, we analyze the evolution of HEIs' stance towards the business sector, regarding potential synergies between them, as a result or consequence of crisis.

3. R&D in Greece in the time of crisis

After the outburst of global financial crisis of 2008, Greece has been experiencing a deterioration of macroeconomic indicators. Over an eight-year period (2008-15), as shown in figure 1, the country lost about twenty five per cent (25%) of its gross value added, official unemployment reached twenty seven per cent (27%), while private consumption declined by almost thirty per cent (30%). These conditions illustrate the deterioration of living standards in Greece in recent years, with them now being below the OECD-average in several relevant indicators.

Figure 1: GDP and unemployment rate in Greece

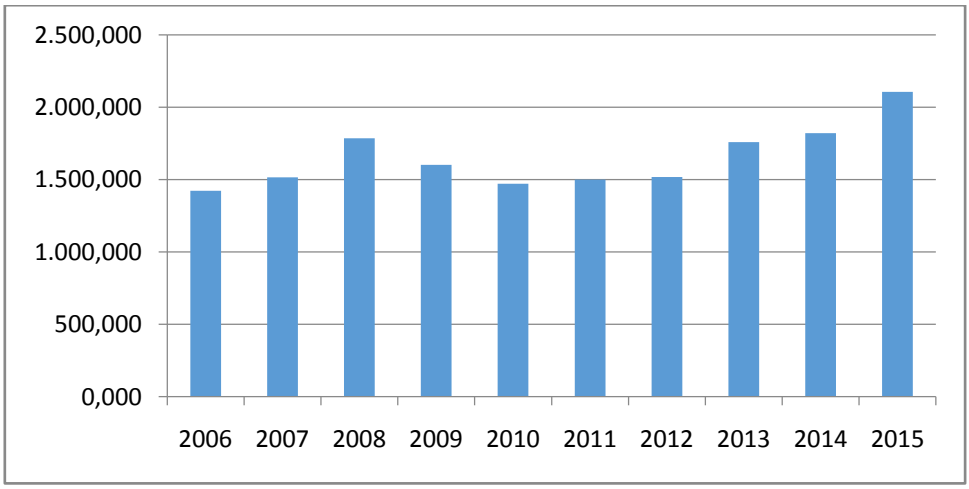


source: OECD (2016)

Factually, research and technology intensity –namely gross national expenditure on research and technology (GERD), as percentage of GDP– is diachronically low in Greece, despite an increase from 0,6% in 2007 to 0,8% (2014) and 0,9% of GDP in 2015. As a matter of fact, the overall R&D investment had grown during the years 2000-2006, but this growth was offset by an even stronger growth of the GDP. Later on, the economic crisis caused the revision of the national R&D intensity target at 1,2% by 2020, a less ambitious target than the 3% set by the EU (European Commission 2014a).

In the context of the fiscal crisis, expenditures on research are among those public expenditures of the State's ordinary budget that were slashed in an effort to tackle central government's deficit. Thus, national R&D expenditure has been facing an additional challenge, namely to resist to significant horizontal, across the table, cuts. However, low national research and technology funding is definitely not related to economic crisis. On the contrary, national R&D funding has increased after 2012 and during the crisis (figure 2). This trend can be attributed to the National Strategic Reference Framework (NSRF) that is related to EU's Structural Funds for Greece in the period 2007-2013, partially compensating for the severe budgetary cuts on institutional funding since 2009.

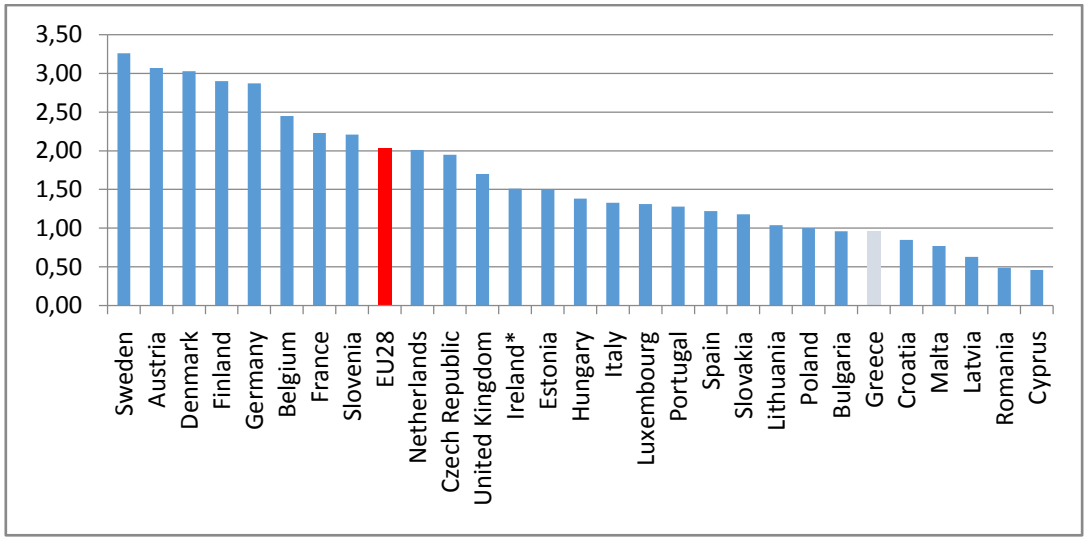
Figure 2: Gross expenditure on R&D in Greece (million PPS)



source: Eurostat (rd_e_gerdtot)

In any case though, R&D intensity in Greece remains the lowest in EU-15 and among the lowest in EU-28. Cross-country and inter-temporal comparisons show that Greece remains at the bottom rank among EU member states (figure 3). Research and technology expenditure in Greece can be compared only to member states that joined EU recently and the gross domestic expenditure on research and technology (GERD) trend contradicts that of member states' commitment to increase research and technology funding to 3% of GDP, according to Barcelona Council decisions of 2002 and Strategy "Europe 2020". However, the main national advisory institution on research and technology in Greece, the National Council for Research and Technology has stressed –amongst others- that national investment on research and technology may offer –under some critical conditions– significant gains towards the recovery of national economy (ESET 2014).

