The Athens Jean Monnet Papers

Working paper Nr. 4/2014

POLITICAL COMPULSIONS, MEMORANDA AND SCIENCE OR THE GREEK SCIENTISTS' EXPERIENCE OF "TIGER BY THE TAIL"

By George I. Lambrou

ΕΥΡΩΠΑΪΚΟ ΚΕΝΤΡΟ ΑΡΙΣΤΕΙΑΣ JEAN MONNET
ΕΘΝΙΚΟ ΚΑΙ ΚΑΠΟΔΙΣΤΡΙΑΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ

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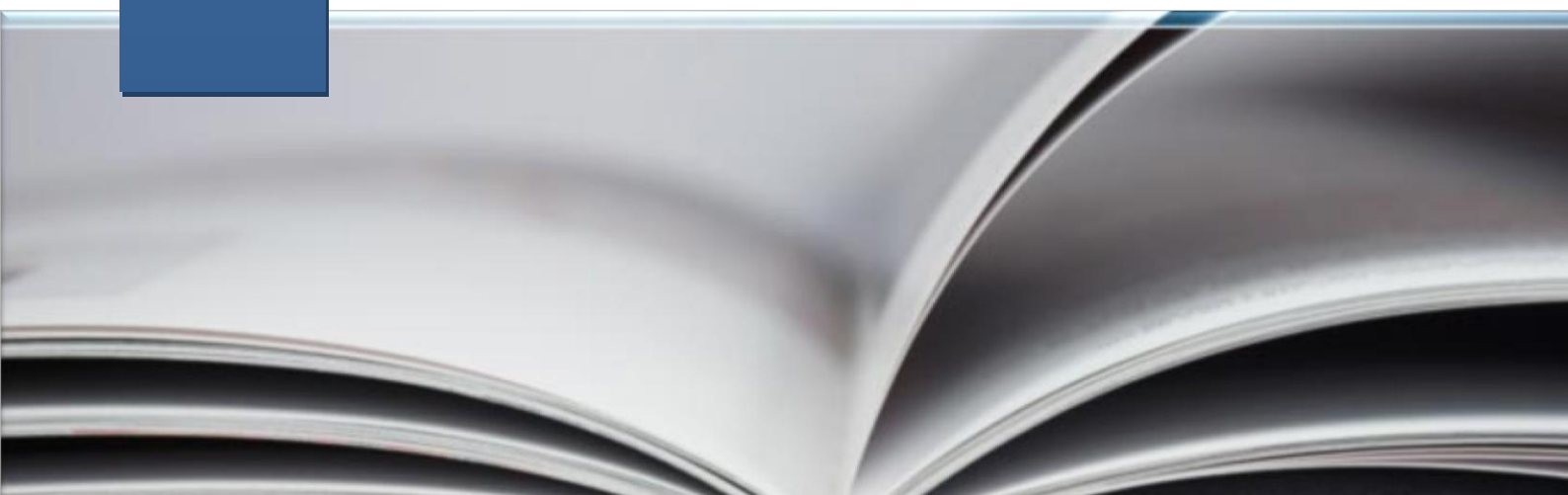

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May 2014

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Author's Information

Dr. Lambrou is a staff member and researcher of the First Department of Pediatrics of the University of Athens (FDPUOA) since 2003. He obtained his diploma in Biology from Philipps-Universität, Marburg Germany. He specialized in developmental biology (embryology) and neurochemistry. He completed his doctoral thesis at the University of Athens, Medical School, emphasizing on Central Nervous System (CNS) tumor proliferation dynamics. The study included the simulation of tumor proliferation using mathematical tools quantum mechanics, non-linear dynamics and game theory.

His has authored more than 90 works, including 20 research papers, 43 conference abstracts, 12 conference papers, six monographs, two books in preparation and one university script also in preparation. His work has received more than 120 citations.

Keywords: Troika, Memorandum, Greek Science, Research, GDP, Publications, Citations

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AKNOWLEDGEMENTS

Special thanks to Prof. P. Kazakos from the University of Athens for his fruitful insight and constructive feedback on the present work. Also, I would like to thank my good friend and collaborator economist Dipl. Wirt. Andreas Tsiftsian for his advice and consulting on microeconomic aspects of Cobb-Douglas curves, production functions and in general all these economical terms that seemed Greek to me. In addition, special thanks to my dear friend and colleague Maria Adamaki for her comments on the text and critical review.
The present work was completed within the frame of the *Jean Monnet* European Centre of Excellence (JMECE) of the University of Athens training program for researchers.

ABSTRACT

For more than four years now Greece has been under the reign of austerity measures, which have significantly affected the lives of citizens in Greece in multiple ways. Scientific research constitutes one of the affected areas and is accompanied by the negatively affected lives of those who implement this "vain" task.
The present article focuses on the political skepsis underlying research strategies and how incorrect decisions in research policies affect or change Greece's chances for recovery and development. Finally, the aim of the present study is to examine the present scientific work in Greece, as compared to the work of other developed nations, and its contribution to the Greek economy and the production of knowledge. In other words, reality and myth will be separated with respect to the scientific research and knowledge production in Greece.

«*Ο Αμερικάνος ή ο Ευρωπαίος, όταν του πω ότι είμαι επιστήμων και δεν κάμνω τίποτε άλλο από το να ερευνώ, με θεωρεί όχι μόνο ως χρήσιμο στοιχείο αλλά ως κάτι ανώτερο από τους κοινούς ανθρώπους. Ο Έλλην με θεωρεί απεναντίας ως ένα άχρηστο ον, και όχι μόνο άχρηστο αλλά και επικίνδυνο. Αυτή είναι η εικόνα ενός κράτους σάπιου, ανίκανου να δημιουργήσει κάτι τι και να συνεισφέρει στη γενική πρόοδο της ανθρωπότητας.* ***Όλα ξένα, όλα κλεμμένα****.* ***Όλα κατά μίμησιν****.* ***Δεν είναι ντροπή****;»*

Γεώργιος Παπανικολάου

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INTRODUCTION

"But somewhere along the line, you changed. You stopped being you.
You let people stick a finger in your face and tell you you're no good.
And when things got hard, you started looking for something to blame, like a big shadow.
Let me tell you something you already know. The world ain't all sunshine and rainbows.
It's a very mean and nasty place and I don't care how tough you are it will beat you to your knees and keep you there permanently if you let it.
You, me, or nobody is gonna hit as hard as life. But it ain't about how hard you're hit.
It's about how hard you can get it and keep moving forward.
How much you can take and keep moving forward.
That's how winning is done!"

Rocky Balboa to his son

Greece has been under heavy recession for the last five years. The fiscal policies applied have brought negative results or no results. However, opinions are really dissociated on this issue: is Greece being saved or not? The answer depends on the responder: The government and the troika would reply a warm "yes", while at the same time the response of the people of Greece would be a warm "NO". One of the main points of the present Prime Minister A. Samaras has been the push towards development and innovation. At the same time, for some unexplainable reason, every measure that has been taken made life more difficult.

It is well known that one of the main driving forces in economic development is scientific research. For the time being, I will divide research into two categories: basic research and applied research. Both are important and both contribute to the enhancement of progress and finally to prosperity. In Greece scientific research is publicly funded and it is performed mainly from higher education and research institutions. In a nutshell, Greece has 23 higher education

institutions (including military academies) and 14 higher technological institutions. It also has 17 research institutions[1].

The debate on higher education in Greece has been going on for almost 40 years, without any reasonable progress. It is remarkable that the main authority for research and development, the General Secretariat for Research and Technology (GSRT), has started its operations and planning since the 1964. Since that time, operational plans are being performed, in order to reshape research in Greece. Adding the term consistency in our discussion about research policies, it is noteworthy that from 2009 to 2012 the supervising authority of the GSRT has been changed three times going back and forth from the Ministry of Education to the Ministry of Development and similarly, numerous General Secretaries of GSRT have come and gone during that period of time[2]. In order to stress the criticality of the situation, the official public body GSRT does not have a statistical reference to Greece's research infrastructure on its website, despite the years of planning. However, such discrepancies are not always due to the inefficiency of public bodies. It is not the scope of the present work to investigate why this happens or how it can be solved[3];

Commissions over commissions have planned and designed new maps for research in Greece. Judging from the results, not much has been accomplished. It is possible that planning has been made with the best of intentions, yet the outcome is was not the intended one.

The last four years several Secretary Generals have passed through GSRT and yet all have resigned, each for different reasons. In **Supplementary Table 1**, a summary of the appointed Secretaries in GSRT is displayed along with **Supplementary Figure 1**, which presents our research diagrammatically[4]. It is

[1] These numbers have been taken from the internet, from various sources. The GSRT does not provide any statistical data on research infrastructure.

[2] http://www.gsrt.gr/central.aspx?sId=106I432I1092I646I437080 the web page is in Greek. English translation is not available ((GSRT), 2014)

[3] Yet it is probable that it can be solved, as us scientists, have found solutions to similar problems in our own scientific *microcosmos*.

[4] Data presented are by approximation, since we were not able to find exact records of appointment dates for each Secretary. Data have been recovered using alternative search techniques.

noteworthy, that average occupation of office has been 1.99 years from 2000 to 2013 and if we exclude the years 2000-2008, this average drops to 1.15 years (**Supplementary Table 1** and **Supplementary Figure 1**). Several examples of ambitious plans for research can be found and at the same time several resignations after plans have failed. From 2009 to date, several attempts have been announced, stating reforms in the Greek research landscape while they appeared very ambitious and with promising intentions. In total four Secretaries have been appointed to the head of GSRT (Abbott, 2009).

The general description of Greek scientists by the politicians is not so fluttering. Greek scientists are considered to be "*no good for nothing*" or incompetent (Papamatthaiou, 2011). Very often they are also accused that their production is of low quality and sometimes, research in Greece resembles the commercial spot "*Live your Myth in Greece*". As far as research funding is concerned, a key point for research, all research grants pass through the office of the Minister for approval, the proper authorities are surpassed and decisions are taken within the respective ministry (Papamatthaiou, 2011). This is one of the reasons why research grants take up to two years to reach their final destination, i.e. the scientists[5].

On the one hand, we have the will of governments to reform research and higher education in Greece and on the other hand, we have no progress. The first question that comes to mind is *why*?

Secondly, Greek scientists that work and struggle through the labyrinth of plans and programs, lacking financial means, are called to be productive.

Finally, the research budget in Greece is one of the lowest in the European Union (EU) and thus, research outcomes would be expected to be similarly low and poor.

To summarize the main concepts of research in Greece and the actual image that this sector emits, we would say that rumor has it: a) that there is no central strategic plan for research in Greece, b) that nepotism, cronyism and

[5] at least in the natural sciences, where we can speak from experience, from the moment of approval to the moment of actual money flow it takes almost, and sometimes more than, two years. The amazing is that in the meantime the responsible public body for grant administration asks for progress reports.

bureaucracy rule, c) that the Greeks are lazy and incompetent (as stated in 2010, it was meant for the sum of the Greek population, and thus it also applies to Greek researchers).

Consequently, in the present work I focus on addressing these issues. I examine the real research production of Greek scientists based on figures. I examine the notion of whether Greek scientists' performance is as low as their funding and I attempt to give an explanation to the resulting phenomenon.

As a closing remark, I quote *George Papanikolaou*, a Greek physician that lived until the mid-20th century, who made a statement (that I have used at the cover page of the present work), describing a state incapable of producing knowledge and incapable of contributing to the promotion and welfare of human kind. He also said that the Greek state ignores scientists and treats them as useless and insane (!). This very statement came from an interview of Prof. Krimizis, chairman of the National Board for Research and Technology in the newspaper "*TO VIMA*" (VIMA, 2012).

If we could summarize the interview, we would say *Ὁ ἔχων ὦτα ἀκούειν ἀκουέτω!* (*He who has ears to hear, let him hear*, Mathew 11:15) but at the same time *φωνή βοῶντος ἐν τῇ ἐρήμῳ* (…*a voice of one crying in the wilderness*…, John 1:23).

It is easy to point the finger and accuse somebody of what (s)he is or what (s)he is not. This does not however mean that the accused should take the insult.

METHODOLOGY

Statistical data have been collected from Eurostat, dating from 1980 to 2013. In cases where data were not available, they appear as N/A, NaN or empty cells.

All numbers concern public and private expenditure and outlays for all countries under investigation.

As research outcome, publications in journals have been considered as derived from the Scopus Database and patents as found in the Eurostat database.

Publications include all indexed publications such as reviews, articles, book chapters, reports etc. as they appear in the drop-down menu "ALL" of Scopus Database (http://www.scopus.com) (SCOPUS, 2014). Publications have been considered from all Scopus disciplines, which are essentially Life Sciences,

Health Sciences, Physical Sciences, Social Sciences and Humanities. Search for countries has been performed using the option "Affiliation" in the Scopus Database. The use of affiliation can include works not entirely made in one country but in several. Yet, the bias remains for all countries similar and thus it was considered to alter the final outcome. Finally, in order to create the publication time series, publication records have been examined year by year from 1980 to November 30th 2013.

Citations have been considered from year 1996 to the date of investigated publications, that is November 30th 2013. Citation data have been used from 1996 to 2012, due to data availability. Citation data were also obtained from SJR Database (http://www.scimagojr.com/) (SCImago, 2014).

Mean values have been calculated as:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}.$$

Linear correlations have been calculated with Pearson's Correlation Analysis. Regressions have been performed using polynomial functions that is of the form $f(x)= a_0+a_1x^n+a_2x^{n-1}+\ldots+a_nx$.

The slope (s) of time series data was calculated as:

$$s = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sum (x - \bar{x})^2}.$$

In order to make comparisons easy, the following methods have been used. As data were not available for all years and all measured factors, I have used the mean values in my analysis. In this way I have tried to include the same bias for all the countries studied.

In order to quantify the different aspects of research, I have borrowed tools from economics, and more specifically microeconomics, using production-cost functions and *Cobb-Douglas* functions. Hence, my definition of capital (*K*) is the cost production of one unit of research and the definition of labor (*L*) is the number of personnel occupied in all sectors of R&D as Full Time Equivalent (FTE).

