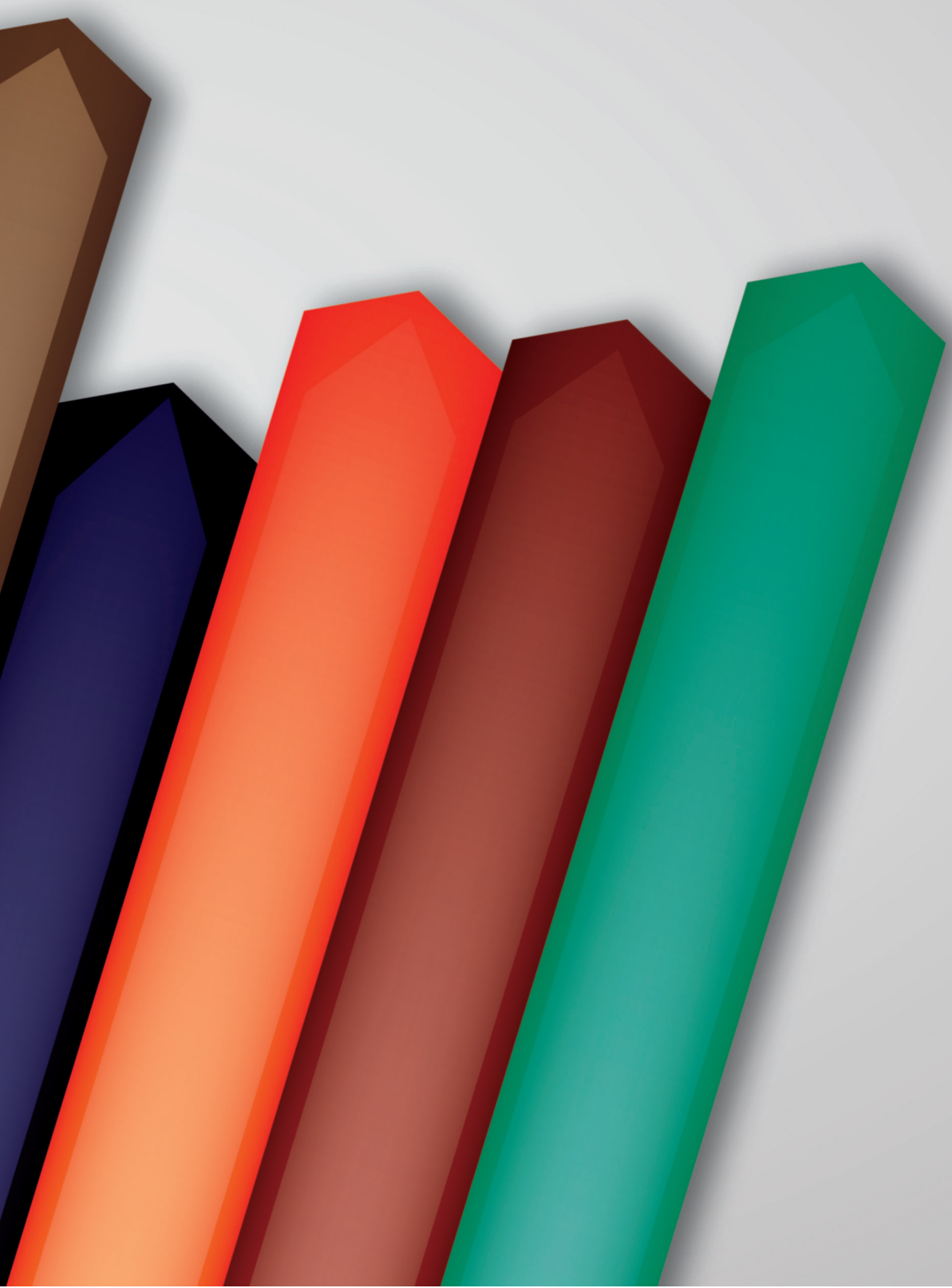
Greek Scientific Publications 1996-2010

A bibliometric analysis of Greek publications in international scientific journals - Scopus



ΕΘΝΙΚΟ ΚΕΝΤΡΟ ΤΕΚΜΗΡΙΩΣΗΣ

NATIONAL DOCUMENTATION CENTRE

Greek Scientific Publications 1996-2010

A bibliometric analysis of Greek publications in international scientific journals – Scopus

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Greek Scientific Publications 1996-2010

A bibliometric analysis of Greek publications in international scientific journals – Scopus

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Data processing was enabled by software solutions which EKT developed to meet the requirements of this study. The software makes uses of a set of tools that allowed the calculation of bibliometric indicators as well as the presentation of data in a user friendly format. Dr Nikos Houssos was the supervisor of a team comprised of the following members:

• Dr Dimitris Karaiskos - software developer
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• Aristomenis Lampropoulos - data cleaning and control techniques
• Andreas Kalaitzis - developer of the study's electronic edition

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- Giannis Kalogirou - President of EKT's Scientific Board and Professor at National Technical University of Athens
- Klea Katsougianni - Vice-President of EKT's Scientific Board and Professor at National & Kapodistrian University of Athens
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- Charalambos Chryssomallidis - Member of EKT's Scientific Board.

Foreword

"Greek Scientific Publications 1996-2010: Bibliometric analysis of Greek publications in international scientific journals - Scopus", –a result of collaborative work–, makes part of the EKT's established study series which records scientific publishing activity in Greece as well as its international impact.

This third edition is based on data drawn from the Scopus database of Elsevier. By presenting indicators from the two internationally established databases (Web of Science / Thomson Reuters: for the previous studies of EKT, and Scopus / Elsevier: for the present study), we aim at increasing the number of Greek publications and scientific fields covered and we provide a fuller picture of significant indicators that depict both the current state and the evolution of Greece's scientific production.

The present study covers a period of 15 years, from 1996 to 2010. It sets out widely used bibliometric indicators at country level, featuring Greece's position in the global environment, as well as detailed data for 95 institutions across 8 categories. Along with indicators at the single level of institutions, the study also presents comparative figures regarding their performance.

Our goal is to provide reliable evidence on the Greek research area, point to its strengths and contribute to a broader understanding of the potentials and challenges of Research and Development (R&D) in Greece. Emphasis is also placed in the availability of data in forms that help end users, –researchers, academic institutions, research centres–, as well as policy makers to comprehend results easily and further exploit them. To this end, the studies are also available in electronic editions, where readers can access all relevant data and information via interactive charts. Data presentation is continuously enriched with additional indicators and information, such as interactive maps that highlight each region's features in RDI.

Evi Sachini

Director EKT

Contents

1. Overview

The study "Greek scientific Publications 1996-2010: bibliometric analysis of Greek publications in international scientific journals / Scopus" is part of a series of studies undertaken by EKT with an aim to record and analyze Greek scientific activity in the international landscape. The present study (the third in the series) relies on data from the Scopus international database. By presenting indicators from the two most established international databases (Web of Science: the previous study of EKT, and Scopus: this version), EKT aims to give a fuller picture of important indicators that characterize both the current state and the evolution of scientific production in the country and expands the number of Greek publications and scientific fields covered. The study examines the period 1996-2010 and follows the same methodological approach to calculating indicators used in previous studies.

Bibliometric indicators provide significant information and contribute to a measurable and objective picture of the Research & Development systems. They are commonly used measures of research activity and performance in institutions, research centers, research groups or individual researchers. Moreover, they provide information about research activity across scientific fields, point to the emergence of new subject areas and map research networks created for the achievement of common scientific goals.

Bibliometric indicators are a valuable tool, part of a broader system of indicators for the evaluation of research activity. It is a fact that an amount of published articles point to certain limitations of bibliometric analyses (e.g. differences in publications practices and citations across scientific fields such as for example the differences observed between the fields of medicine and humanities). However, these limitations can be overcome when bibliometric indicators are interpreted in the right contextual framework, taking into account additional data and statistics but also qualitative research outcomes.

The National Documentation Center (EKT) has applied a robust methodological approach and validation techniques in bibliometrics. It has also developed software tools which enabled the processing of data collected and the calculation of bibliometric indicators (data cleaning, processing and normalisation, distribution of publications across scientific fields and subfields, graphic representation).

The indicators present the number and share (%) of publications, percentage (%) of cited publications, number and share (%) of citations, citation impact and field normalised citation score.

The following paragraphs summarise findings regarding the total output and performance of Greek publications, the main institution categories in which scientific activity is distributed, scientific fields with the greatest share of publications, scientific collaborations etc. Readers may find detailed information about data and figures throughout the chapters and read about the study's methodological approach in Annex I.

Indicators

Greece in an international context

Until 2010, the number of Greek publications is continuously growing. In 2010, a small decline was observed. However, the number of citations that Greek publications received –the basis of bibliometric analyses- continued to increase and Greece strengthened its international position in terms of the impact, originality, quality, and visibility of scientific publications. Bibliometric indicators for this period were high, Greece's position among EU and OECD countries was also high, citation impact was growing and institutional performance was improved.

In more detail:

- The number of Greek publications displayed a steady increase from 1996 until 2009, outpacing annual growth rates of the EU and the OECD. However, this positive trend was reversed in 2010 and Greek publications recorded a negative rate of change. The growth rate of OECD and EU publications was also reduced.
- In 2010, Greece's share of EU publications was 2.4% and of OECD publications was 0.85% –significantly improved compared to 1996.
- With regard to the number of citations, Greek publications surpassed the EU and OECD growth rate during 1996-2010. During the last 5-year period 2006-2010, Greek publications received 277.130 citations, which is 5 times more than those received in 1996.
- The average number of citations per publication (citation impact) gives an estimation of the impact of publications, especially at country level. During the last 5-year period 2006-2010, Greek publications received 4.98 citations on average surpassing the OECD (4.79) average and approaching the EU (5.52) average. The period 1996-2000 Greek publications received only 2.45 citations on average.
- The relative citation impact continued rising throughout the 1996-2010 period and in 2006-2010 was equal to 1.04 in relation to OECD countries and 0.90 in relation to EU countries.
- There was also an increase in the visibility and impact of Greek publications in the international community. In terms of figures, over the 5-year period 2006-2010, 65.6% of Greek publications received citations.

Key actors in the production of scientific publications

The study examined the scientific publications of eight major institution categories. More specifically, Greek institutions were classified into categories according to the sector of activities in which they belong –e.g. higher education, research, health services e.tc.-, as well as their legal status as public or private institutions.

The majority of Greek scientific publications was produced by "Universities", "Public Health Institutions" and "Research Centers supervised by GSRT". These were followed by "Technological Educational Institutes", "Other Public Research Centers", "Private Health Institutions", "Other Public Institutions" and "Other Private Institutions".

More specifically, over the period 2006-2010, Universities had a share of 79% in the total number of Greek publications (43,960 publications), "Public Health Institutions" 14.3% (7,933 publications),"GSRT Research Centers" a share of 12% (6,675 publications), "Technological Educational Institutes" 5.2% (2,868 publications), "Other Public Research Institutions" 3.3% (1,862 publications), "Private Health Institutions" 2.6% (1,441 publications), "Other Private Institutions" 2.3% (1,291 publications) and "Other Public Institutions" 1.7% (942 publications).

With the exception of "GSRT Research Centers", most of the institution categories had a decline in their publication output in 2010.

In the context of a general growth of indicators of Greek scientific activity, the visibility and impact of scientific publications measured during 1996-2010 had a positive course for all institution categories.

During the last 5-year period 2006-2010:

- "GSRT Research Centers" and "Private Health Institutions" had the highest percentage (%) of cited publications among all institution categories, being 75% and 69.5% respectively.
- "GSRT Research Centers" and "Private Health institutions" were above the world average in terms of publication impact, with field normalised citation scores 1.20 and 1.18 respectively.

Key scientific fields of Greek publications

With an aim to identify the key scientific fields in which Greek research activity takes place, Greek publications were classified into six major scientific fields: "Natural Sciences", "Engineering & Technology", "Medical & Health Sciences", "Agricultural Sciences", "Social Sciences" and "Humanities" and their subcategories as defined in the Revised Field of Science and Technology Classification in the Frascati manual / OECD (Annex III).

The majority of Greek scientific publications came from the field of Natural sciences (a share of 53.4% in 2010) followed by "Medical & Health Sciences" (42%), "Engineering and Technology" (23.1%), "Social Sciences" (10.7%), "Agricultural Sciences" (5.1%) and Humanities (1.7%).

During 1996-2010, Greek publications in the "Natural Sciences" and "Engineering and Technology" were continuously decreasing. There was a growth in publications from the field of "Medical & Health Sciences", "Social Sciences" and "Humanities". The number of publications in the "Agricultural Sciences" remained stable.

During the last 5-year period 2006-2010:

- In all six major scientific fields, the impact of publications improved considerably. The field-normalised citation score in the field of the "Humanities" was the highest (1.14), followed by "Engineering and Technology" (1.12), "Agricultural Sciences" (0.99), "Natural Sciences" (0.97), "Medical and Health Sciences" (0.93) and the "Social Sciences" (0.81).
- The top performing scientific subfields were the following: in "Natural Sciences" the subfield of "atmospheric science" with citation score of 1.35, in "Engineering and Technology" the subfield "energy" (1.77), in "Medical and Health Sciences" the subfield "critical care and intensive care medicine" (1.43), in "Agricultural Sciences" the subfield "food science" (1.10), in "Social Sciences" the subfield "transportation" (1.34) and in "Humanities" the subfield "archeology" (2.10).
- As regards the institution categories that excel in each major scientific field, citation scores above the world average were observed in the following cases: in the fields of "Natural Sciences" and "Engineering & Technology" for the publications of the "GSRT Research Centers" (1.11 and 1.25); in the field of "Medical & Health Sciences" for the publications of the "GSRT Research Centers" (1.22), "Private Health Institutions" (1.17) and "Other Public Research Institutions" (1.03); in the field of "Agricultural Sciences" for the publications of "GSRT Research Centers" (1.06) and "Universities" (1.05); in the field of "Social Sciences" for the publications of "GSRT Research Centers" (1.11); finally, in the field of "Humanities" for the publications of "GSRT Research Centers" (2.55) and "Universities" (1.04).

Scientific Collaborations

The collaboration degree in Greek publications showed a clear increasing trend over the period 1996-2010, both at national and international level.

- In 2010, co-publications accounted for 62.3% of the total Greek publications output, compared to only 51.5% in 1996. This figure was close to the average EU and OECD. 39.5% of Greek publications involved international collaborations while 32.1% national collaborations.
- During the period 1996-2010, there was a remarkable rise in national collaborations, which may be partially explained by an increasing national funding for research collaborative work.
- An increasing trend was also observed in international collaborations, however occurred at a slower pace when compared to national collaborations. During the 5-year period 2006-2010 Greek researchers

collaborated with researchers from 166 countries around the world. Greece's main partners were the United States, the UK, Germany, France and Italy.

- The level and type of collaboration varies significantly for the different institution categories. The share of publications with no collaboration is particularly high for Universities, accounting for 37.9% over the last 5-year period 2006-2010. "GSRT Research Centers" had the highest international networking activity, accounting for 54% of international collaborations during the last 5-year 2006-2010. Finally, national collaboration holds a significant place in all institution categories; "Private Health Institutions" ranked first (73.5% during 2006-2010) in these type of co publications.
- The majority of publications produced by national collaborations included "Universities" as partners. "Universities" have particularly strong collaborative links with "GSRT Research Centers" and "Public Health Institutions".

Institution categories

The following section briefly presents the key characteristics and bibliometric indicators for eight institution categories, as well as the institutions that achieved the highest values. The data refers to the last 5-year period of this study, 2006-2010.

Universities

Number and share of (%) publications: The greatest number of publications in the category "Universities" was attributed to the National & Kapodistrian University of Athens and the Aristotle University of Thessaloniki. The National & Kapodistrian University of Athens accounted for 11,919 publications and had a share of 27.1%, while the Aristotle University of Thessaloniki accounted for 8,932 and had a share of 20.3%. The University of Patras (11.7%) had a share higher than 10%, with the National Technical University of Athens coming very close to that percentage (9.8%).

Change in the number of publications: Between 2006 and 2010, there was a rise in the number of publications in 18 out of 21 Universities. 7 Universities showed a rate of change above the average rate for the "Universities" category (the University of Western Macedonia, the University of the Peloponnese, the Ionian University, the Harokopio University of Athens, the University of Piraeus, the Athens University of Economics and Business and the University of Macedonia of Economic and Social Sciences).

Percentage (%) of cited publications: This indicator was higher than the Greek average (65.6%) for the publications of the University of Crete (74.7%), the Technical University of Crete (71.4), the Agricultural University of Athens (71.4%), the Harokopio University of Athens (69.9%), the University of Ioannina (69.9%), the National & Kapodistrian University of Athens (68.9%), the University of Patras (68.9%), the University of Thessaly (67.3%) and the Aristotle University of Thessaloniki (66.1%).

Number and share (%) of citations: The higher number of citations was attributed to Universities with the higher number of publications -the National & Kapodistrian University and the Aristotle University of Thessaloniki-. The former had 68,680 citations and a share of 31.3% in the total Universities' citations, while the latter had 40,063 publications and a share of 18.2%.

Citation impact indicators*: The Technical University of Crete, the University of Crete, the Harokopio University of Athens and the University of Ioannina ranked first, exceeding the world average (1,26, 1,17, 1,17 and 1,12 respectively).

Major scientific fields and impact of publications:** "Natural Sciences" was the scientific field where the majority of Universities (18 out of 21) produce systematically publications. The highest citation score (1.25) was achieved by the publications produced by the Technical University of Crete. Publications with an impact higher than the world average, defined as 1, were attributed to the University of Crete (with a citation score of 1.19), the University of the Peloponnese (1.09), the Harokopio University of Athens (1.08), the University of Ioannina (with a citation score of 1.05) and the National & Kapodistrian University of Athens (1.01). The

* The indicator refers to the impact (field normalised citation score) for the total publications output of each University. In chapter 4, you can find detailed information regarding publications in each major scientific field (per University).

** The field-normalised citation score was calculated only for Universities with more than 75 publications for the period 1996-2010, which is more than 5 publications per year.

citation scores for the National Technical University of Athens (0.98), the Aristotle University of Thessaloniki (0.95), the University of Thessaly (0.93) and the University of Patras (0.91) were notably high, approaching the world average.

'Engineering and Technology' was also a well-represented field with publications coming from 16 Universities. In this field, the impact of publications was above the world average for the University of Crete (citation score:1.65), the University of Macedonia (1.54), the University of Western Macedonia (1.28), the Technical University of Crete (1.27), the Agricultural University of Athens (1.27), the National Technical University of Athens (1.18), the University of Piraeus (1.17), the University of Ioannina (1.12), the University of Patras (1,11), the University of the Aegean (1.10), the Aristotle University of Thessaloniki (1.08) and the University of Thessaly (1.06).

Publications in the field 'Medical and Health Sciences' came from 12 Universities. Universities with the highest ranking in the field were: the Harokopio University of Athens (1.23), the University of Ioannina (1.20), the University of Crete (1.08), the Technical University of Crete (1.05) and the University of the Aegean (1.03).

In "Agricultural Sciences" 10 Universities were active, with high citation scores during 2006-2010. Publications with the highest field-normalised citation score were those of the University of Patras (1.65), the Harokopio University of Athens (1.21) and the National Technical University of Athens (1.14), the University of Ioannina (1.11), the National & Kapodistrian University of Athens (1.09), the Agricultural University of Athens (1.09) and the University of Crete (1.02).

Eighteen Universities were active in terms of the number of publications they produced in the field of "Social Sciences". The Universities with citation scores above the world average were the Technical University of Crete (1.25) and the Agricultural University of Athens (1.01), while the University of Ioannina's citation score was the same as the world average (1.00).

Finally, two Universities were systematically involved in publications in the field of "Humanities", while publications from the Aristotle University of Thessaloniki had the highest citation score (1.66).

Scientific Collaboration: The degree of collaboration was generally low in Universities' category. The National Technical University of Athens had the highest share of publications without collaboration (44.4%). Publications produced under international collaboration lagged behind those produced under national collaboration. Eight (out of 21 Universities) showed the sharpest pattern of association with national institutions in publications (50%), whereas, in terms of international collaborations, only the publications of the University of Crete and the University of Western Macedonia exceeded 40%.

TEI

Number and share of (%) publications: Among all TEIs in the country, the TEIs of Athens, Crete and Thessaloniki produced the greatest number of publications. During the last 5-year period of the study, the ranking of TEIs in terms of the number of publications and the share in the total number of publications in the relevant category is as follows: TEI of Athens 682 (23.8%), TEI of Crete 409 (14.3%), TEI of Thessaloniki 374 (13%). The shares of the rest of TEIs was less than 10%.

Change in the number of publications: Between 2006 and 2010, 14 out of 16 TEIs accounted for notable growth in their publication figures. However, their annual output of scientific publications remained relatively low and variable over time.

Percentage (%) of cited publications: During the five years 2006-2010, the publications in TEIs of Ionian Islands (68.8%), Crete (67.5%), Kalamata (65.7) achieved a percentage of cited publications which is greater than the average for Greece. The publications of the TEI of Epirus followed with 63,6%.

Number and share (%) of citations: The following TEIs had the highest number of citations and shares of citations in the category: Crete (24.5%; 1,987 citations), Athens (19.3%; 1,567 citations), Thessaloniki (10%; 808 citations), Western Macedonia (7.1%; 573 citations), Larissa (6.8%; 554 citations), Patras (6.2%; 505 citations) and Piraeus (6.2%; 501 citations). The remaining TEIs had shares below 5%.

Citation impact indicators*: Regarding citation impact indicators, the TEI of Crete (1.09), ASPETE (1.06) and the TEI of Patras (1.03) were above the world average, while the TEIs of West Macedonia (0.95) and Piraeus (0.91) –although high–, did not exceed the world baseline.

* The indicator refers to the impact (field normalised citation score) for the total publications output of each TEI. In chapter 5, you can find detailed information regarding publications in each major scientific field (per TEI).

Major scientific fields and impact of publications*: Fourteen out of the sixteen TEIs produced publications in the field of "Natural Sciences". The publications of the TEIs of Kavala (field-normalised citation score: 1.04) and Crete (1.03) had the highest impact. The TEIs of Lamia (0.99), Patras (0.96) and Epirus (0.94) were close to the world average.

Eleven TEIs were systematically active in the scientific field "Engineering & Technology". The field-normalised citation scores of publications for the TEI of Crete (1.25), ASPETE (1.18), and the TEIs of Patras (1.15), Western Macedonia (1.15), Piraeus (1.12) and Serres (1.11) surpassed the world average.

In "Medical & Health Sciences" six TEIs produced publications. Those coming from the TEI of Patras had a citation score equal to the world average.

"Agricultural Sciences" was the field linked to the publishing profile of 6 TEIs whose field normalised citation scores were below the world average.

In the scientific field of "Social Sciences" systematically active were the TEIs of Athens and Thessaloniki.

Scientific Collaboration: The number of joint publications was higher with domestic partners than with international partners. More than 55% of co-publications were recorded with national partners for all TEIs; the TEI of Kalamata had the highest ranking (88.9%). The TEI of Western Macedonia (10.6%) and the TEI of Lamia (39.7%) accounted for the lowest and the highest share of publications with international partnerships, respectively, while the TEI of Piraeus (32.2%) ranked first for the number of publications without collaboration.

Research Centers supervised by GSRT

Number and share of (%) publications: The top performing institutions in terms of published output were the "Foundation for Research and Technology – Hellas" (FORTH) and the National Center of Scientific Research, DEMOKRITOS. During the 5-year period 2006-2010, FORTH had 2,047 publications and participated in 30.7% of the publications in the category "GSRT Research Centers" and NCSR DEMOKRITOS had 2,004 publications, participating in 30% of the publications in this category. As for the remaining Research Centers, their share accounted for less than 10%.

Change in the number of publications: Comparing the rate at which the number of publications changed from 2006 to 2010, we note that 10 Research Centers had a positive trend over time while the number of publications for the Biomedical Sciences Research Center "Alexander Fleming", the Center for Research and Technology Hellas, ATHENA, the Hellenic Pasteur Institute and the Hellenic Center for Marine Research was above the average for that category.

Percentage (%) of cited publications: This figure was high for all Research Centers, ranging from 67.4% to 83%, and being above the Greek average of 65.6%.

Number and share (%) of citations: FORTH had 15,758 citations and a share of 36% in the total citations of the category, NCSR DEMOKRITOS had 12,229 citations and a share of 27.9%, and NHRF had 4,750 citations and a share of 10.8%. As for the remaining Research Centers, their shares amounted to less than 10%.

Citation impact indicators:** Nine out of twelve GSRT Research Centers presented high citation scores of their publications, approaching or exceeding the world average. The relatively low number of publications by the Biomedical Sciences Research Center "Alexander Fleming" accounted for the highest citation score (1.69) which was followed by that of the Foundation for Research and Technology – Hellas (1.30) and that of the Center of Research and Technology Hellas (1.29). The citation score of the following Centers was also high: The Center for Research and Technology Thessaly (citation score: 1.18), the National Observatory of Athens (1.16), the Hellenic Center for Marine Research (1.12), the National Center of Scientific Research DEMOKRITOS (1.11), ATHENA (1.08) and the Hellenic Pasteur Institute (citation score: 1.00). Moreover, the National Hellenic Research Foundation (0.96) scored close to the world average.

Major scientific fields and impact of publications*: In all major scientific fields the field-normalised citation score seems to climb towards or above the world average in the majority of publications by Research Centers.

* The field-normalised citation score was calculated only for TEIs with more than 50 publications for the period 1996-2010.

** The indicator refers to the impact of (field normalised citation score) for the total publications output of each Research Center. In chapter 6, you can find detailed information regarding publications in each major scientific field (per Research Center).

*** The field-normalised citation score was calculated only for Research Centers with more than 75 publications for the period 1996-2010, which is more than 5 publications per year.

In the field of "Natural Sciences", the publications came from 10 Research Centers with a field-normalised citation score ranging from 0.78 to 1.54: B.S.R.C. Fleming (1.54), FORTH (1.21), HCMR (1.12), CERTH (1.09), NOA (1.08), NCSR DEMOKRITOS (1.07), ATHENA (1.00), NHRF (0.95), CE.RE.TE.TH. (0.83) and PASTEUR (0.78).

Six Research Centers were active in the scientific field "Engineering & Technology". The publications with an impact higher than the world average baseline were those of NOA (field-normalised citation score: 1.56), CERTH (1.51), FORTH (1.39), NCSR DEMOKRITOS (1.16), while those of HCMR and NHRF were close to it (0.97 and 0.91).

The higher volume of publication output in "Medical & Health Sciences" came from 6 Research Centers. The publications of all Research Centers rated, in terms of impact, above the world average baseline: B.S.R.C. Fleming (1.86), FORTH (1.62), CERTH (1.31), CE.RE.TE.TH and HPI (1.40 each) and NHRF and NCSR DEMOKRITOS (1.08 each).

In "Social Sciences" only FORTH produced systematically publications, whereas no Research Centers were systematically active in the scientific fields of "Agricultural Sciences" and "Humanities".

Scientific Collaboration: The networking activity, in terms of the number of publications with partnerships, was high for the majority of Research Centers. GSRT Research Centers present a high degree of international co-authorship and have only a few publications without partnerships. Publications with international collaboration were higher than those with Greek-based institutions in the case of four Research Centers (B.S.R.C. Fleming, NOA, NHRF and HCMR). B.S.R.C. Fleming showed the sharpest pattern of association with international institutions (69%). HCMR (48.6%) and CE.RE.TE.TH (89.5%) accounted for the lowest and highest share of publications with national collaboration, respectively.

Other Public Research Institutions

Number and share of (%) publications: The National Agricultural Research Foundation and the Academy of Athens stood out in this category with a number of publications of 692 and 652 respectively. These were followed by the Benaki Phytopathological Institute (166), the Research Academic Computer Technology Institute (111), the Mediterranean Agronomic Institute of Chania (89), the Institute of Geology and Mineral Exploration (73), the Center for Renewable Energy Sources and Saving (39), the Center of Planning and Economic Research (38) and the Institute of Engineering Seismology & Earthquake Engineering (30).

Change in the number of publications: Regarding the rate at which the number of publications changed from 2006 to 2010, we note that there was growth (rate of change >1) for KEPE, Academy of Athens, IGME, BPI, MAICH and ITSAK.

Percentage (%) of cited publications: CRES (79.5%), the Academy of Athens (75.5%), MAICH (73) and ITSAK (70%) presented a higher performance than the world average (65.6%).

Number and share (%) of citations: During 2006-2010, the Academy of Athens had 4,455 citations, the National Agricultural Research Foundation had 2,305, MAICH 478, BPI 370, RA-CTI 329, CRES 181, IGME 173, ITSAK 82 and KEPE 56.

Citation impact indicators*: The values of the field-normalised citation score were above the world average in the case of the small number of publications ITSAK (1.27), the publications of the Academy of Athens (1.13), and the small number of publications of MAICH (1.03).

Major scientific fields and impact of publications:** In the area of "Natural Sciences", the Academy of Athens, the National Agricultural Research Foundation, IGME, BPI, MAICH and RA-CTI accounted for the highest number of publications. The field-normalised citation score was above the world average for the Academy of Athens (citation score: 1.13).

Four Public Research Institutions were active in the scientific field "Engineering & Technology" (CRES, National Agricultural Research Foundation, the Academy of Athens and RA-CTI. The field-normalised citation score was high for the Academy of Athens (citation score: 1.11), with the score for CRES coming close to the world average (0.94).

The higher volume of publication output in "Medical & Health Sciences" came from the Academy of

* The indicator refers to the impact (field normalised citation score) for the total publications output of each Public Research Institution. In chapter 7, you can find detailed information regarding publications in each major scientific field (per Public Research Institution).