Figure 3: R&D intensity (GERD as % of GDP, 2015)

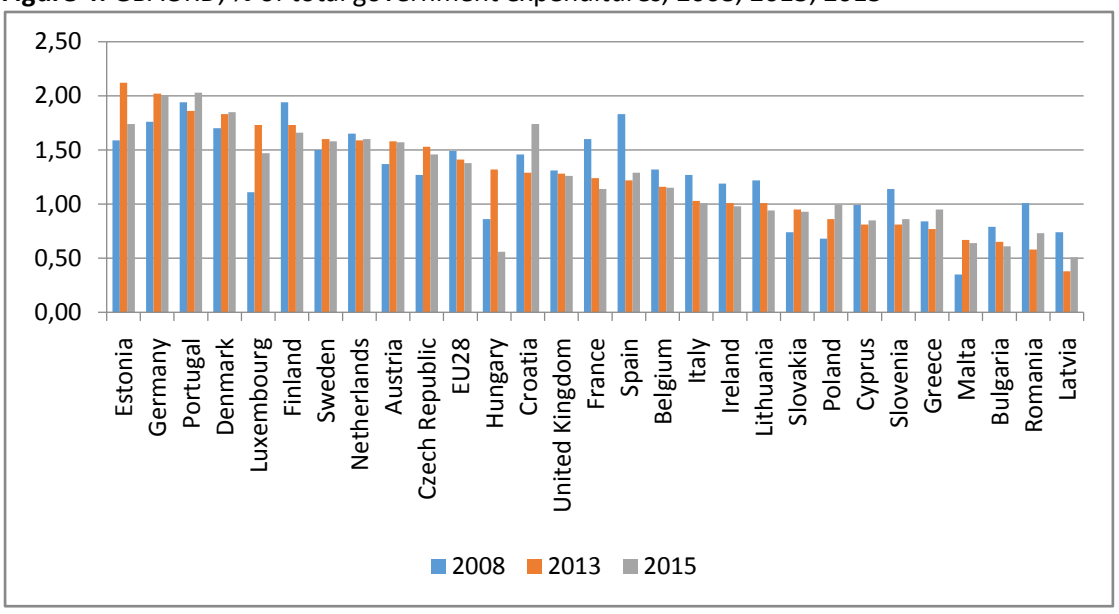


* data 2014

Source: Eurostat (rd_e_gerdtot)

In terms of government budget appropriations or outlays for R&D (GBAORD), it is clear that reductions between 2008 and 2013 are to be seen not only in Greece, but also in countries, like Latvia, Romania, Spain and France. This slashing, though, ran against to other countries' counter-cyclic approach towards R&D spending, themselves also facing extreme deterioration of macro-economic conditions (e.g. Ireland, Portugal). Instead, they opted for fiscal protection, even increase of public R&D funding (European Commission 2014b). Nevertheless, Greece had the extra task to deal with challenging fiscal adjustment and severe austerity measures, according to the MoUs between Greece, the IMF and the EU (European Commission and ESM). Actually GBAORD in Greece has finally increased -in relevant and not necessarily in absolute terms- after 2013, thanks to the general uplift of R&D expenditure in Greece and as a result of the stagnation in general government expenditures.

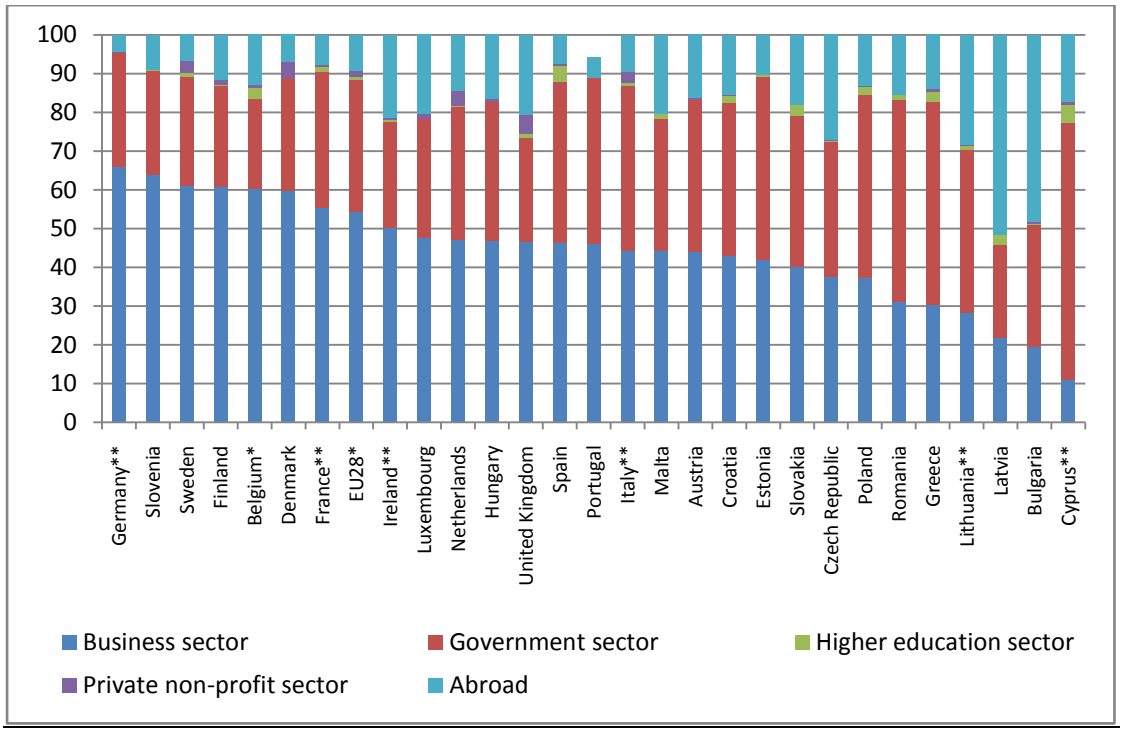
Figure 4: GBAORD, % of total government expenditures, 2008, 2013, 2015



source: Eurostat (gba_nabste)

Structurally, the State is the main actor in the area of research and tertiary education in Greece, as it is the main R&D performer and funder. At the same time, universities and technological educational institutes –constituting the major part of the higher education sector- are exclusively public, according to the Constitution. One persisting finding across time has been the under-investment of firms in R&D activities, leading to a situation, where the contribution of business sector in R&D funding, performance, as well as knowledge creation is significantly lower than in most EU member states. Thus, R&D funding in Greece depends mostly by government that funds research that is performed in public sector (government and higher education sector in the Greek case), achieving one of the highest shares among EU member states. On the contrary, R&D funding by the business sector in Greece is one of the lowest in EU (figure 5).

Figure 5: GERD by source of funds in EU, 2015 (% of GERD)



source: Eurostat (rd_e_gerdfund) - authors' calculation
** data 2011*
*** data 2013*

Since the main R&D performer in Greece are HEIs and not the business sector, being a telling difference to global trends, it is meaningful to analyze further the funding sources of R&D that is performed in this particular sector. Table 1 shows that diachronically almost 75% of HEIs' R&D is funded by government, either as institutional funding (via ordinary budget) or as project funding (via NSRF), while funding from abroad is also significant for HEIs.

Table 1: R&D Expenditure in the Higher Education Sector by source of funds, 2011-2014

Source of funds	**2011**	**2012**	**2013**	**2014**
Businesses	50,1	42,1	30,0	33,0

Government	389,2	377,3	395,7	406,4
GOV: Ordinary Budget	340,9	321,2	253,1	251,6
GOV: NSRF	41,5	49,8	125,5	133,9
GOV: other source	6,7	6,3	17,1	21,0
Higher Education Sector	30,9	25,7	37,7	41,1
Private non-Profit Sector	4,1	3,2	3,8	3,9
Abroad	85,2	86,0	81,5	76,7
EU	77,3	78,1	74,6	68,8
Other sources from abroad	7,9	7,9	6,9	7,9
Total	**559,5**	**534,3**	**548,6**	**561,1**

source: EKT (http://metrics.ekt.gr/el/statistika-etak/datatables)

Resources from abroad, mainly from EU (namely funds from Framework Programme-FP) make a significant contribution to the national R&D activities. Thus, the portion of funds coming from abroad for R&D performed by both HEIs and government is significantly higher than the EU-average (tables 2 and 3). Interestingly enough, funding from abroad is not related to FDI-type investments in the Greek case, but to EU's FP calls and projects.