Elasticity $E_{K,L}$ with input I (labor and capital) and output Q (publications or citations) is defined as:

$$E_{K,L} = \frac{\partial Q_{E,L}}{\partial I_{E,L}} \frac{I_{E,L}}{Q_{E,L}}$$

Cobb-Douglas production function was used in order to calculate the total factor productivity (A). The function used is $Y=AL^bK^a$, where Y is the total production of publications, L is the labor occupied in that production as the personnel in Full Time Equivalent (FTE) per year, K is the capital used as the cost per publication per year, a is the elasticity of capital and b is the elasticity of labor.

Thus A will be: $A = \frac{Y}{L^b K^a}$.

Plots have been performed with Microsoft Excel and regressions with the MATLAB® (The Mathworks, Inc. Natick MA) simulations mathematical environment.

Variables collected are summarized in **Table 1**, as well as all data are provided as supplementary data in one excel file (*Raw Data.xlsx*).

As a unit of research, I have used two measures: the number of publications per year and its mean value, as well as the number of citations per year and its mean value. In addition, data for citations were available only from 1996 and forth. When it comes to citation cost, I have used the outlays from 1980 to present for all countries; I believe that citations reflect the quality of work and quality is not suddenly produced in a single year, it is a rather slow process mirroring many years of work.

Variable	Symbol	Description	Source	Function
mean	**μ**	average value of all studied variables	Calculation	$\overline{x} = \frac{\sum_{i=1}^{n} x_i}{n}$
slope	**s**	slope of time-series for all studied variables	Calculation	$s = \frac{\sum (x-\bar{x})(y-\bar{y})}{\sum (x-\bar{x})^2}$
Population	**P**	Total population of countries under investigation from 1980-2013	Eurostat Database Demographic balance and crude rates (demo_gind) (EuroStat, 2014a)	
Gross Domestic Product (GDP)	**GDP**	Gross Domestic Product in Million Euros of countries under investigation	Eurostat Database GDP and main components - Current prices (nama_gdp_c) (EuroStat, 2014b)	
Total R&D Expenditure %GDP	**%GDP**	Outlays, appropriations spent for Research and Development (R&D) as percentage of GDP	Eurostat Database Total intramural R&D expenditure (GERD) by sectors of performance and source of funds (rd_e_gerdfund) (EuroStat, 2014f)	
Total R&D Expenditure in Million Euros	**GDP Mio Euro**	Outlays, appropriations spent for Research and Development (R&D) in absolute numbers (in Million Euros)	Eurostat Database Total intramural R&D expenditure (GERD) by sectors of performance and source of funds (rd_e_gerdfund) (EuroStat, 2014f)	
Total R&D Exp as GBAORD	**GDP GBAORD**	Total Government budget appropriations or outlays on R&D (GBAORD) as a percentage of total general government expenditure	Eurostat Database otal GBAORD as a % of total general government expenditure (gba_nabste) (EuroStat, 2014c)	

Personnel FTE	**Personnel FTE**	Total Personnel Occupied in R&D and all Sectors as Full Time Equivalent (FTE): FTE equals the number of persons in Head Count (HD) as if they were full time employed (sorted in alphabetical order)	Eurostat Database Total R&D personnel and researchers by sectors of performance, qualification and sex (rd_p_persqual) (EuroStat, 2014g)	
Personnel HC	**Personnel HC**	Total Personnel Occupied in R&D and all Sectors as Head Counts (HD)	Eurostat Database Total R&D personnel and researchers by sectors of performance, qualification and sex (rd_p_persqual) (EuroStat, 2014g)	
EPO Patents in Numbers	**EPO Patents in Numbers**	Patent applications to the EPO by priority year at the national level	Eurostat Database Patent applications to the EPO by priority year at the national level (pat_ep_ntot) (EuroStat, 2014d)	
EPO Patents by GERD	**EPO Patents by GERD**	Total Number of Patent Applications to EPO by Milliard Euros of Total R&D Expenditure (GERD)	Eurostat Database Patent applications to the EPO by priority year at the national level (pat_ep_ntot) (EuroStat, 2014d)	
USPTO Patents in Numbers	**USPTO Patents in Numbers**	Patent applications to the USPTO by priority year at the national level	Eurostat Database Patents granted by the USPTO by priority year at the national level (pat_us_ntot) (EuroStat, 2014e)	
USPTO Patents by GERD A	**USPTO Patents by GERD A**	Total Number of Patent Applications to USPTO by Milliard Euros of Total R&D Expenditure (GERD)	Eurostat Database Patents granted by the USPTO by priority year at the national level (pat_us_ntot) (EuroStat, 2014e)	
Publications	**Q**	Publications Time-Series 1980-2013	http://www.scopus.com	
Publications per Capita		Publications per Million Capita	Calculation	(Publications (Q)/P)*1E06
Publications per Personnel FTE		Publications Time-Series per FTE Personnel	Calculation	Publications (Q)/Personel FTE
GDP Expend per Personnel FTE		GDP Expenditure in Euros per Capita Personnel FTE	Calculation	Total R&D Expenditure in Million Euros /Personel FTE

Cost of Publications		Publications Time-Series per Cost/Publication	Calculation	Total R&D Expenditure in Million Euros /Publications (Q)
Elasticity with Respect to K	$\mathbf{E_K}$	Elasticity with respect to Capital (*K*) (capital is defined as the cost/publication and Q is the output of capital defined as the total number of publications for the respective time points) (Elasticity is also used by the symbol *a*, in Cobb-Douglas Function)	Calculation	$E_{K,L} = \frac{\partial Q_{E,L}}{\partial I_{E,L}} \frac{I_{E,L}}{Q_{E,L}}$
Elasticity with Respect to L	$\mathbf{E_L}$	Elasticity with respect to Labor (*L*) (labor is defined as the Personnel in FTE per year and Q is the output of labor defined as the total number of publications for the respective time points) (Elasticity is also used by the symbol *b*, in Cobb-Douglas Function)	Calculation	$E_{K,L} = \frac{\partial Q_{E,L}}{\partial I_{E,L}} \frac{I_{E,L}}{Q_{E,L}}$
Sum_Elasticity_Publications		Sum of Capital (*K*) and Labor (*L*) elasticities (*a*+*b*)	Calculation	E_K+E_L or $a+b$
Cobb-Douglas Publications	**A**	Cobb-Douglas Production Function for Publications-Total Factor Productivity (*A*)	Calculation	$Y=AL^bK^a$ $A = \frac{Y}{L^b K^a}$

Elasticity_Citations_K	$\mathbf{E_K}$	Elasticity with respect to Capital (*K*) (capital is defined as the cost/citation and Q is the output of capital defined as the total number of citations for the respective time points) (Elasticity is also used by the symbol *a*, in Cobb-Douglas Function)	Calculation	$E_{K,L} = \frac{\partial Q_{E,L}}{\partial I_{E,L}} \frac{I_{E,L}}{Q_{E,L}}$
Elasticity_Citations_L	$\mathbf{E_L}$	Elasticity with respect to Labor (*L*) (labor is defined as the Personnel in FTE per year and Q is the output of labor defined as the total number of citations for the respective time points) (Elasticity is also used by the symbol *b*, in Cobb-Douglas Function)	Calculation	$E_{K,L} = \frac{\partial Q_{E,L}}{\partial I_{E,L}} \frac{I_{E,L}}{Q_{E,L}}$
Sum_Elasticity_Citations		Sum of Capital (*K*) and Labor (*L*) elasticities (*a*+*b*)	Calculation	E_K+E_L or $a+b$
Cobb-Douglas Citations	**A**	Cobb-Douglas Production Function for Citations-Total Factor Productivity (*A*)	Calculation	$Y=AL^bK^a$ $A = \frac{Y}{L^b K^a}$
Citations		Citations Time-Series	http://www.scimagojr.com	
Cost of Citations		Cost of Citation in Euros	Calculation	Total R&D Expendit in Mio Eu A/Citations

Table 1. Summary of variables used in the present study. The source of each variable is mentioned whether it was obtained from a database or it was calculated.

RESULTS

General Remarks

Apart from words, rumors and prejudicial comments, there are some measures that can be used to account for what happens in the Greek scientific community. As mentioned in the "*Introduction*" section, research in Greece is performed mainly in public institutions. There is some privately funded research but the budgets are negligibly small.

GDP for Research-The Capital (K)

In **Figure 1** I present all budget appropriations for Research and Development (R&D) as percentage of GDP (%GDP) or in absolute numbers in million Euros. Greece spends on average 0.593% of its GDP for R&D, measuring fifth from the bottom in a total of 42 countries (**Figure 1A**). The good news is that it spends money for R&D with an increasing tendency as shown in **Figure 1B,** despite the memorandum. Interestingly, countries such as the United Kingdom, Netherlands and Bulgaria manifest a decreasing tendency in this sector, probably as a result of restrictive fiscal policies. In total, Greece has spent 12,306.00 million Euros on R&D for the period 1980-2012, with Malta spending the lowest (348.6 million Euros) and the United States spending the highest (5,970,150.89 million Euros) for the same period. This number is really overwhelming, since it surpasses that of 28 countries of the European Union, who have spent 2,977,922.36 million Euros for the same period (**Figure 1F**). Finally, when accounting for the total government budget appropriations on R&D (GBAORD) as percentage of the total government expenditure, Greece occupies the third position from the bottom (**Figure 1G**), spending 0.57% of the GBAORD. This finding also shows that most of the R&D outlays comes from government appropriations (GBAORD), leaving a 0.02% of funding that comes from other sources. Please bear in mind that the GDP expenditures for R&D are considered as the economic factor Capital (*K*).

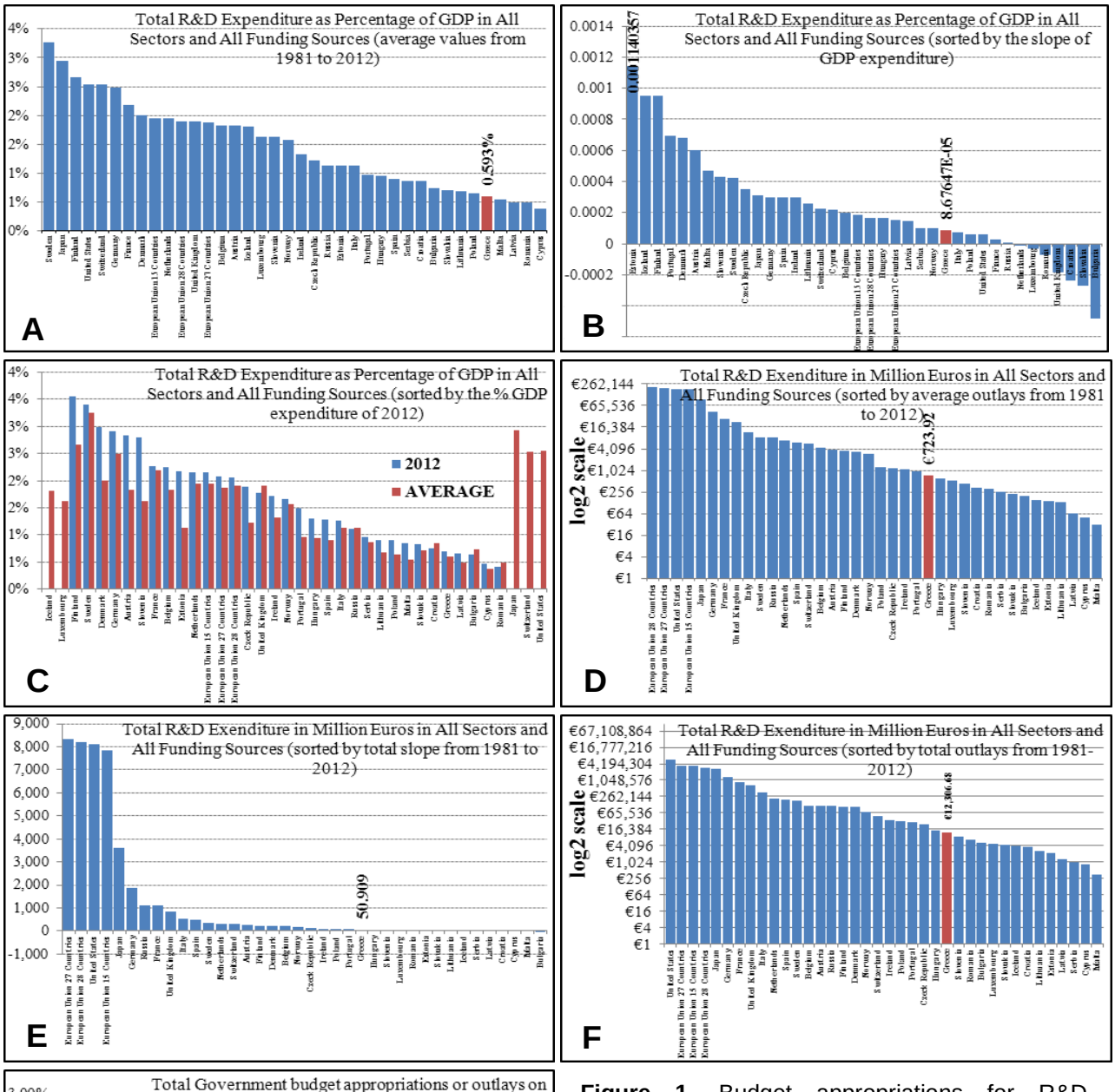

Figure 1. Budget appropriations for R&D. Average R&D budget expenditures as percentage of GDP is presented in (**A**) from 1981-2012. The average growth or decline of the %GDP is presented in (**B**) by calculating the total slope of all percentages from (A). A comparison of the %GDP for 2012 and the average %GDP is presented in (**C**). Similarly, the same is manifested in terms of absolute appropriations in Million Euros (as for the %GDP), which is presented in (**D**) and (**E**). The total amount spent by all funding sources is presented in (**F**) in million Euros. Finally the total government appropriations or outlays on R&D (GBAORD) as % of total general government expenditure are presented in (**G**), where the average values of %GDP are shown. In all diagrams Greece is marked with red.