** The field-normalised citation score was calculated only for Public Research Institutions with more than 75 publications for the period 1996-2010, which is more than 5 publications per year.

Athens and the National Agricultural Research Foundation. The field-normalised citation score (1.09) for the Academy of Athens exceeded the world baseline average.

In "Agricultural Sciences" three Institutions were active: MAICH (with a citation score above the world average: 1.16), BPI and the National Agricultural Research Foundation.

Scientific Collaboration: The degree of coauthorship was high for all 9 Research Centers. National collaboration dominated: more than 50% of co-publications were recorded with national partners for all Research Institutions; the Research Academic Computer Technology Institute has the highest ranking (90.1%). RA-CTI (34.8%) and the Academy of Athens (53.7%) account for the lowest and the highest share of publications with international partnerships.

Public Health Institutions

Number and share of (%) publications: This study provides analytical bibliometric data for 16 institutions. The volume of articles published by the Evaggelismos Hospital in Athens (EVAGGELISMOS) was consistently the highest in the "Public Health Institutions" category over the period 1996-2010 (722 publications and a share of 9.1%).

Change in the number of publications: The rate of change in publication output in the "Public Health Institutions" category, between 2006 and 2010, was higher for the following hospitals: the SOTIRIA General Hospital of Athens (SOTIRIA), the G. PAPAGEORGIOU General Hospital (G. PAPAGEORGIOU), KORGIALENIO-BENAKIO Hospital of Athens (KORGIALENIO), the G. Papanikolaou General Hospital of Thessaloniki (G. PAPANIKOLAOU), the TZANEIO General Hospital (TZANEIO), the G. Gennimatas General Hospital of Athens (G. GENNIMATAS), the Hospitals supervised by Ministry of National Defence (MOD HOSPITALS) and the "Aghia Sophia" Children's Hospital (AGHIA SOPHIA).

Percentage (%) of cited publications: Throughout the period 1996-2010, the number of citations of publications produced by the hospitals was high in all cases and varied from 51.6% (for the G. PAPAGEORGIOU General Hospital G. PAPAGEORGIOU) to 74.6% (for the Onassis Cardiac Surgery Center O.C.S.C.).

Number and share (%) of citations: An examination of citation score and the share of citations for each institution in the "Public Health Institutions" category in the period 2006-2010 showed that the Evaggelismos Hospital of Athens- EVAGGELISMOS- (3,212 citations and share of 8.8%) came first.

Citation score indicators*: The citation score of SOTIRIA General Hospital of Athens and the IPPOKRATIO General Hospital of Athens (1.06 and 1.03) were the highest and above the world average. Other hospitals with citation scores above 0.90 were the G. Papanikolaou General Hospital of Thessaloniki (0.99) and the "Aghia Sophia" Children's Hospital (0.98).

Major scientific fields and impact of publications:** Public health institutions were mostly active in the scientific field "Medical & Health Sciences". In this field, the publications with the highest impact were those of SOTIRIA (0.98), AGHIA SOPHIA (0.98), G. PAPANIKOLAOU (0.97) and IPPOKRATIO ATHENS (0.96).

A lower number of publications was recorded in the field of "Natural Sciences", where 11 hospitals were active. The following hospitals had the publications with the highest score in the field: SOTIRIA (1.38), IPPOKRATIO ATHENS (1.22), G. PAPANIKOLAOU (1.11), G. GENNIMATAS (1.07) and LAIKO (1.02).

Scientific Collaboration: The majority of publications result from national collaborations, occurring in over 70% of total publications, as is the case for the Tzaneio General Hospital of Piraeus (TZANEIO) (79.7%). The share of publications produced as a result of international collaboration was much lower and ranged from 12.7% (TZANEIO) to 31.8% (the Onassis Cardiac Surgery Center).

* The indicator refers to the impact (field normalised citation score) for the total publications output of each Public Health Institution. In chapter 8, you can find detailed information regarding publications in each major scientific field (per Public Health Institution).

** The field-normalised citation score was calculated only for Public Health Institutions with more than 75 publications for the period 1996-2010, which is more than 5 publications per year.

Private Health Institutions

Number and share of (%) publications: The top performing institutions in terms of published output were the HENRY DUNANT hospital (HENRY DUNANT) (with 67 publications), HYGEIA Group (Hygeia) (44), the Alfa Institute of Biomedical Sciences (AIBS) (41), IASO hospital (23), METROPOLITAN hospital (20), St. Luke's Hospital St. LUKE (16), EUROCLINIC Group (15), the Hellenic Cooperative Oncology Group - HeCOG (15) and the Athens Medical Group (12).

Change in the number of publications: The rate of change in the publications of St. Luke's Hospital (St. LUKE) and the Hellenic Cooperative Oncology Group (HeCOG) exceeded that of the category "Private Health Institutions", between the years 2006 and 2010. An increase in the number of publications occurred also in the cases of IASO, METROPOLITAN and EUROCLINIC Group.

Percentage (%) of cited publications: In the period 2006-2010, the Alfa Institute of Biomedical Sciences (AIBS), the HENRY DUNANT hospital (HENRY DUNANT), the EUROCLINIC Group, the Hellenic Cooperative Oncology Group (HeCOG), and METROPOLITAN accounted for a share of 85.1%, 78.8%, 73.1%, 72.3% and 71.8%, respectively, exceeding the Greek average of 65.6%.

Number and share (%) of citations: As regards the citations and the share of citations of the category "Private Health Institutions", the HENRY DUNANT hospital (HENRY DUNANT) ranks first over the period 2006-2010, with 6,145 citations and a share of 53.6%, and is followed by the Alfa Institute of Biomedical Sciences (AIBS), accounting for 3,351 citations and a share of 29.2%, the HYGEIA Group, with 1,290 citations and a share of 11.2% and METROPOLITAN, with 1,010 citations and a share of 8.8%. The rest institutions in the category accounted for a share of less than 5% of the citations (Figure 9.2.3).

Citation impact indicators*: The citation score was the highest for the HENRY DUNANT hospital - HENRY DUNANT (1.88), the Alfa Institute of Biomedical Sciences - AIBS (1.56) and METROPOLITAN (1.41), surpassing the world average.

Major scientific fields and impact of publications:** Private Health Institutions were principally active in the scientific field "Medical & Health Sciences". The publications with a score higher than the world average baseline were those of HENRY DUNANT (citation score 2.10), AIBS (1.62) and METROPOLITAN (1.47).

In the field of "Natural Sciences", there was a low number of publications, mainly from AIBS and HENRY DUNANT, which recorded a field-normalised citation score of 1.41 and 1.05 respectively.

Scientific Collaboration: There was a high share of publications resulting from national and international collaboration, with the highest score being recorded in the cases of METROPOLITAN (90%) and AIBS (93.3%), respectively.

* The indicator refers to the impact (field normalised citation score) for the total publications output of each Private Health Institution. In chapter 9, you can find detailed information regarding publications in each major scientific field (per Private Health Institution).

** The field-normalised citation score was calculated only for Private Health Institutions with more than 75 publications for the period 1996-2010, which is more than 5 publications per year.

This chapter presents the bibliometric indicators for the total scientific output of Greece -as recorded in the Scopus database- and compares the yield of research publications to that of the EU-27 and the OECD countries*. It provides an outlook on the productivity and performance regarding Greece's publications over the 15-year period 1996-2010, and highlights recent growth trends.

The table below summarises bibliometric indicators for Greek publications for the most recent 5-year period (2006-2010).

* OECD refers to the 34 member countries as listed in Annex V.

2. Greek Scientific Publications: Indicators and Characteristics

PUBLICATIONS	2010
Number of Greek publications	11,816
Share (%) of Greek publications in EU countries	2.40%
Share (%) of Greek publications in OECD countries	0.85%
CITATIONS	**2006-2010**
Number of citations to Greek publication	277,130
Share (%) of Greek citations in EU	2.17%
Share (%) of Greek citations in OECD	0.90%
CITATION IMPACT	**2006-2010**
Citation Impact *(average number of citations per publication)*	4.98
Relative citation impact of publications from Greece compared to EU	0.90
Relative citation impact of publications from Greece compared to OECD	1.04

2.1 Publications

In 2010, there were 11,886 Greek publications in international scientific journals registered in Scopus database. Greece's output volume shows decreasing trends and has slipped from 12,162 publications in 2009 (Figure 2.1.1).

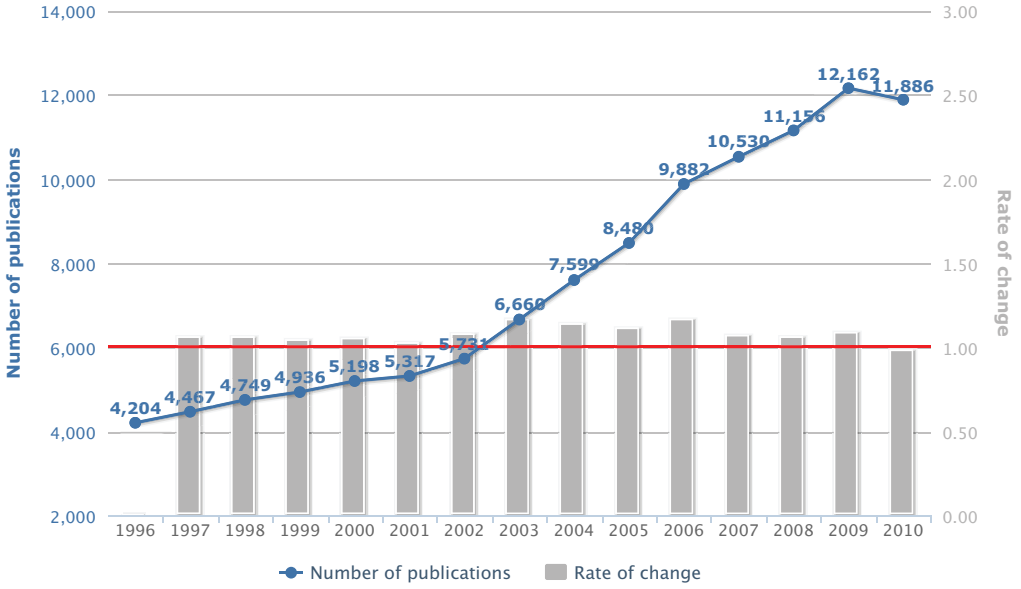


Figure 2.1.1 Development of the number of Greek scientific publications, 1996-2010 / Source: Scopus 1996-2010

The number of Greek publications displayed a steady increase from 1996 until 2009, outpacing annual growth rates of the EU and the OECD (Figure 2.1.2). However, this positive trend was reversed in 2010; the rate of change in Greek publications was negative that year, falling behind the average rate of change in the publications in the EU and OECD countries.

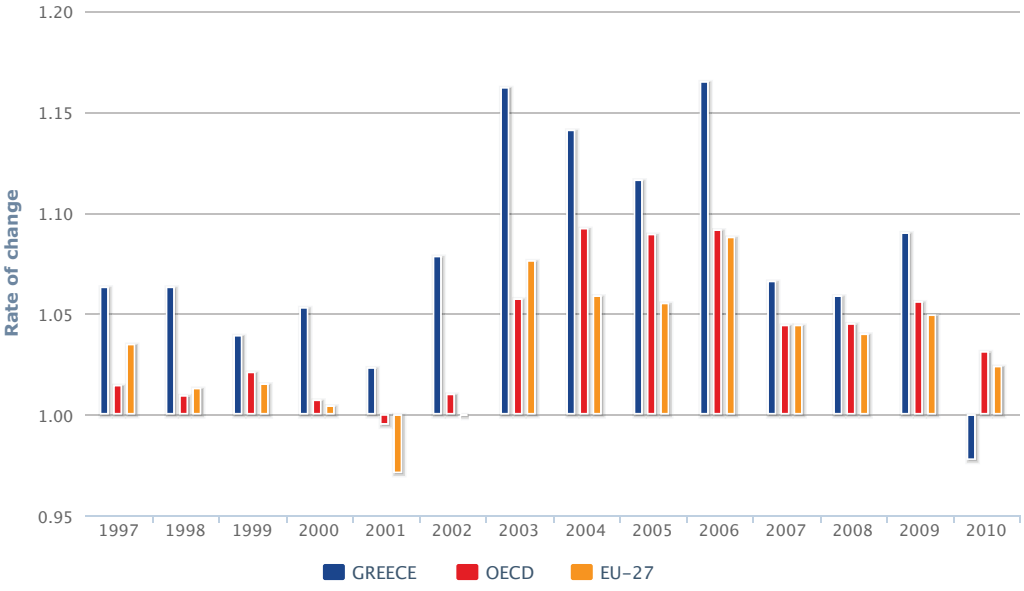


Figure 2.1.2 Change in the number of publications in Greece, EU and OECD, 1996-2010 / Source: Scopus 1996-2010

Rate of change: 1 + [(number of publications in year "n" – number of publications in year "n-1")/ number of publications in year "n-1"]. The rate is 1, if the number of publications is the same across the years compared.

Greece's share of EU and OECD publications followed a period of constant growth between 1996 and 2007, remaining stable afterwards (Figure 2.1.3). In 2010, Greece's share in EU publications is 2.4% and its share in OECD publications is 0.85%, considerably larger compared to 1996.

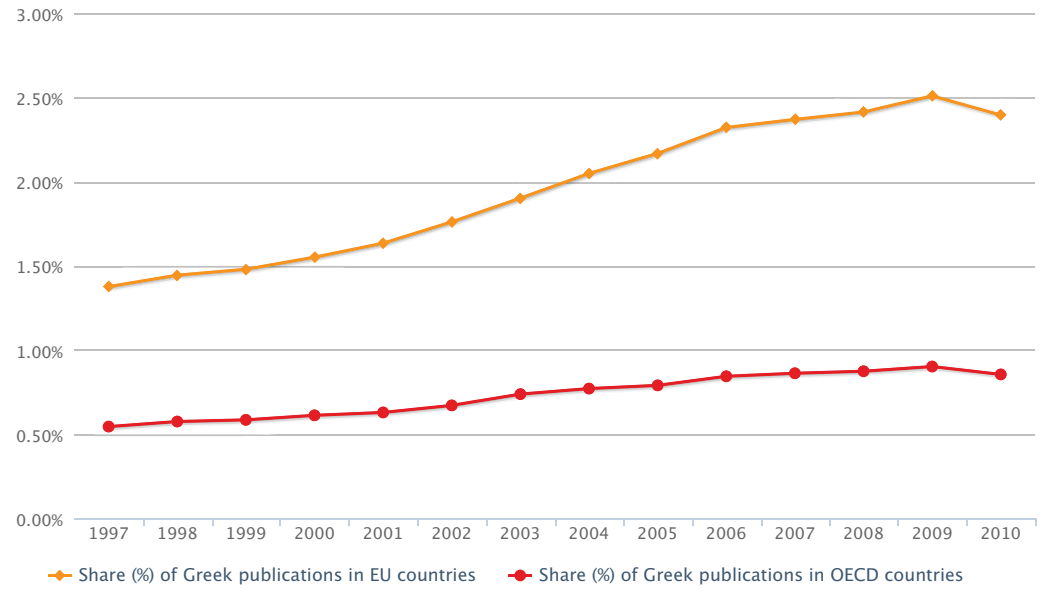


Figure 2.1.3 Share (%) of Greek publications in EU and OECD, 1996-2010 / Source: Scopus 1996-2010

2.2 Citations

Citation counts to scientific publications are among the most common indicators in bibliometrics and constitute a quantifiable evidence of the significance and influence of research. Figure 2.2.1 tracks citations received by Greek publications between 1996 and 2010. According to standard bibliometric practices, data is presented in five-year moving windows, from 1996 through to 2010, –a reliable form of representation for citation trends throughout time–. Each five-year window displays the number of citations to those publications produced within the same five years.

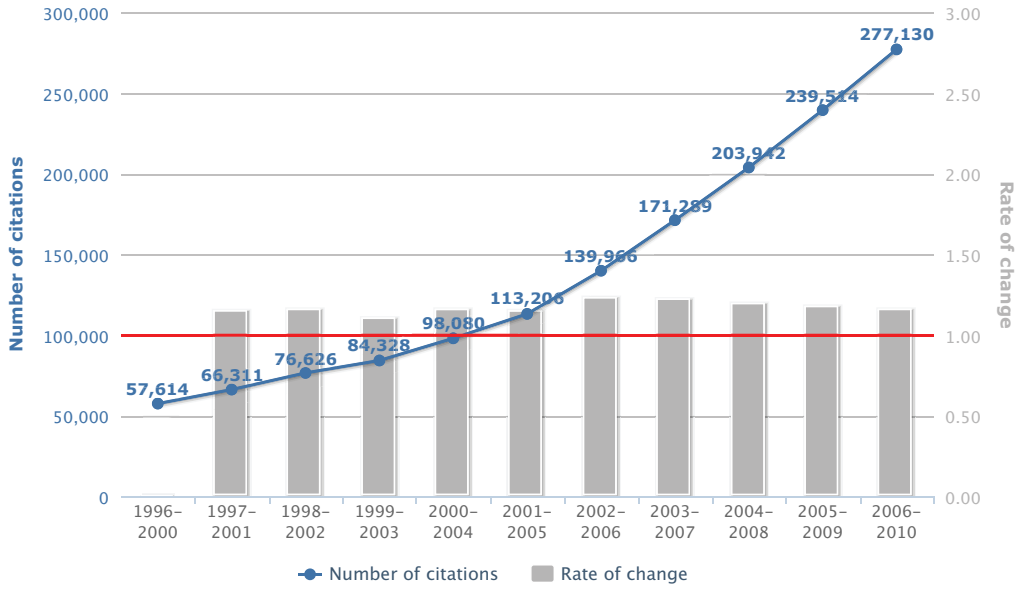


Figure 2.2.1 Development of the number of citations to Greek publications, 1996-2010 / Source: Scopus 1996-2010

Between 1996 and 2010, global trends demonstrated a significant increase in the overall citations counts, both in the EU and the OECD countries. This has been a result of the intense networking activities of the research community and of the wide scientific knowledge diffusion across borders.

Throughout this period, Greece had a satisfactory performance. In the last 5-year window, 2006-2010, Greek publications received 277,130 citations, –4 times more than those received in 1996-2000–. In addition, the growth rate of the number of citations to Greek publications surpassed the EU and OECD baseline (Figure 2.2.2). Accordingly, Greece's share of EU and OECD citations increased (Figure 2.2.3): in 2006-2010 was equal to 2.17% and 0.90%, respectively.

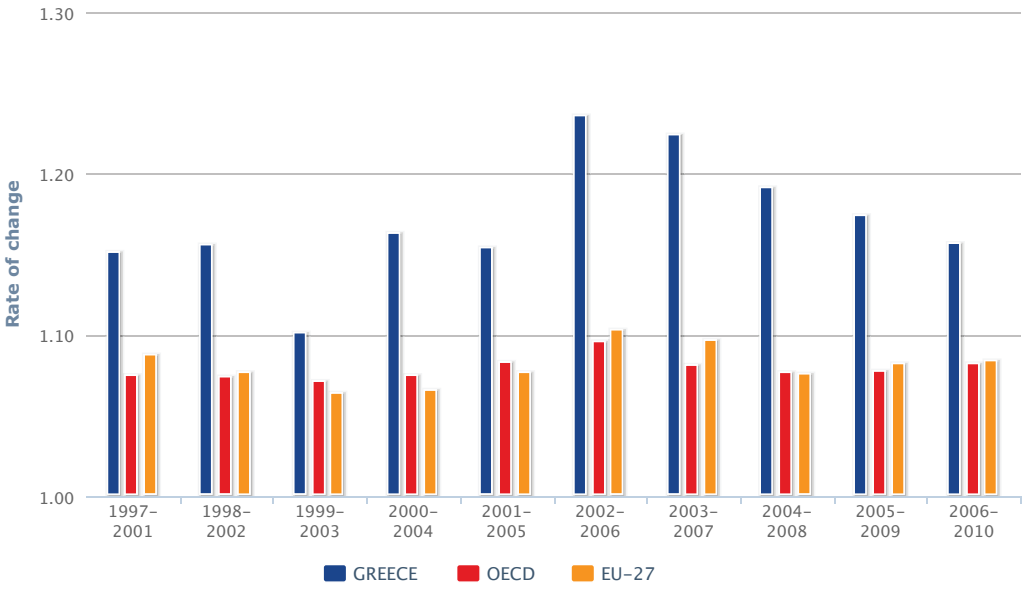


Figure 2.2.2 Change in the number of citations for Greece, EU and OECD, 1996-2010 / Source: Scopus 1996-2010

Rate of change: 1 + [(number of publications in year "n" – number of publications in year "n-1")/ number of publications in year "n-1"]. The rate is 1, if the number of publications is the same across the years compared.

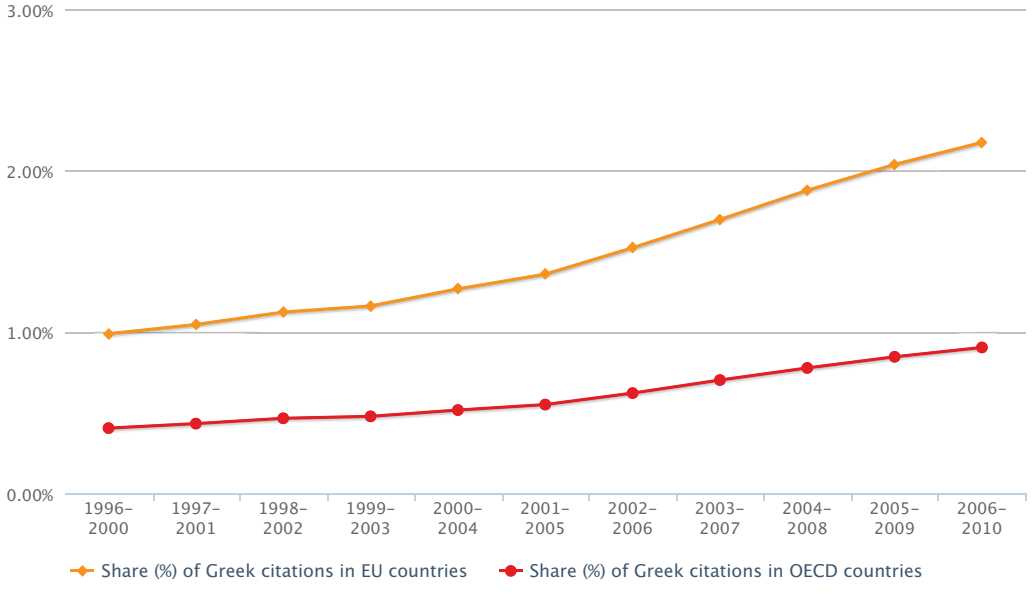


Figure 2.2.3 Share (%) of Greek citations in EU and OECD, 1996-2010 / Source: Scopus 1996-2010

An additional important indicator of visibility and impact of research is the number of cited publications and its percentage (%) in the total publications output. The percentage (%) of Greek cited publications presented a steady upward trend between 1996-2010, reaching up to 65.6% in 2010 (Figure 2.2.4).

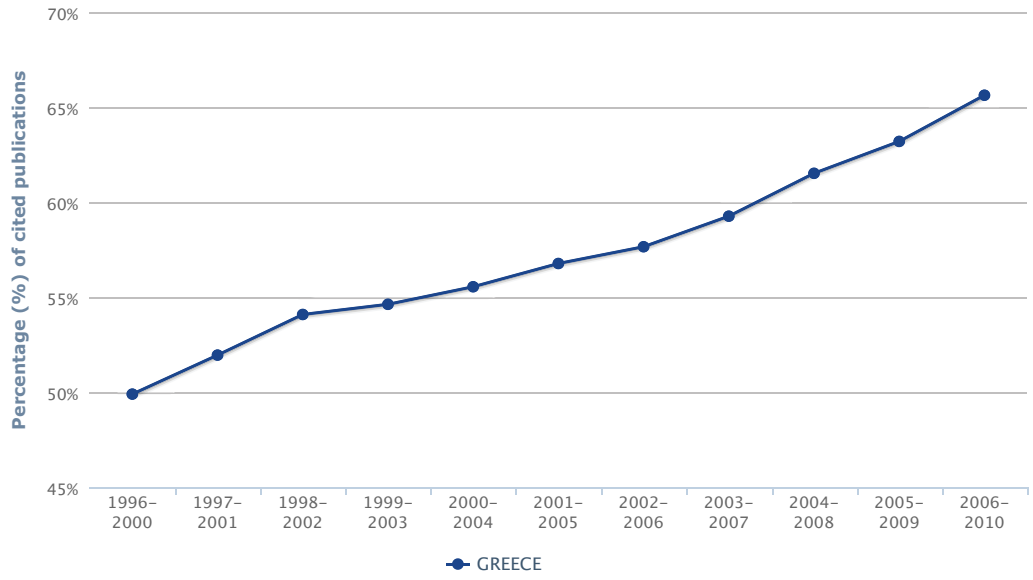


Figure 2.2.4 Percentage (%) of cited publications in Greece, 1996-2010 / Source: Scopus 1996-2010

2.3 Citation impact

The average number of citations per publication remains a good proxy for the scientific impact of publications when comparing countries. This indicator – henceforth referred to as "citation impact"– is calculated as the ratio of the total number of citations to the total number of publications, without taking into account differences in citation practices among scientific fields.

Figure 2.3.1 presents the citation impact of Greek, EU and OECD publications. In the most recent 5-year period, 2006-2010, Greek publications received 4.98 citations on average, surpassing the OECD (4.79) and approaching the EU (5.52) average.

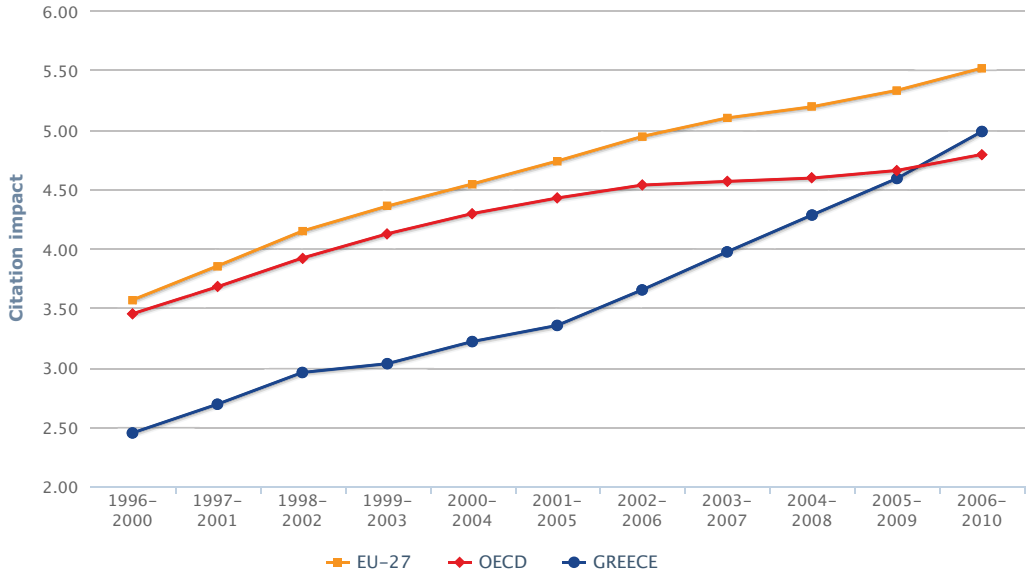


Figure 2.3.1 Citation impact of publications from Greece, EU and OECD, 1996-2010 / Source: Scopus 1996-2010

Notably, between 1996-2010, the growth rate of the citation impact of Greek publications exceeded the corresponding figure for EU and OECD publications. This rate slowed down during 2006-2010, following the trend of the EU and OECD publications which, in fact, showed a higher decrease compared to that of Greek publications (Figure 2.3.2).

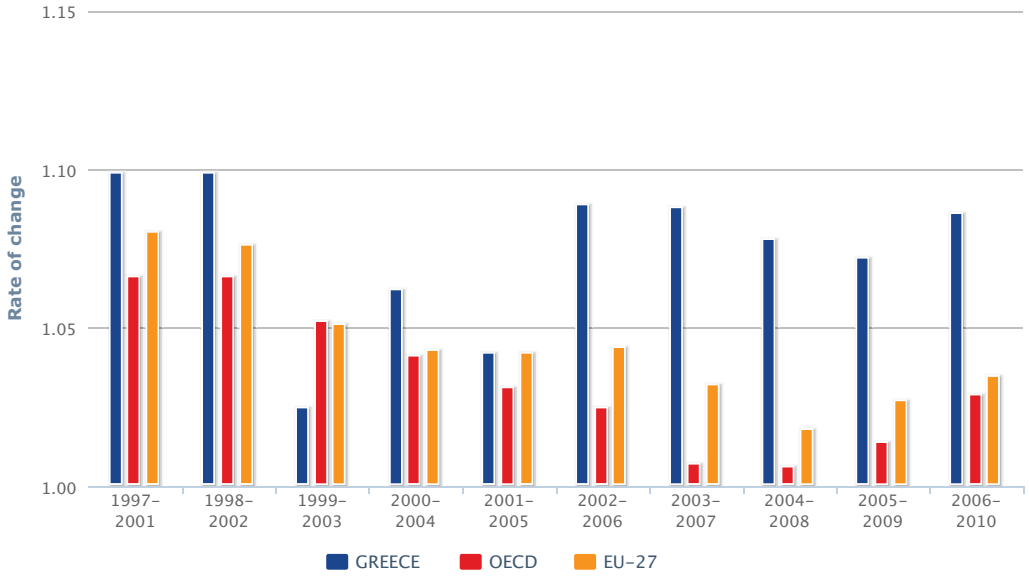


Figure 2.3.2 Change in the citation impact of publications from Greece, EU and OECD, 1996-2010 / Source: Scopus 1996-2010

Rate of change: 1 + [(number of publications in year "n" – number of publications in year "n-1")/ number of publications in year "n-1"]. The rate is 1, if the number of publications is the same across the years compared.