Table 2: Total R&D Performed by Higher Education Sector and Funded from Abroad (as % of GERD)

	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
EU28	1,11	1,14	1,24	1,18	1,28	1,38	1,59	1,70	1,95	:
Greece	:	10,10	:	:	:	:	:	6,13	6,43	5,31

source: Eurostat, authors' calculation

Table 3: Total R&D Performed by Government and Funded from Abroad (as % of GERD)

	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
EU28	0,87	0,97	0,95	0,91	0,88	0,90	1,00	:	1,10	:
Greece	:	6,19	:	:	:	:	:	3,91	4,20	4,33

source: Eurostat, authors' calculation

As far as GERD performed by HEIs and funded by BES is concerned, Greek performance is diachronically higher than the EU average (table 4)[1].

Table 4: R&D Performed by Higher Education Sector and Funded by Business Enterprise Sector (as % of GERD)

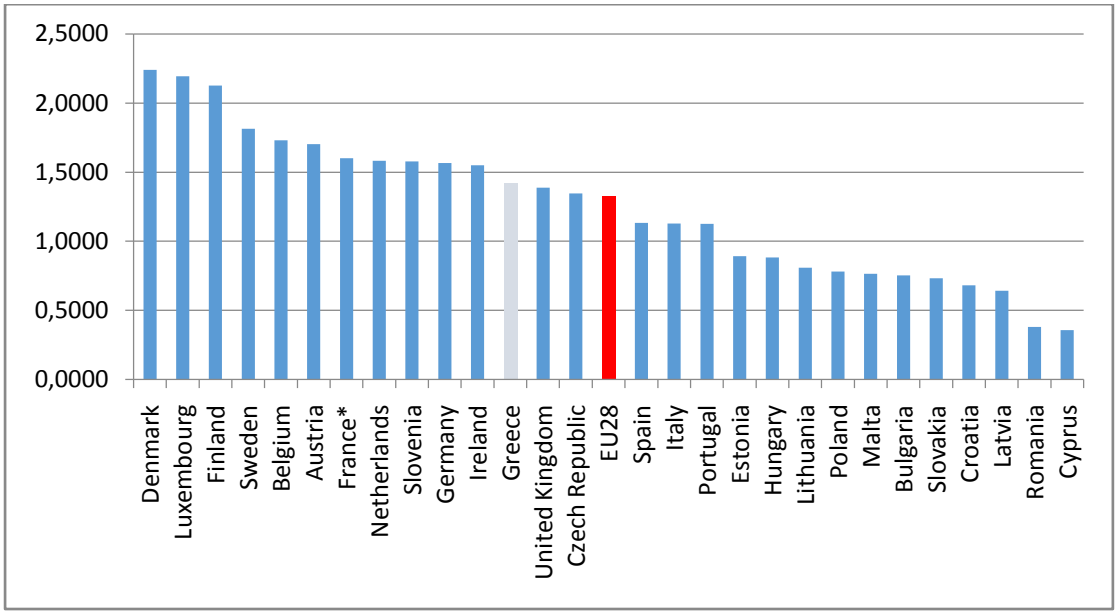
	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
EU28	1,42	1,46	1,50	1,57	1,58	1,55	1,56	1,55	1,52	:
Greece	:	4,23	:	:	:	:	:	3,60	3,15	2,77

source: Eurostat, own calculation

[1] Deeper analysis on synergies between HEIs and the business sector –in terms of R&D and innovation- are provided in section 5.

When trying to focus on the main actors for research, education and innovation, data on personnel and human capital is also helpful, as a robust and sound indicator of the overall picture of a knowledge-based economy. As such, the state of the Greek human capital in matters of R&D has been consistent with the range of previously pointed out indicators. From the total number of R&D personnel a third are technicians and supporting staff, whereas the two thirds are researchers. As the following graph indicates, performing a cross-country analysis, Greece does seem to lag behind in comparison with those countries that are considered to be highly developed, but not with most other developed countries. Indeed, if read in conjunction with data on R&D funding, this graph signals one of the strong points of the national innovation system, that is the high degree of highly-educated human capital, a necessary precondition for any sound and sustainable economic recovery, especially in conditions of high unemployment that is even higher among young people.

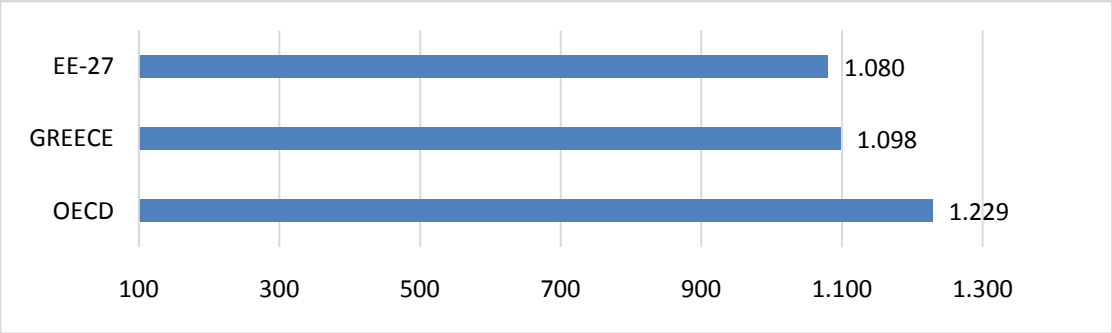
Figure 6: Total R&D personnel, as % of total employment (FTE), 2015



* data 2014
source: Eurostat (rd_p_perslf)

Coming to some (positive) qualitative characteristics of the Greek research and innovation system, certain elements do indicate above-average qualities, although it is designated –as a whole- as rather weak-to-medium (European Commission 2016). If publications are a measure of the productive capability of the science base, then the domestic human capital, given the inter-temporal low levels of R&D funding, manages to attain a robust publication-, citation- and impact-rate among EU and OECD countries. In more detail, Greece is ranked 15th among the EU28 member states having the top 10% cited publications (European Commission 2015b), while according to the number and percentile breakdown of publications that were ranked worldwide in the top 1%, 5%, 10%, 25% and 50% of the most cited publications per year and per scientific field, Greek publications are above the world average in the 1%, 5%, 10% and 25% percentiles during the most recent 5year period 2010-2014 (Sachini et al. 2016). Controlling for the number of publications in terms of the national population, Greece has, just incrementally, surpassed the European countries' median, yet still lags behind of the OECD countries (figure 7).