Personnel in Research-The Labor (L)

Greece approximately occupies the middle range with respect to employed personnel in R&D, with an average of 26,148 people in FTE units for the period 1980-2012. The higher employment of a single country is manifested by the Russian Federation, yet without knowing the data for employment of the United States (**Figure 2A**). It appears that Greece is above the average in the tendency of employing people for R&D, which signifies an increasing interest in that area (**Figure 2B**). At this point it is worth mentioning that such positive tendencies are also manifested by northern Europe countries, while the Russian Federation manifests a highly decreasing tendency in this area. This analysis will constitute my basis for the economic factor Labor (*L*) in the present study.

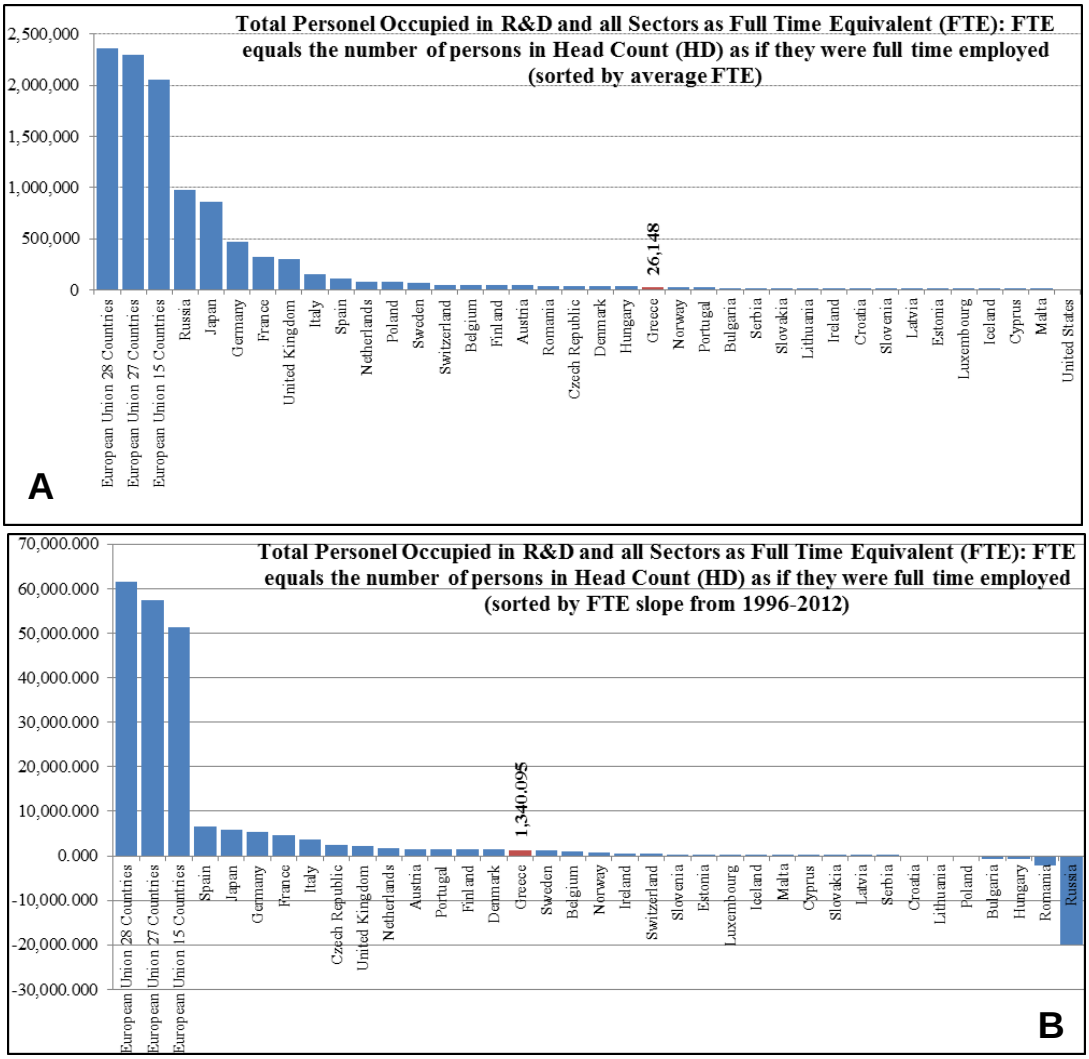

Figure 2. Total personnel occupied on average in countries from 1980-2012. There were no available data for the United States as found in the Eurostat database (**A**). Slope of the personnel employed in countries from 1980-2012 as FTE (**B**). Greece is marked with red

The Outputs of Research-Publications and Citations (Q)

The next step includes the investigation of the output of the research area and this is the number of publications and citations.

Greece occupies the 27th position among 238 countries for the absolute number of publications and the 28th position for the absolute number of citations. This performance is way beyond the financial assets offered to research. In addition, the University of Athens has been ranked in the top 200 universities of the world. Greece also holds the 52nd position in self-citations (17.7%), with champions in this category being China (54.45%) and the United States (48.23%). Finally, Greece occupies the 30th position in h-index ranking among 238 countries, another positive performance as compared to the provided assets. These data are presented in the supplementary data section (**Supplementary Table 1**) (Data retrieved from: http://www.scimagojr.com). The above rankings have been performed without taking into account any other factors, such as GDP expenditure for R&D or per capita distribution.

Accounting for the outputs of research when compared to 42 countries, Greece stands close to the median. In particular, it has a record of 229,897 publications from 1980-2013 (median=249,270) (**Figure 3A**), with an average of 6,761 publications per year (median=7,352) (**Figure 3B**) and an increasing tendency (slope) of 559 (median=523) (**Figure 3C**). In addition, Greece stands close to the median in citations, when compared to 42 countries. More specifically, it has a total citations record of 1,827,577 from 1996-2012 (**Figure 4A**), with the United States presenting a record of 133 million citations and the first place occupied by the EU holding a record of ~140 million citations. Interestingly, Greece presents an average of 107,000 citations per year (median=135,263) (**Figure 4B**); most countries manifested a decreasing tendency of citations (slope) where Greece manifested a slope of -1336 (median=-4252) (**Figure 4C**) and finally it has a record of 7.94 citations/publication (median=8.85) (**Figure 4D**)[6].

Overall, we could say that citations are a measure of quality and thus Greece performs better as compared to countries with higher research budgets. For example, Greece is first in citations in the Balkan and Baltic areas (except for

[6] There is a difference in this calculation from the www.scimagojr.com database, due to the fact that I have included more publications for each country. Dividing this number with the provided citations number it returns a lower resutlt than in the appering in the database.

Sweden and Poland). Thus, a clue that was not included in the present research but was reported elsewhere, is that Greece holds the 13th place among leading science nations concerning its proportion of research in 2012 that is in the top 1% of most-cited papers (Van Noorden, 2012). The result is presented in **Figure 5** and it was reproduced from the data provided in (Van Noorden, 2012). This estimation was also in absolute numbers without considering facts such as GDP percentage for R&D or number of researchers employed in that area.

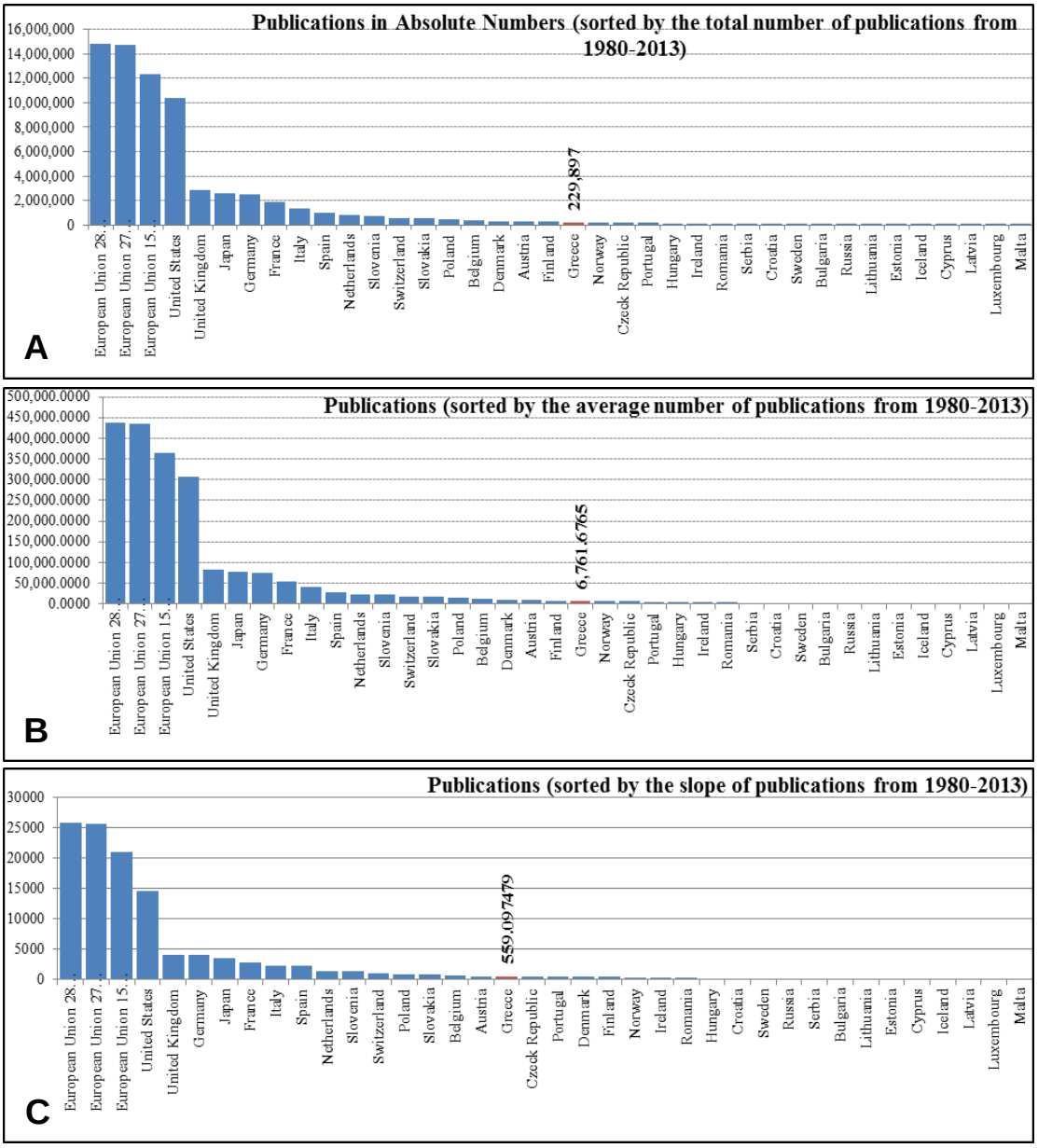

Figure 3. Publication metrics. Absolute number of publications for the period 1908-2013 (**A**), average number of publications for the period 1980-2013 (**B**) and tendency of publication change for the period 1980-2013 (**C**). Greece is marked with red.

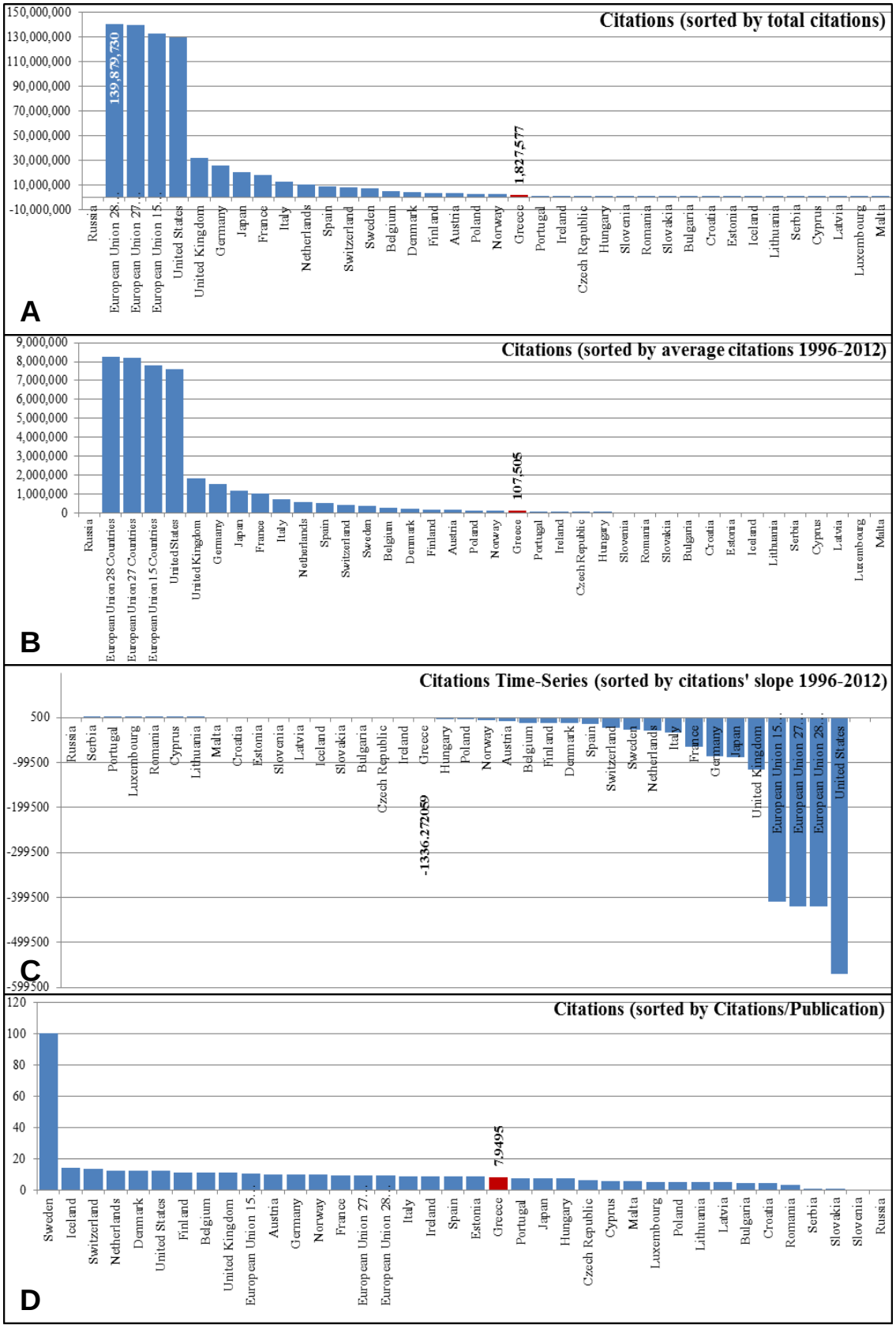

Figure 4. Citations. Total citations from 1996-2012 (**A**), average number of citations per year (**B**), citations' slope (**C**) and index of citations/publication (**D**).