The "relative impact" indicator, as described in Figure 2.3.3, compares citations -per-publication average against the EU and OECD baseline figure, represented in the graphs by the figure "1".

Greece's citation impact relative to the EU (0.90) and OECD (1.04) exhibited an ascending trend between 1996-2010, surpassing the OECD baseline but not yet exceeding the EU baseline.

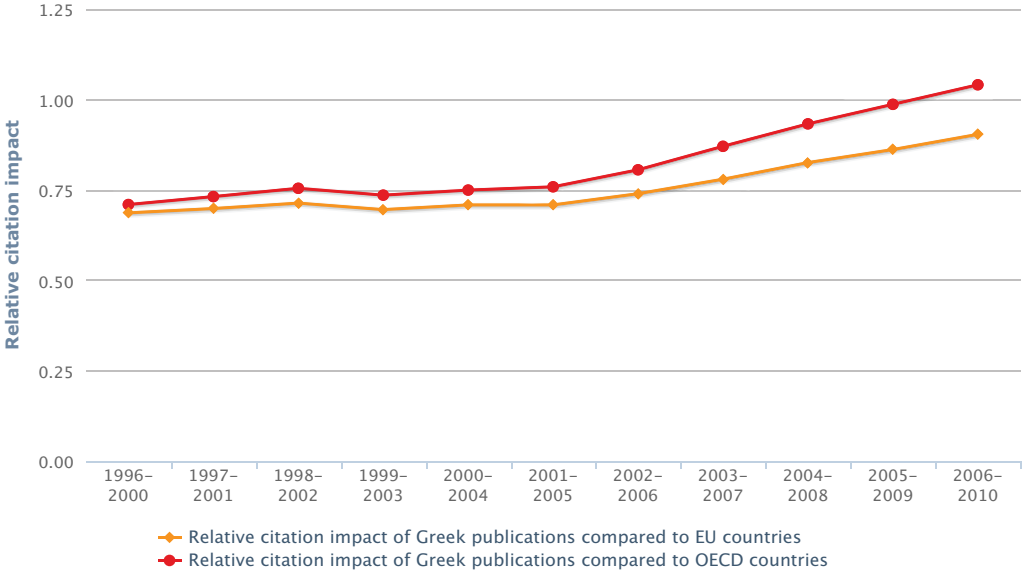


Figure 2.3.3 Relative citation impact of publications from Greece compared to EU and OECD, 1996-2010 / Source: Scopus 1996-2010

2.4 Major fields of science

Aiming at identifying the fields of research where Greek research teams were most active and successful, Greek publications were classified into the six major fields of science "Natural Sciences", "Engineering & Technology", "Medical & Health Sciences", "Agricultural Sciences", "Social Sciences" and "Humanities" and their subcategories, according to the revised edition of the "Revised Field of Science and Technology Classification" Frascati Manual by the OECD (Annex III). The results of this classification corresponding to the entire period between 1996 and 2010, are presented in Figure 2.4.1.

"Natural sciences" proved to be Greece's highest representation in the total number of publications, constituting 53.4% in 2010. "Medical & Health Sciences" represented the second highest share of Greece's total publications, with an increasing trend between 1996-2010, and equal to 42% of the total publication in 2010.

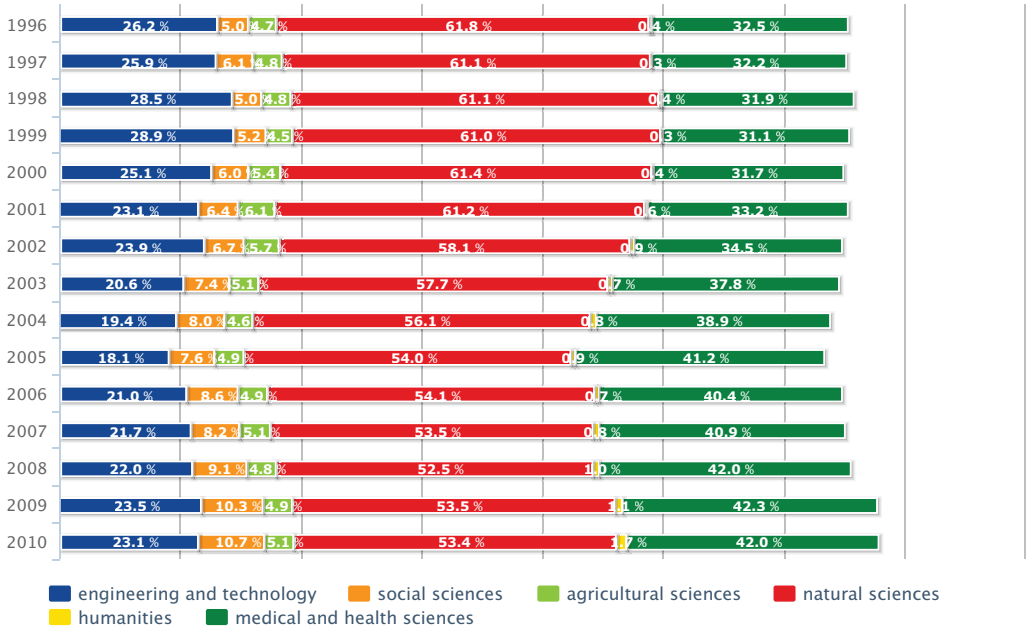
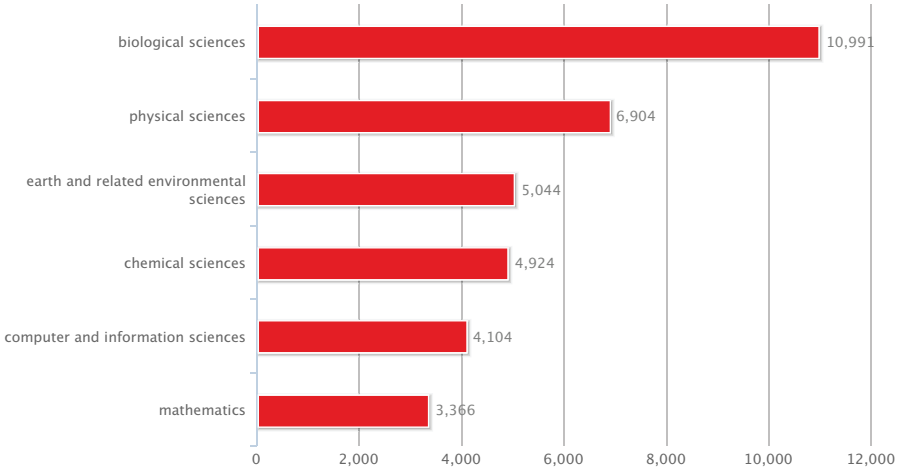


Figure 2.4.1 Distribution (%) of Greek publications across major fields of science, 1996-201 / Source: Scopus 1996-2010

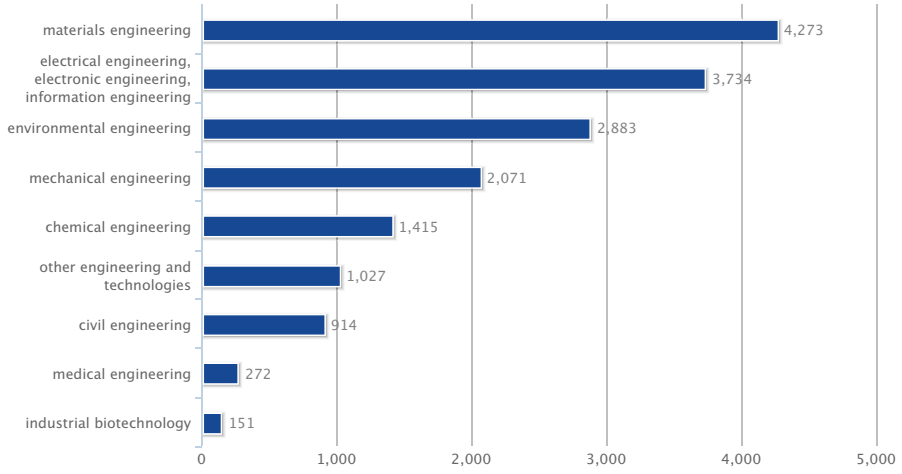
Publications in "Engineering and Technology" accounted for a slightly declining share which was equal to 23.1% in 2010. The remaining share of Greek publications was distributed among the "Social Sciences" which had a growing share after 2007 (10.7% in 2010), the "Agricultural Sciences" with a rather stable share (5.1% in 2010), and the "Humanities" with the lowest share (1.7% in 2010). It was somewhat expected that the field of "Humanities" would be the one with the lowest share of publications, given that scientific production in the field is overwhelmed by monographs and books.

Figure 2.4.2 tracks the number of Greek publications in the subcategories of the six major fields of science. Data refer to the most recent 5-year period, 2006-2010.

Natural Sciences



Engineering & Technology



Medical & Health Sciences

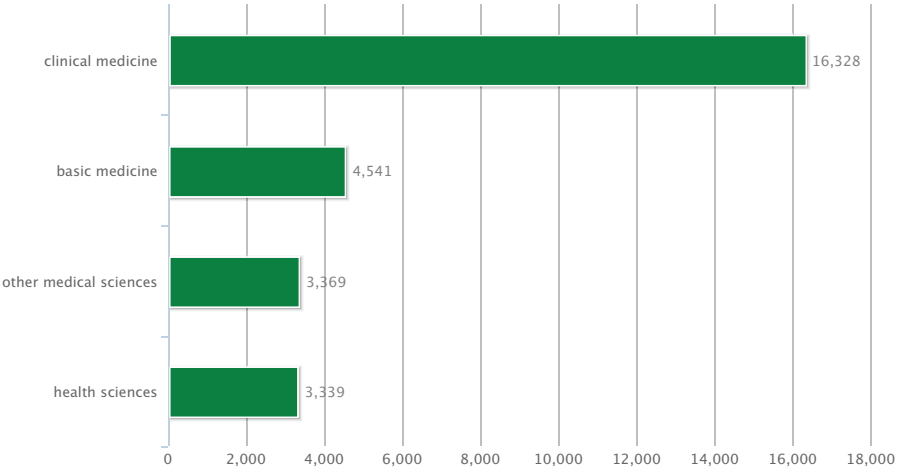


Figure 2.4.2 Number of publications in the 6 major fields, 2006-2010 / Source: Scopus 1996-2010

Figure 2.4.3 shows the "field-normalised citation score" of Greek publications for the 5-year period 2006-2010 in the six major scientific fields. This indicator is the ratio of the average number of citations received by Greek publications to the world average of citations of the same time period and scientific subject field. The normalisation was done at the level of each article/publication according to the 307 Scopus scientific subject fields. In the case that of a publication attributed to more than one subject field, a mean value of the fields was calculated. The field-normalised citation score or "citation score" was calculated using software developed by EKT. A value greater than 1, indicates that the impact of Greek publications was higher than the world average.

In the period 2006-2010, Greek publications approached the world average across all major fields, displaying citation scores from 0.81 to 1.14. The higher citation scores were attributed to the publications in the two major fields "Humanities" (1.14) and "Engineering and Technology" (1.12). These were followed by the fields "Agricultural Sciences" (0.99), "Natural Sciences" (0.97), "Medical and Health Sciences" (0.93) and "Social Sciences" (0,81).

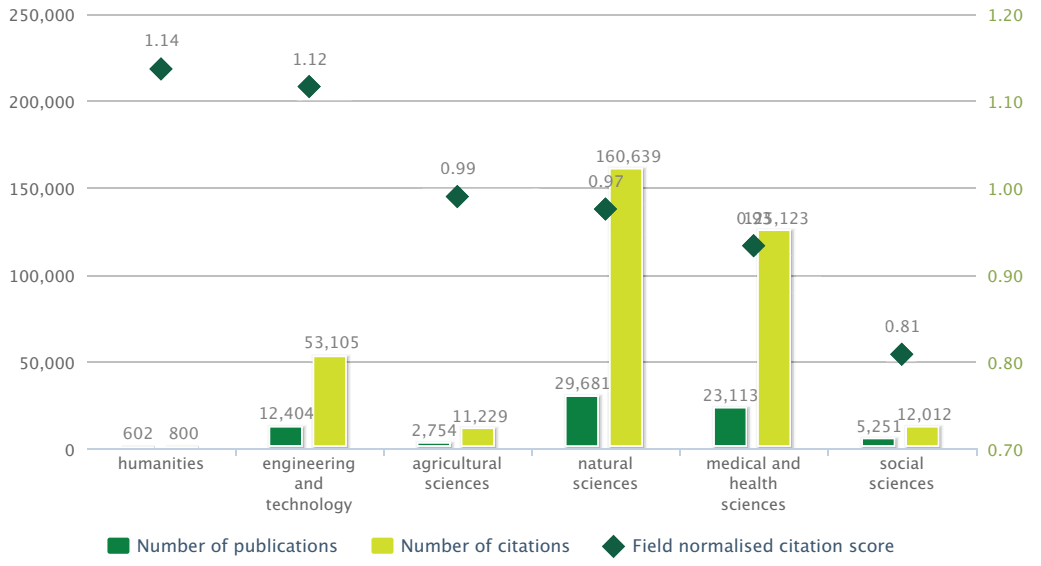


Figure 2.4.3 Publications, citations and field normalised citation score of Greek publications relative to the world, 2006-2010 / Source: Scopus 1996-2010

Within each major field of science, one can identify the specific scientific subject fields in which Greek publications excel and achieve citation scores above the world average. Table 2.4.4 ranks these scientific subfields for the period 2006-2010.

Table 2.4.1 Scientific subfields of Greek publications with field normalised citation score > 1 / Source: Scopus 1996-2010

NATURAL SCIENCES					
Specific scientific field (Scopus)	**Field normalized citation score**	**Number of publications**	**Specific scientific field (Scopus)**	**Field normalized citation score**	**Number of publications**
atmospheric science	1.35	533	computer networks and communications	1.07	897
oceanography	1.30	304	ecology	1.06	402
chemistry (all)	1.29	1,108	instrumentation	1.05	462
catalysis	1.29	334	human-computer interaction	1.04	117
physics and astronomy (all)	1.27	1,471	aquatic science	1.04	619
global and planetary change	1.27	65	immunology	1.04	1,014
computer vision and pattern recognition	1.25	211	electrochemistry	1.04	264
genetics	1.25	888	organic chemistry	1.03	1,125
nuclear and high energy physics	1.24	986	computer science (all)	1.03	276
mathematical physics	1.19	502	acoustics and ultrasonics	1.03	126
biochemistry, genetics and molecular biology (all)	1.15	569	immunology and microbiology (all)	1.02	63
surfaces and interfaces	1.14	397	analysis	1.02	333
filtration and separation	1.13	205	ecology, evolution, behavior and systematics	1.02	570
earth-surface processes	1.11	225	inorganic chemistry	1.01	546
fluid flow and transfer processes	1.11	148	artificial intelligence	1.01	650
computer graphics and computer-aided design	1.09	227	environmental science (all)	1.00	1,074
physics and astronomy (miscellaneous)	1.07	551	software	1.00	858

ENGINEERING AND TECHNOLOGY

Specific scientific field (Scopus)	Field normalized citation score	Number of publications
energy (all)	1.77	271
fuel technology	1.72	367
energy engineering and power technology	1.60	467
engineering (miscellaneous)	1.57	170
process chemistry and technology	1.45	331
ceramics and composites	1.39	333
renewable energy, sustainability and the environment	1.39	555
automotive engineering	1.37	104
chemical engineering (miscellaneous)	1.37	72
polymers and plastics	1.32	583
signal processing	1.29	337
civil and structural engineering	1.25	827
engineering (all)	1.21	488
aerospace engineering	1.21	140
industrial and manufacturing engineering	1.16	546
geotechnical engineering and engineering geology	1.15	388
materials chemistry	1.14	1,026
control and systems engineering	1.13	639
building and construction	1.12	284
environmental engineering	1.10	553
nuclear energy and engineering	1.10	236
electrical and electronic engineering	1.09	2,683
bioengineering	1.07	361
mechanical engineering	1.06	1,256
materials science (all)	1.04	1,298
safety, risk, reliability and quality	1.02	372
materials science (miscellaneous)	1.01	128

MEDICAL & HEALTH SCIENCES

Specific scientific field (Scopus)	Field normalized citation score	Number of publications
critical care and intensive care medicine	1.43	255
rheumatology	1.42	342
epidemiology	1.40	270
anesthesiology and pain medicine	1.29	173
rehabilitation	1.24	166
chemical health and safety	1.20	119
genetics (clinical)	1.18	298
internal medicine	1.18	429
reproductive medicine	1.18	308
hepatology	1.12	205
infectious diseases	1.11	666
pharmaceutical science	1.11	375
nutrition and dietetics	1.09	305
medicine (all)	1.09	2,861
immunology and allergy	1.07	566
public health, environmental and occupational health	1.06	854
endocrinology, diabetes and metabolism	1.06	796
transplantation	1.05	138
medicine (miscellaneous)	1.03	523
health professions (all)	1.03	99
nursing (all)	1.02	274
biochemistry (medical)	1.01	150
urology	1.01	484

AGRICULTURAL SCIENCES

Specific scientific field (Scopus)	Field normalized citation score	Number of publications
food science	1.10	1,368
forestry	1.00	173

SOCIAL SCIENCES

Specific scientific field (Scopus)	Field normalized citation score	Number of publications
transportation	1.34	226
management science and operations research	1.09	408
health (social science)	1.08	89
human factors and ergonomics	1.04	60
library and information sciences	1.00	233

HUMANITIES

Specific scientific field (Scopus)	Field normalized citation score	Number of publications
archaeology	2.10	184
history	1.53	254
archaeology (arts and humanities)	1.11	106

2.5 Scientific collaboration

Nowadays, collaboration of the scientific community at national and international level, is an important factor towards an enhanced knowledge production and scientific excellence. Indeed, interactions and scientific relationships across networks, teams, institutions and countries increase the visibility, the number of citations and the impact of publications. The level of international collaboration can be measured by analyzing author institutional affiliations provided on publications.

The collaboration degree in Greek publications* and its evolution over the period 1996-2010, as displayed in Figure 2.5.1, showed a clear increasing trend, both at national and international level. In 2010, co-publications by Greek researchers accounted for 62.3% of the total publications output, compared to only 51.5% in 1996. This figure was close to the average EU and OECD. However, the years following 2008, the degree of national collaborations marked a slight decrease, while the degree of international collaboration continued to increase.

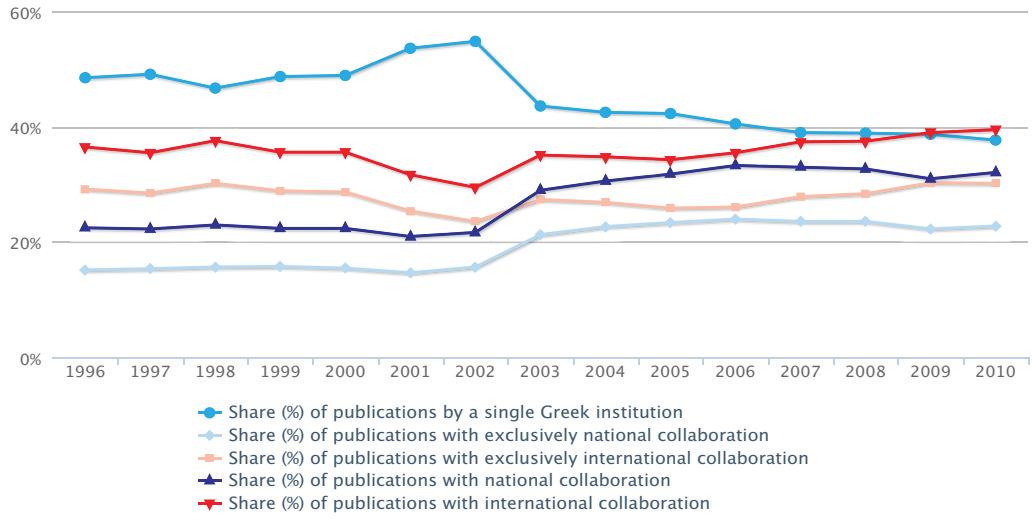


Figure 2.5.1 National and international collaboration in Greek publications, 1996-2010i / Source: Scopus 1996-2010

During the most recent 5-year period 2006-2010, Greek researchers cooperated with scientists from 166 countries. Figure 2.5.2 highlights these links and regions. Greece's main publishing partners were the United States, the UK, Germany, France and Italy.

* Collaboration degree was calculated on the basis of the whole counting approach. Consequently, in the case of a publication produced by authors who came from different countries, each country received a whole count of the publication.

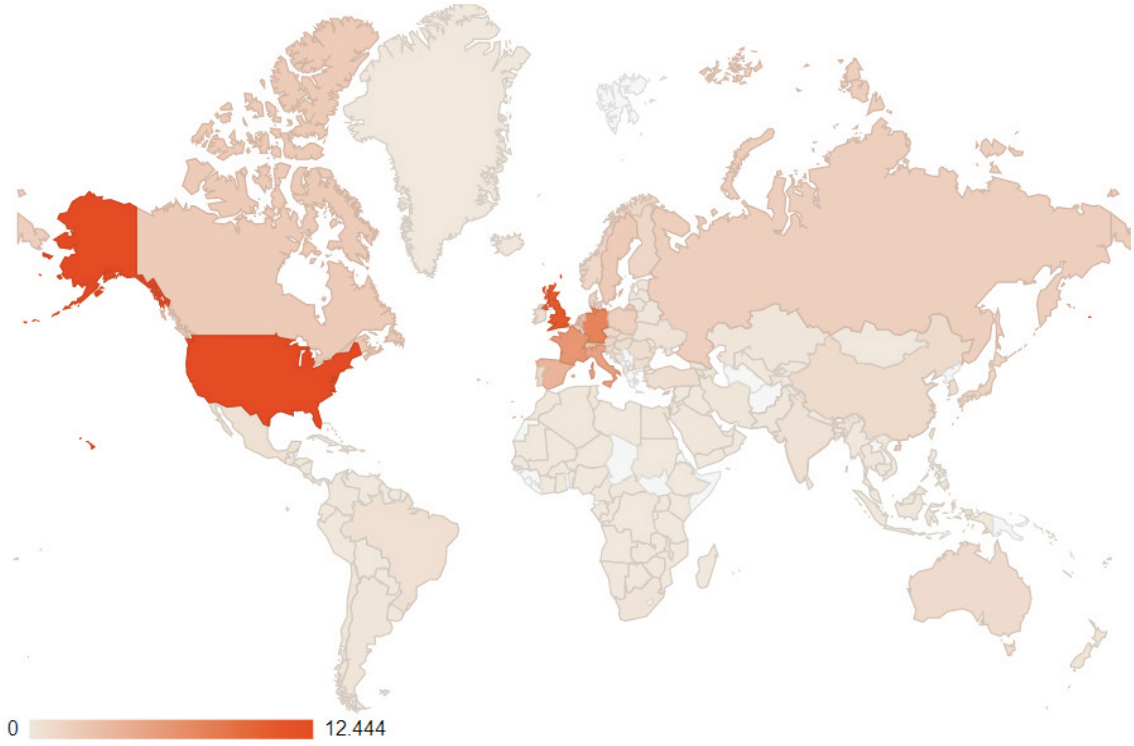


Figure 2.5.2 Countries collaborating in Greek publications, 2006-2010 / Source: Scopus 1996-2010

Figure 2.5.3 illustrates the annual growth in the number of Greek publications with national*, international** and no*** collaboration for the period 1996-2010.

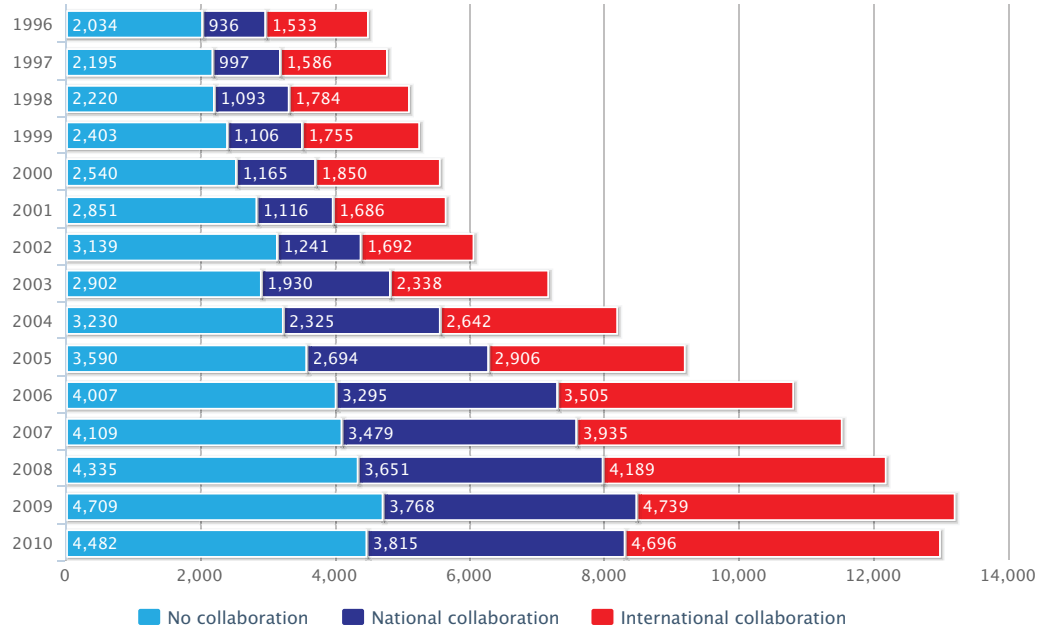


Figure 2.5.3 Distribution of Greek publications by type of collaboration, 1996-2010 / Source: Scopus 1996-2010

* Number of publications with at least one national collaboration.

** Number of publications with at least one international collaboration.

*** Number of publications with one single Greek institution.

This section presents the bibliometric indicators for the main categories of institutions. Greek institutions were classified into categories according to their sectors – e.g. higher education, research, health services – as well as their legal status –e.g. public or private institutions–.

Specifically, institutions were grouped into 8 categories. The table below shows the number of publications and citations for each institution category for the years 2006-2010.

3. Scientific Publications by Institution Categories

	2006-2010	
	Number of publications	Number of citations
Universities	43,960	219,658
Technological Educational Institutes	2,868	8,104
Research Centers supervised by GSRT	6,675	43,813
Other Public Research Institutions	1,862	8,348
Public Health Institutions	7,933	36,601
Private Health Institutions	1,441	11,475
Other Public Institutions	942	3,014
Other Private Institutions	1,291	5,100

3.1 Publications

The majority of the Greek scientific publications were produced by "Universities", "Public Health Institutions" and "Research Centers supervised by GSRT". These were followed by "Technological Educational Institutes", "Other Public Research Centres", "Private Health Institutions", "Other Public Institutions" and "Other Private Institutions".

In detail, during 1996-2010, the category "Universities" was the top performing institution category –in terms of the number of publications–. Indeed, the great majority of Greek publications was produced with the participation of Universities. As a result, the annual change in the number of publications issued by Universities actually defined the change in the total number of Greek publications. Until 2010, Universities experienced a constant growth in their publications. In 2010, a small decline was observed and Universities produced fewer publications (9,302) compared to 2009 (9,534) (Figures 3.1.1 and 3.1.2).

"Public Health Institutions" are second in terms of the number of publications –with 1,612 publications in 2010–. Up to 2009, their publications followed an upward trend and started decreasing in 2010 (Figures 3.1.1 and 3.1.2).

The "Research Centres supervised by GSRT" were ranked third among the eight institution categories, producing 1,479 publications in 2010 and marking a steady increase since 2001 (Figure 3.1.1). It is worth mentioning that this category is the only one showing an increase in 2010 (Figures 3.1.1 and 3.1.2).

The publication output of "Technological Educational Institutes (TEI)" was lower –with 658 publications in 2010 (Figure 3.1.1)–. Since 2005, the category holded the 4th place among all institution categories and until 2009, its growth rate was well above the average rate of Greek publications. In 2010, TEI' s publications were stable (Figures 3.1.1 and 3.1.2).

The category "Other Public Research Centres" includes 9 research institutions supervised by several Ministries. With a publication output of 390 publications in 2010, the category displayed a steady upward trend until 2009 and a small decline in 2010 (Figures 3.1.1 and 3.1.2).