Figure 7: Number of publications per million of population, 2012



source: EKT (2015b)

A second positive point of the domestic R&D system is the issue of participation in the European R&D projects. According to available data on the 7th Framework Programme (FP7), Greece ranks 9th in terms of participation in FP projects and 11th in terms of funding from the FP, among 28 EU member states. In FP7, the country managed to receive funds amounting to more than 1 billion €, a sum that surpassed many EU member states. Table 5 indicates the participation scores of the Greek innovation base and actors in terms of the funds received in the latest European Framework Programme in 2007-2013. High national performance is partially attributed to the fact that national resources and budget fund R&D projects and activities only to a lesser degree; thus, domestic actors had to excel in their search for obtaining sources of funding from abroad. Signaling, mostly, features of research excellence, the manifestation of such "revealed" capability to lure funds points to a capable and well-networked science and technology base. As a matter of fact, Greece holds the 8th position over time, in terms of participation, coordinating role in research projects and power of its actors within the networks (centrality indicator). In total, Greek organisations have participated in 4039 research projects (18,2% of all EU projects), with a total budget of 3200 million € (5,2% of the total budget) during the period 1984-2009, while some Greek institutions, mainly universities and research centers, have acquired inter-temporally an important role in these research networks (Protogerou et al. 2010).

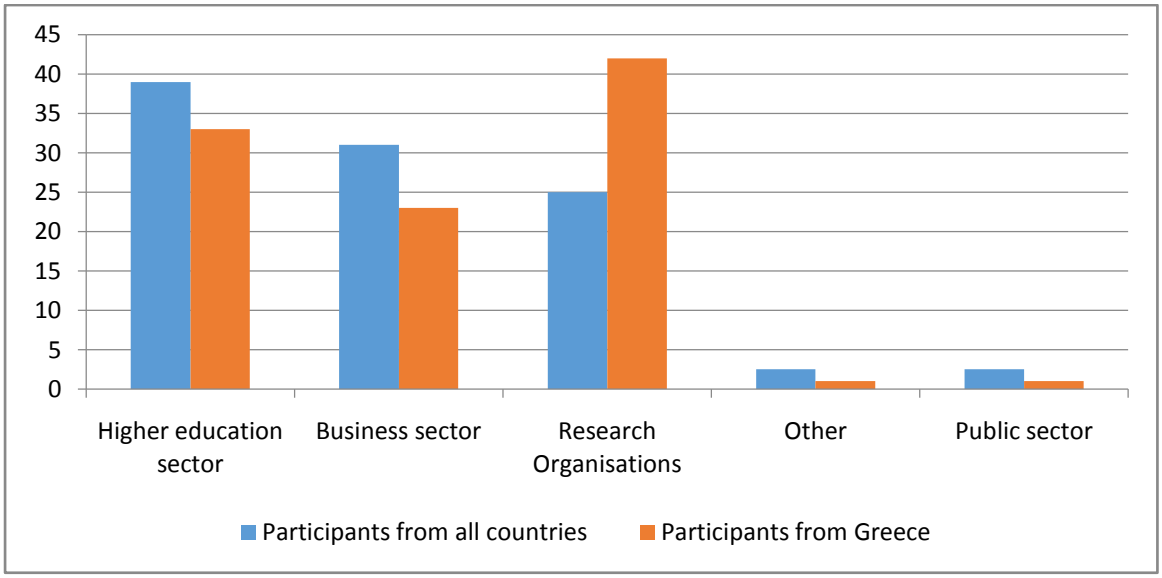
Table 5: Funding from EU's FP7, by type of Greek organisation and Specific Programme

	COOPERATION	CAPACITIES	PEOPLE	IDEAS	EURATOM	TOTAL
HIGHER EDUCATION SECTOR	283,15	45,26	37,33	22,38	0,64	388,76
GOVERNMENT SECTOR	224,06	56,17	39,47	30,30	0,64	350,64
BUSINESS SECTOR	185,08	47,72	9,96	-	-	242,76
PRIVATE NON PROFIT SECTOR	9,14	6,95	1,04	1,18	-	18,31
TOTAL	**701,43**	**156,10**	**87,80**	**53,86**	**1,28**	**1.000,47**

source: EKT (2015a)

In terms of types of organisations that were funded by the FP7, research centers –that are mostly public in Greece- and the higher education sector have been the main Greek participating actors, while the business sector takes the third place, in contrast to what is the general trend, according to data that cover FP7 operation, as a whole, for entities from all countries that were funded by the FP7 (figure 8).

Figure 8: Share of EC contribution among FP7 grant holders, by type of funded organisation



source: European Commission (2015). Seventh FP7 Monitoring Report 2013. Brussels: EC, Directorate-General for Research and Innovation. - authors' calculation

These indications attest that there are elements of the national research system having good potential that may prove to be critical in the effort of redirecting the national growth and productive model towards a more sustainable and knowledge intensive path. For that reason it is fundamental to exploit the existing comparative advantages of the Greek system, taking into account characteristics and elements mentioned above, in order to contribute to economy recovery and return to growth, after almost eight years of continuing recession.

4. HEIs in Greece. Major trends and dimensions of HEIs' developmental activities

Institutionally, tertiary education in Greece is supervised by the Ministry of Education, Research and Religious Affairs that determines operation matters such as recruitment, payroll, students' enrolment, etc. A certain degree of autonomy for higher education institutes can be observed in academic and managerial issues (e.g. academic structure, every-day-management, etc.), yet they rely heavily on institutional funding from the Ministry. Universities' mission as defined by relevant statute is 'to generate and transmit knowledge through research and teaching, to prepare students for its application on a professional level, and to cultivate the arts and culture'. Thus, in terms of institutional policy or strategies supporting HEIs' all three missions, Greek HEIs possess homogeneous characteristics. The same is also true for state defined constitution, line-item budgets, staff status as civil servants, etc. The result of all that is that while there is scope for institutional policy or a strategy implemented at the university level, in principle, this is by definition rather limited. At the end of the day, the main perception of the Greek population and academic community about academic studies has been for many years that universities offer mostly theoretical and general knowledge without focusing on the practical aspect that will be applied on business, underestimating constantly HEIs' third mission. At the same time a wide proportion of graduates was either self-employed or was employed by the State and did not intend to deal with entrepreneurial activities,.