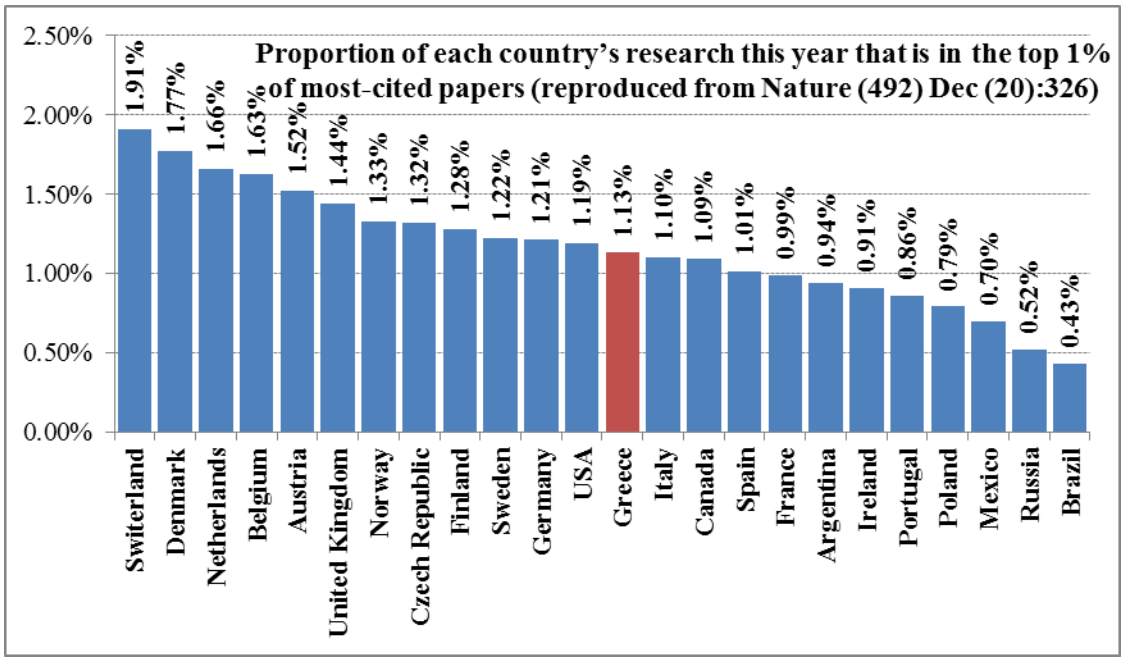

Figure 5. Number of research papers published in 2012 by leading science nations, and the proportion of each country's research this year that is in the top 1% of most-cited papers (Source: Nature (492) Dec (20):326)

Metrics of Research-Publications per Capita

Considering the various types of pre-mentioned factors, Greece still retains its place in the global "market" of research. Greece holds a publication record of 20,969 publications per capita in total from 1980-2013 (median=23,354) (**Figure 6A**) and an average of 616 publications/per capita/per year (median=686) (**Figure 6B**).

Accounting for the publications per researcher I find that Greece has an average of 0.3 publications (median=0.248) (**Figure 7A**) occupying the 9th position among 42 countries and 3rd position among the EU 15 (including the average of EU 28) (**Figure 7B**). One could argue that the number of publications *per se* does not reflect the quality of research. This argument is true and therefore I have taken the number of citations as a quality measure. However, the number of publications is a measure of the intensity of work performed. It is certain that a country with the lowest budget for research would not be expected to perform well in knowledge production. Despite all this, Greece holds the first places in publications per researcher, meaning that research is labor intensive. This also

leads us to a conclusion about the quality of the research staff in Greece, since they can exploit low assets and result in higher productivity.

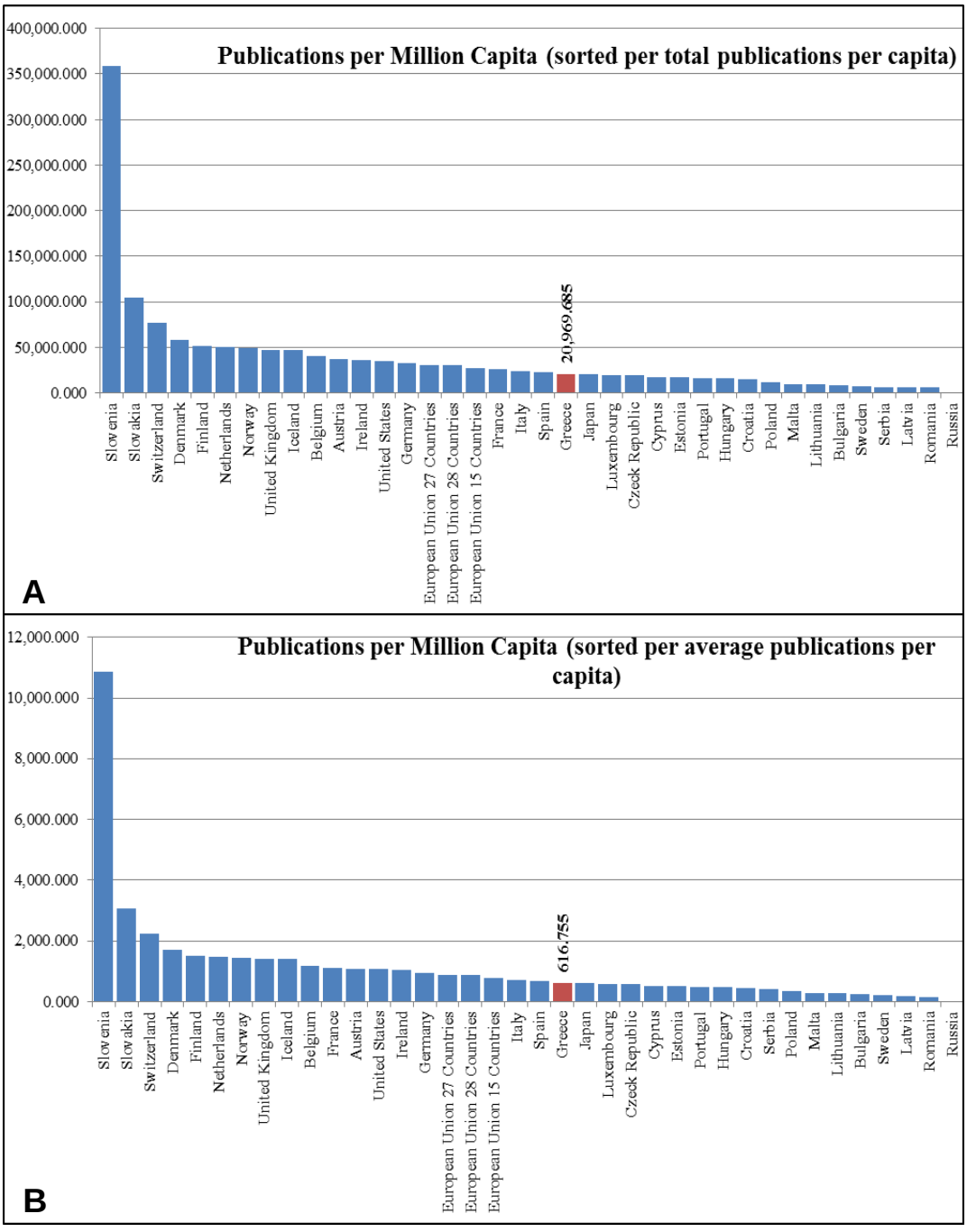

Figure 6. Publications per Million Capita. Total numbers 1980-2013 (**A**) and average numbers per year (**B**).

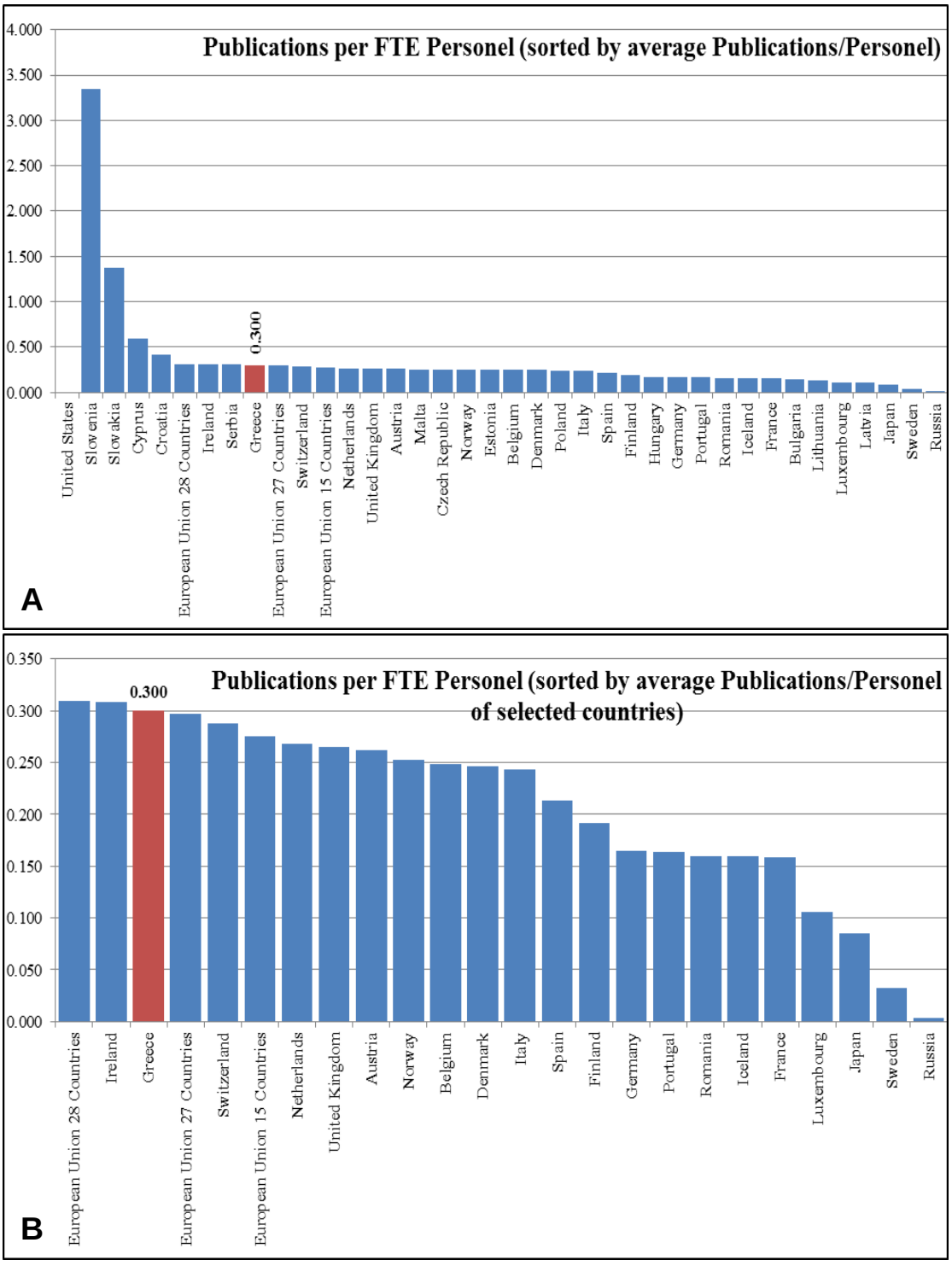

Figure 7. Publications per Personnel FTE. Average publications per researcher in all countries investigated (**A**), average publications per researcher in selected countries (mostly EU 15) (**B**).

Metrics of Research-Publications per Researcher

Similarly, if we examine the cost of each of the factors examined, i.e. how much per unit labor (researcher) and per unit output (publication and citation), we find that Greece is ranked in the lowest categories (**Figure 8**). More specifically, the average budget per researcher is 30,358 Euros (per year), holding the 11th lowest place among 42 countries, while an astonishing amount of money is spent per researcher in Sweden and Switzerland, exceeding 120 million Euros. Although the amounts spent in the above two countries seem “out of this earth”, we need to recall that it is the product of the division of GDP spent for R&D and the number of researchers. However, as we will see in the following sections, this expenditure is reflected in the number of citations each publication receives. Similarly, a publication in Greece costs 104,000 Euros (**Figure 8B**) holding the 10th lowest place among 42 countries and a citation costs on average 23,583 Euros (**Figure 8C**) holding the 6th lowest place.