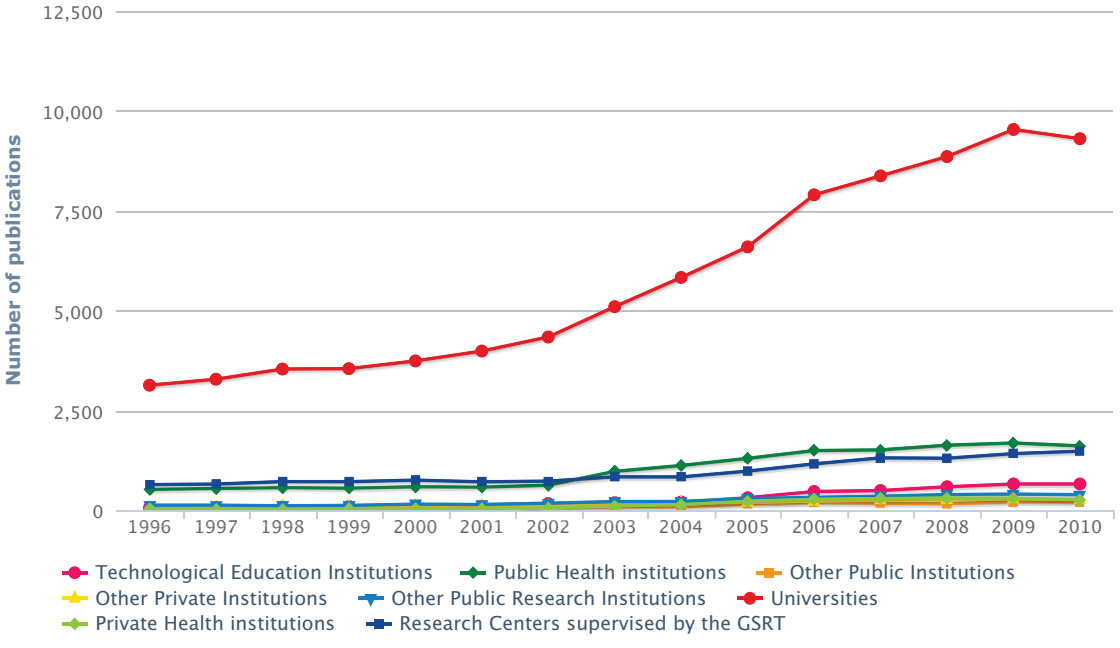
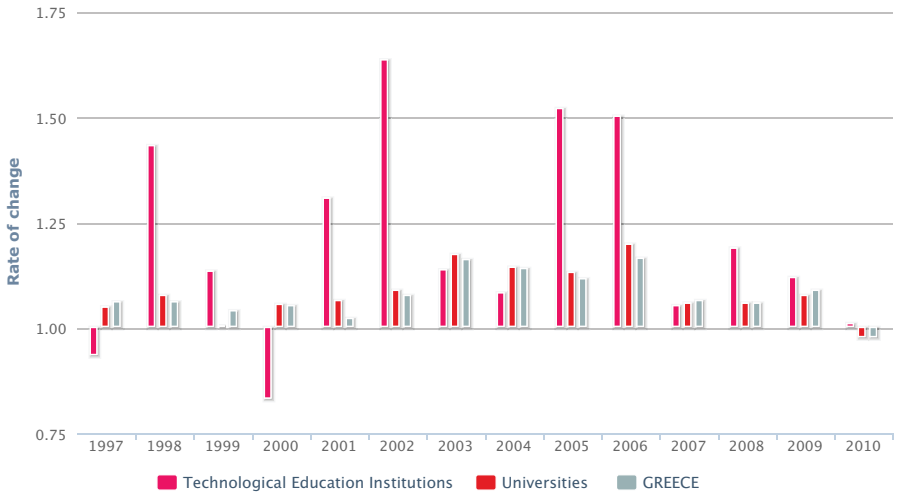
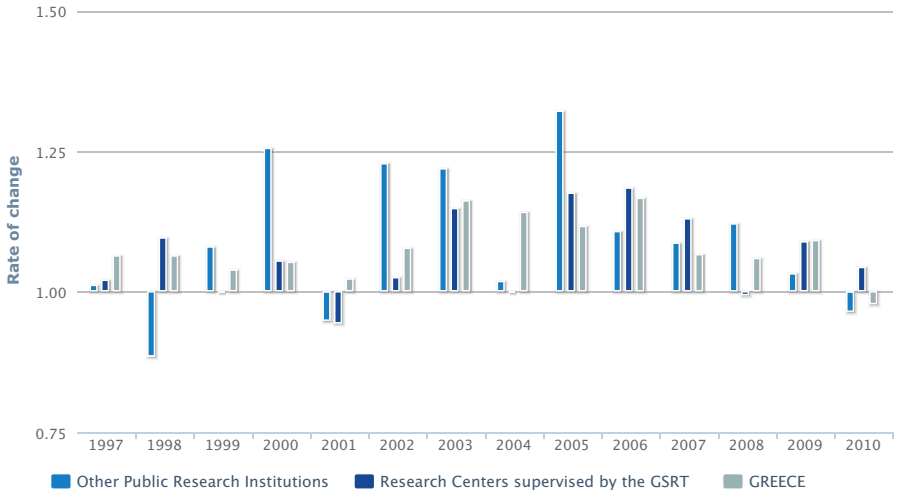


Figure 3.1.1 Development of the number of publications, by institution category, 1996-2010 / Source: Scopus 1996-2010

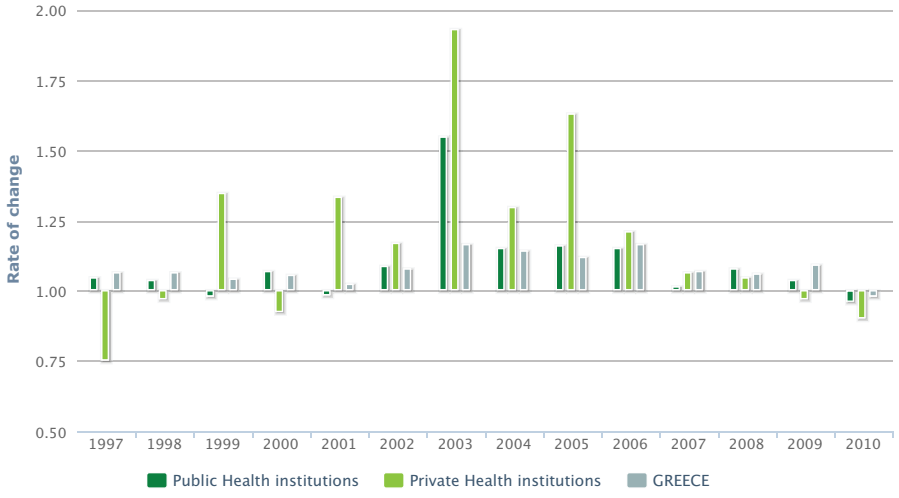
Universities-TEI



Research Centers



Health institutions



● **Other Institutions**

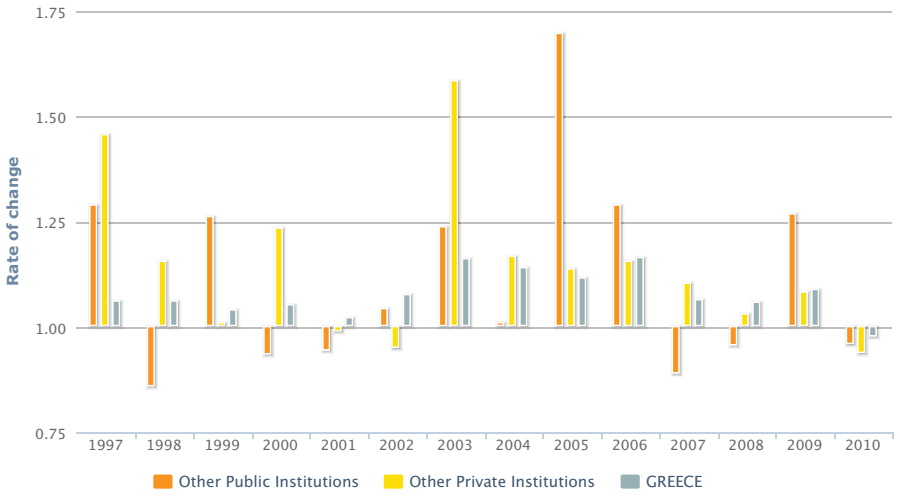


Figure 3.1.2 Change in the number of publications, 1996-2010 / Source: Scopus 1996-2010

The publication output of "Private Health Institutions" varied with up-and-downs throughout the period. Following 2008, we observed a negative change rate. In 2010, Private Health Institutions produced 267 publications (Figures 3.1.1 and 3.1.2).

Other Public and Private Institutions made a smaller contribution to the total publication output –e.g. in 2010 accounted for 200 and 265 publications respectively (Figure 3.1.1)–.

Figure 3.1.3 shows the share of the total number of Greek publications* per each institution category for the latest five year period 2006-2010. Universities were ranked first with a share of 79%. They were followed by Public Health Institutions (14.3%), Research Centres supervised by GSRT (12%), Technological Educational Institutes (5.2%), Other Public Research Institutions (3.3%), Private Health Institutions (2.6%), Other Private Institutions (2.3%) and Other Public Institutions (1.7%).

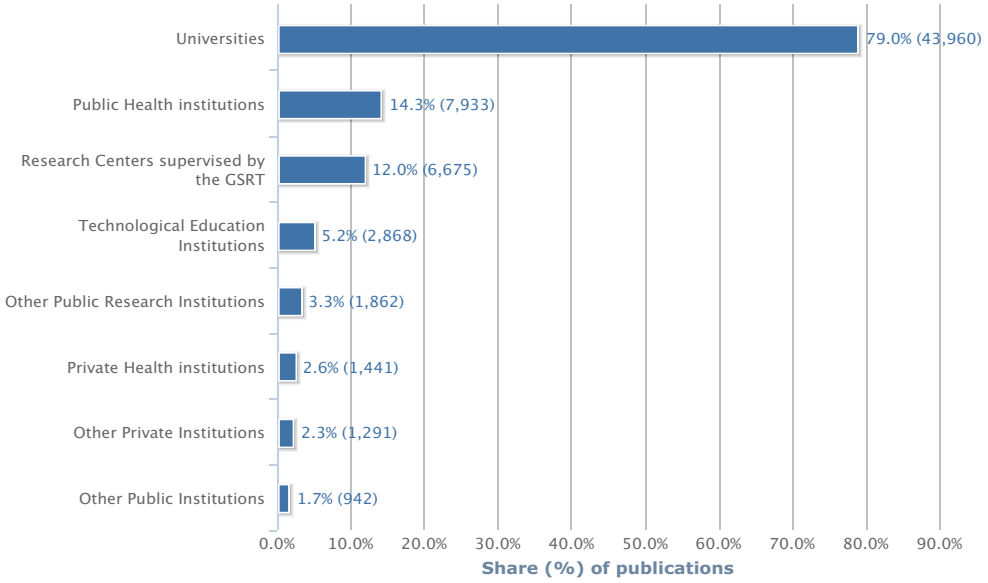


Figure 3.1.3 Number and share (%) of publications, by institution category, 2006-2010 / Source: Scopus 1996-2010

* As demonstrated in the Methodology (Annex I), each institution category received a whole count of the publication (whole counting) for publications produced as a result of collaboration between institutions in different institution categories. The (%) share of publications by institution category was calculated as a proportion of the total number of Greek publications (Figure 3.1.3) and indicated the degree of "participation" of each category to Greece's total publication output. Hence, in the case of Universities, a share of 79% would mean that Universities participated in 79% of the total number of Greek publications.

3.2 Citations

Between 1996-2010, citation indices grew over time for all institution categories following the growth trend of Greek publications and their indicators.

"Research Centres supervised by GSRT" and "Private Health Institutions" had the highest percentage (%) of cited publications among all institution categories (Figure 3.2.1). This figure varied from 55% for "Technological Educational Institutes" to 75% for "Research Centres supervised by GSRT," with the Greek average being 65.6%.

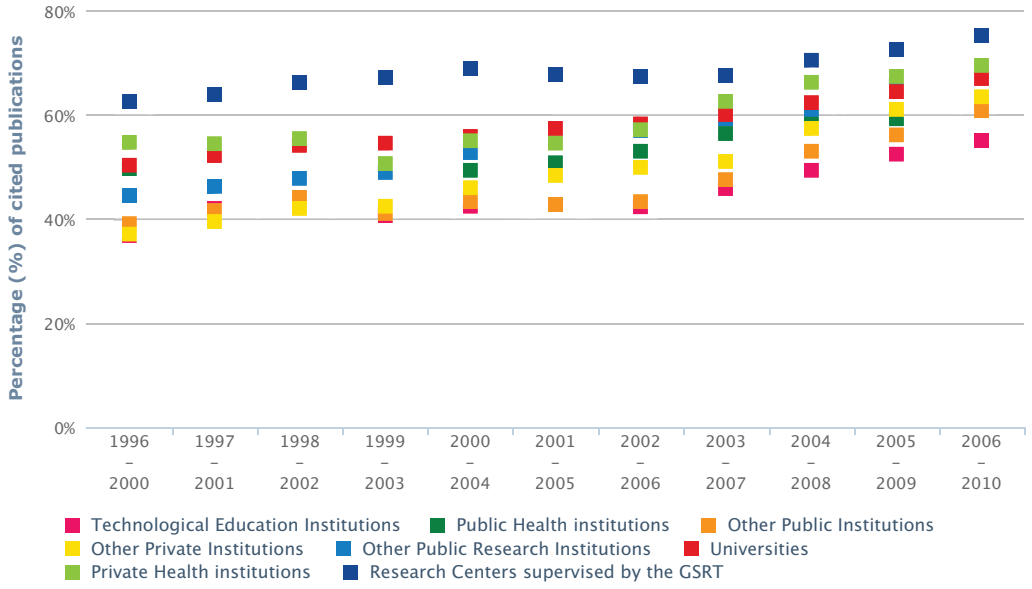


Figure 3.2.1 Percentage (%) of cited publications, by institution category, 1996-2010 / Source: Scopus 1996-2010

Figure 3.2.2 tracks the number of citations and its growth/evolution between 1996-2010. During 1996-2010, the number of citations in the institution categories grew.

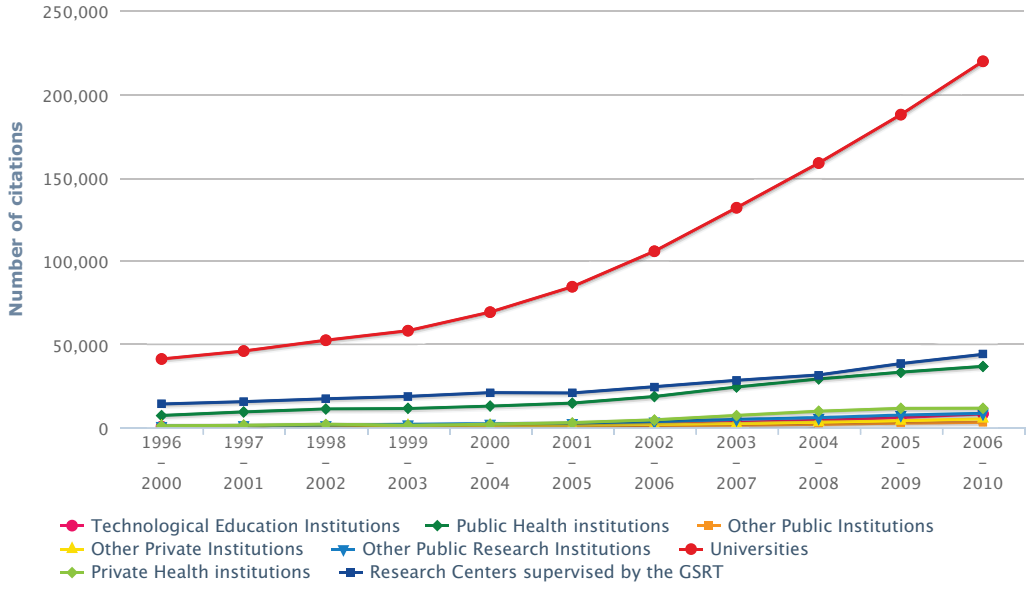


Figure 3.2.2 Number of citations, by institution category, 1996-2010 / Source: Scopus 1996-2010

Apart from the highest representation in the number of publications, "Universities" had also the highest share in the number of citations. More specifically, during 2006-2010, Universities' publications received 219,658 citations, accounting for 79.3% of the total number of citations of Greek publications. The number and share of citations for the rest institution categories was: 43,813 and 15.8% for "GSRT Research Centers", 36,601 and 13.2% for "Public Health Institutions", 11,475 and 4.1% for "Private Health Institutions", 8,348 and 3% for "Other Public Institutions", 8,104 and 2.9% for "Technological Educational Institutes", 5,100 and 1.8% for "Other Private Institutions "and 3,014 and 1.1% for "Other Public Institutions" (Figures 3.2.2 and 3.2.3).

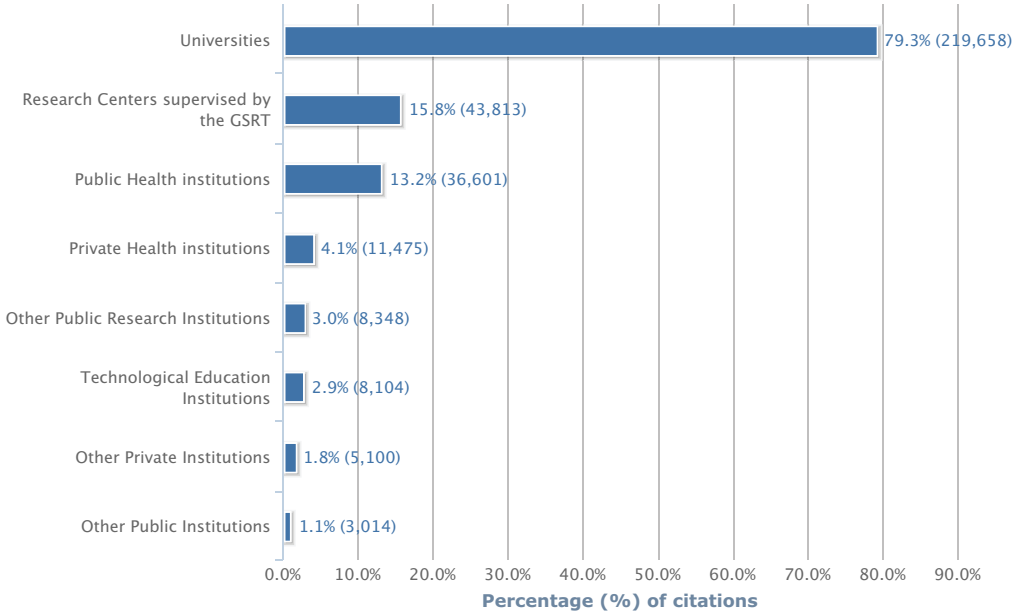


Figure 3.2.3 Number and share (%) of citations by institution category, 2006-2010 / Source: Scopus 1996-2010

3.3 Citation impact

Figure 3.3.1 shows, for each institution category, the number of publications and citations for the latest 5-year period (2006-2010) and the relevant "field-normalised citation score". The field normalised citation score or "citation score" is the relative number of citations to publications of a specific category compared to the world average of citations to publications of the same time period and scientific subject field. The normalisation is done at the level of publication according to the 307 scientific subject fields. In case that a publication was attributed to more than one subject field, a mean value of the fields was calculated. The citation score was calculated using software developed by EKT. A value greater than 1, indicates that the impact of publications was higher than the world average.

"Research Centres supervised by GSRT" and "Private Health Institutions" had citation scores above the world average, –1.20 and 1.18 respectively–. Other institution categories had lower citation indicators.

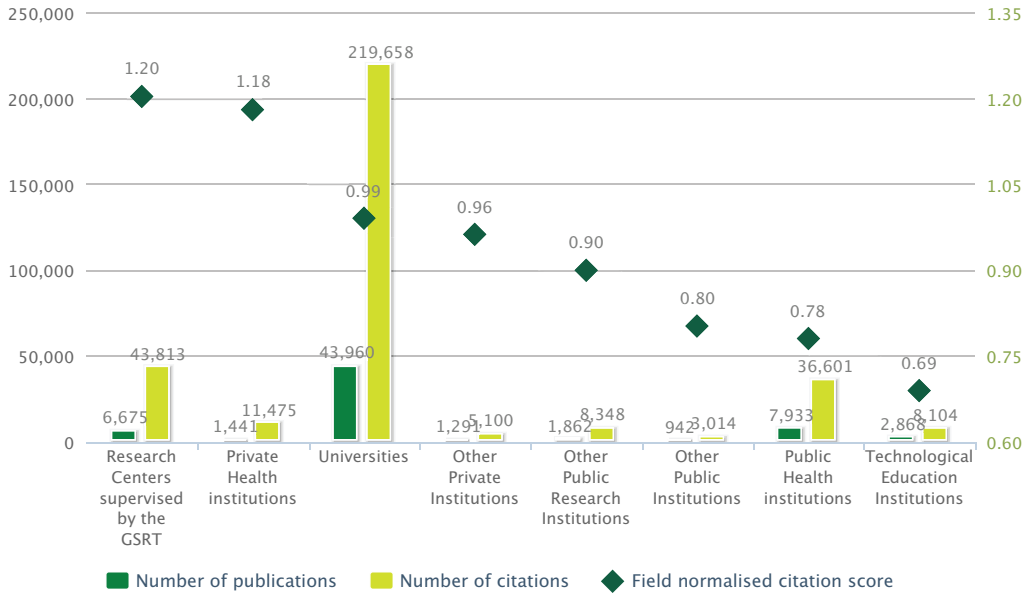


Figure 3.3.1 Publications, citations and field normalised citation score relative to the world, by institution category, 2006-2010. Data refers to the total number of publications in each category for all scientific fields / Source: Scopus 1996-2010

3.4 Major fields of science

The citation scores of publications across the six major fields of science for all institution categories* appear in Figure 3.5.1 The Figure also displays the number of publications and citations. Data refers to the most recent 5-year period 2006-2010.

In "Natural Sciences", citation scores for a small number of publications attributed to the "Research Centres supervised by GSRT" (1.11) were above the world average, with the publications of the "Universities" coming close (0.97).

In "Engineering and Technology" the highest citation score (1.25) was attributed to the publications of "GSRT Research Centres". The publications of "Universities" followed (1.13), and the publications of "Other Public Research Centres" were very close to the world average (0.99).

In "Medical Sciences", publications of three institution categories had a slightly better performance that the world average: "GSRT Research Centres" (1.22), "Private Health Institutions" (1.17) and "Other Public Research Centres" (1.03).

In "Agricultural Sciences" the higher citation scores were attributed to the publications of "GSRT Research Centres" (1.06) and "Universities" (1.05).

In "Social Sciences", citation scores were below the world average for all institution categories. Publications of "GRST Research Centres" had the higher value (1.11).

Finally, in the field of "Humanities", only "GRST Research Centres" and "Universities" produced publications in a systematic way. However, both institution categories had citation scores above the world average and "GRST Research Centres" exceeded that baseline by far (2.55 and 1.04 for "Universities").

* The field normalized citation rate was provided only for the institution categories with more than 75 publications for the period 1996-2010.

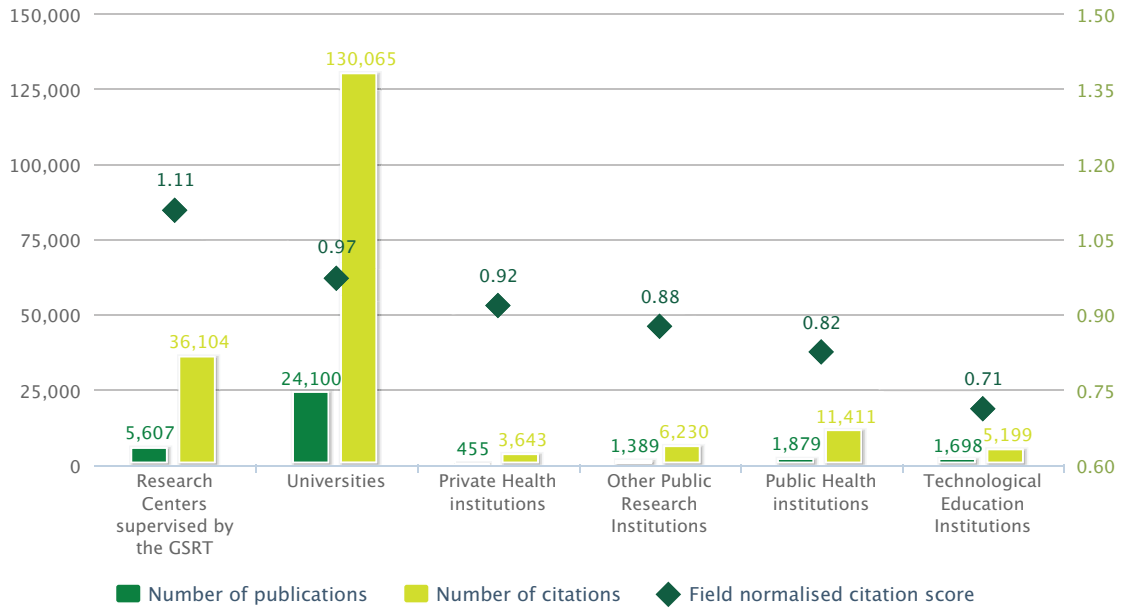


Figure 3.4.1 Publications, citations and field normalised citation score in the major field of "Natural Sciences" relative to the world, by institution category, 2006-2010 / Source: Scopus 1996-2010

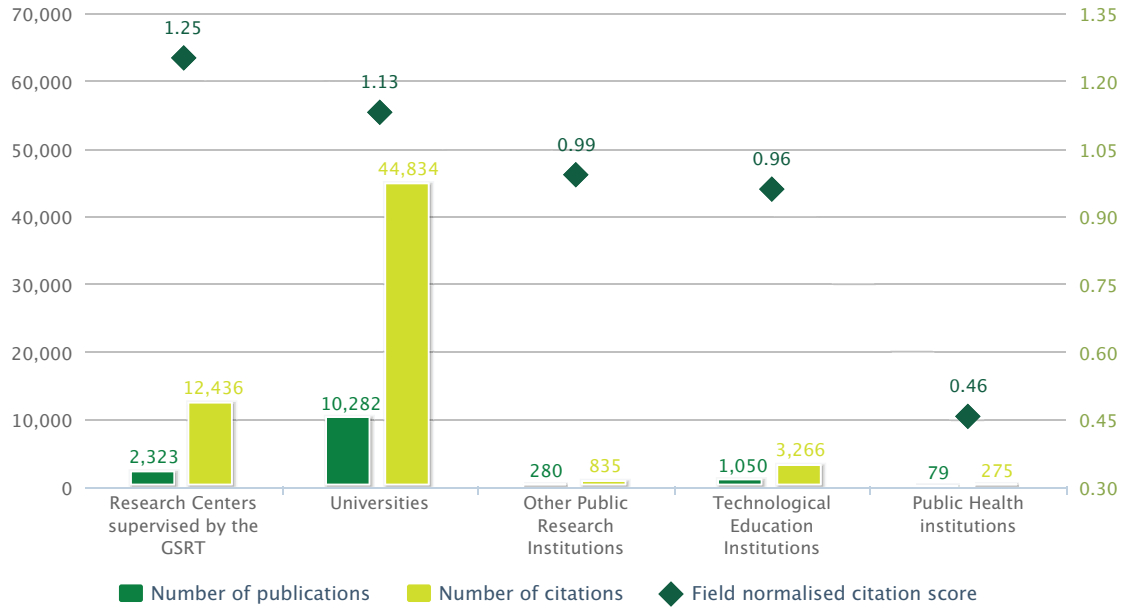


Figure 3.4.1 Publications, citations and field normalised citation score in the major field of "Engineering & Technology" relative to the world, by institution category, 2006-2010 / Source: Scopus 1996-2010

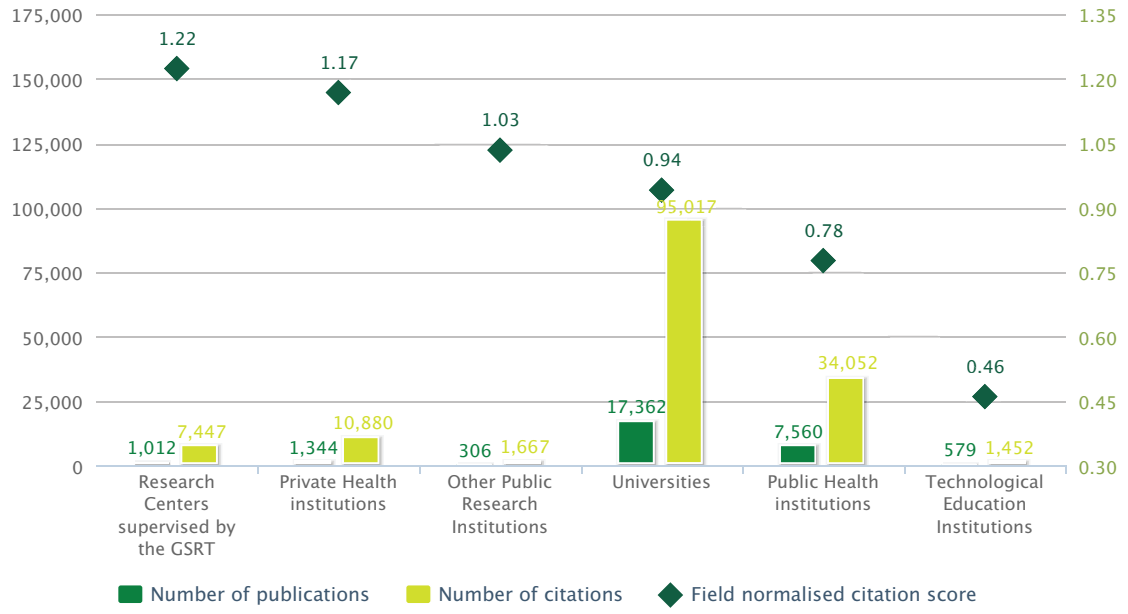


Figure 3.4.1 Publications, citations and field normalised citation score in the major field of "Medical & Health Sciences" relative to the world, by institution category, 2006-2010 / Source: Scopus 1996-2010