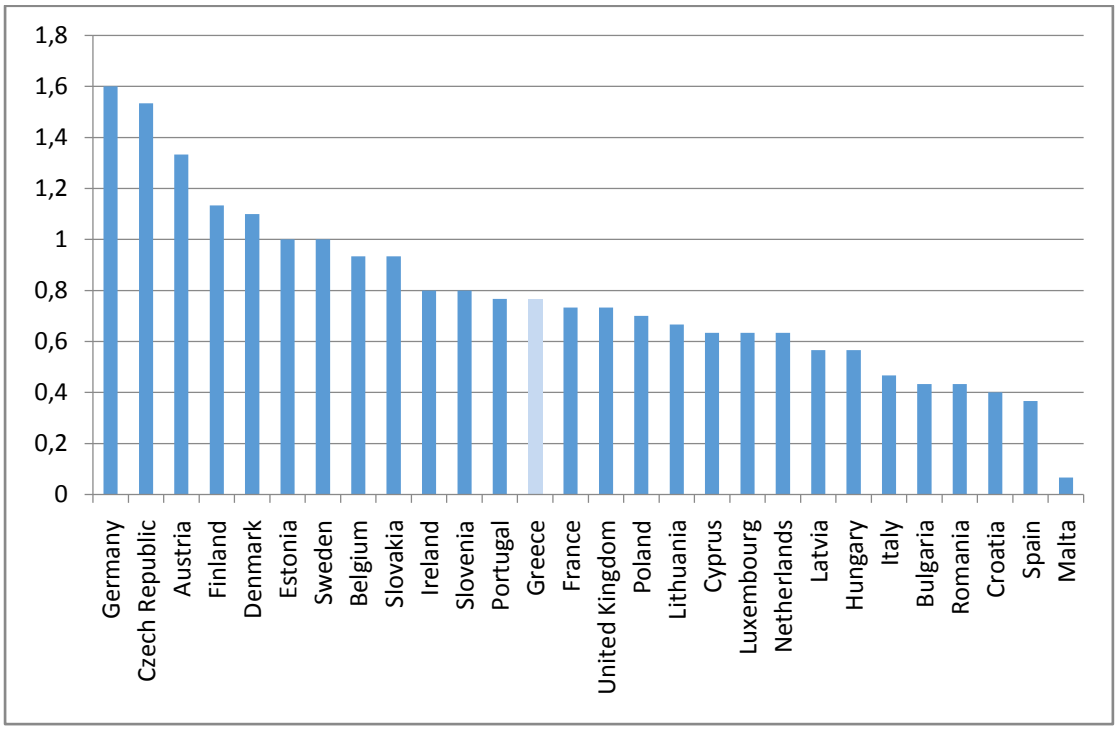
Coming to evaluation practices and tradition, the institutional evaluation of HEIs follows international standards and norms, both by external and internal evaluators, without any particular focus on HEIs' "third mission". The basic structure of the evaluation process refers to: i) the curricula, ii) teaching activities, iii) research activities, iv) other services, v) strategic planning and vi) recommendations. HEIs are asked to provide general information (history and numeric data), data on governance, strategic development, financial planning, and academic performance of the staff (teaching, publications), as well as information about available infrastructures, informational systems, buildings, curricula, public access, etc. More direct information on the third mission of HEIs is requested, when research activities are analysed, mainly in relevance to technology transfer results and visibility in society, especially when the examined faculty/scientific field favors interaction with business and production. In line with what already mentioned, it is not surprising that HEIs' external evaluation committees often highlight the need to foster business and entrepreneurship closer to HEIs (e.g. evaluation of University of Crete, in 2014-2015).

Coming to one dimension of the developmental role of HEIs in Greece, it is interesting to examine the typology of the researchers employed, in relation to the sector of R&D performance. A reversed picture of the performing sector is clear in relation to most other countries, too, as in the case of R&D funding and performance. That is, whereas the business sector is the employment locomotive for R&D personnel (e.g. in EU28 business employs about 45% of total, reaching up to 70% in Sweden), in Greece the private sector employs less than 20% of the respective human capital. Reversely, the higher education sector is the main employer, as almost 70% of the total R&D workforce is employed in HEIs and public research institutes (PRIs).

Congruent to this, is career of PhD holders. HEIs stand as the main employer of this highly educated group, followed by the government; it is only in the third position that the business sector is positioned as an actual employer of PhD's (EKT 2015d), something that is indicative for the productive pattern of Greece. Thus, the contribution of universities in real economy, in particular via the employment of PhD holders, is important, according to the results of the CDH survey of OECD. However, during the crisis the unemployment rates have raised significantly (around 2% until 2007, 6% in 2009, 10% in 2012 and 13,5% in 2013), influencing national human potential in a negative way. This is especially true not only because of the de-learning procedures inescapably tied to any non-employed individual, but also because of the brain-drain outward flow. In turn, this means that there is plenty of underutilized human capital, of high scientific standards ready to be mobilized, when conditions are ripe.

Moreover, a point of special attention in examining the developmental university is the role that Greek HEIs play in skills acquisition. In combining both research and education, namely providing studies at doctorate level (ISCED8), the contribution of Greek universities is significant and has been increasing since the mid-2000s, as the number of graduates at ISCED8 level is growing. The result is that Greece is placed in the middle among the EU countries regarding the number of PhD students, as a percentage of corresponding age in 2015 (figure 9).

Figure 9: Students in tertiary education by age groups - as % of population, 25-34 years, 2015



source: Eurostat (educ_uoe_enrt07) – authors' calculation

HEIs' developmental role is also directly related to their local embeddedness, as even in Regions that are non-R&D intensive, the level of embeddedness into the social fabric is important (Cowan and Zinovyeva 2013, Goddart and Vallance 2013). Actually, public policy on higher education has promoted the founding of regional universities and technological educational institutes since the 1980s, broadening interconnections between the higher education sector and local societies, but not in a purely developmental, sustainable and sophisticated way. Instead of that, regional HEIs have operated as catalysts for regional growth, in an easy and "shallow" way, as student population increased residents in several cities, mobilizing those economic activities that deal mostly with housing and infrastructural amenities, leading to higher demand, final consumption and income in local economies (Labrianidis 1993, Labrianidis 2011).

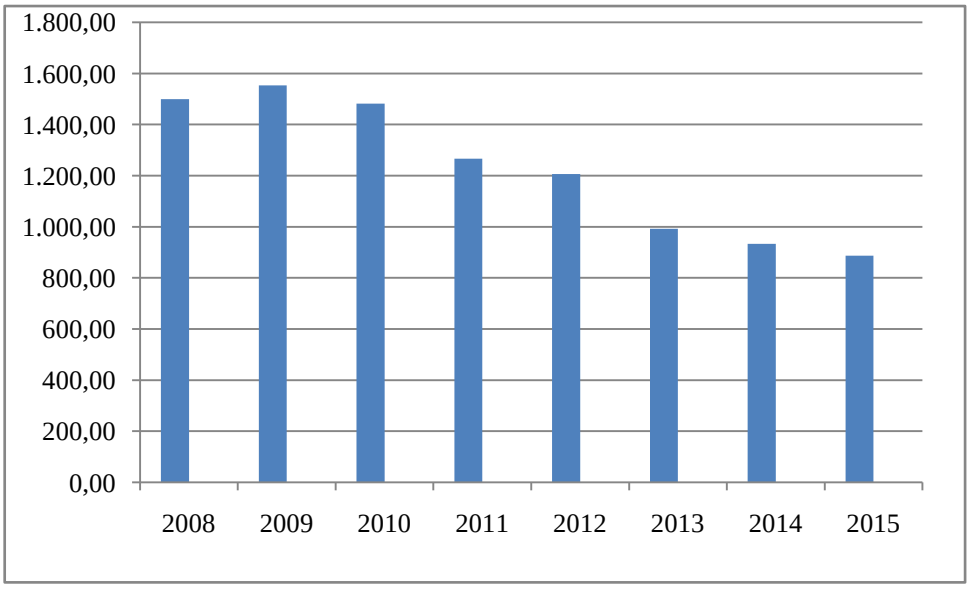
On the other hand, peripheral HEIs have usually close research interconnections with local research institutes and centers, with the Region of Crete being probably the most prominent case in Greece, hosting University of Crete and Foundation of Research and Technology. However, these interactions may take place not in a completely structured manner, given that close geographical proximity allows for a multitude of possible, unstructured interfaces that do rely more on interpersonal relationships. Furthermore, HEIs cater for local societal challenges, as expressed by local authorities via requests for planning and consultative services. These can be argued to be one of the most explicit moves undertaken by the State to link HEIs with the needs of the knowledge-user communities. In this context, Regional Operational Programmes –operated by Regional authorities within the framework of NSRF– finance diachronically –amongst others- R&D-related investment.