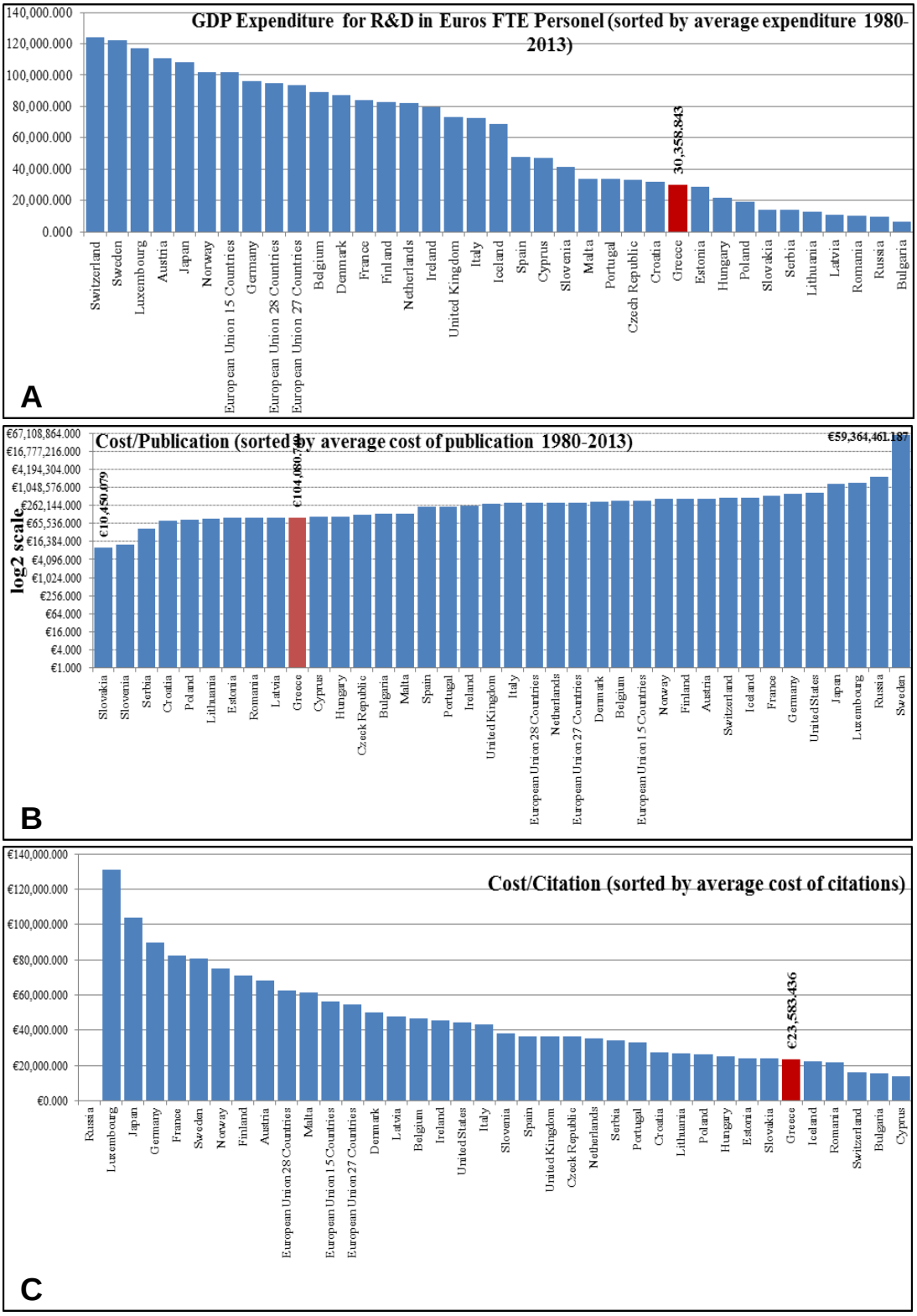

Figure 8. GDP expenditure in Euros per researcher (**A**), cost/publication in euros (**B**), cost/citation in euros (**C**).

Metrics of Research-Indices

In order to get more insight on these data I have performed a series of correlation diagrams. These are presented in **Figure 9**. When plotting the average GDP expenditure per researcher vs. average publications per researcher, we can see that Greece performs better than other countries with higher budgets. Interestingly, Slovakia and Slovenia perform better than everyone else. If we observe the trend line, we can remarkably see that as the expenditure per researcher raises, the number of publication falls (**Figure 9A**). This of course would be good news for the policy makers and the financial ministers in that they would cut off budgets for research in order to raise the productivity. Nonetheless, the "bad" news (for the finance minister) is that this raise in expenditures is reflected in the quality of publications. A probable explanation would be that as expenditure rises, researchers focus on more complicated topics that need more assets to be accomplished. This actually is a hint that the researchers, when offered the right tools, make turns towards the correct direction and attempt to answer more difficult scientific questions. This can also be seen from the fact no linear relationship exists between high expenditure and the number of publications. How is this explained? We should take a look at **Figure 9B**. I have plotted the average GDP expenditure per researcher vs. citations/publication. The picture is reversed as Slovakia and Slovenia go below the median and most of the countries are above the median. Remarkably Sweden (who I need to remind you spends an immense amount of money per researcher and publication) rises above all with 100 citations/publication on average. Therefore, I have created three phases for research (shaded area in **Figures 9A** and **9B**). The *Initiation Phase* (grey-shade) includes countries that start to mature in scientific disciplines, without necessarily meaning that some of them don't produce excellent works. The second phase is the *Intermediate Phase* (blue-shade), which includes countries with mature elements of research and finally there is the *Mature Phase* (red-shade), which includes countries with a long research history and sciences that have become more and more focused to quality. Please note how the trend line changes in a slope as we go from the number of publications (**Figure 9A**) to the number of citations (**Figure 9B**). Greece manifests a relatively mature philosophy in science as, while being in the intermediate phase, it has helped set foot towards more qualitative works.

Another interesting observation is that in publications (**Figure 9A**) and citations (**Figure 9B**), Greece remains near the median; this manifests a mature reaction of the Greek scientists to the ratio of publications vs. citations. It seems that there is hesitation to publish on the cost of quality, given the resources we have. Also, as compared to more mature countries, we can see the following differences: Germany uses 300% more resources in Euros per researcher and has 28% more citations than Greece. Luxembourg uses 390% more resources and produces 31% less citations than Greece. Japan uses ~300% more resources and produces 3% less citations as compared to Greece. Yet, this is not an absolute criterion for the performance of a country and other factors such as science policy, political stability and so on, are involved. For example, it is possible that a country puts more emphasis on applied research, thus leading to productive outputs, and less on academic values and *vice versa*. It is also remarkable, as seen from the general trend of citations in **Figure 9B**, to see that for a raise of approximately 2 units of citations/publication, the average expenditure per researcher must be raised by ~20,000 Euros.

The picture gets clearer in **Figure 9C**, where I have plotted the cost per publication vs. citations per publication. The model used is an exponential function and appears to fit the data well. This diagram agrees with the previous separation of research phases, as it separates the mature phase very well, showing a distinctive intermediate phase, yet with countries at the initiation phase coming very close to the intermediate phase. Greece pertains its position in all three diagrams and this agrees with our observation that scientific research in Greece can be characterized by a relative maturity and consistency.

Finally, when plotting the average number of publications to the cost per publication, the champions appear to be the countries that spend the most. In other words, while the United States stands as a country, it is yet surpassed by the European Union of 28 countries and other 15 countries as they spend less and produce more (**Figure 9D**)[7].

[7] For a more detailed view on the comparisons the reader is encouraged to study the supplementary data "*Raw Data.xlsx*"

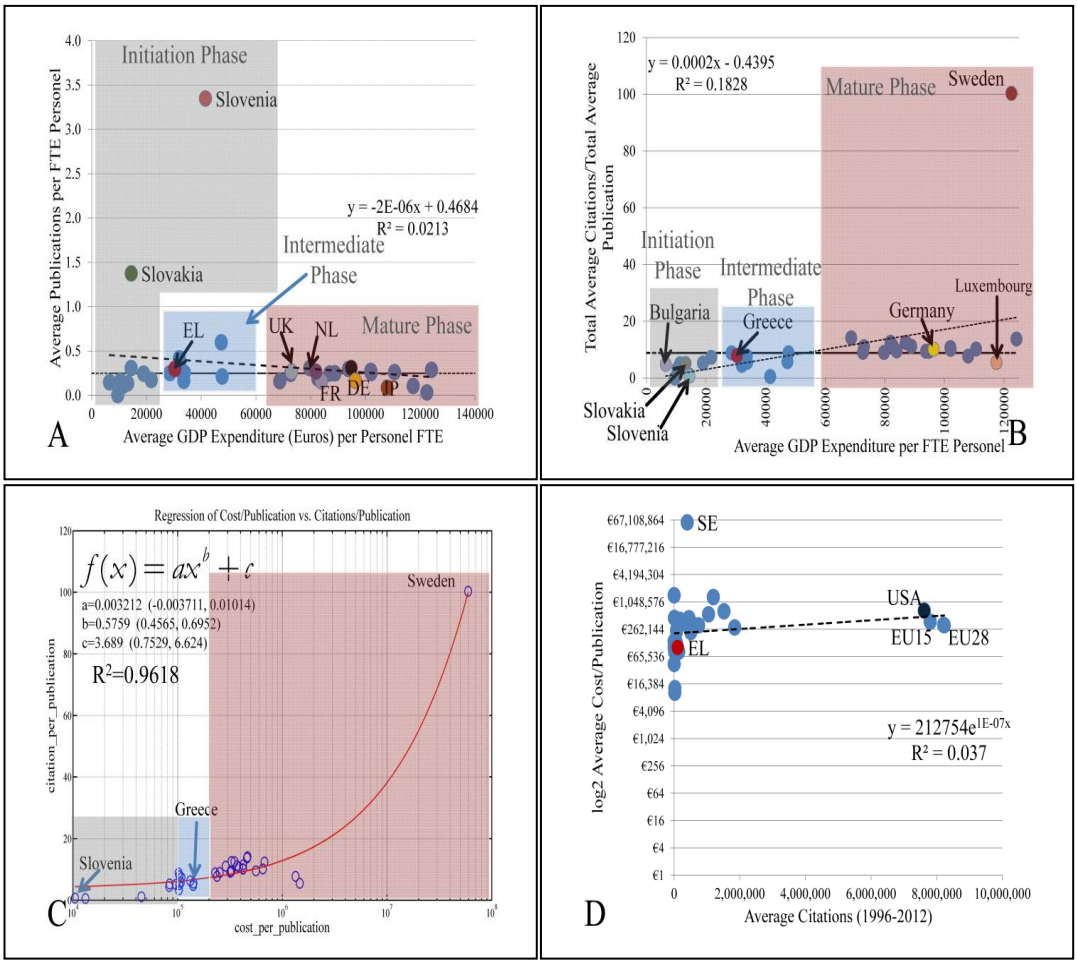

Figure 9. Relations between variables. The Average GDP for R&D in euros per Personnel FTE vs. Average number of Publications per FTE is presented in (**A**) the straight continuous line with dashed edges represents the median of the *y* values. The Average GDP for R&D in euros per Personnel FTE vs. Total Average ratio of Citations/Publications is presented in (**B**) the straight continuous line with dashed edges represents the median of the *y* values. The Cost per Publication vs. the number of Citations/Publication is presented in (**C**). The Average number of Citations vs. the log2 transformed Average Cost per Publication is presented in (**D**). In (**A**), (**B**) and (**C**) the grey-shaded area is the *Initiation Phase*, the blue-shaded area is the *Intermediate Phase* and the red-shaded area is the *Mature Phase*.

Metrics of Research-Microeconomic Indices

The final step in the comparison analysis concerns the conceptualization of research as a commercial institution. Although this is not in complete agreement with the author's views and opinions, this type of analysis is included for reasons of objectivity.

Hence, it includes the calculations of elasticity for publications with respect to capital, labor, the sum of those elasticities and the total factor productivity using Cobb-Douglas functions. In particular, for my model the elasticity of supply has been used, in the sense that by changing the inputs we also affect the outputs. Elasticity of supply figures range from zero to infinity. However, it is possible for the results to be a negative number. Negative elasticities of supply figures result in an inelastic relationship between the quantity supplied and the price. This means that a change in price has no effect on the change in supply. Positive numbers mean that the relationship between price and quantity supplied is elastic. Elastic relationships indicate that a change in price will significantly affect the change in quantity supplied. Yet, in the long run, it is possible that supply can be negative as in the case for high-tech products.

To sum up the properties of these factors, we could say that if the elasticity $E=-\infty$ (perfectly elastic), then an infinitesimal change in resources produces an immense (infinite) change in outputs. If $E=0$ (perfectly inelastic), then an infinitesimal change in resources produces no change to output. If $0<E<1$ (inelastic), a change in inputs results to an upward under proportional change in outputs. If $E>1$ (elastic), a change in resources produces an upward over proportional change to the output. If $E<0$ (inelastic), a change in resources produces a downward disproportional change in outputs. These should be kept in mind as I move forward with my analysis.

If we consider capital (GDP expenditures and thus cost per publication) and labor (researchers) as the inputs and publications as the outputs, then the result is what is presented in **Figure 10**. For capital, Greece stands with an elasticity factor of -1<-0.72<0 (**Figure 10A**). This means that the supply is inelastic and thus a change in capital would have negative disproportionate effects. This might seem irrational but there is an explanation that touches the very heart of problems for the Greek scientific community: the lack of infrastructures. At a national level, this is a serious problem overall. For example, how can you make a fair and functional taxing system when there are no adequate and concrete databases to gather data in a concise and systematic manner? How can you plan for a health system when there are no data on the health system? Interestingly enough, this analysis has highlighted this discrepancy that scientists have to face. This brings to mind a saying that we have in Greece: "money spend without

infrastructures is like pouring water to a straw basket". Nevertheless, we see that countries that rank in the Mature Phase of research manifest an E<-1, meaning an inelastic demand: by increasing capital the number of publications fall. This is possible if raising funds turns the attention to better quality.

When we examine the case of labor, Greece manifests an E>0, which makes the resources positively unit elastic (**Figure 10B**). This comes to an agreement with my previous observation that research in Greece is labor intensive. This highlights one more time that research human resources perform well despite the discrepancies.