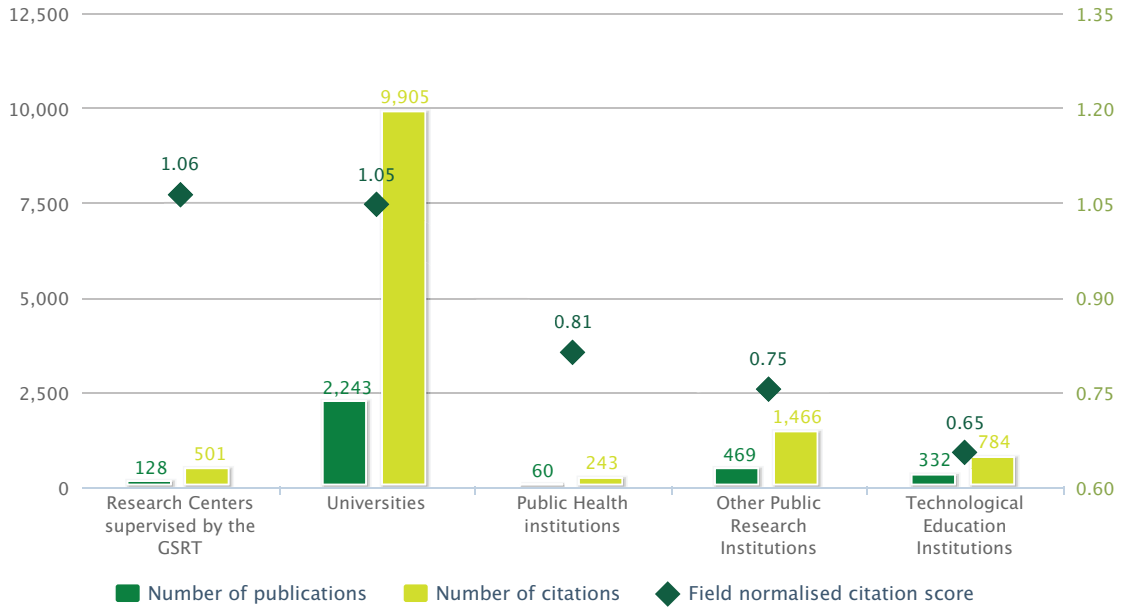


Figure 3.4.1 Publications, citations and field normalised citation score in the major field of "Agricultural Sciences" relative to the world, by institution category, 2006-2010 / Source: Scopus 1996-2010

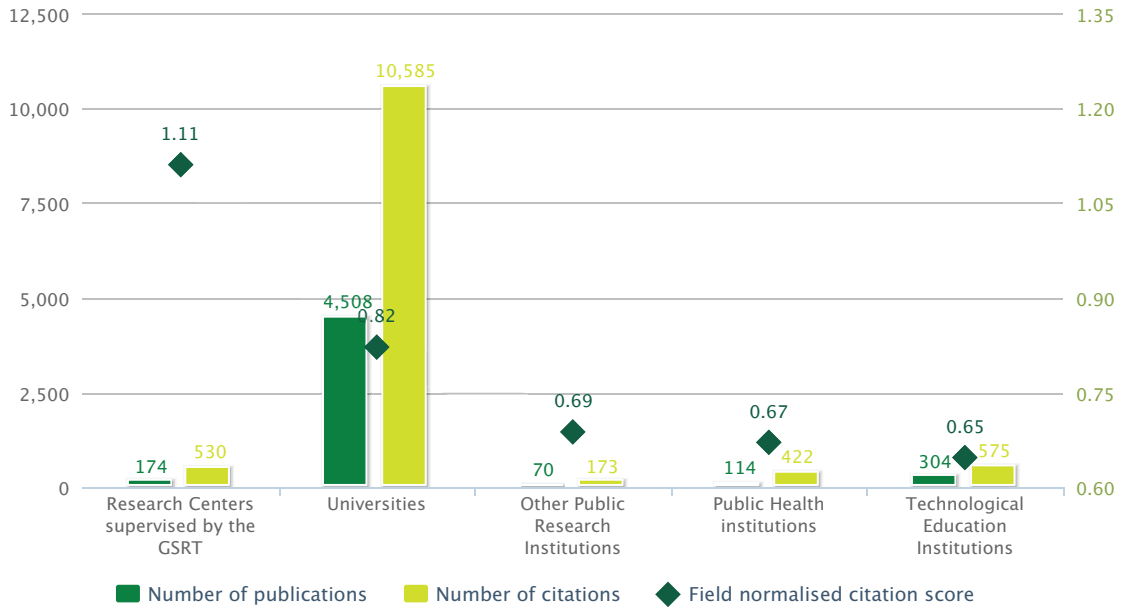


Figure 3.4.1 Publications, citations and field normalised citation score in the major field of "Social Sciences" relative to the world, by institution category, 2006-2010 / Source: Scopus 1996-2010

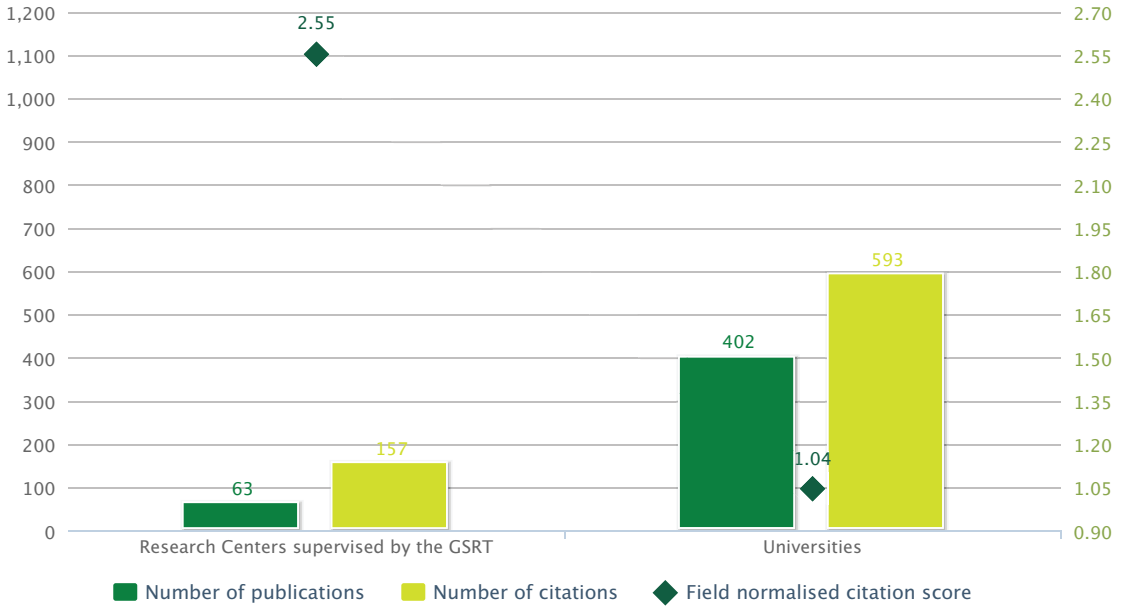


Figure 3.4.1 Publications, citations and field normalised citation score in the major field of "Humanities" relative to the world, by institution category, 2006-2010 / Source: Scopus 1996-2010

3.5 Scientific collaboration

During 1996-2010, all institution categories showed increasing trends in the levels of international and national collaboration.

Notably, up to 2008, there was a considerable growth in the collaborations across national institutions. This can be partly explained by an increase in funding from the national research consortia within national Structural Funds Programmes. For example, the publications being a result of national collaboration* had risen from 833 in 1996 to 3,396 in 2010 for "Universities", from 299 to 869 for "Research Centres supervised by GSRT" and from 40 to 445 for "Technological Educational Institutes" (Figure 3.5.1).

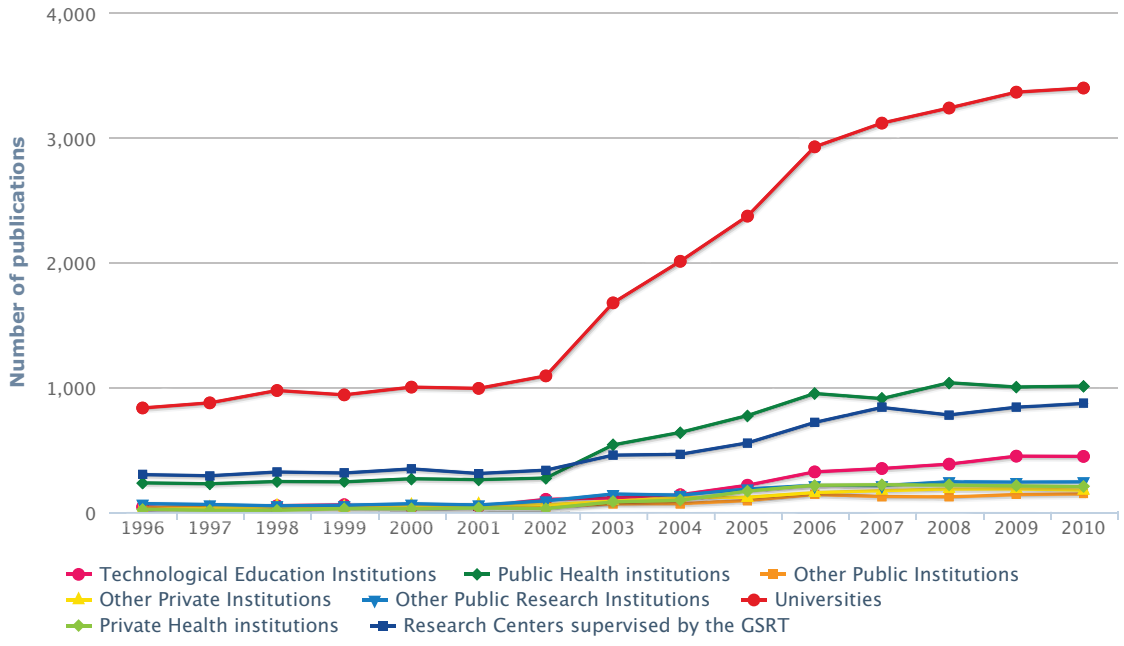
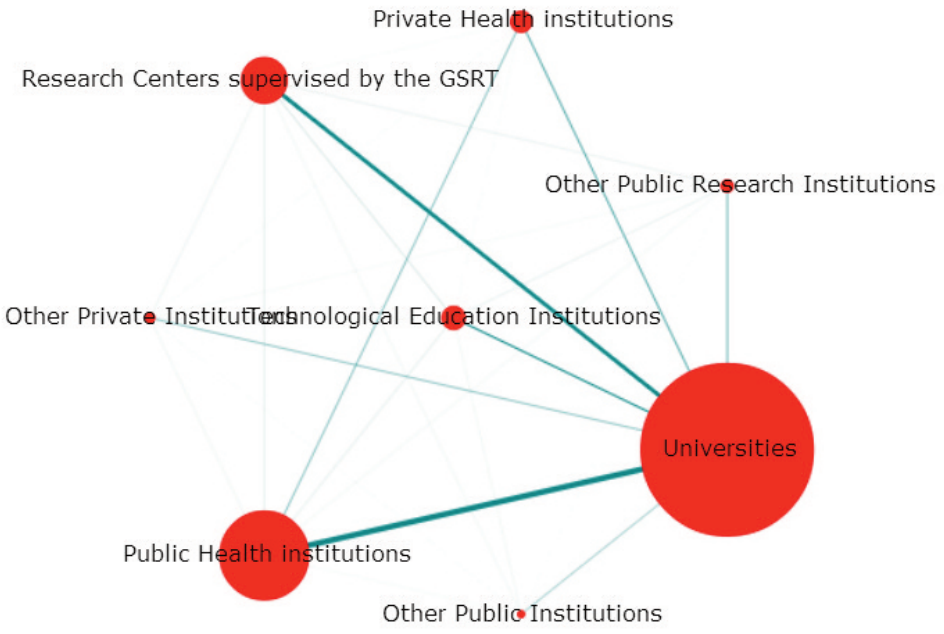


Figure 3.5.1 Number of publications with national collaboration, by institution category, 1996-2010 / Source: Scopus 1996-2010

The majority of publications with national collaboration included Universities as partners (Figure 3.5.2). Universities exhibited strong collaborative links with "Research Centres supervised by GSRT" and "Public Health Institutions".

* Publications with national collaboration are publications produced as a result of collaboration between at least two Greek institutions, either of the same category (for example a publication produced as a result of collaboration between 2 Universities) or of different Categories (for example a publication produced as a result of collaboration between a University and a Private Health Institution).



	Universities	TEI	Research Centers supervised by GSRT	Other Public Research Institutions	Public Health Institutions	Private Health Institutions	Other Public Institutions	Other Private Institutions
Universities	8,503	2,048	4,725	1,158	7,014	1,352	678	894
TEI	2,048	194	255	142	161	34	86	71
Research Centers supervised by GSRT	4,725	255	199	140	192	45	85	117
Other Public Research Institutions	1,158	142	140	28	78	15	26	56
Public Health Institutions	7,014	161	192	78	2,521	910	50	93
Private Health Institutions	1,352	34	45	15	910	341	5	33
Other Public Institutions	1,158	86	140	28	50	15	28	56
Other Private Institutions	894	71	117	56	93	33	37	18

Figure 3.5.2 Mapping of collaborations between categories of Greek institutions, 2006-2010 / Source: Scopus 1996-2010

The growth rate of Greek publication activity produced with international collaboration was slightly lower than the growth rate of publications produced as a result of national collaboration. More specifically, the number of international publications had risen from 1,113 in 1996 to 3,348 in 2010 for "Universities", from 355 in 1996 to 842 in 2010 in "Research Centres supervised by GSRT" and from 26 in 1996 to 141 in 2010 for "Technological Educational Institutes" (Figure 3.5.3).

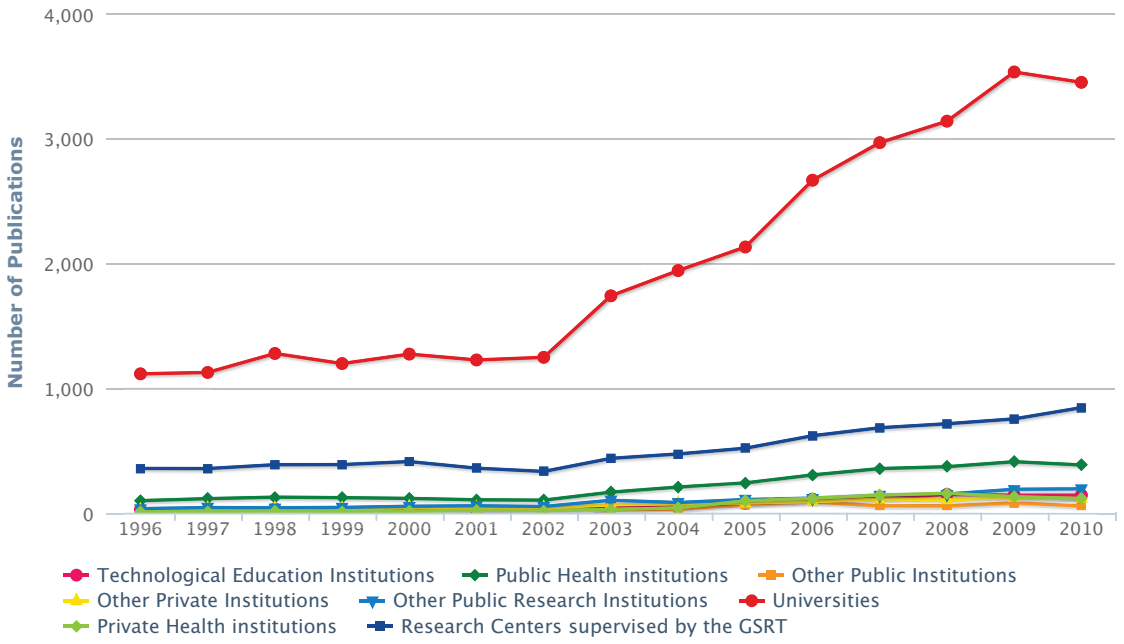


Figure 3.5.3 Number of publications with international collaboration, by institution category, 1996-2010 / Source: Scopus 1996-2010

The level and the type of collaboration –national or international- varied significantly within Institution Categories (Figure 3.5.4). "Universities" had the highest share of publications without collaboration*, which was equal to 37.9% during the 5-year period 2006-2010. "GSRT Research Centres" had the highest share of publications with international collaborations** (54% during the 5-year period 2006-2010). Finally, "Private Health institutions" had the highest share of publications with national collaborations*** (73.5% during the 5-year period 2006-2010).

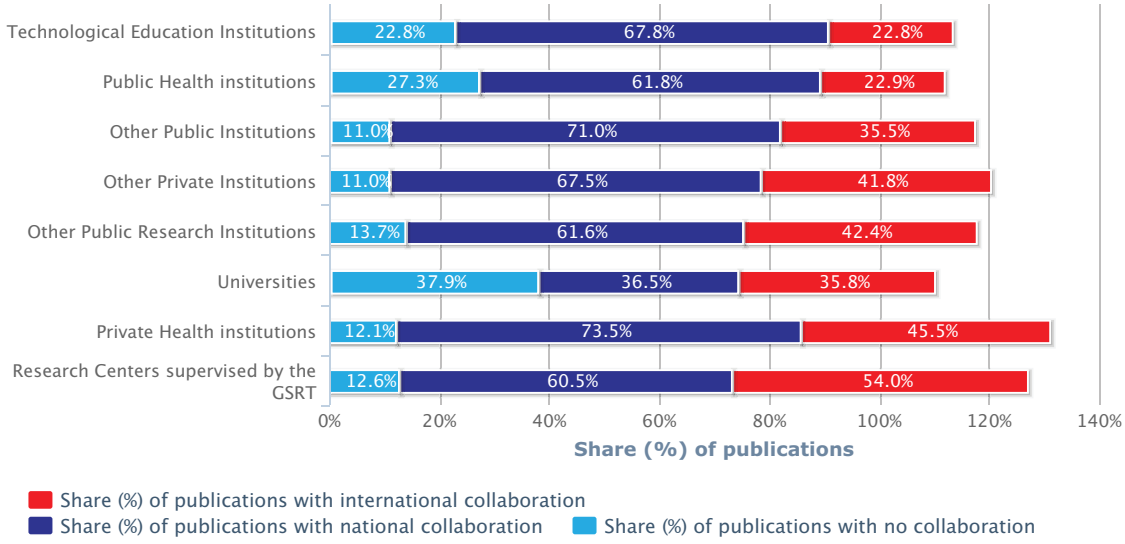


Figure 3.5.4 Share (%) of publications with national, international and no collaboration, by institution category, 1996-2010 / Source: Scopus 1996-2010

* Number of publications with no collaboration, per institution.

** Number of publications with at least one international collaboration.

*** Number of publications with at least one national collaboration.

Universities account for the majority of scientific output in Greece. The chapter examines bibliometric indicators for the publications produced by 21 Universities. The table below presents the number of publications and citations for each University. Data corresponds to the period 2006-2010.

4. Scientific Publications by Universities

		2006-2010	
		Number of publications	Number of citations
Agricultural University of Athens	AUA	1,218	5,409
Aristotle University of Thessaloniki	AUTH	8,932	40,063
Athens University of Economics and Business	AUEB	787	2,093
Demokritos University of Thrace	DUTH	2,114	7,872
Harokopio University of Athens	HUA	691	3,541
Hellenic Open University	HOU	220	554
Ionian University	IONIO	88	141
National & Kapodistrian University of Athens	UOA	11,919	68,680
National Technical University of Athens	NTUA	4,327	18,114
Panteion University of Social and Political Sciences	PANTEION	140	252
Technical University of Crete	TUC	906	4,940
University of Central Greece	UCG	50	161
University of Crete	UOC	4,045	27,167
University of Ioannina	UOI	3,774	24,812
University of Macedonia of Economic and Social Sciences	UOM	496	1,205
University of Patras	UPATRAS	5,124	25,551
University of the Peloponnese	UOP	333	883
University of Piraeus	UNIPI	691	1,687
University of the Aegean	AEGEAN	1,153	3,582
University of Thessaly	UTH	2,486	11,077
University of Western Macedonia	UOWM	211	503

Publications by University Research Institutes and University Hospitals are also included.

The International Hellenic University, the Athens School of Fine Arts and the University of Western Greece are not represented in the graphs.

4.1 Publications

The greatest number of publications was attributed to the National & Kapodistrian University of Athens/UOA and the Aristotle University of Thessaloniki/AUTH - the country's largest Higher Education Institutions - with 2,533 and 1,839 publications in 2010 respectively (Figure 4.1.1). These were followed by 6 other Universities with more than 400 publications in 2010: the University of Patras/UOP (1,006 publications), the National Technical University of Athens/NTUA (859), the University of Crete/UOC (841), the University of Ioannina/UOI (818), the University of Thessaly/UTH (559) and the Demokritos University of Thrace/DUTH (491). The remaining Universities produced 261 or less publications in 2010.

There was a growth trend in the number of publications by Universities from 1996 to 2009, which leveled off for some of them in 2010. However, it has been a steady rise for the Harokopio University of Athens/HUA, the University of Central Greece, while the publications of the Universities of Ioannina, Thessaly, Piraeus, Western Macedonia, as well as the Demokritos University of Thrace, marked an increase for most of the period, as shown in Figure 4.1.1.

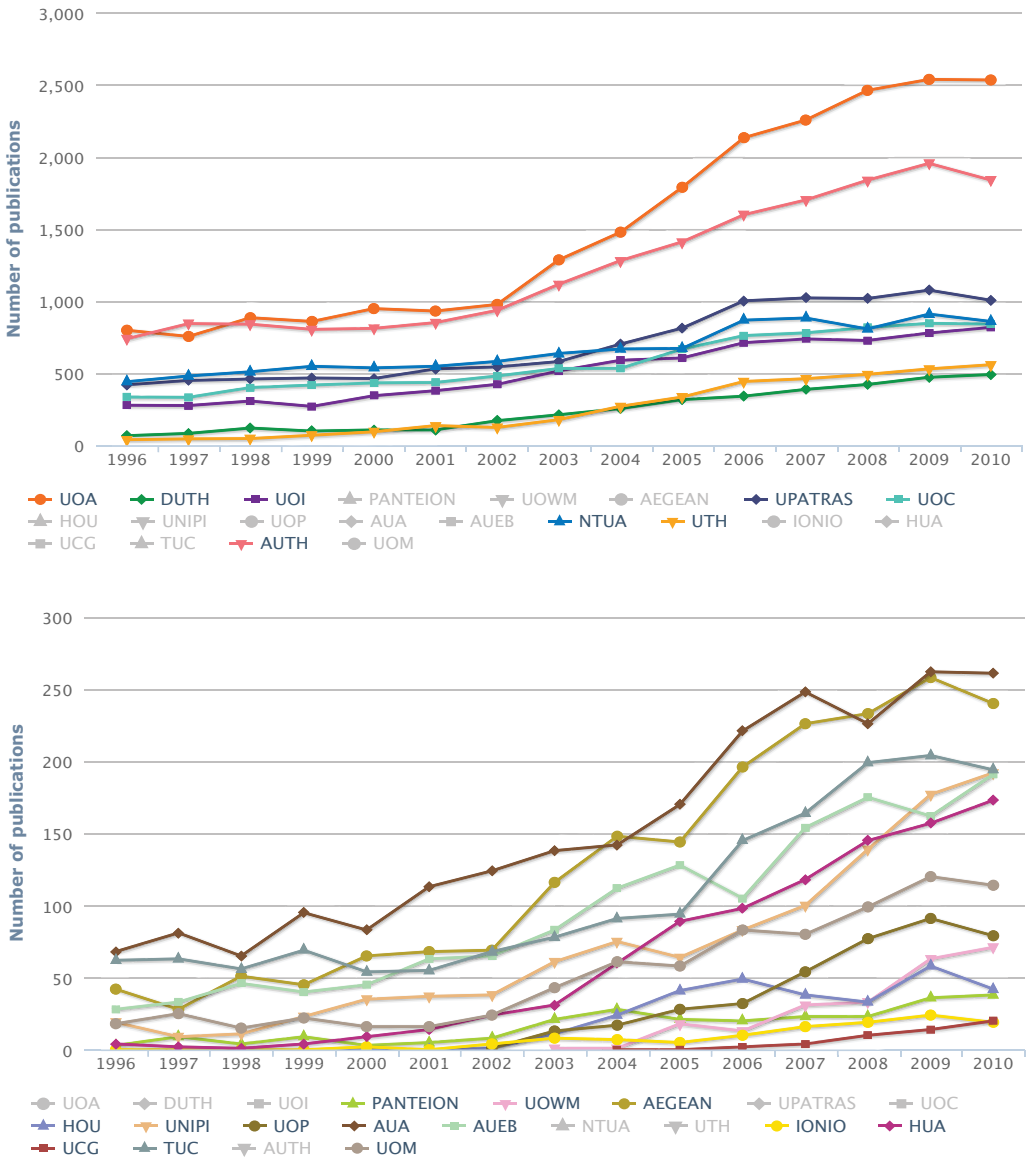


Figure 4.1.1 Development of the number of publications by University, 1996-2010 / Source: Scopus 1996-2010

Figure 4.1.2 demostrates the number of publications and its annual change rate between 1996 and 2010 for each University.

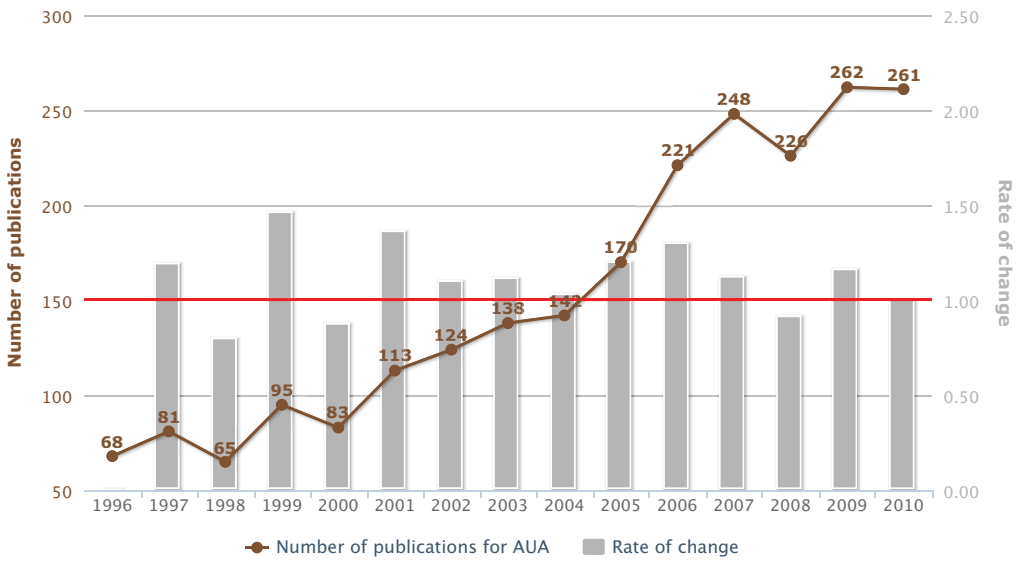


Figure 4.1.2 Number of publications and rate of change in the number of publications by Agricultural University of Athens, 1996-2010 / Source: Scopus 1996-2010

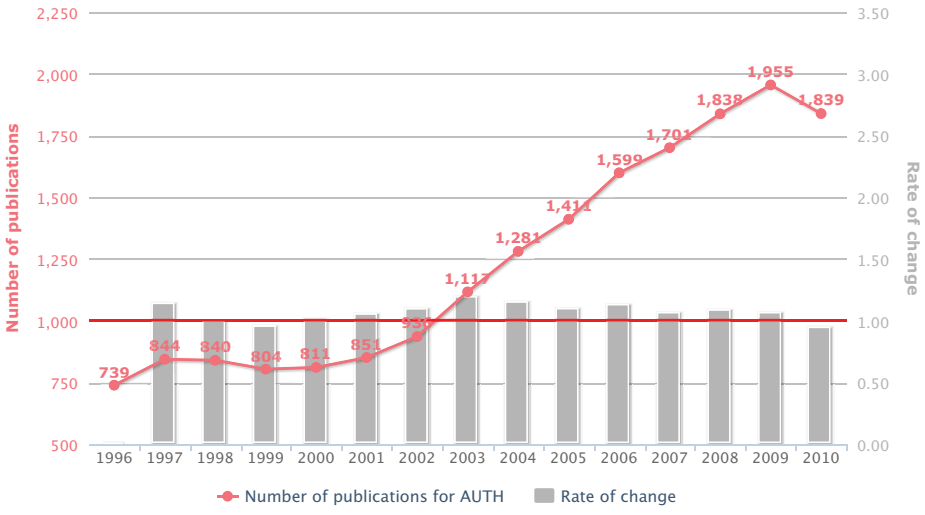


Figure 4.1.2 Number of publications and rate of change in the number of publications by Aristotle University of Thessaloniki, 1996-2010 / Source: Scopus 1996-2010

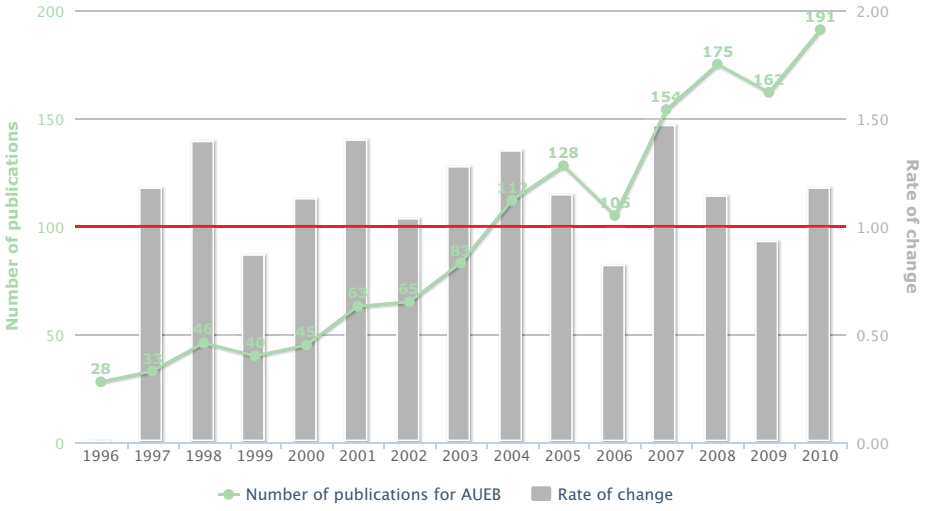


Figure 4.1.2 Number of publications and rate of change in the number of publications by Athens University of Economics and Business, 1996-2010 / Source: Scopus 1996-2010