5. Crisis as a catalyst for bringing HEIs closer to the business sector in the Greek case?

As implied in section 4, interactions between education and research are strong, as a result of the identification of universities and technological educational institutes as the main R&D performers in Greece. Nevertheless, innovation-related linkages are not that strong for several reasons, such as the scarce participation of business sector in R&D production. This implies the insufficient exploitation of research and knowledge production, as well as the inadequate technology diffusion throughout the economic and social fabric. As a matter of fact, Greek HEIs have mostly focused on operating and working in education and research than on promoting their third mission. This, in turn, was formulated upon the general perception that HEIs had their role and mission directly linked to these two dimensions of the knowledge triangle. This thesis has been cultivated and embedded since the early 1980s, when the modern institutional framework on higher education was introduced. Evidence for this are recruitment rules for academic staff, exclusively relying on academic criteria and performance, low mobility of staff between HEIs and other sectors (mainly the business sector), and governance modes of HEIs.

Financially, the government/state budget is the main funding source for HEIs. State budget comprises of (a) the Ordinary Budget that is intended mainly for institutes' operation, payroll, etc., (b) the Investment Budget, comprising of other government revenues as well as EU cohesion funds, which is allocated in the form of infrastructure- and project-funding, and (c) a budget annexed to the general budget, that is actually adjacent to the government budget. In this context, the impact of crisis on education has been severe. Higher education sector receives less than one quarter of the total budget for all levels of education, according to the budget of the Ministry of Education. This share has fallen slightly from 24,8% in 2008 to 22,7% in 2015, but the general trend is definitely negative for education expenditures as a whole and particularly for higher education sector, as it is shown in figure 10.

Figure 10: Final ordinary budget appropriations for higher education sector (million euro)

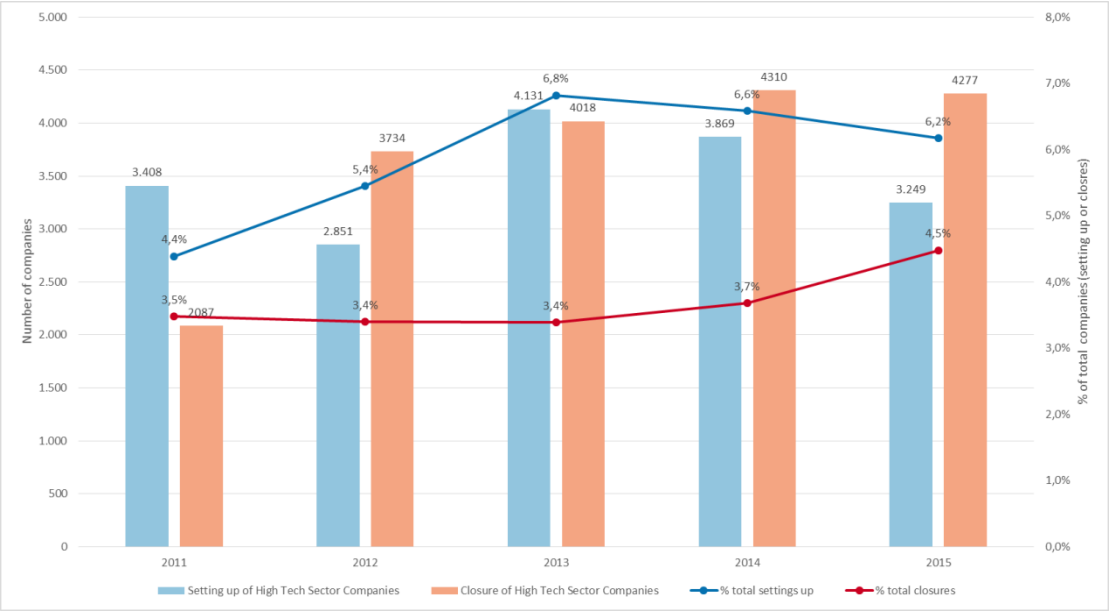


source: Ministry of Finance (http://www.mnec.gr/sites/default/files/financial_files/KENTRIKES%20YPHRESIES%202016.pdf accessed 03-12-2015)

Vast reduction of the latter has led to a major change in HEIs' attitude towards seeking alternative, non-institutional –and probably non-public– funding. Under these circumstances, HEIs reconsidered their strategies intending to broaden their activities, running against past dominant perceptions, which focused on education and research, offering mostly theoretical and general knowledge (EKT 2016b). Although the definition of a clear, general rule is not easy, as some HEIs or even specific faculties may be more "business-friendly" than others, facilitating linkages with the business sector, the dominant perception has not come in terms with HEIs' "third mission" or the third dimension of the "knowledge triangle" scheme. Therefore, despite some exceptions that have been pro-active, it is widely accepted that the barriers between academic and business community are yet to be overcome, for instance in terms of substantial R&D networking, mobility, spin-offs, etc.

When analyzing HEIs' R&D-related linkages to businesses, a question that arises is how sophisticated and knowledge-intensive is the Greek productive structure, in order to support greater R&D collaboration between the actors of the triple helix. Actually, the prolonged character of the economic crisis affected businesses both from the demand and supply side. The combination of economic downturn and fiscal austerity are negatively influencing aggregate demand. In addition to this, the banking crisis has led to tougher credit conditions, essentially blocking entirely any access to capital. In this context, firm demographics is an important indicator of the business environment. Making use of the latest and most comprehensive available data on companies' formation and closure in Greece in high technology sector, according to the NACE classification, 2011 appears to be the first and only year that birth of high tech companies exceeded the closure of similar entities. Up to 2013, the birth of high technology companies represented a growing portion of the total, while closures stood approximately the same, yet since then, births have been decreasing (from 6,8% in 2013 to 6,2% in 2015), and reversely, closures have been increasing at a higher rate for the same period (EKT 2016a).