Considering the sum of elasticities, I proceed to the following explanations. If $a+b=1$, the production function has constant returns to scale, meaning that doubling the usage of capital *K* and labor *L* will also double output Y. If $a+b<1$, returns to scale are decreasing. Finally, if $a+b>1$, then returns to scale are increasing. The term *returns to scale* is a related term to *economies of scale* that describe what happens as the scale of production increases in the long run, when all input levels including labor and capital are variable. Greece manifested a sum of elasticities of 2.6 (**Figure 10C**), meaning that with increasing inputs the output would increase disproportionally, in the long run. In addition, most countries in the *Mature Phase*, manifested a >1 sum of elasticities, indicating similar long term returns to scale. The most difficult factor to interpret is the Cobb-Douglas Total Factor Productivity (**Figure 10D**). Its results appear contradictory, as this factor is meant to be a metric for productivity. Thus, Greece manifested a low *Total Factor Productivity* (TFP), ranked almost beside Sweden, which have manifested with other metrics superior performance in quality of work. However, if we take this performance (of Sweden) in technocratic terms, they have spent large amounts of money to produce few "products". Yet, this is not true, since the impact of these "products" is immense if translated to innovation and growth. In this sense, Sweden is in the right way of producing quality "products", i.e. publications and so is Greece, France, Austria, Estonia, Netherlands, Germany and EU27. On the other side, from the pure technocratic view, those countries with a larger TFP metric are performing well, yet most of them are in the area where they spend less and produce less. In the sense of research measures, they should make a turn in research policies and focus more on quality than quantity. It is possible that TFP cannot be applied to research. The reason is that research is regarded

as one of the factors that attribute high TFP metrics to a country when applied and thus it would be a dead-loop situation.

Similar analysis has been performed for citations, as a factor of output. In both elasticity of labor and capital, Greece obtained negative values, thus *E<0*. This is somehow difficult to explain, since it appears that in the long run adding assets has an effect of "product" decrease (**Figure 11**).

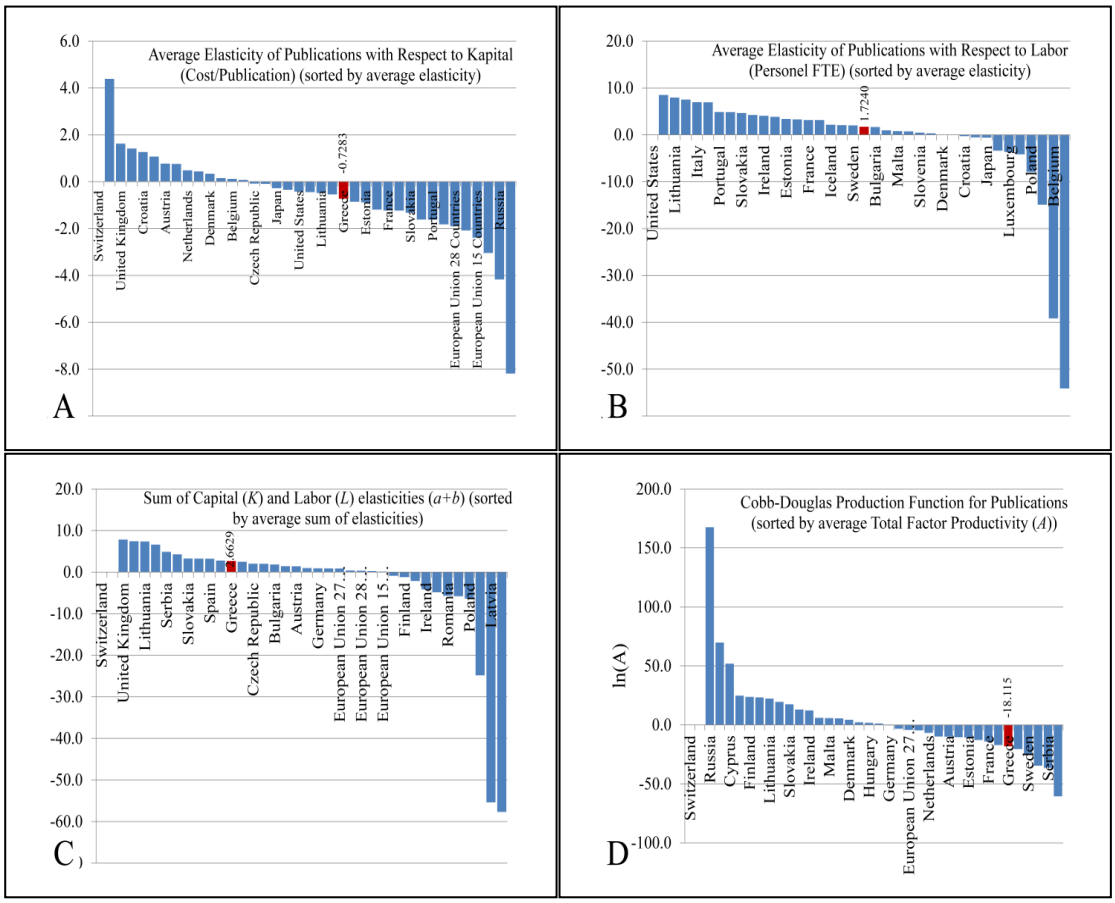

Figure 10. Microeconomic metrics for research with respect to publications. Average elasticity of publications with respect to capital (*K*) (**A**). Average for publications with respect to labor (*L*) (**B**). Sum of *K* (*a*) and *L* (*b*) elasticities (**C**). Cobb-Douglas Total Factor Productivity (*A*) for publications (**D**). Greece is marked with red.

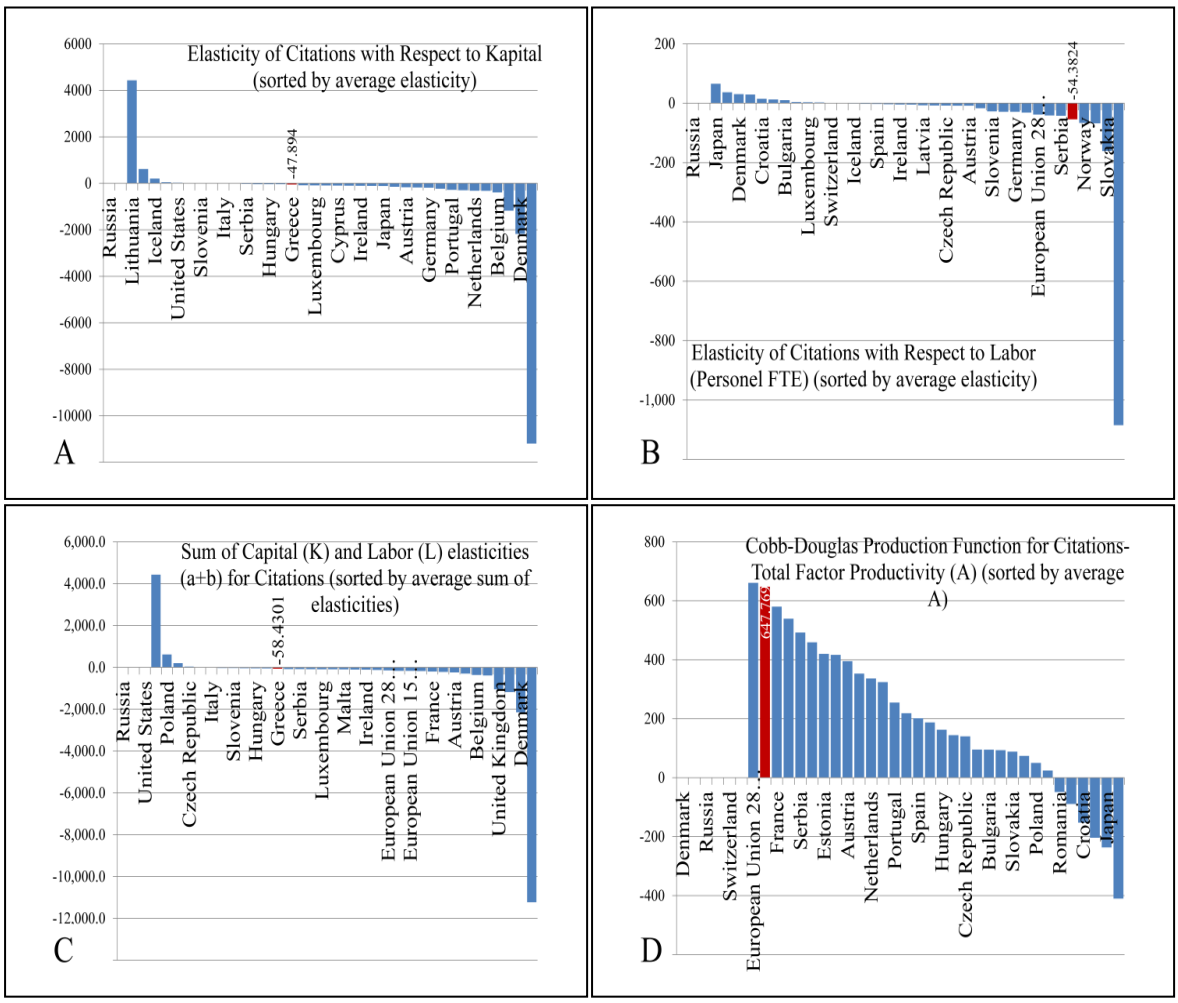

Figure 11. Microeconomic metrics for research with respect to citations. Average elasticity of citations with respect to capital (*K*) (**A**). Average for citations with respect to labor (*L*) (**B**). Sum of *K* (*a*) and *L* (*b*) elasticities (**C**). Cobb-Douglas Total Factor Productivity (*A*) for citations (**D**). Greece is marked with red

Patents

As a final section I have left the analysis of patents. This is an area in which Greece does not perform very well. Considering the patent applications to the European Patent Office (EPO),(**Figure 12A**) and the patent applications to the United States Patent and Trademark Office (USPTO) (**Figure 12C**), Greece is sixth from the bottom. Similarly, if we account for the patents applied with respect to milliard Euros of R&D spent, Greece also manifests a low performance

(Petrakis, 2011). For this effect, several reasons can be used towards an explanation. One possible reason is that industrial development has been declining in Greece the last 30 years. Policies in that area have led to shrinkage in industry and industrial production, which are the main demanding areas for patents. Another reason is the fact that the relation between the research community and the private sector is not very solid. While this appears to be a disadvantage for the Greek research community, it can be seen from several point of views. For example, we need to ask: is the research community's sole responsibility that the connection to the Greek private sector is not well defined? What is the part of responsibility of the Greek private sector in that area? For example, it has been noticed that the actual investment of the private sector to R&D is very low and, when performed, it is of very low risk. It is known that investing in R&D is a high risk-high profit relation.

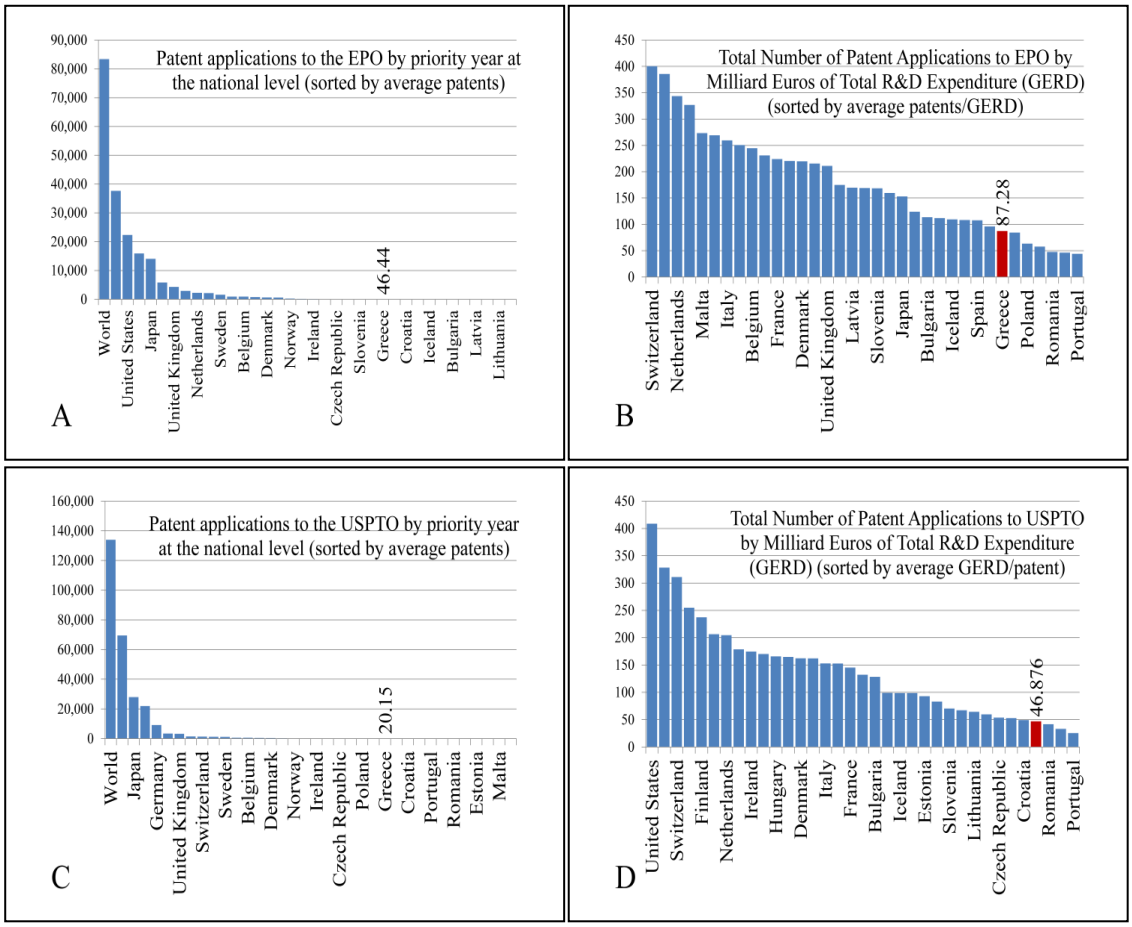

Figure 12. Patent application data. Patent applications to EPO in average values by year (**A**). Patent applications to EPO by milliard euros of total R&D expenditure in average values (**B**). Patent applications to the USPTO in average values by year (**C**). Patent applications to the USPTO by milliard euros of total R&D expenditure (**D**).