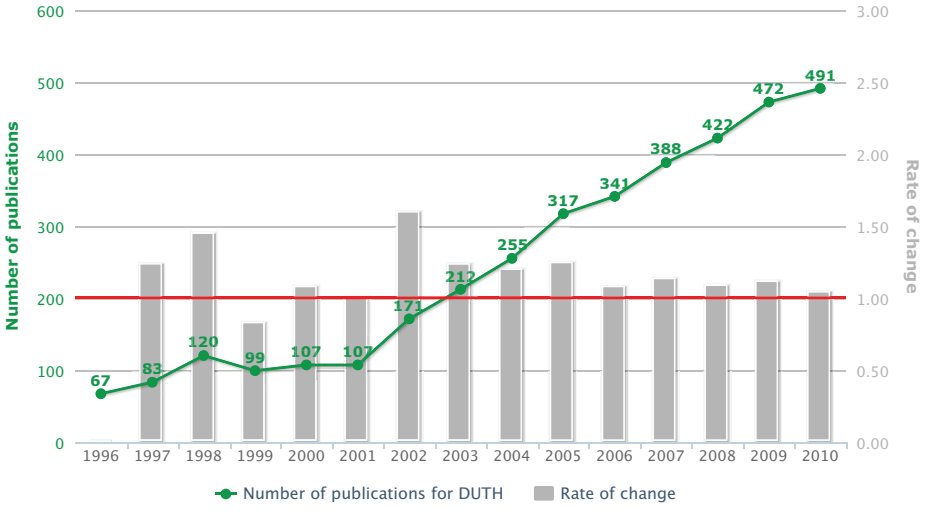


Figure 4.1.2 Number of publications and rate of change in the number of publications by Demokritos University of Thrace, 1996-2010 / Source: Scopus 1996-2010

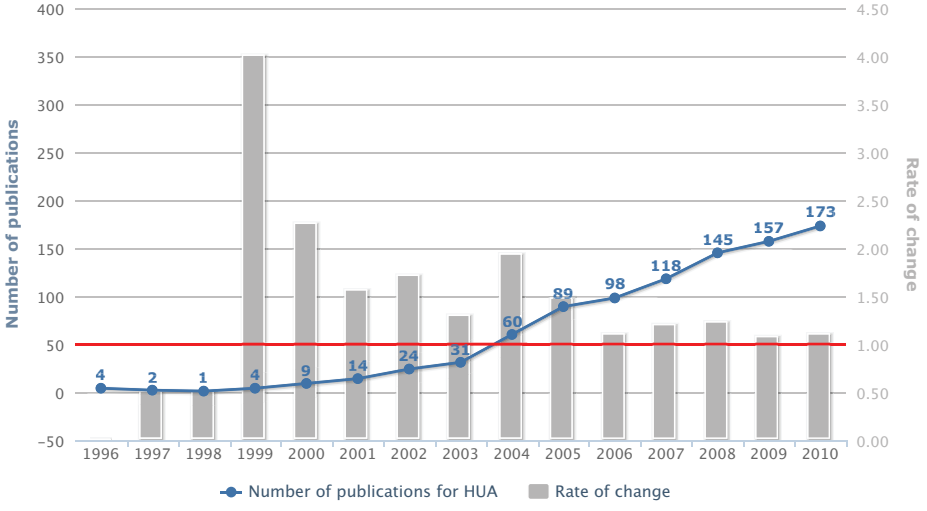


Figure 4.1.2 Number of publications and rate of change in the number of publications by Harokopio University of Athens, 1996-2010 / Source: Scopus 1996-2010

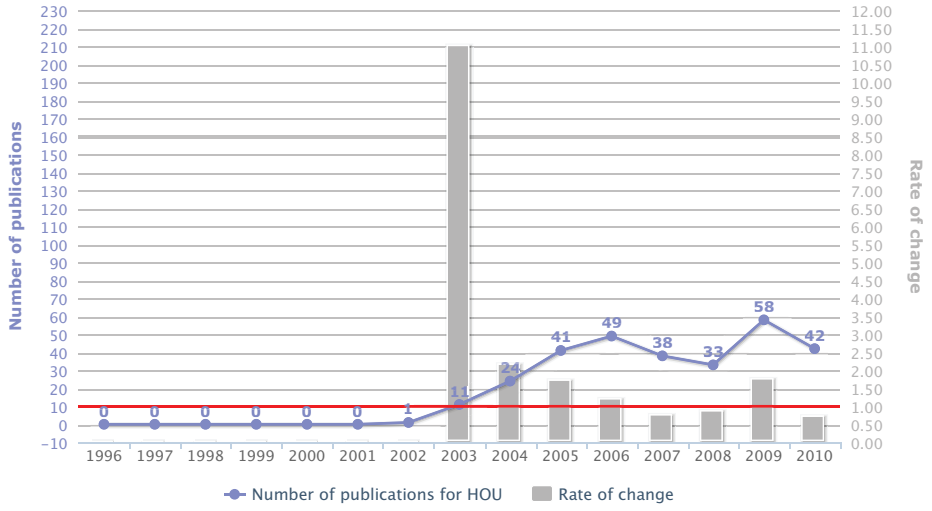


Figure 4.1.2 Number of publications and rate of change in the number of publications by Hellenic Open University, 1996-2010 / Source: Scopus 1996-2010

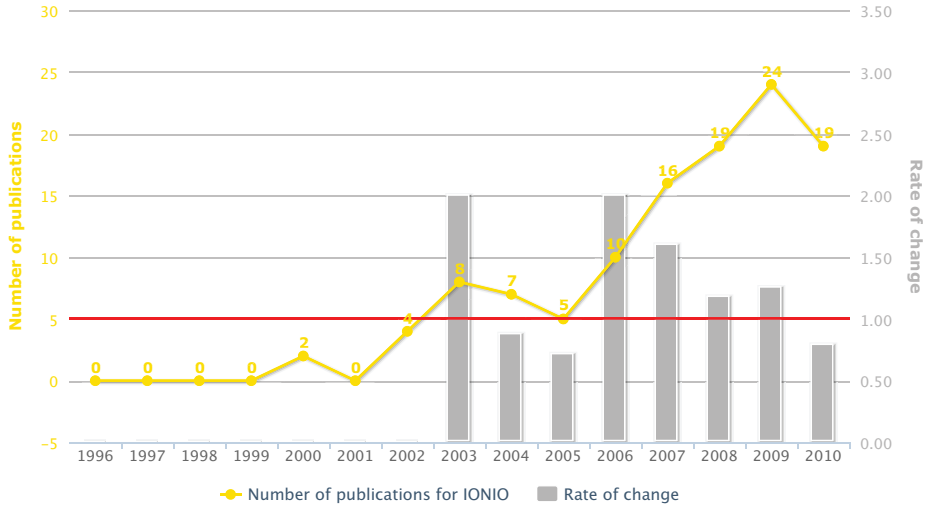


Figure 4.1.2 Number of publications and rate of change in the number of publications by Ionian University, 1996-2010 / Source: Scopus 1996-2010

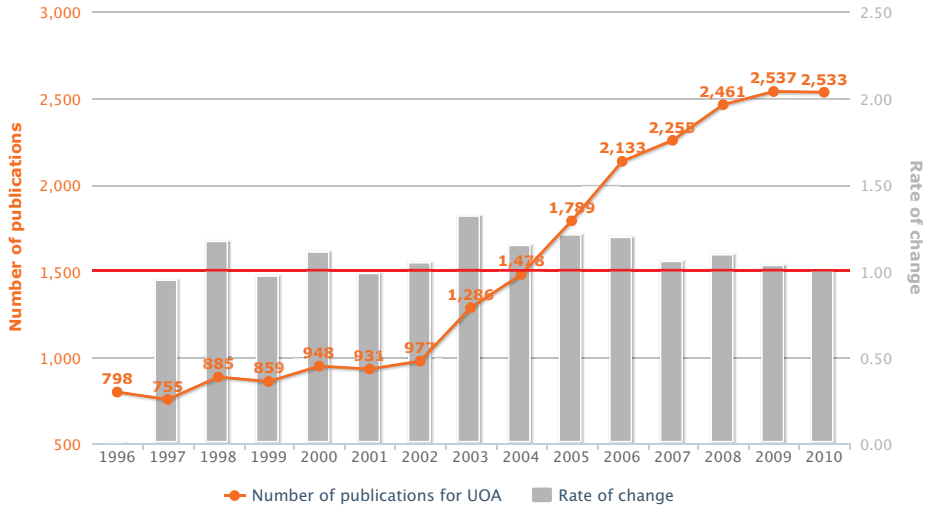


Figure 4.1.2 Number of publications and rate of change in the number of publications by National and Kapodistrian University of Athens, 1996-2010 / Source: Scopus 1996-2010

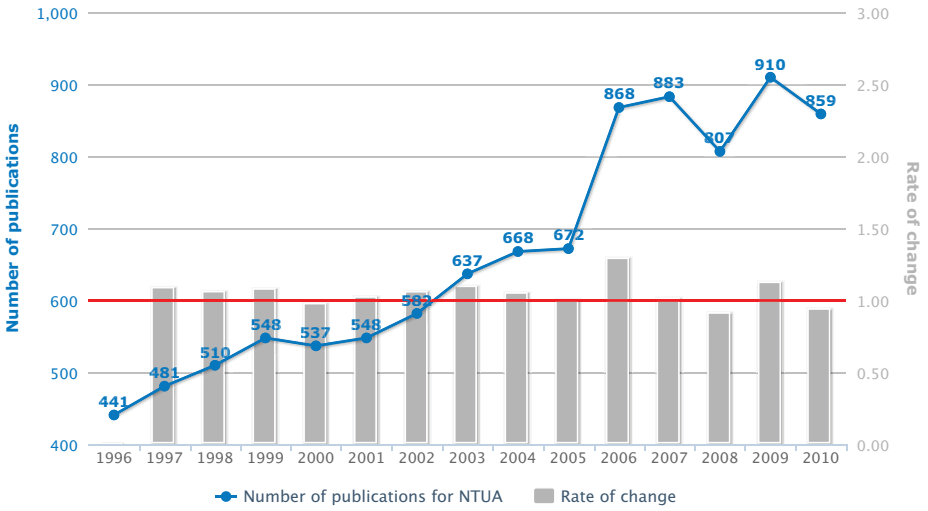


Figure 4.1.2 Number of publications and rate of change in the number of publications by National Technical University of Athens, 1996-2010 / Source: Scopus 1996-2010

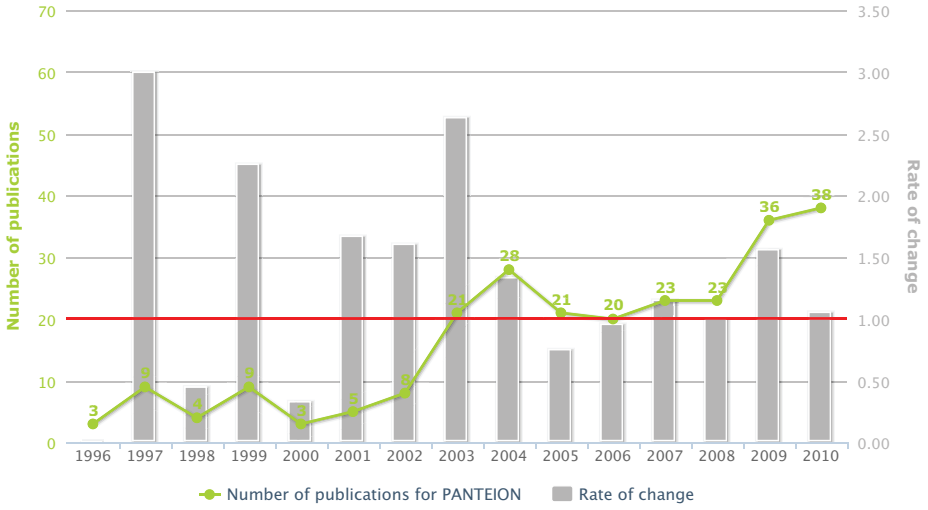


Figure 4.1.2 Number of publications and rate of change in the number of publications by Panteion University of Social and Political Sciences, 1996-2010 / Source: Scopus 1996-2010

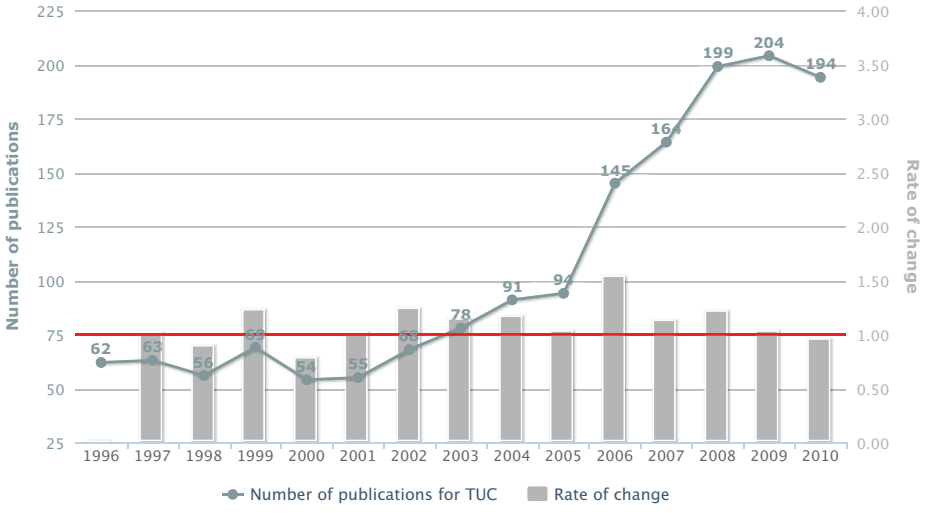


Figure 4.1.2 Number of publications and rate of change in the number of publications by Technical University of Crete, 1996-2010 / Source: Scopus 1996-2010

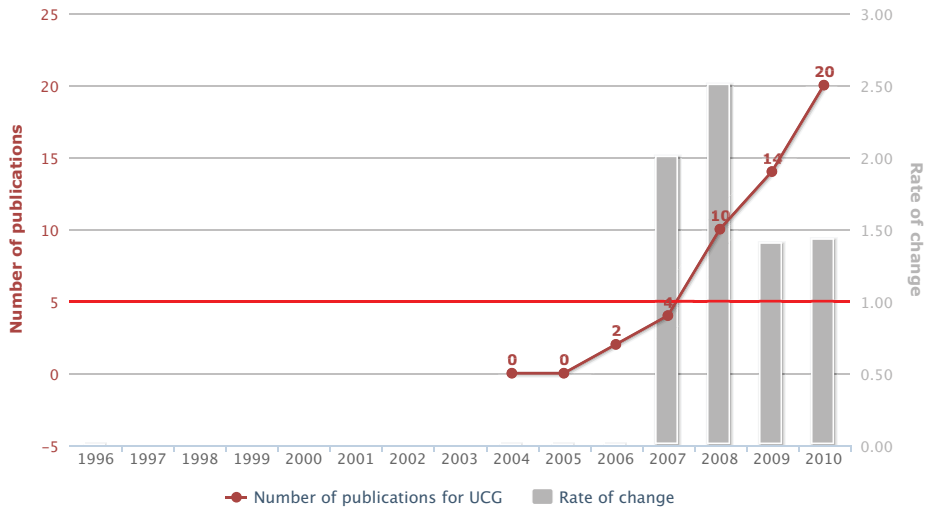


Figure 4.1.2 Number of publications and rate of change in the number of publications by University of Central Greece, 1996-2010 / Source: Scopus 1996-2010

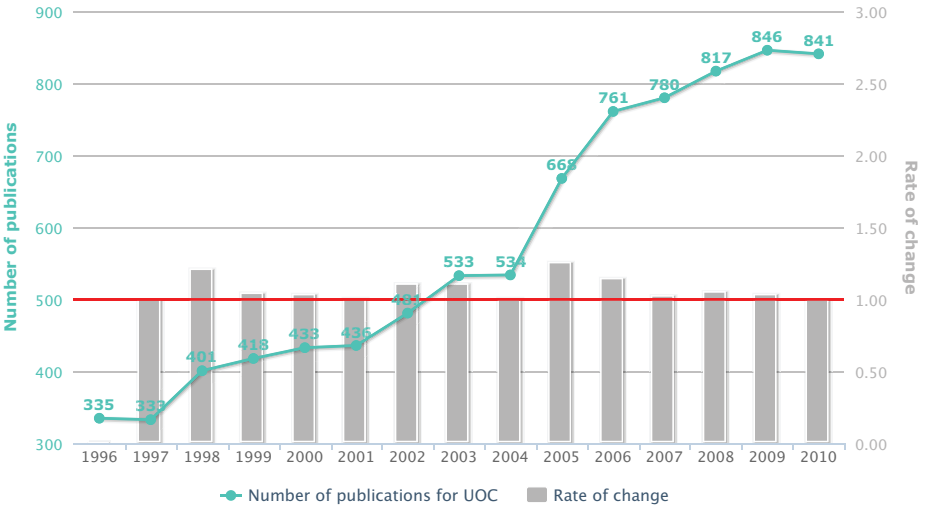


Figure 4.1.2 Number of publications and rate of change in the number of publications by University of Crete, 1996-2010 / Source: Scopus 1996-2010

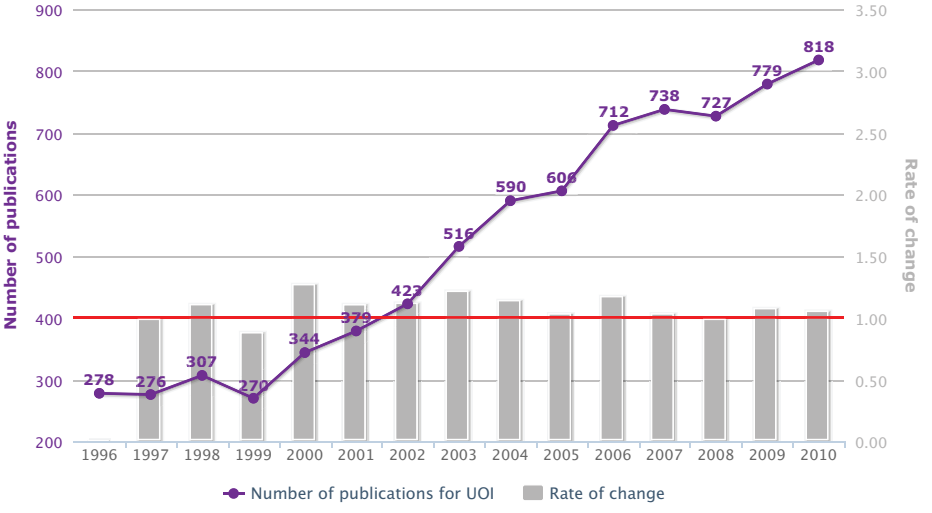


Figure 4.1.2 Number of publications and rate of change in the number of publications by University of Ioannina, 1996-2010 / Source: Scopus 1996-2010

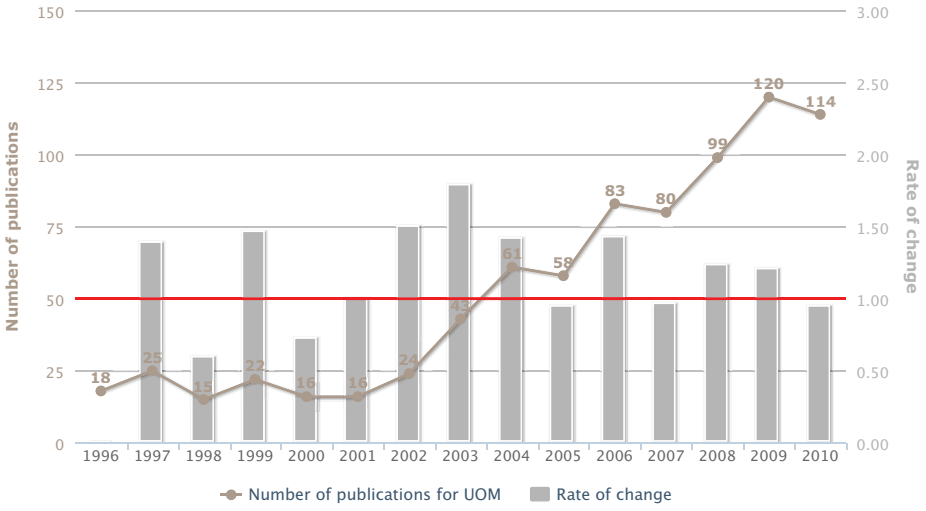


Figure 4.1.2 Number of publications and rate of change in the number of publications by University of Macedonia of Economic and Social Sciences, 1996-2010 / Source: Scopus 1996-2010

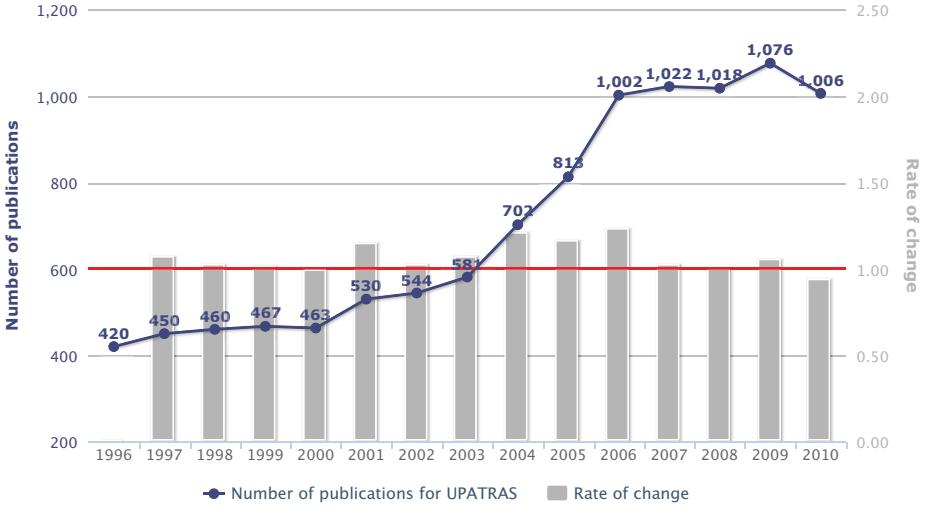


Figure 4.1.2 Number of publications and rate of change in the number of publications by University of Patras, 1996-2010 / Source: Scopus 1996-2010

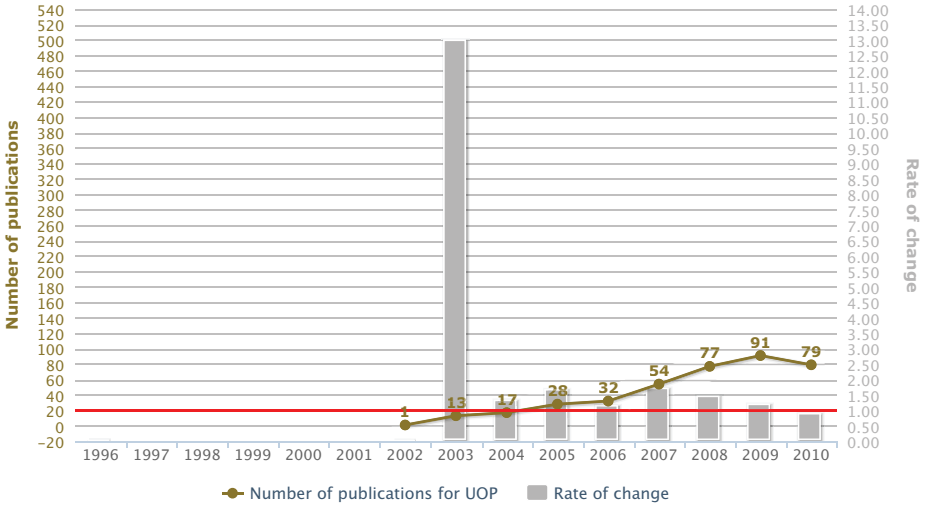


Figure 4.1.2 Number of publications and rate of change in the number of publications by University of Peloponnese, 1996-2010 / Source: Scopus 1996-2010

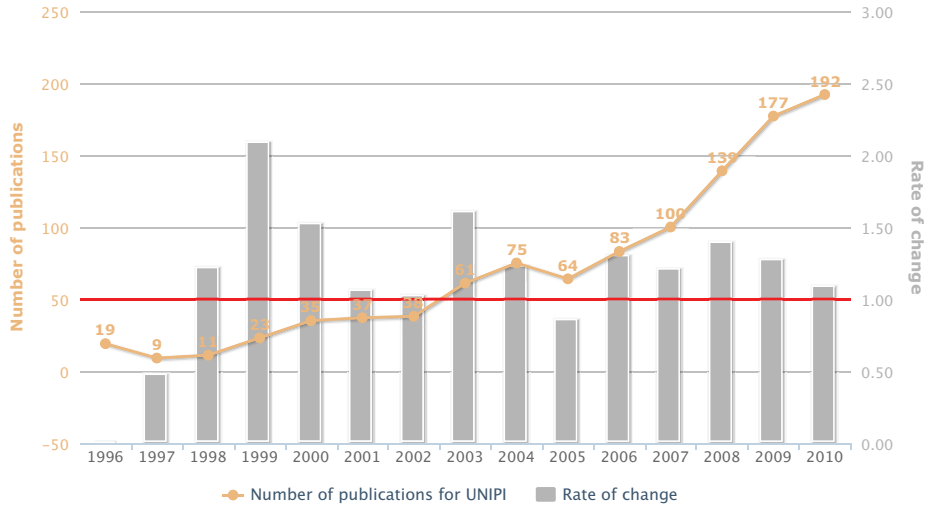


Figure 4.1.2 Number of publications and rate of change in the number of publications by University of Piraeus, 1996-2010 / Source: Scopus 1996-2010

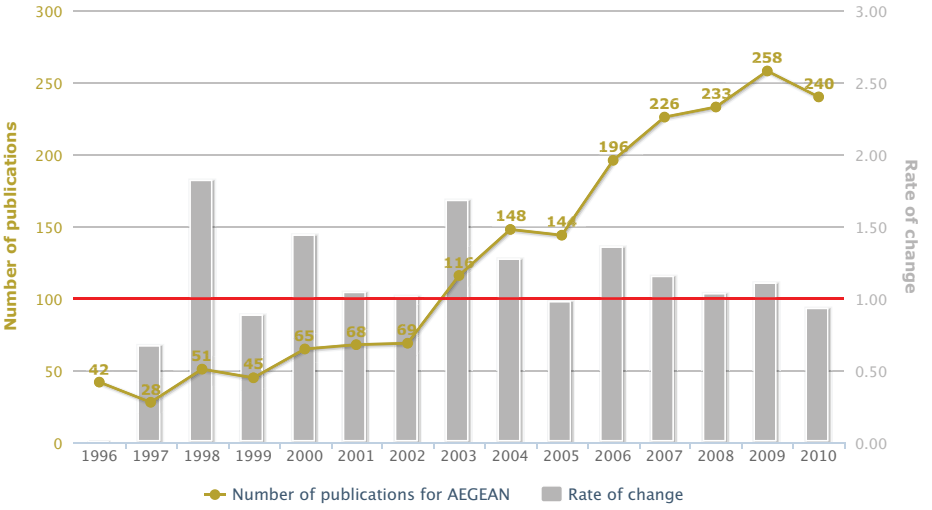


Figure 4.1.2 Number of publications and rate of change in the number of publications by University of the Aegean, 1996-2010 / Source: Scopus 1996-2010

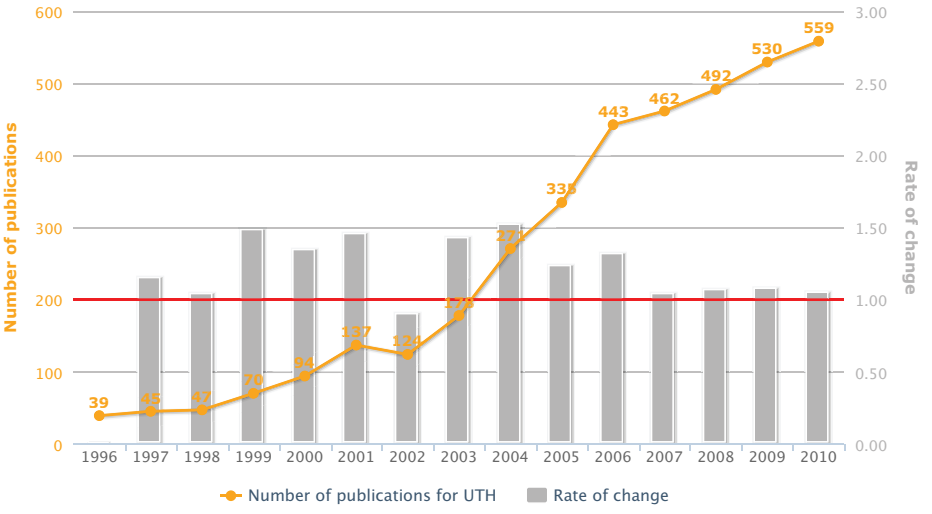


Figure 4.1.2 Number of publications and rate of change in the number of publications by University of Thessaly, 1996-2010 / Source: Scopus 1996-2010

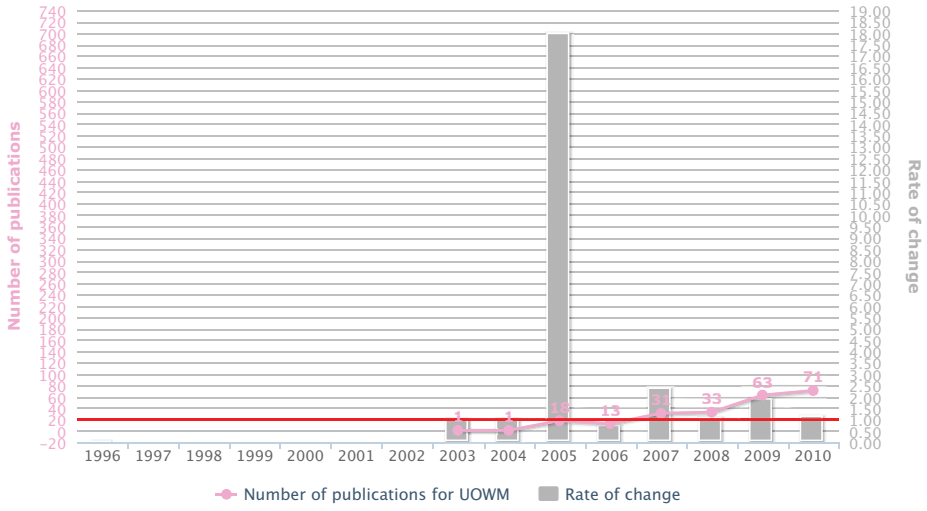


Figure 4.1.2 Number of publications and rate of change in the number of publications by University of Western Macedonia, 1996-2010 / Source: Scopus 1996-2010

Focusing on the last 5-year period, Figure 4.1.3 displays, for each University, the number of publications and the (%) share it holds within the category of "Universities". The National & Kapodistrian University of Athens/UOA accounted for 11,919 publications and a share of 27.1%, the Aristotle University of Thessaloniki/ AUTH for 8,932 publications and a share of 20.3%, the University of Patras/UOP for 5,124 publications and a share of 11.7%. Other Universities had a share of less than 10%.