Figure 11: Demography of high technology sector companies (birth and closure), 2011-2015



Note: definition of high technology sector follows NACE classification, i.e. high technology manufacturing, NACE 21, 26, and, high technology knowledge intensive services, NACE 59-63, 72. source: EKT (2016a)

Making use of the latest available cross-country indicators and focusing on the SMEs, which form the backbone of the domestic economy, Greece is the only country among EU member states (together with Spain) that records negative perspectives of the recovery in all key business aspects such as number of enterprises, value added and employment. A similar image is portrayed, when examining the firms' employment growth/decrease from 2008 to 2014 in sectors of different technology and knowledge intensity (Muller et al. 2015). Moreover, Greek enterprises in high-technology manufacturing and knowledge-intensive high-technology services constitute 1,4% of the relevant total EU population (table 6).

Table 6: Percentage of high-tech enterprises in selected EU member states, 2013.

Belgium	3,3%
Czech Republic	3,8%
Denmark	1,7%
Germany	11,8%
Greece	**1,4%**
Spain	5,5%
France	14,6%
Italy	11,6%
Hungary	3,7%
Netherlands	9,2%
Austria	2,1%
Portugal	1,7%
Sweden	6,0%
United Kingdom	19,6%

Source: Eurostat (htec_eco_ent2)

This is equally indicated in analyzing the high-technology portion of Greek exports, too. In 2013, only 2,6% of total exports were of high-tech. This, in effect, placed Greece at the bottom among EU countries (table 7). Thus, the productive structure of Greece is directed to more traditional sectors of low technology intensity, while domestic private sector's activities point to a lesser-degree of innovation potential, given the number of enterprises activated in knowledge intensive activities.

Table 7: High-tech trade (exports towards all countries of the world) as a percentage of total exports, 2013

Malta	28,60%
Luxembourg	22,20%
France	20,40%
Ireland	19,70%
Cyprus	18,10%
Netherlands	17,70%
Hungary	16,30%
United Kingdom	15,50%
Czech Republic	15,10%
Estonia	15,00%

Austria	14,20%
Germany	14,20%
Sweden	13,00%
Slovakia	9,60%
Denmark	9,30%
Belgium	8,70%
Latvia	8,00%
Croatia	7,90%
Poland	6,70%
Italy	6,60%
Finland	6,20%
Lithuania	5,80%
Romania	5,60%
Slovenia	5,50%
Spain	5,40%
Portugal	3,40%
Greece	2,60%

Source: Eurostat (htec_trd_tot4)

On this basis, though, the picture of R&D relevant synergies between HEIs and business is rather mixed. At the same time that the productive structure of Greece does not contribute to strong knowledge intensive linkages between HEIs and businesses, and Greek HEIs have not paid special attention to third mission, the share of the R&D that is performed by higher education sector and is funded by business sector (as % of total R&D that is performed by HEIs) is close to the EU average –or even lower than it- (table 8). On the other hand, though, it is one of the highest among EU countries and almost the triple than the EU average, as % of the total R&D that is funded by the business sector (table 9). In any case, one should have in mind that HEIs in Greece are the main R&D performers, in contrast to what is the norm in other EU countries, where the business sector dominates R&D performance and funding; so, one would probably expect that this share should be even higher in the Greek case.

Table 8: R&D Performed by Higher Education Sector and Funded by Business Enterprise Sector (as % of total R&D performed by HEIs)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
EU28	6,37	6,56	6,72	6,74	6,42	6,34	6,53	6,42	6,38	6,35	:
Greece	8,91	:	:	:	:	:	8,96	7,88	5,47	5,97	7,58

source: Eurostat, own calculation

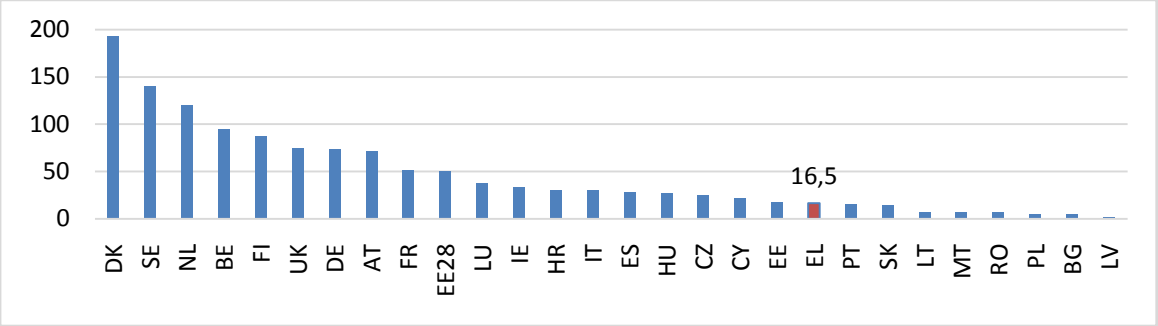
Table 9: R&D Performed by Higher Education Sector and Funded by Business Enterprise Sector (as % of total R&D funded by the business sector)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
EU28	2,65	2,67	2,76	2,82	2,84	2,86	2,79	2,72	2,72	2,69	:
Greece	13,62	:	:	:	:	:	11,00	10,15	6,76	7,43	9,12

source: Eurostat, own calculation

On the other hand, examining the combined research output of the academic in tandem with the private sector stand as an important measure of the established knowledge networks given that one such output indicator, i.e. scientific co-publications in international journals, mark the revealed capacity of the two sectors to produce scientifically-relevant know-how of high quality. Examining this indicator, the level of such public-private co-publications in Greece significantly lags the majority of EU countries, standing at three times less than the EU average pointing to weak public-private knowledge flows (figure 12).

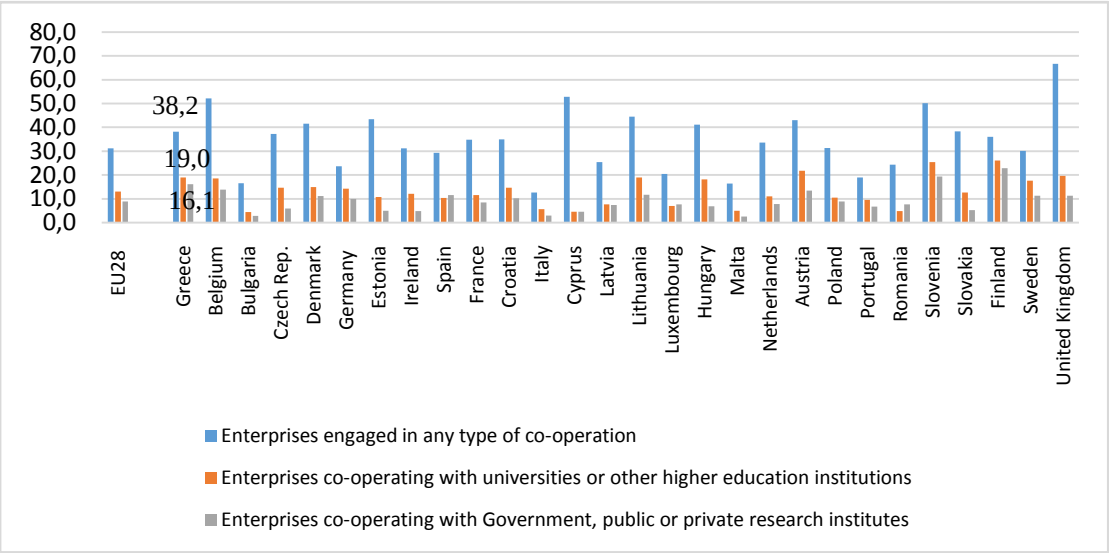
Figure 12: Public-private co-publications (per million of population)