Metrics of Research-Time Series of Greece

Having examined the performance of Greece in research in the previous sections, we can now take a look at the time evolution of that performance in some indicative areas. In **Figure 13**, I present the evolution of the R&D expenditure as a percentage of GDP for all years with available data. The variation in GDP expenditures for R&D remained small for the complete period of time under investigation. This provides a hint that this sector was never an area of priority for all political decisions in the past 30 years. It is however ironic that despite the indifference that the Greek governments have shown towards scientific research, they all expected immense outcomes. The second paradox to this is that according to the present analysis, the research community has delivered!

Delivery in absolute numbers is presented in **Figure 14**. The growth rate of publications in the Greek community is exponential. As a matter of fact, by investigating the effect the recession had in research production, we see a negligible change in the slope of publication production (slope 1980-2007=455 and slope 2008-2012=433), even though we observe a change in the kurtosis of the "production" line during recession (**Figure 14B**, **14C**).

Finally, if we examine the time-series of publications per capita (**Figure 15A**) and publications per researcher (**Figure 15B**), we observe that in the first case Greece is performing very well despite constant financing. This suggests an excellent use of the available resources and maximizing their effects, which results in a sufficient number of publications. In the case of publications per researcher, Greece is performing much better than more mature countries with respect to research. In addition, if we examine citations per researcher (**Figure 15C**), we see two interesting results. First, citations are overall falling in all countries. Second, Greece follows the general trend and falls in the area where traditional and research mature countries also fall. Exceptional performance in citations per researcher is manifested by Sweden, UK and the Netherlands. It is nonetheless interesting how all converge to a single point.

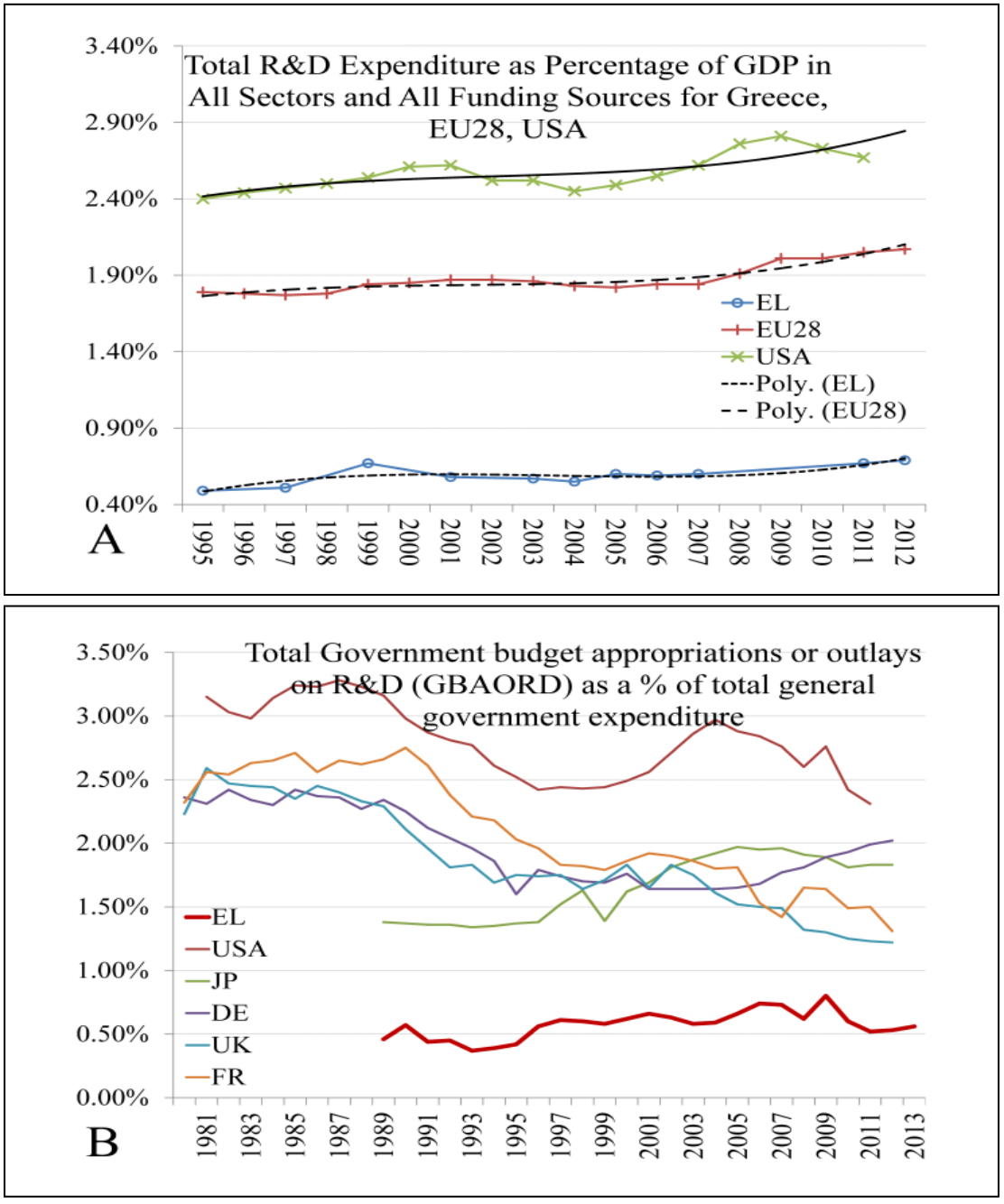

Figure 13. Time series of total R&D expenditure as percentage of GDP (**A**) and total government appropriations or outlays on R&D (GBAORD) as a % of total general government expenditure (**B**).

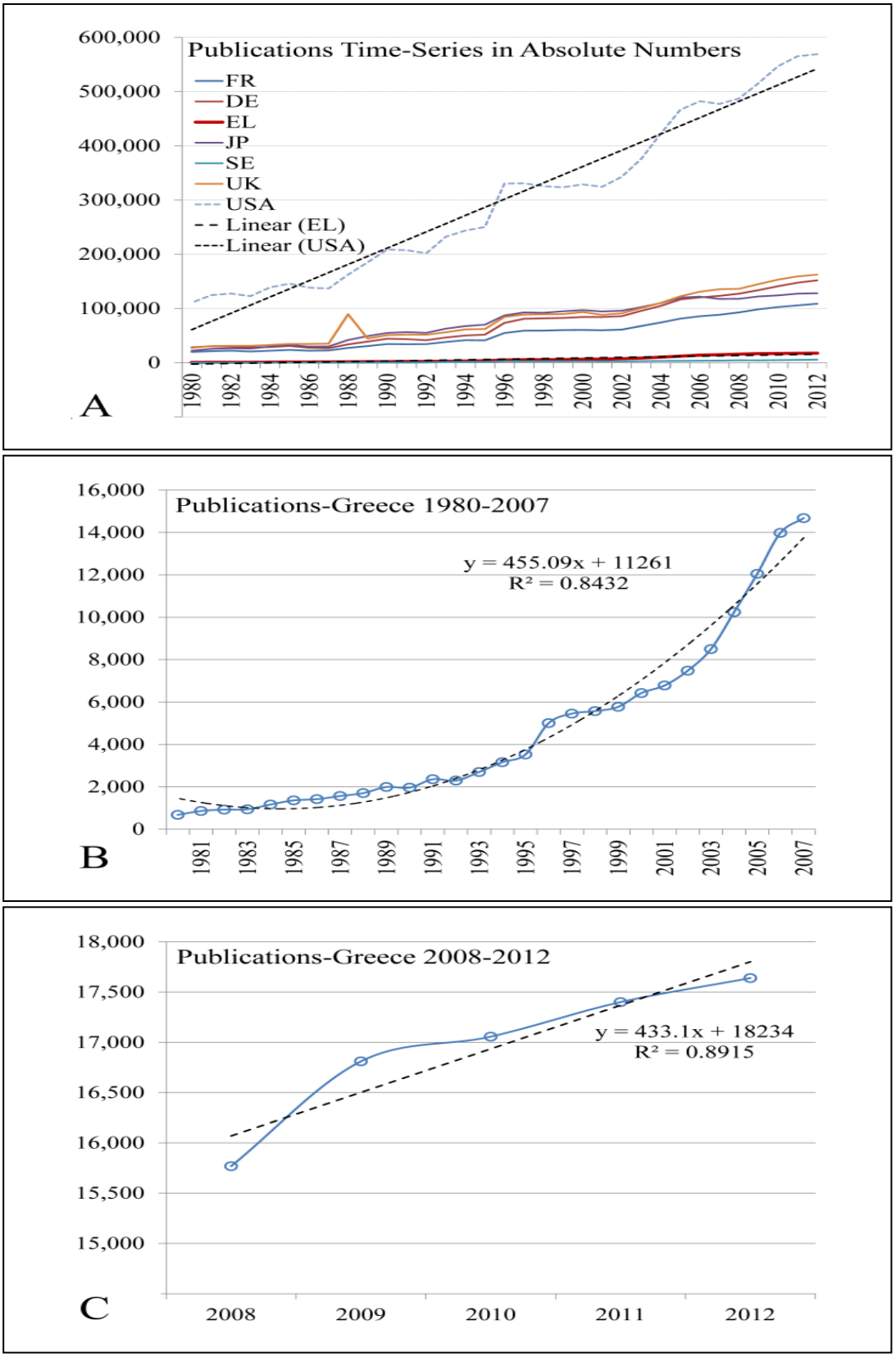

Figure 14. Publications time-series as compared to different countries (**A**). Publications in Greece 1980-2007 in absolute numbers (**B**) and publications in Greece in absolute numbers 2008-2012 (**C**).

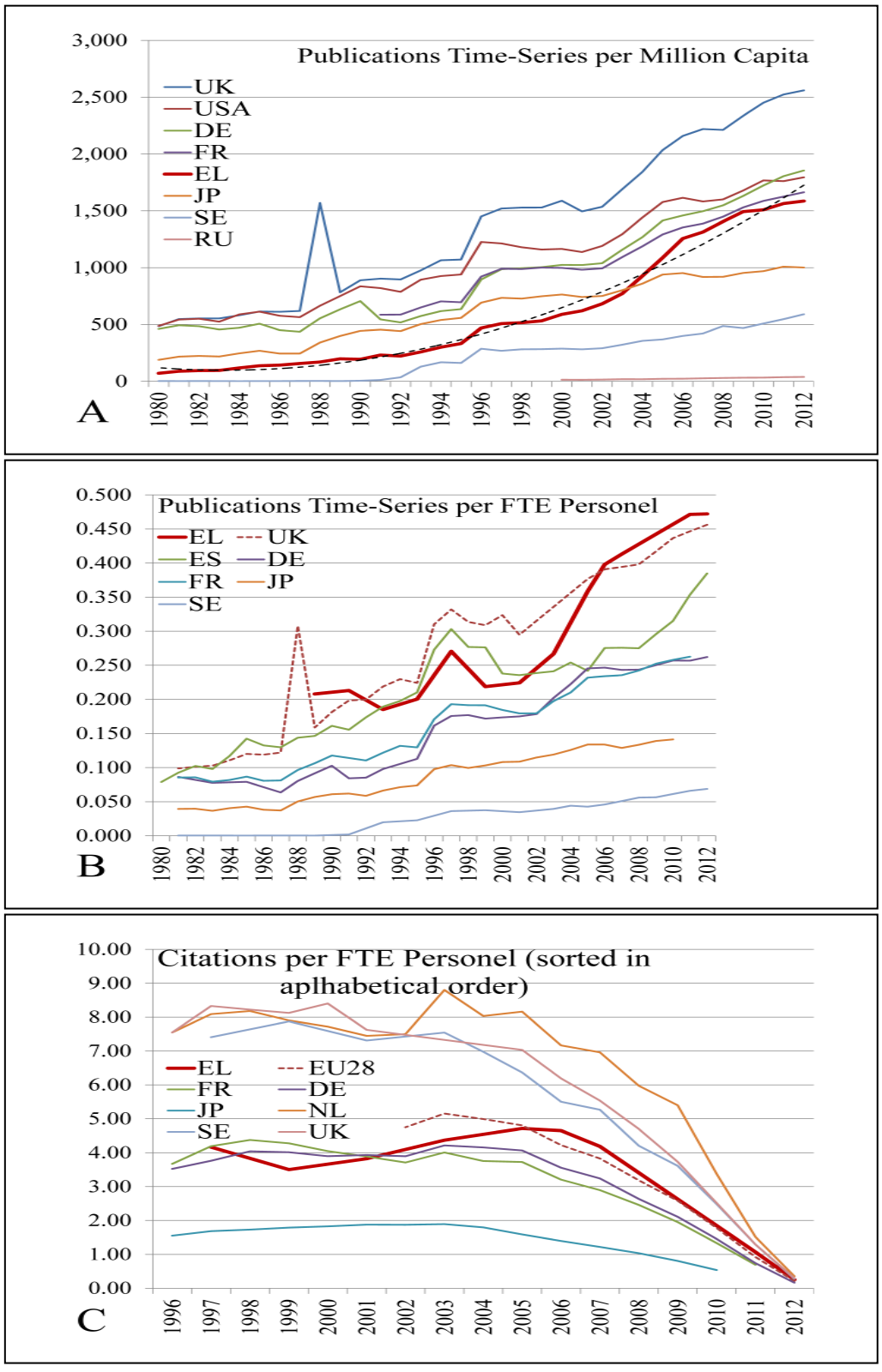

Figure 15. Time series of publications per million capita (**A**), publications per FTE personnel (**B**) and citations per FTE personnel (**C**).