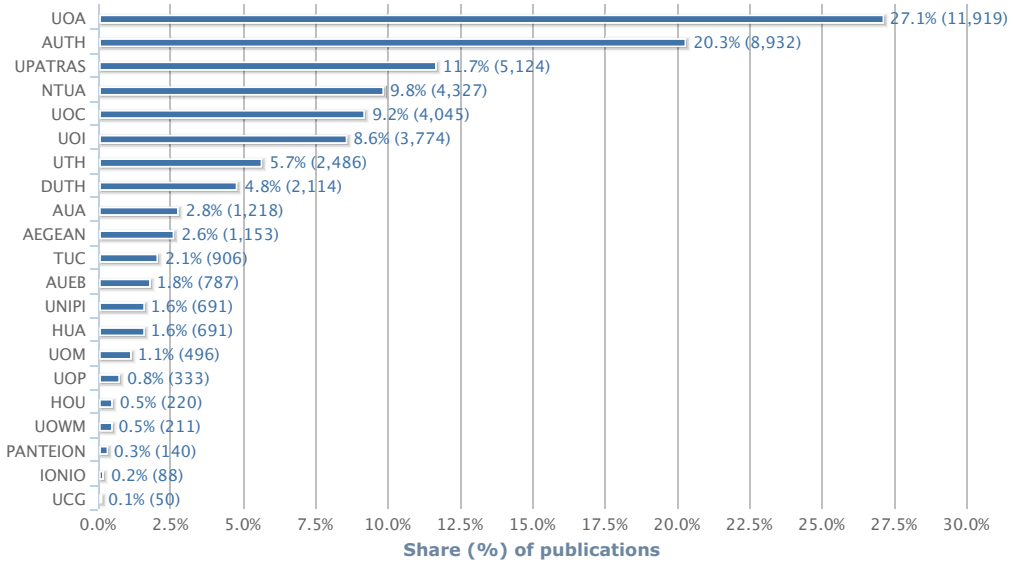


Figure 4.1.3 Number and share (%) of publications, by University, 2006-2010 / Source: Scopus 1996-2010

As shown in Figure 4.1.4, between 2006 and 2010, there was a rise in the number of publications in 18 Universities while 7 of them had a rate of change above the average rate of the category "Universities" (University of Western Macedonia/UOWM, University of Peloponnese/UOP, University of Piraeus/UNIPI, Panteion University of Social and Political Sciences, Ionian University, Athens University of Economics and Business and Harokopio University of Athens/HUA).

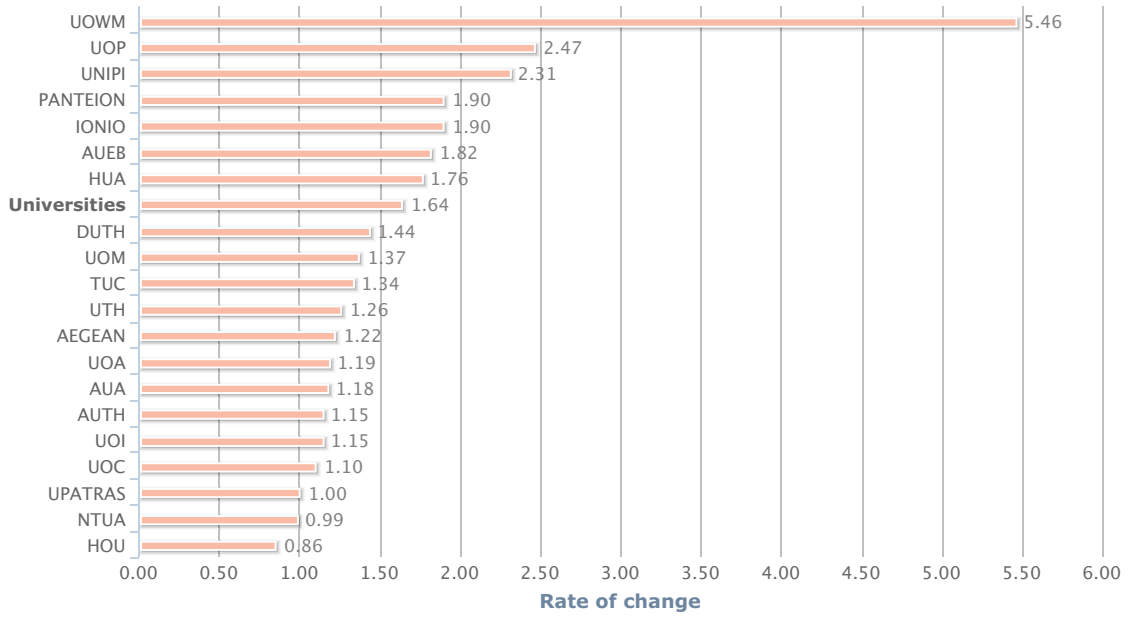


Figure 4.1.4 Change in the number of publications between 2006 and 2010, by University / Source: Scopus 1996-2010

4.2 Citations

Figure 4.2.1 1 demostrates, the percentage (%) of cited publications for each University, over the period 1996-2010. An increasing trend was observed for all Universities, with the University of Crete/UOC, achieving the best performance.

The percentage (%) of cited publications was above Greek average (65.6%) for the following institutions: the University of Crete/UOC (74.7%), Technical University of Crete (71.4%), the Agricultural University of Athens/AUA (71.4%), the Harokopio University of Athens/HUA (69.9%), the University of Ioannina (69.9%), the National & Kapodistrian University of Athens/UOA (68.9%), the University of Patras/UOP (68.9%), the University of Thessaly (67.3%) and the Aristotle University of Thessaloniki (66.1%).

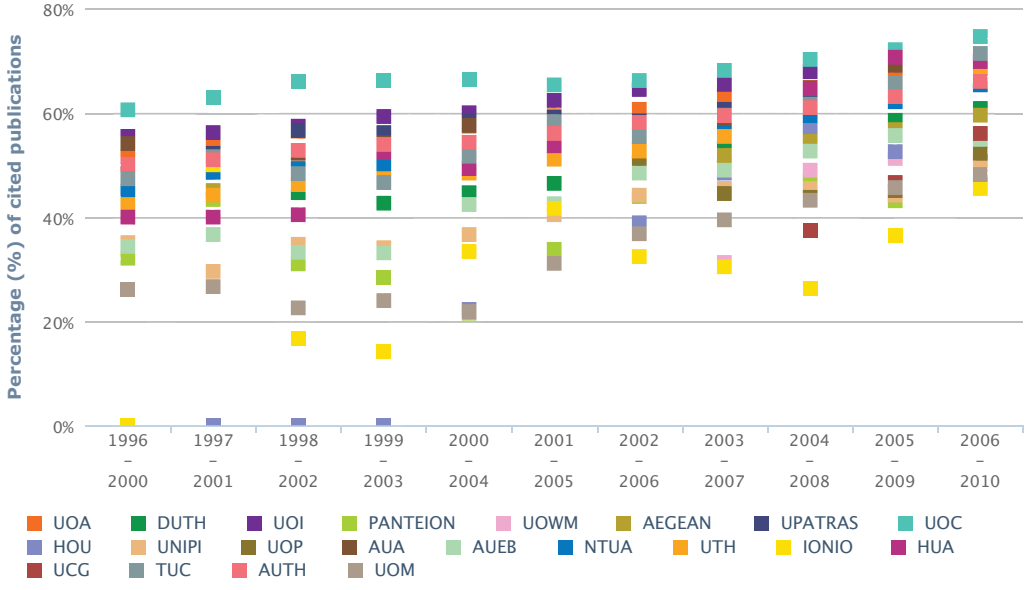


Figure 4.2.1 Percentage (%) of cited publications by University, 1996-2010 / Source: Scopus 1996-2010

There was growth in the number of citations received by publications of all Universities (Figure 4.2.2). Universities were ranked as follows in decreasing order of the number of citations received by their publications: National & Kapodistrian University (UOA), Aristotle University of Thessaloniki (AUTH), University of Crete (UOC), University of Ioannina (UOI), University of Patras (UOP), National Technical University of Athens (NTUA), University of Thessaly (UTH) and Demokritos University of Thrace (DUTH).

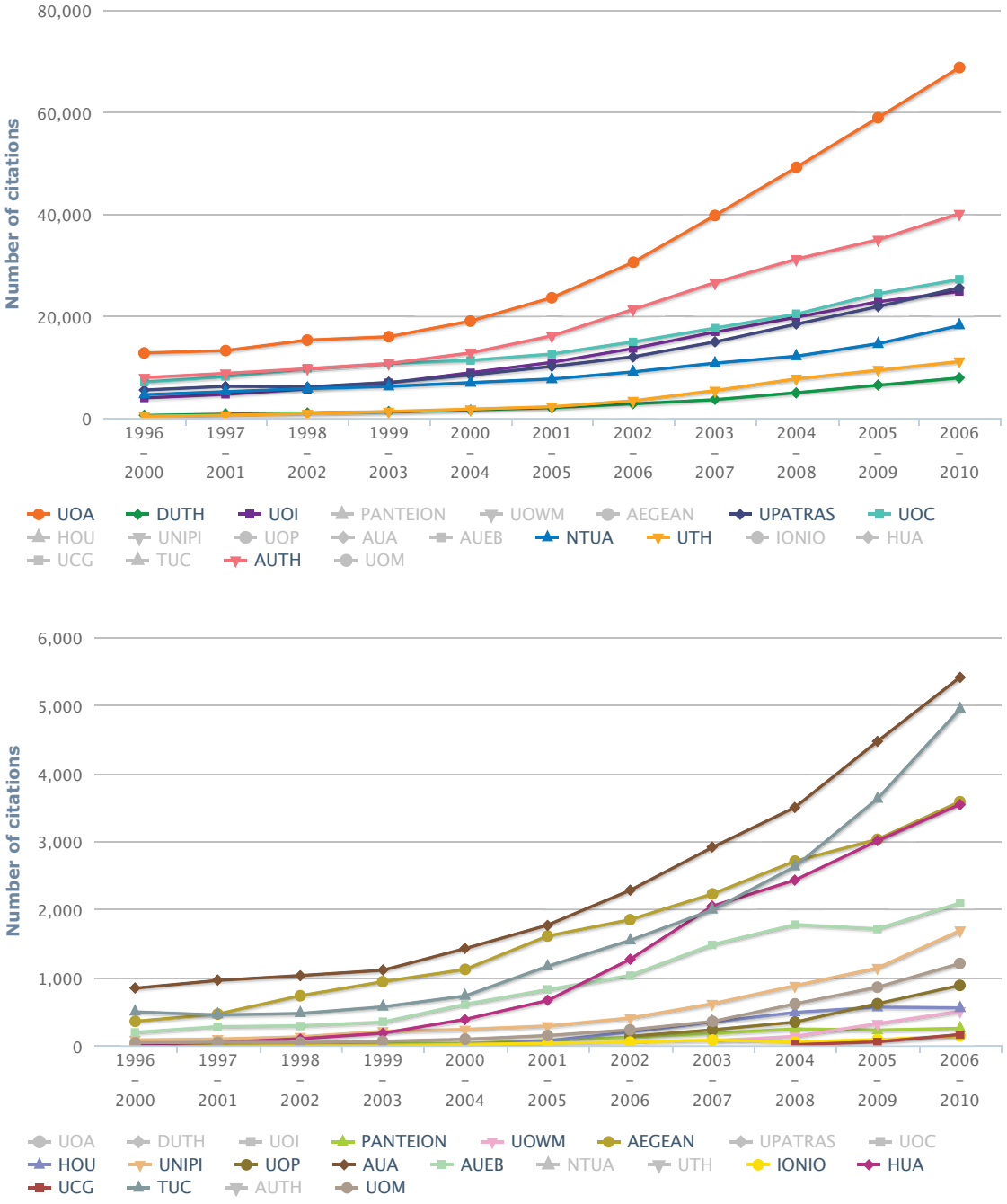


Figure 4.2.2 Number of citations by University, 1996-2010 / Source: Scopus 1996-2010

The Universities with a share of citations in the total citations of the category "Universities" higher than 10% were the National & Kapodistrian University of Athens/UOA (68,680 publications; a 31.3% share), the Aristotle University of Thessaloniki/AUTH (40,063 publications; a share of 18.2%), the University of Crete/UOC (27,167 publications; a share of 12.4%), the University of Patras/UOP (25,551 publications; a share of 11.6%) and the University of Ioannina/UOI (24,812 publications; a share of 11.3%). The remaining Universities had less than a 10% share (Figure 4.2.3)

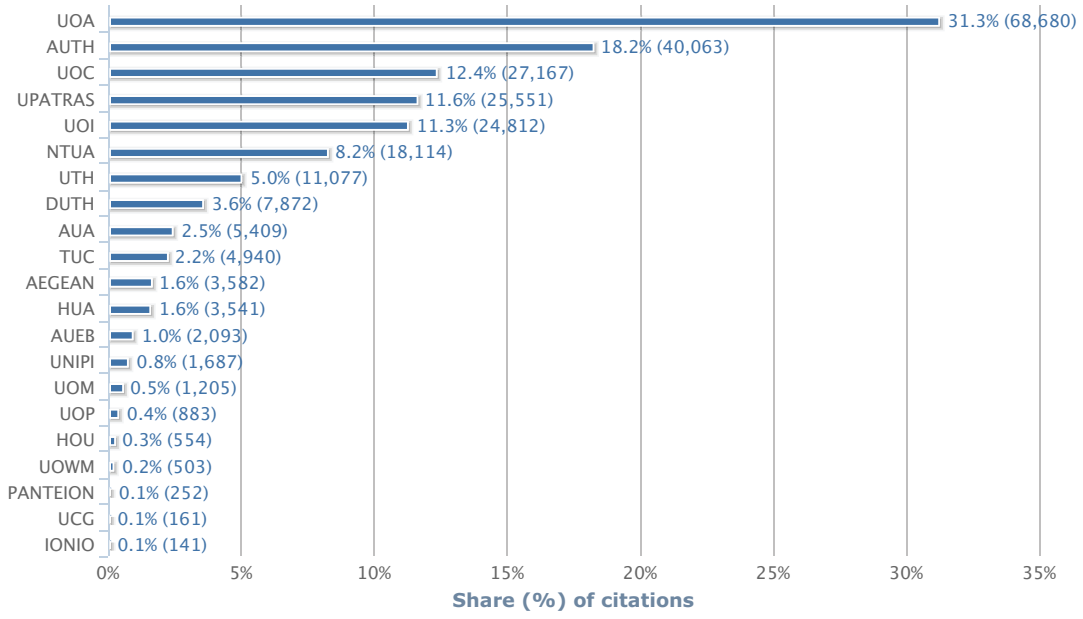


Figure 4.2.3 Number and share (%) of citations by University, 2006-2010 / Source: Scopus 1996-2010

4.3 Citation impact

With regard to the 5-year period 2006-2010, Figures 4.3.1 and 4.3.2* display the number of publications and citations as well as the relevant "field-normalised citation score" for each University. The field normalised citation score or "citation score" is the relative number of citations to publications of a University compared to the world average of citations to publications of the same time period and scientific subject field. The normalisation was done on an individual article level according to the 307 scientific subject fields. If an article was originating in more than one scientific fields, a mean value of the fields was calculated. The citation score was calculated using software developed by the National Documentation Centre (EKT). A value greater than 1, indicated that the impact of publications was higher than the world average.

The Technical University of Crete/TUC, the University of Crete/UOC, the University of Ioannina/UOI, the National Technical University of Athens and the University of Western Macedonia ranked first, exceeding the world average (citation scores 1.26, 1.17, 1.12, 1.07 and 1.04 respectively). The citation score was approaching the world average with values over 0.90 - for the Agricultural University of Athens/AUA (0.98), the University of the Peloponnese (0.97), the National & Kapodistrian University of Athens (0.97), the Aristotle University of Thessaloniki (0.95), the University of Thessaly (0.94), the University of Patras (0.93), the University of Piraeus/UNIPI (0.93), and the Athens University of Economics and Business (0.91)-.

* The indicators are shown in two separate Figures to illustrate them more clearly.

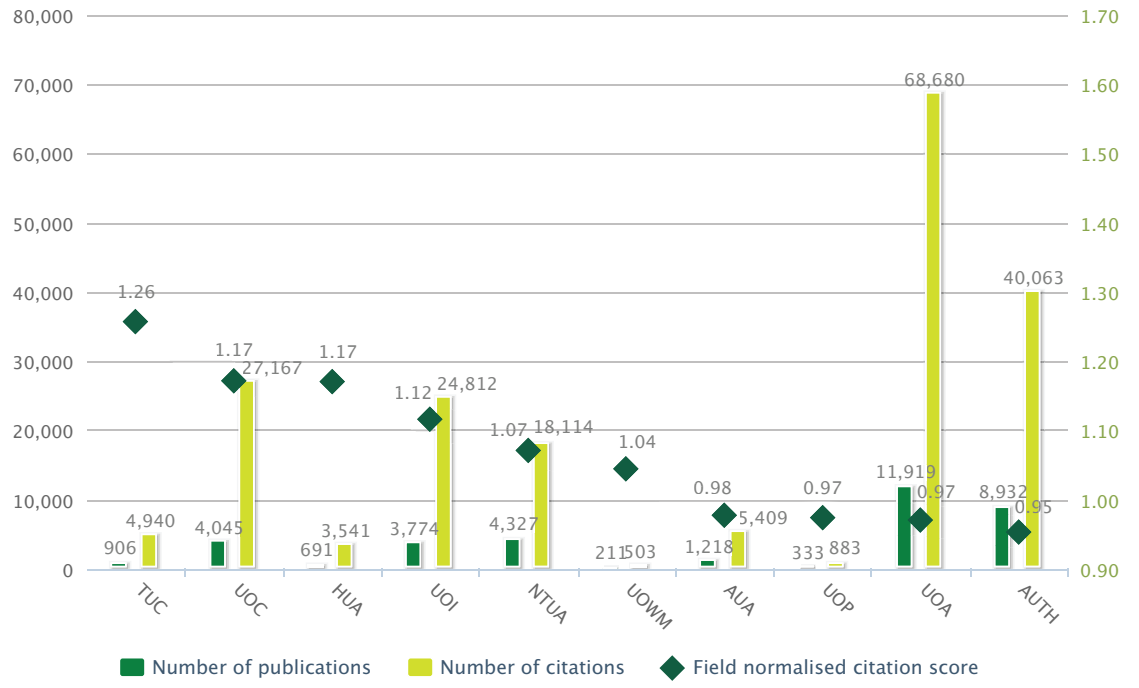


Figure 4.3.1 Publications, citations and field normalised citation score relative to the world, by University, 2006-2010. Data refers to the total number of publicationsin each University for all scientific fields / Source: Scopus 1996-2010

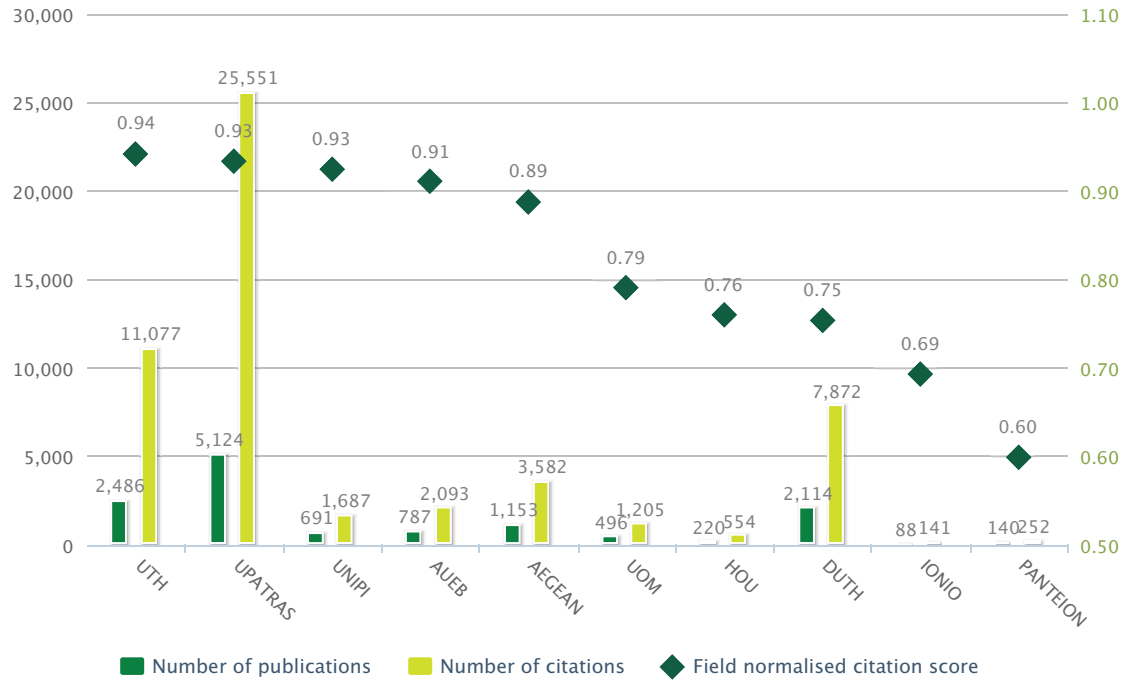


Figure 4.3.2 Publications, citations and field normalised citation score relative to the world, by University, 2006-2010. Data refers to the total number of publicationsin each University for all scientific fields / Source: Scopus 1996-2010

4.4 Major fields of science

Figure 4.4.1 displays the number of publications and citations and the field-normalised citation score by "Universities" in the six major scientific fields* during 2006-2010. The Figure presents the overall performance of each University in each of the six major fields. Indicators were calculated, after normalisation on an individual article level. Figure 4.4.2 displays specific scientific subfields with citation scores above 1.5 and thus provides a detailed picture regarding the Universities' performance.

In "Natural Sciences", 18 out of 21 Universities were active. The highest citation score (1.25) was achieved by a small number of publications produced by the Technical University of Crete/TUC. In addition, the citation scores exceeded the world average in the following cases: the University of Crete/UOC (1.19), the University of the Peloponnese (1.09), the Harokopio University of Athens/HUA (1.08), the University of Ioannina/UOI (1.05) and the National & Kapodistrian University of Athens/UOA (1.01). The publications of the National Technical University of Athens/NTUA (0.98), the Aristotle University of Thessaloniki/AUTH (0.95), the University of Thessaly (0.93) and the University of Patras/UOP (0.91) were close to the world average.

Sixteen Universities were active in "Engineering & Technology". The publications with citation scores higher than the world average baseline were those of the University of Crete/UOC (1.65), the University of Macedonia (1.54), the University of Western Macedonia/UOWM (1.28), the Technical University of Crete/TUC (1.27), the Agricultural University of Athens/AUA (1.27), the National Technical University of Athens/NTUA (1.18), the University of Piraeus/UNIPI (1.17), the University of the Aegean (1.10), the Aristotle University of Thessaloniki/AUTH (1.08) and the University of Thessaly/UTH (1.06). The publications of the following institutions were close to the world average: the National & Kapodistrian University of Athens/UOA (0.99), the University of the Peloponnese (0.98) and the Athens University of Economics and Business/AUEB (0.96).

The majority of publications in "Medical & Health Sciences" came from 12 Universities. Publications with the highest citation scores were those of the Harokopio University of Athens/HUA (1.23), the University of Ioannina/UOI (1.20), the University of Crete/UOC (1.08), the Technical University of Crete/TUC (1.05) and the University of the Aegean (1.03).

In "Agricultural Sciences" publications emerged mainly from 10 Universities with high citation scores during 2006-2010. The highest citation scores were reached by the University of Patras/UOP (1.65), the Harokopio University of Athens/HUA (1.21) and the National Technical University of Athens/NTUA (1.14). The citation scores of publications by the University of Ioannina/UOI (1.11), the National & Kapodistrian University of Athens/UOA (1.09), the Agricultural University of Athens/AUA (1.09) and the University of Crete (1.02) were also above the world baseline.

In "Social Sciences" there was a large number of active Universities (18 out of 21) but with a much lower publication output relatively to other scientific fields. The publications of the following institutions were above world average: the Technical University of Crete/TUC (1.25) and the Agricultural University of Athens/AUA (1.01), whereas the publications of the University of Ioannina/UOI reached the world average (1.00).

Finally, only two Universities were found to systematically produce publications in the field of "Humanities". Aristotle University of Thessaloniki/AUTH was the University with the highest citation score (1.66).

* For each major scientific field, the field normalized citation score was calculated only for Universities with at least 75 publications in the field.