Source: European Commission (2015b)

An additional indicator of the networking orientation of HEIs is cooperation with innovative enterprises, established for carrying out product and/or process innovation activities. Figure 13 illustrates a high percentage in relation to the innovative enterprises engaging in cooperation of any type. By employing such capital-intensive way to keep tuned with technological developments, Greek enterprises manage to network with those innovation-either as contractors, or low-end manufacturers (EKT 2015c). On a cross European country comparison, Greek enterprises indicate a higher than the EU average degree of engagement in any type of cooperation. The same, and more importantly in the context of this paper, is the case of established cooperation with both public universities and the public research institutes. Synergies between HEIs and businesses are quite higher than the EU average, but at the same time they are clearly lower than other types of businesses' cooperation.

Figure 13: Cross country comparison of cooperating innovative enterprises 2010-2012 (as % of innovative enterprises)



source: Eurostat (inn_cis8_coop)

In terms of policy tools and relevant initiatives, trying to boost synergies between HEIs and businesses, rather important was the creation of public technology intermediary organisations (university technology transfer offices, technological development centres / poles / clusters, etc). The main obstacle in these organisations was the cease of operations after the end of public funding, as they have not been institutionalized into regularly, contributing to research capabilities' enhancement and higher business sector's funding. NSRF 2007-2013 has funded the establishment of the Innovation & Entrepreneurship Unit (IEU-MOKE) in all HEIs, aiming at integrating research, education and innovation, for instance via seminars, presentations, mentoring on entrepreneurship, etc. Additional initiatives are taken by separate Universities, such as participation in innovation hubs, hosting of innovation-related activities, and organisation of tutoring and mentoring schemes to boost innovative entrepreneurship. Given the above, the definition of a clear, general rule is not easy, as some HEIs or even specific faculties may be more "friendly" or facilitate easier this kind of linkages.

In addition, the General Secretariat for Research and Technology (GSRT) of the Ministry of Education had been regularly launching a number of financial measures in order to enhance the blossoming of relationships between academia, research and business sector, strengthening at the same time the national innovation potential. These measures explicitly sought to enhance the interaction between the private and public sector, either by increasing the 'entrepreneurial contribution in the research effort', or by 'linking R&D and innovation with the national productive nexus'. GSRT's "Co-operation initiative" was a major funding tool in the programming period 2007-2013, and R&D cooperation between HEIs or PRIs with businesses was a prerequisite for the submission of an R&D proposal. However, interconnections for R&D between HEIs and the business sector remained rather limited beyond this particular initiative (Sachini et al. 2017).

On the whole, R&D and innovation statistics and data, as well as on output deliverables, such as co-production of scientific articles, R&D synergies, collaboration for innovation and mobility of human capital, have showed off so far *firstly* the R&D context in Greece amidst the crisis and *secondly* the case of university-business linkages at present. Quantitative data do indicate the modest level of interaction between academia and enterprises, providing a mixed and more complicated picture, since R&D collaborations between HEIs and businesses are above the EU average, as a share of total R&D expenditures -this finding is mitigated though by the fact that HEIs are the major R&D performer in Greece- but at the same time, other indicators, such as co-publications and co-patenting are low. The evolution of some relevant data before and amidst the crisis (e.g. R&D performed by HEIs and funded by business, co-publications), or the incomplete time-series of other data (collaborations between innovative enterprises and HEIs for innovative activities, collaborations in R&D projects) do not attest that there is a change of paradigm regarding HEIs-business interactions. Actually, this may be explained by the fact that this is a change that needs some time to be clearly demonstrated by quantitative indicators and R&D outputs. In qualitative terms though, what is observed is a change of HEIs' attitude towards entrepreneurship and synergies with the business sector, mainly, as a result of the severe reduction of their main funding source, namely the State and the ordinary budget.

6. Conclusion

HEIs have an important contribution to the economic and social growth. One dimension of the developmental university may be expressed by HEIs' collaboration with business that enables knowledge flows and can create the ideal conditions for the promotion of new technology and innovation (Bektas and Tayauova 2014). Business sector is also interested in this kind of synergies, as these are factors that enhance firms' competitiveness and productivity. The role of HEIs, as developmental entities, has been major in Greece, mostly in terms of social mobility. At the same time HEIs are the main R&D performers and PhD employers in the country, in contrast to what is observed as international trends, where the business sector has the lion's share in these fields of activity. Actually, the limited participation and performance of Greek business sector in R&D implies also the insufficient exploitation of research and knowledge production of the country. On this ground, the need to overcome barriers between academia and business world has been diachronically present in public sphere, mostly as a wishing trend (Tsipouri and Papadakou 2005, Bartzokas 2007).

Nowadays, lasting economic recession and unfavorable financial conditions strengthen this trend, in terms of policy planning, public discourse and academia's receptivity. This imposes the strengthening of relationships between the higher education sector -the main R&D performer in Greece- and the business sector -the main potential user of new knowledge. Thus, it is of major importance to promote good practices for leveraging business sector and HEIs - PRIs collaboration and strategic networking towards more sophisticated and knowledge-intensive production, deploying the knowledge triangle potential. Moreover, under current conditions, Greece needs not only to face numerous and well known structural challenges for implementing successfully a different, knowledge-intensive growth pattern, but needs to address a number of factors that have been amplified during crisis, namely brain-drain, the weakening administrative capacity, etc. As a matter of fact, R&D and innovation sectors seem to gain some ground in terms of planning policy, mainly as a result of introducing smart specialization in the programming period 2014-2020 (GSRT 2015), but the final impact and result of this policy strategy remain an open question that is to be seen in the near future.

However, what is already clear is the shift of HEIs' stance towards business on the one hand and academia's stance towards entrepreneurship, on the other. This is expressed more evidently in qualitative terms and is definitely attributed to crisis and its consequences, such as the major reductions of public funding to HEIs, the cut-back of academia's payroll, the serious limitations in new research and academic job opportunities and positions in public sector, etc. Recent fiscal crisis, and reduced institutional funding to HEIs, has made them seek for alternative sources of funding. In this context, HEIs had to reconsider their strategies intending on broadening their activities. It is these particular tectonic shifts that have made HEIs, as public bodies, and academic community, as individual entities, become more open and receptive to collaborations with enterprises, as well as to entrepreneurial activity, as a whole, phenomena that favoured indirectly HEIs' in this way the "third mission" in Greece.

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