DISCUSSION AND CONCLUSIONS

On dit que Dieu est toujours pour les gros bataillons
It is said that God is always on the side of the big battalions

Dieu n'est pas du côté des gros bataillons, mais du côté de ceux qui tirent le mieux
God is not on the side of the big battalions, but on the side of those who shoot best

François-Marie Arouet
(21 November 1694 – 30 May 1778)
(known by his *nom de plume Voltaire*)

General Remarks

Greece is a small country. Therefore, it will never be able to deploy large amounts of resources to research. Supposing that political decisions were to be made in order to improve research performance in Greece, they should be made in the direction of better exploitation of the existing conditions. This means that tools must be offered to researchers in order to assist them in their efforts. But first let me explain what I mean by tools, as these do not necessarily include financial tools, such as more funding for research or more people from abroad. The previous results show that human scientific resources in Greece perform just fine given the discrepancies of the Greek situation. Bureaucracy is a killer for Greek science. In 2009 the GSRT has announced a research program with the code name "THALES". Projects were submitted in 2009. Approvals came almost two years later and money a little bit later. In an era of high competitiveness, a two-year delay in a research project can put it on the shelf of history, as another research team in another better-funded country could perform the same research much faster. In this case, the problem is entirely political and it has to do with the attitude of policy makers towards science. Bureaucracy is a problem that does not need large amounts of money to be solved. The question is why are policy makers not dealing with it? I leave the answer to the judgment of the reader and to the discretion of the policy makers!

Results in research are not a short-term asset. Instead, they are to be considered long-term and the procedure is tedious and costly.

Comments on GDP Expenditure for R&D and Other Paradox

Statements of policy makers have outlined the need for innovation and its connection to development. This however constitutes a paradox, as the GDP expenditure remains the lowest in the EU, despite everyone (from the side of policy-makers) yelling for innovation. This could be attributed to the recent recession, but we have seen that it has been constantly low for the last 30 years. Therefore, recession should be ruled out.

Furthermore, a serious discussion is currently held on the form of funding, i.e. whether it be public or private. To begin with, the fact that research is publicly funded is according to some "*the source of all evil*". We could however dispute this fact since we have seen that public spending in Greece is far from excessive. Reason would stand beside those who claim the above, yet this would be true only if Greece was spending more than other countries and that money did not offer the expected results. On the other hand, private funding requires industrial production and Greece does not produce goods at the same rate as it imports them. However, we have seen that there is a small percentage of private funding in research but it is not adequate to cover the distance between Greece and other countries. Another disadvantage of private funding, as compared to public funding, is the financing of basic research. This is a point that seems to be completely unknown to policy makers. But, how would one be expected to produce innovation without basic knowledge? Let us use the pharmaceutical industry as an example. There is a tight relationship between new drug development and basic research; it is impossible to create a solution without understanding the basic cellular mechanisms of pathogenesis. In addition, it is documented that scientists are expected to present applied results, something that at the end of the day will lead to a product. Yet, science is financed to find the solution to a problem, but the idea of financing the comprehension of the problem does not even come in question. Also, this policy rules out other, very important, disciplines such as sociology or philosophy whose research results would be of extreme use to the society but of zero profit for any corporation.

When we observe countries in the *Mature Phase* producing, apart from publications and generation of new knowledge, we also discern exploitable research results, which is due to the long process that preceded. This is a

process where knowledge has been collected throughout many years, sometimes even centuries and all this additive knowledge becomes value and products. German cars are believed to be the best in the world. Yet, if another country attempted to make a factory that would produce the same cars, they would have failed. This would not be due to technological reasons but due to the fact that the quality of the cars has as necessary prerequisite a discussion around the table 80 years ago, a discussion between a grandfather and his grandson, during which instructions were given on how to build a nice car or how to manage the family's factory.

Another controversial issue is that privately funded research remains private. But knowledge should be free to mankind. What would have happened if Schrodinger's wave function was privately funded? What if the human genome belonged to a corporation and there was no free access to it by the scientific community? Concluding, of course it is important to be able to use private funds in research in order to deliver innovative products, but it is mandatory to have publicly funded research in order to preserve the right of mankind to access knowledge.

Comments on Research Human Resources

Our results have shown that research in Greece is labor intensive. While using reduced resources and limited tools, it has been shown that production of research "goods" is above average for publications and close to the median for citations. Despite this, many Greek scientists perform better than colleagues who live in countries with more available resources. At this point, we should stress one of the main problematic areas of the research and higher education scenes in Greece. The problem is called motivation. Chances of promotion in the academic or research area are close to zero. Maybe it is a subjective judgment, but not many people in this branch of work are in it for the money. Mostly, it is the interest and love for science and not the monetary reward that makes it attractive. I assume that if there was enough motivation (without a single Euro raise) researchers in Greece would have quadrupled their efforts. Obstacles to this motivation are nepotism, cronyism and bureaucracy: very serious problems that the Greek scientific community is faced with.

A Theory on the Functionality of Greek Science

"*Where there is smoke there is fire*". By this saying, we try to say that there are several discrepancies in the Greek higher education and research system. However, how is it possible that Greek scientists do produce good quality work and are competitive in the international niche? A possible explanation would be that research in Greece does not function up-to-bottom but bottom-up. That means that researchers are not functioning under the guidance of a more senior research member, but are self-motivated and produce by themselves. If we keep in mind that nepotism and cronyism are taken for granted in the Greek higher education and research system then it would be expected that higher academic positions are occupied by less qualified personnel within a political system that is functioning in such a way. Thus, there are two main forces in research. The first force pushes science backwards due to the lack of qualifications and the second force pushes science forwards due to the presence of qualifications and zeal for knowledge. It might sound simplified, yet if one takes a poll within the Greek scientific community, the first complaint that will be heard is that politics and politicians are involved in the selection of higher rank scientific personnel.

What Should We Do?

Let us assume that one bright day a policy maker comes forward and asks the scientific community their opinion in what to do in order to improve the conditions of research in Greece, or in other words asks "*what should we do?*" The answer is difficult but not impossible. First, the target group for this question should be from the bottom to the top and not the opposite.

A good starting point would be the improvement of working conditions for the existing human resources, i.e. the people who have been serving science in Greece despite all its problems. What policy makers do not understand is that by making living conditions better for the existing researchers, it would automatically lead to an improvement of research quality and *then* to an attraction of scientists from abroad. Great emphasis has been given to attracting scientists from abroad and at the same time totally neglecting the existing personnel that gives its everyday fight in Greece. Local scientists, based on the previous numbers, have proved that they work well under extremely difficult conditions.

Overall, steps taken towards an improvement of current conditions should include the following: a) elimination of bureaucracy (Petrakis, 2011), b) motivation and chances of promotion for young scientists and c) elimination of nepotism and cronyism. And by the way, these changes are inexpensive!.

When it comes to investments and public expenditures, money should be directed at the creation of infrastructures, for a start. These should include *correctly* built institutions and databases (both are expensive). Databases are actually first on the row, since data are the most important thing in all aspects of science. I should mention that during the last decades many attempts have been made in Greece in order to create databases, ranging from human resources in research to medical databases. None of these attempts has worked. As a matter of fact, several years ago, we submitted a proposal for the creation of a medical database (please see Author's Affiliation). The reviewer's comment, among others, was that (s)he could not guarantee that the project would go through since many similar attempts that had taken place in Greece had never worked. Having already included this fact in our proposal, in support of our project, this comment literally made us cry with laughter! Just for the record we should mention the key to success of databases. They should start from small-scale and then go to large-scale projects. This means one should start with building a database in a single institution (let's say one department of a hospital), follow how it works, improve it where necessary and then apply this model to other institutions (departments) and finally to a national scale. One would argue that this would take centuries to be completed, yet millions of Euros have been spent and Greece is still in need for databases.

Without the above prerequisites and infrastructures, every Euro spent would not give its additive value to research.

Once the above are accomplished, then efforts should focus on "shooting best".

Conclusions

Based on the assumptions and hypotheses presented in the *Introduction* section, we have seen that budget does not necessarily coincide with research quality. Greek scientists, although mal-financed, perform better than other countries with larger budgets. Scientific work in Greece is in the intermediate phase but has the

potential to reach the mature phase, where other more advanced countries are. Despite deep structural problems in the scientific community, Greek scientists are above or close to the median in almost all areas and criteria of research. The few assets offered are being used in such a way that they produce an additive value, thanks to the Greek scientific human resources. In order to solve problems, there should be a bottom-up (starting from the postgraduate students) dialogue and a recording of the procedures that actually take place. Greece is in dire need for infrastructures and without them money invested would not produce the desired outcomes. Efforts are already focusing on (and should keep on doing so) "Shooting best", which means exploiting all present conditions, thinking outside of the box, surprising, improving, improvising and overcoming.

As a joke, Greek scientists sometimes call each other "*Odysseus*" due to the solutions they have to come up with while faced with everyday problems.

Concluding Remarks

In an attempt to inspire some courage into the spirit of the fellow citizens, I would like to conclude with two remarks. In approximately 200 B.C. the Roman Consul *Flaminicus* initiated an increasing interest towards Greece. The Greek General *Philopoemen*, afraid of an upcoming Roman attack, turned for consult to the *Oracle of Delphi*. *Pythia* gave this response; "*Ἀσκὸς κλυδωνιζόμενος μηδεπώποτε βυθιζόμενος*" (Translated by the author: Battered flask that never sinks). The second comes from a theatrical play by *Lakis Lazopoulos* (*Sorry…I'm Greek*), which I really enjoyed. I quote in a free translation "…*do you think that Odysseus did not know where Ithaca was? Of course he did. It took him so long because he wanted to live the adventure and experience the journey*…".

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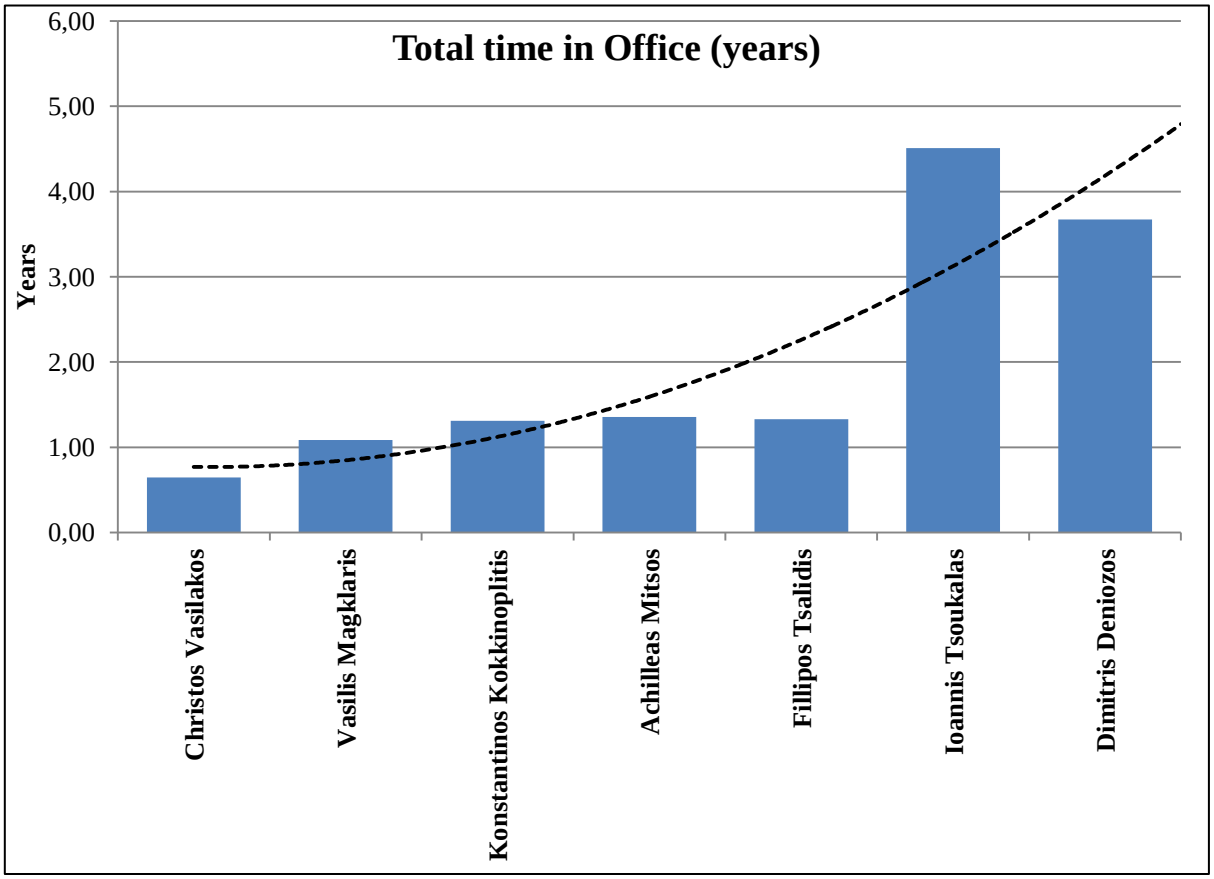
SUPPLEMENTARY FIGURES



Supplementary Figure 1. Total time in Office for Secretary Generals of the GSRT. For explanation on the available data please refer to **Supplementary Table 1**.

SUPPLEMENTARY TABLES

Prime Minister	Name of Secretary	Date of Appointment	Total time in Office (years)
Antonis Samaras	Christos Vasilakos	1-Aug-13	0.65
Antonis Samaras	Vassilis Magklaris	1-Jul-12	1.08
Loukas Papadimos	Konstantinos Kokkinoplitis	11-Mar-11	1.31
Georgios Papandreou	Achilleas Mitsos	1-Nov-09	1.36
konstantinos Karamanlis	Fillipos Tsalidis	4-Jul-08	1.33
Konstantinos Simitis	Ioannis Tsoukalas	1-Jan-04	4.51
Konstantinos Simitis	Dimitris Deniozos	1-May-00	3.67
		Average	**1.99**

Supplementary Table 1. Secretary General appointments of the GSRT. It appears that the post has been volatile after 2008. From 2000 to 2013 the average time in office was 1.99 years, which drops drastically to 1.15 years to if we exclude the years 2000-2008. Please note the figures are by approximation since it was not possible to find a concrete list of all Secretaries served the GSRT. Dates of appointment and the government that appointed them has been found in the internet using alternative and indirect search techniques (for example, through grant announcements or press conferences that are still available on the web).