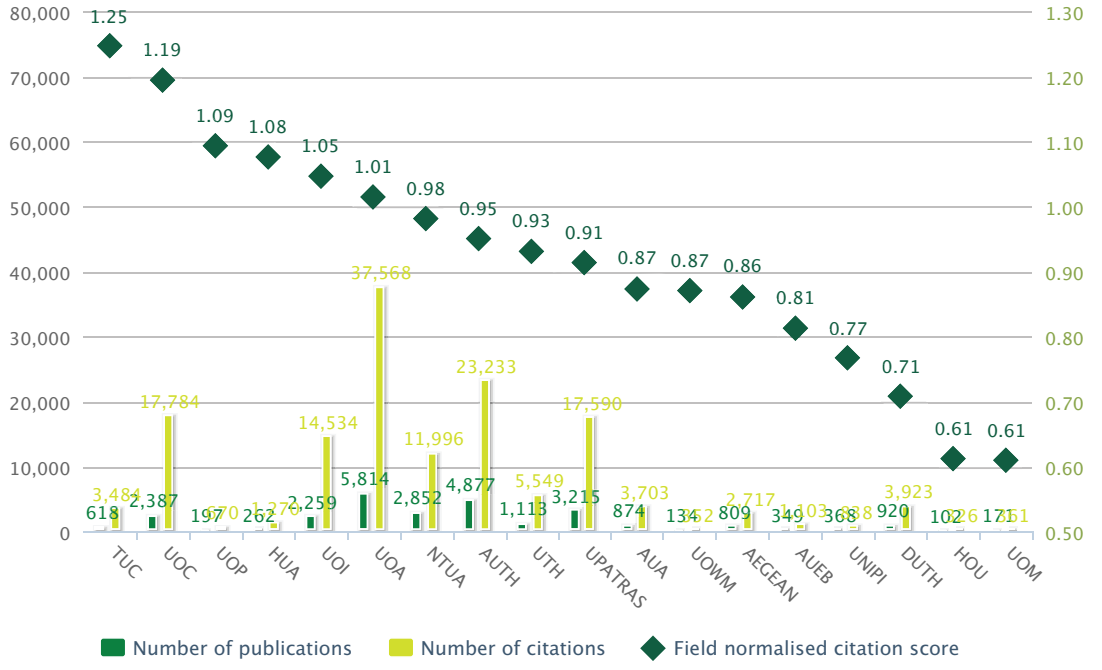


Figure 4.4.1 Publications, citations and field normalised citation score relative to the world, by University, in the major field of "Natural Sciences", 2006-2010 / Source: Scopus 1996-2010

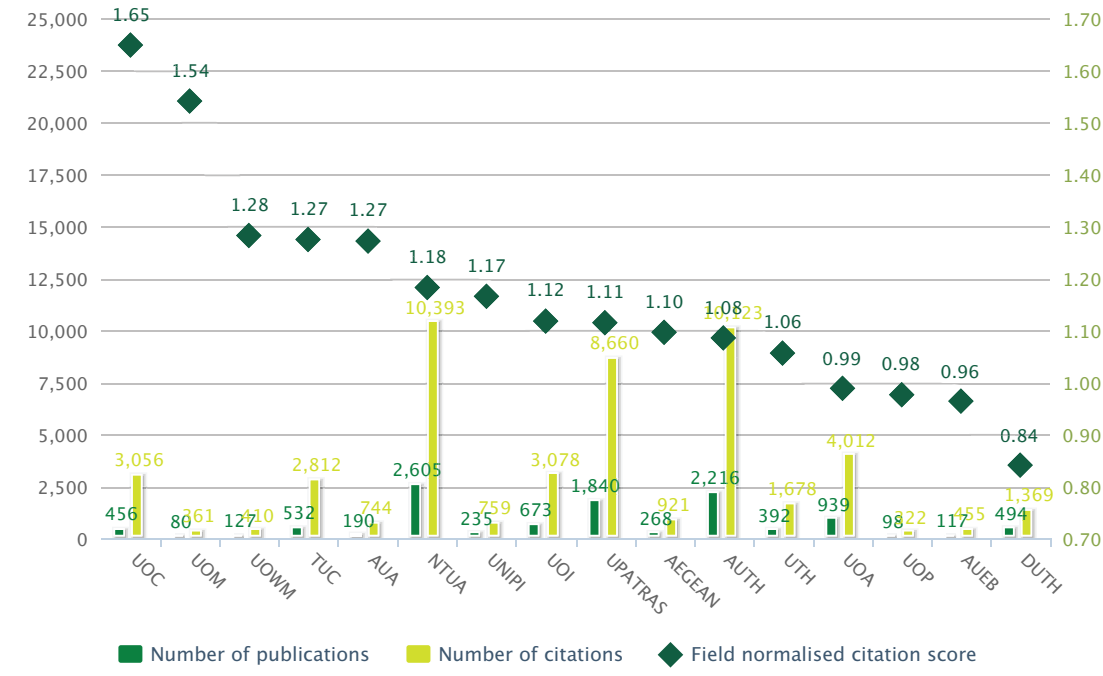


Figure 4.4.1 Publications, citations and field normalised citation score relative to the world, by University, in the major field of "Engineering & Technology", 2006-2010 / Source: Scopus 1996-2010

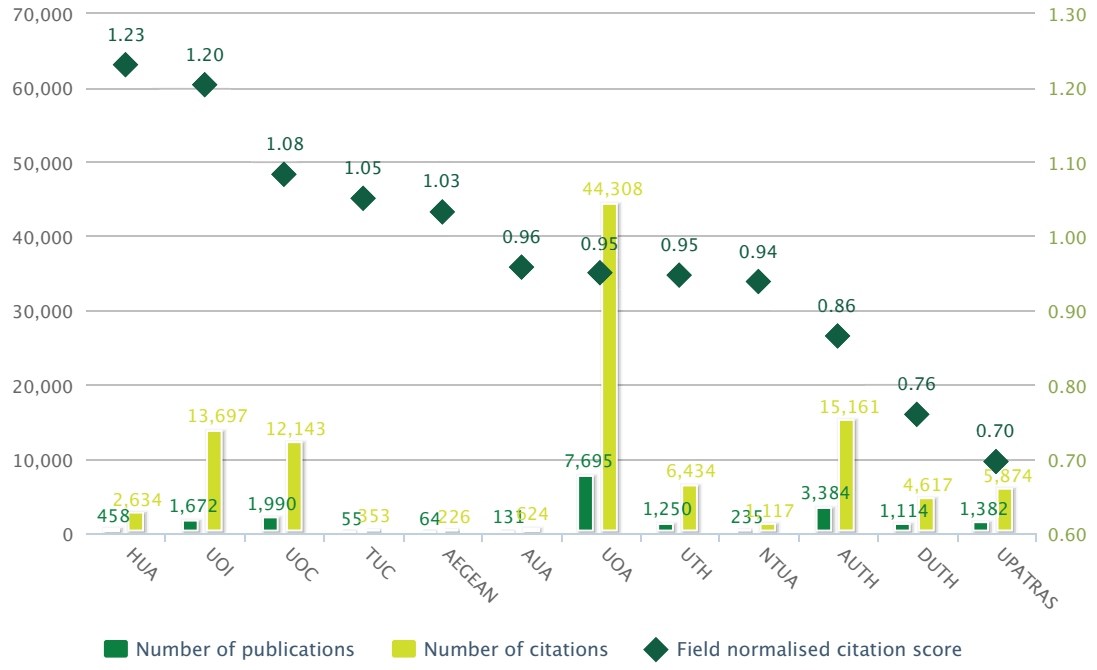


Figure 4.4.1 Publications, citations and field normalised citation score relative to the world, by University, in the major field of "Medical & Health Sciences", 2006-2010 / Source: Scopus 1996-2010

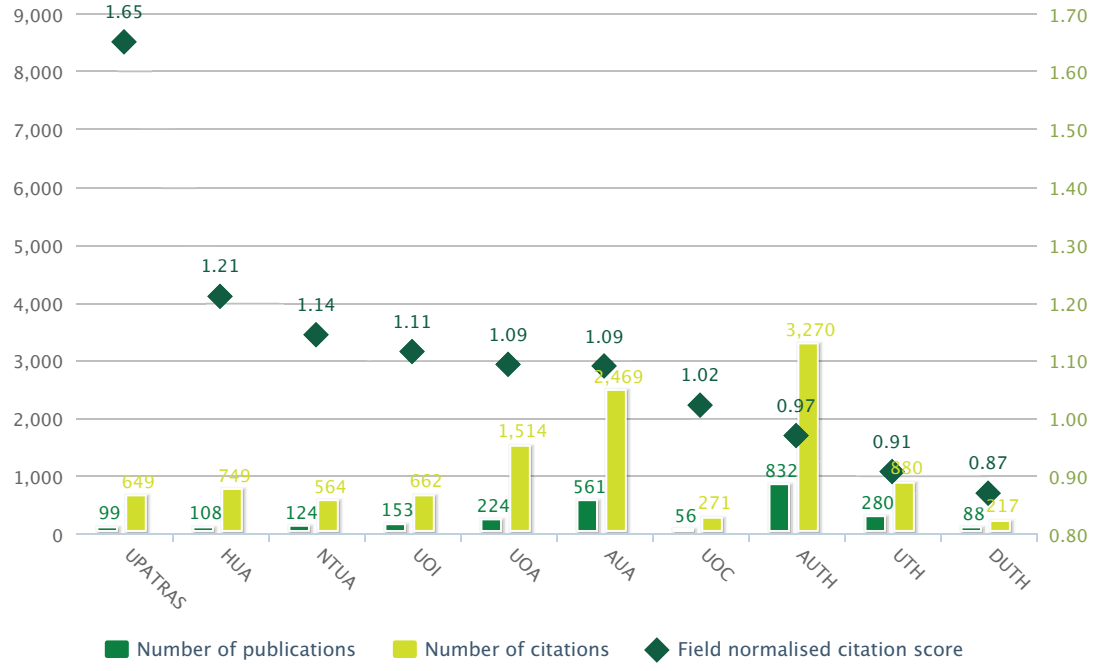


Figure 4.4.1 Publications, citations and field normalised citation score relative to the world, by University, in the major field of "Agricultural Sciences", 2006-2010 / Source: Scopus 1996-2010

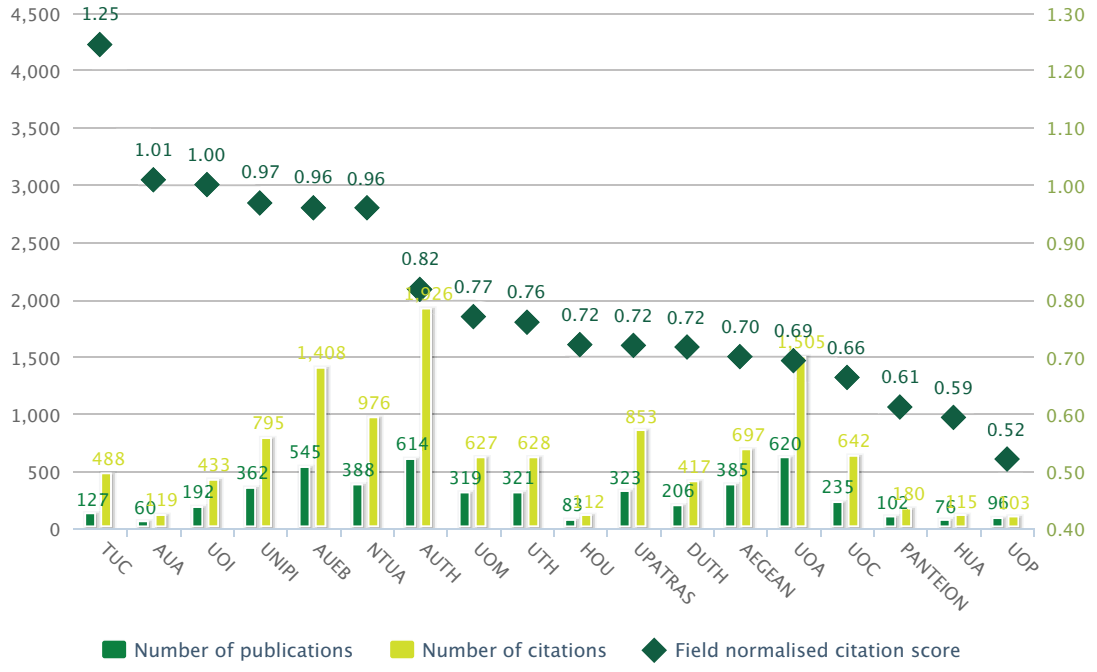


Figure 4.4.1 Publications, citations and field normalised citation score relative to the world, by University, in the major field of "Social Sciences", 2006-2010 / Source: Scopus 1996-2010

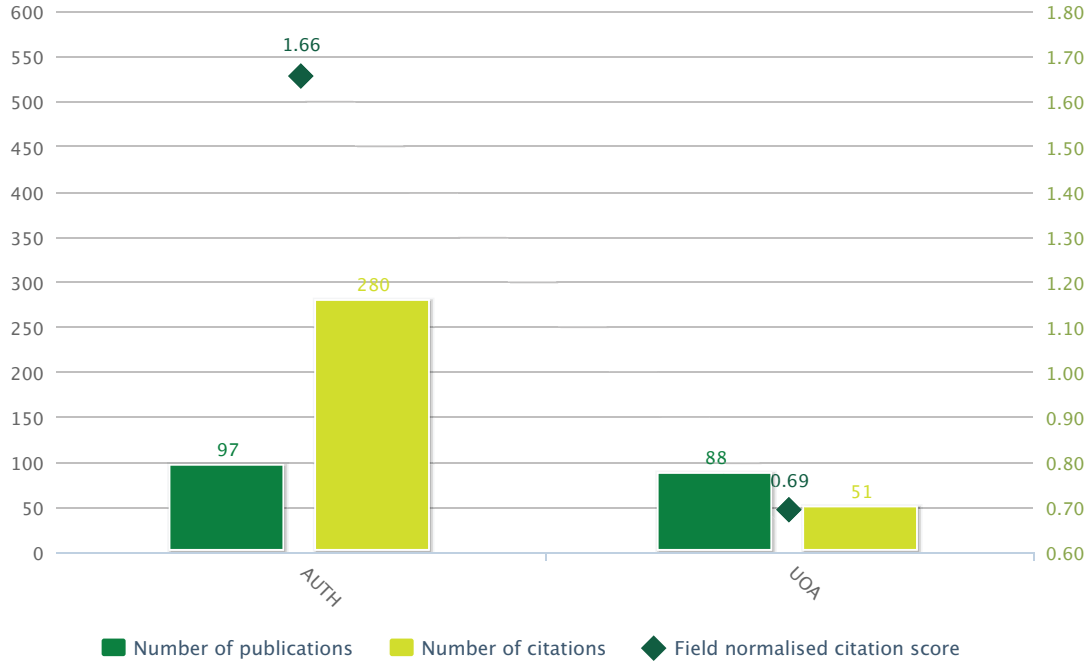


Figure 4.4.1 Publications, citations and field normalised citation score relative to the world, by University, in the major field of "Humanities", 2006-2010 / Source: Scopus 1996-2010

NATURAL SCIENCES

Subfield of major filed of science (Frascati Manual)	Specific scientific field (Scopus)	University	Field normalized citation score	Number of publications
biological sciences	genetics	HUA	4.24	11
biological sciences	genetics	UOI	3.13	61
earth and related environmental sciences	oceanography	NTUA	3.07	13
chemical sciences	catalysis	UTH	3.04	8
computer and information sciences	artificial intelligence	UTH	3.02	13
computer and information sciences	computer science (all)	UTH	3.01	12
earth and related environmental sciences	atmospheric science	UPATRAS	2.67	37
chemical sciences	chemistry (miscellaneous)	UOC	2.67	18
computer and information sciences	information systems	UTH	2.56	20
earth and related environmental sciences	earth-surface processes	UOI	2.45	9
chemical sciences	organic chemistry	TUC	2.39	20
computer and information sciences	computer networks and communications	UTH	2.36	32
earth and related environmental sciences	pollution	UOC	2.29	37
physical sciences	physics and astronomy (all)	TUC	2.26	19
mathematics	mathematical physics	UOI	2.22	63
computer and information sciences	human-computer interaction	AEGEAN	2.22	10
earth and related environmental sciences	atmospheric science	UOC	2.21	75
mathematics	mathematical physics	UOA	2.15	170
computer and information sciences	computer networks and communications	AUTH	2.13	134
computer and information sciences	computer vision and pattern recognition	UOC	2.12	12
biological sciences	virology	DUTH	2.10	8
biological sciences	aquatic science	NTUA	2.08	8
physical sciences	instrumentation	UOA	2.07	109
earth and related environmental sciences	environmental science (all)	UOC	2.01	69
physical sciences	physics and astronomy (all)	UOA	2.00	363
computer and information sciences	computational theory and mathematics	UOP	2.00	13
biological sciences	biochemistry. genetics and molecular biology (all)	UOC	1.98	65
computer and information sciences	theoretical computer science	UOP	1.92	8
chemical sciences	chemistry (all)	UPATRAS	1.91	181
chemical sciences	physical and theoretical chemistry	AUA	1.90	8
physical sciences	instrumentation	UOI	1.87	70
computer and information sciences	software	UOP	1.86	21
earth and related environmental sciences	oceanography	UOC	1.86	28
earth and related environmental sciences	geophysics	UOC	1.85	19
earth and related environmental sciences	earth-surface processes	TUC	1.85	18
mathematics	analysis	TUC	1.83	11
chemical sciences	chemistry (all)	UOP	1.82	18
computer and information sciences	computer graphics and computer-aided design	UOC	1.80	11
biological sciences	biotechnology	TUC	1.77	17
computer and information sciences	computer vision and pattern recognition	UOI	1.76	14
chemical sciences	chemistry (all)	UOC	1.76	111
biological sciences	biochemistry	TUC	1.76	10
chemical sciences	analytical chemistry	AEGEAN	1.74	10
physical sciences	surfaces and interfaces	UPATRAS	1.73	69
earth and related environmental sciences	management. monitoring. policy and law	UOWM	1.73	11
physical sciences	condensed matter physics	UOC	1.72	206
physical sciences	fluid flow and transfer processes	UTH	1.72	17
earth and related environmental sciences	ecological modeling	TUC	1.71	8
physical sciences	surfaces and interfaces	NTUA	1.71	59
physical sciences	atomic and molecular physics. and optics	UOC	1.71	126
earth and related environmental sciences	geophysics	TUC	1.70	17
physical sciences	acoustics and ultrasonics	UOA	1.69	9
biological sciences	biochemistry. genetics and molecular biology (all)	UTH	1.69	31

Subfield of major filed of science (Frascati Manual)	Specific scientific field (Scopus)	University	Field normalized citation score	Number of publications
computer and information sciences	theoretical computer science	AUTH	1.69	32
earth and related environmental sciences	atmospheric science	NTUA	1.68	35
mathematics	mathematical physics	NTUA	1.68	57
physical sciences	nuclear and high energy physics	UOC	1.65	85
chemical sciences	organic chemistry	NTUA	1.64	125
earth and related environmental sciences	earth-surface processes	AEGEAN	1.64	13
biological sciences	parasitology	AUTH	1.63	21
physical sciences	physics and astronomy (all)	UOC	1.63	150
computer and information sciences	computer science (all)	UNIPI	1.60	14
biological sciences	ecology. evolution. behavior and systematics	AEGEAN	1.59	44
earth and related environmental sciences	environmental chemistry	UOC	1.59	40
earth and related environmental sciences	geophysics	UOI	1.59	9
mathematics	mathematics (all)	TUC	1.59	14
computer and information sciences	computer graphics and computer-aided design	UOI	1.58	23
computer and information sciences	computational theory and mathematics	UTH	1.58	11
chemical sciences	catalysis	UPATRAS	1.56	78
computer and information sciences	computer vision and pattern recognition	UOA	1.55	26
chemical sciences	filtration and separation	AUA	1.54	11
biological sciences	biochemistry. genetics and molecular biology (all)	NTUA	1.54	13
mathematics	mathematical physics	AUTH	1.54	67
chemical sciences	catalysis	TUC	1.54	20
mathematics	computational mathematics	UOP	1.54	10
physical sciences	acoustics and ultrasonics	TUC	1.54	9
computer and information sciences	computer graphics and computer-aided design	AUTH	1.52	27
earth and related environmental sciences	management, monitoring, policy and law	UNIPI	1.52	26
physical sciences	physics and astronomy (miscellaneous)	UOA	1.51	93
chemical sciences	colloid and surface chemistry	UOC	1.50	11
chemical sciences	colloid and surface chemistry	UOC	1.50	11

ENGINEERING AND TECHNOLOGY

Subfield of major filed of science (Frascati Manual)	Specific scientific field (Scopus)	University	Field normalized citation score	Number of publications
civil engineering	civil and structural engineering	AEGEAN	4.77	9
environmental engineering	energy engineering and power technology	UOI	3.56	10
environmental engineering	fuel technology	UOI	3.44	11
environmental engineering	energy (all)	UNIPI	3.42	19
mechanical engineering	mechanical engineering	UOC	2.90	31
environmental engineering	energy (all)	UOC	2.85	11
electrical engineering, electronic engineering, information engineering	control and systems engineering	UTH	2.64	13
mechanical engineering	aerospace engineering	NTUA	2.63	30
chemical engineering	process chemistry and technology	UTH	2.61	10
other engineering and technologies	engineering (miscellaneous)	UOA	2.58	26
other engineering and technologies	engineering (miscellaneous)	UOI	2.51	14
other engineering and technologies	engineering (all)	AUTH	2.38	57
other engineering and technologies	engineering (all)	UOC	2.32	8
materials engineering	mechanics of materials	UOC	2.28	26
materials engineering	ceramics and composites	NTUA	2.26	64
chemical engineering	bioengineering	TUC	2.25	12
mechanical engineering	automotive engineering	TUC	2.14	12
environmental engineering	renewable energy, sustainability and the environment	AUA	2.11	17
materials engineering	materials science (all)	UOC	2.10	98
materials engineering	electronic, optical and magnetic materials	TUC	2.04	8

electrical engineering, electronic engineering, information engineering	signal processing	TUC	2.03	30
electrical engineering, electronic engineering, information engineering	electrical and electronic engineering	UOM	2.02	22
electrical engineering, electronic engineering, information engineering	control and systems engineering	UOM	1.98	12
chemical engineering	process chemistry and technology	UPATRAS	1.92	63
environmental engineering	energy (all)	NTUA	1.90	69
materials engineering	electronic, optical and magnetic materials	UOC	1.89	106
other engineering and technologies	engineering (all)	TUC	1.88	28
environmental engineering	fuel technology	NTUA	1.86	135
electrical engineering, electronic engineering, information engineering	electrical and electronic engineering	UTH	1.83	46
environmental engineering	renewable energy, sustainability and the environment	UPATRAS	1.82	62
materials engineering	materials science (all)	AUA	1.82	8
chemical engineering	bioengineering	UOC	1.81	33
environmental engineering	fuel technology	AUTH	1.81	50
environmental engineering	energy engineering and power technology	NTUA	1.80	178
environmental engineering	energy (all)	UOWM	1.79	13
environmental engineering	energy (all)	TUC	1.75	12
civil engineering	building and construction	UOI	1.73	14
environmental engineering	fuel technology	UOWM	1.73	15
materials engineering	polymers and plastics	AUA	1.71	8
mechanical engineering	aerospace engineering	AUTH	1.71	15
other engineering and technologies	engineering (miscellaneous)	AUTH	1.69	16
electrical engineering, electronic engineering, information engineering	hardware and architecture	UTH	1.69	11
mechanical engineering	industrial and manufacturing engineering	UOA	1.69	10
civil engineering	civil and structural engineering	UOI	1.68	28
materials engineering	surfaces, coatings and films	TUC	1.68	8
environmental engineering	fuel technology	UPATRAS	1.66	34
environmental engineering	environmental engineering	UPATRAS	1.64	61
environmental engineering	energy (all)	UOI	1.64	9
mechanical engineering	industrial and manufacturing engineering	AUA	1.63	21
mechanical engineering	nuclear energy and engineering	NTUA	1.61	82
environmental engineering	renewable energy, sustainability and the environment	UOA	1.61	26
mechanical engineering	industrial and manufacturing engineering	UOM	1.60	8
electrical engineering, electronic engineering, information engineering	control and systems engineering	UOC	1.59	12
other engineering and technologies	safety, risk, reliability and quality	AUA	1.59	21
mechanical engineering	mechanical engineering	AUA	1.57	11
electrical engineering, electronic engineering, information engineering	electrical and electronic engineering	TUC	1.57	108
other engineering and technologies	engineering (all)	UOI	1.54	23
materials engineering	materials chemistry	NTUA	1.53	100
environmental engineering	energy engineering and power technology	UOA	1.52	14
materials engineering	materials science (miscellaneous)	UOI	1.52	8
materials engineering	metals and alloys	UOC	1.51	14
materials engineering	surfaces, coatings and films	UOC	1.51	72
environmental engineering	renewable energy, sustainability and the environment	NTUA	1.50	155
civil engineering	civil and structural engineering	UOA	1.50	28
other engineering and technologies	engineering (all)	UOA	1.50	30
other engineering and technologies	engineering (all)	UOA	1.50	30

MEDICAL & HEALTH SCIENCES				
Subfield of major filed of science (Frascati Manual)	**Specific scientific field (Scopus)**	**University**	**Field normalized citation score**	**Number of publications**
clinical medicine	genetics (clinical)	UOI	3.24	37
clinical medicine	rheumatology	UOC	2.60	49
clinical medicine	internal medicine	UOI	2.48	33
health sciences	epidemiology	UOI	2.34	37
clinical medicine	rheumatology	HUA	2.27	8
other medical sciences	medicine (all)	UOI	2.24	236
clinical medicine	critical care and intensive care medicine	DUTH	2.14	11
health sciences	health information management	UOI	2.10	8
basic medicine	anatomy	UOC	2.09	10
clinical medicine	critical care and intensive care medicine	UTH	2.00	12
clinical medicine	hepatology	UTH	1.99	16
health sciences	health policy	UOC	1.97	14
health sciences	nursing (all)	UOC	1.97	17
health sciences	health policy	UOI	1.95	10
health sciences	epidemiology	UOC	1.90	30
clinical medicine	critical care and intensive care medicine	UOA	1.79	99
health sciences	chemical health and safety	AUTH	1.79	24
health sciences	advanced and specialized nursing	DUTH	1.77	8
health sciences	radiological and ultrasound technology	UOC	1.73	47
clinical medicine	immunology and allergy	UOC	1.71	82
clinical medicine	urology	AUTH	1.66	60
clinical medicine	critical care and intensive care medicine	UOC	1.65	29
basic medicine	toxicology	DUTH	1.64	15
basic medicine	physiology (medical)	UOC	1.59	22
other medical sciences	medicine (all)	AUA	1.59	18
clinical medicine	reproductive medicine	AUTH	1.58	70
clinical medicine	rheumatology	UPATRAS	1.57	17
clinical medicine	pediatrics, perinatology and child health	HUA	1.56	19
clinical medicine	otorhinolaryngology	UTH	1.54	14
basic medicine	pharmaceutical science	NTUA	1.53	8
basic medicine	biological psychiatry	UOC	1.52	11
clinical medicine	orthodontics	AUTH	1.51	29
clinical medicine	rheumatology	UOI	1.51	61
health sciences	health informatics	UOI	1.50	15

AGRICULTURAL SCIENCES

Subfield of major filed of science (Frascati Manual)	Specific scientific field (Scopus)	University	Field normalized citation score	Number of publications
agriculture, forestry and fisheries	agronomy and crop science	UPATRAS	2.74	17
agriculture, forestry and fisheries	forestry	UPATRAS	2.58	11
agriculture, forestry and fisheries	agronomy and crop science	NTUA	2.18	17
agriculture, forestry and fisheries	forestry	AUA	1.63	22
agriculture, forestry and fisheries	soil science	UOI	1.63	9

SOCIAL SCIENCES

Subfield of major filed of science (Frascati Manual)	Specific scientific field (Scopus)	University	Field normalized citation score	Number of publications
psychology	psychology (all)	AUEB	2.19	9
educational sciences	education	UNIPI	2.12	19
social and economic geography	transportation	TUC	2.11	22
economics and business	business, management and accounting (all)	UOI	1.96	8
economics and business	tourism, leisure and hospitality management	AUTH	1.84	12
economics and business	management science and operations research	UOI	1.84	15
media and communications	library and information sciences	AUTH	1.83	19
social and economic geography	transportation	AUTH	1.68	15
economics and business	finance	TUC	1.60	8
educational sciences	education	NTUA	1.59	15
other social sciences	sociology and political science	DUTH	1.56	14
economics and business	strategy and management	UOI	1.56	12
economics and business	management science and operations research	UNIPI	1.54	43
social and economic geography	transportation	UNIPI	1.54	32
economics and business	management science and operations research	TUC	1.51	36

HUMANITIES

Subfield of major filed of science (Frascati Manual)	Specific scientific field (Scopus)	University	Field normalized citation score	Number of publications
history and archaeology	archeology	AUTH	3.05	31
history and archaeology	history	AUTH	2.53	36

Figure 4.4.2 Scientific subfields of "Universities" publications with field normalised citation score ≥1.5, 2006-2010 / Source: Scopus 1996-2010

4.5 Scientific collaboration

Universities' publications produced as a result of scientific collaboration at the national and international level increased significantly during 1996-2010. Figure 4.5.1 shows the number of publications produced with collaborations at the national level and Figure 4.5.2 demonstrates those produced as a result of collaborations at an international level.

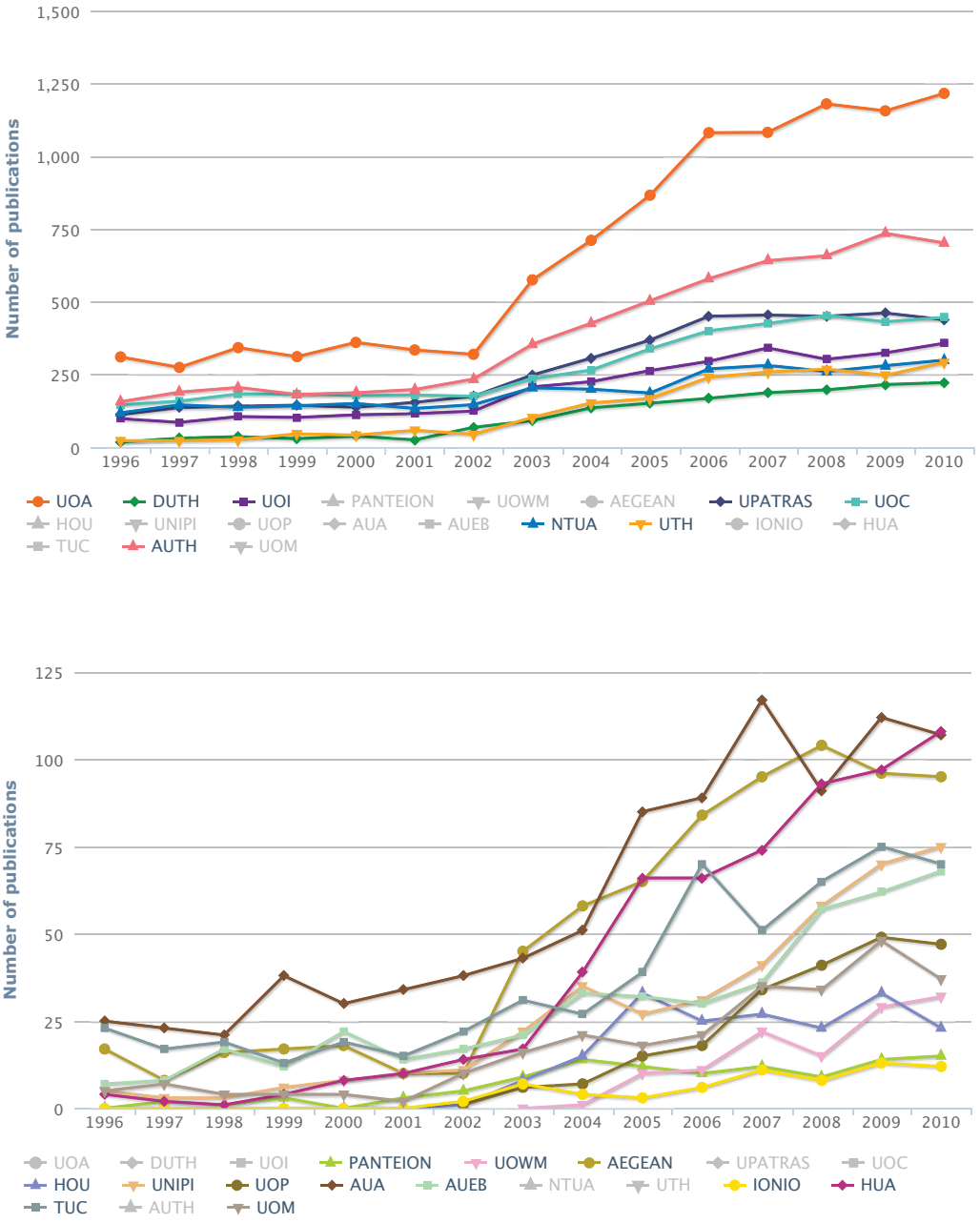


Figure 4.5.1 Number of publications with national collaboration, by University, 1996-2010 / Source: Scopus 1996-2010

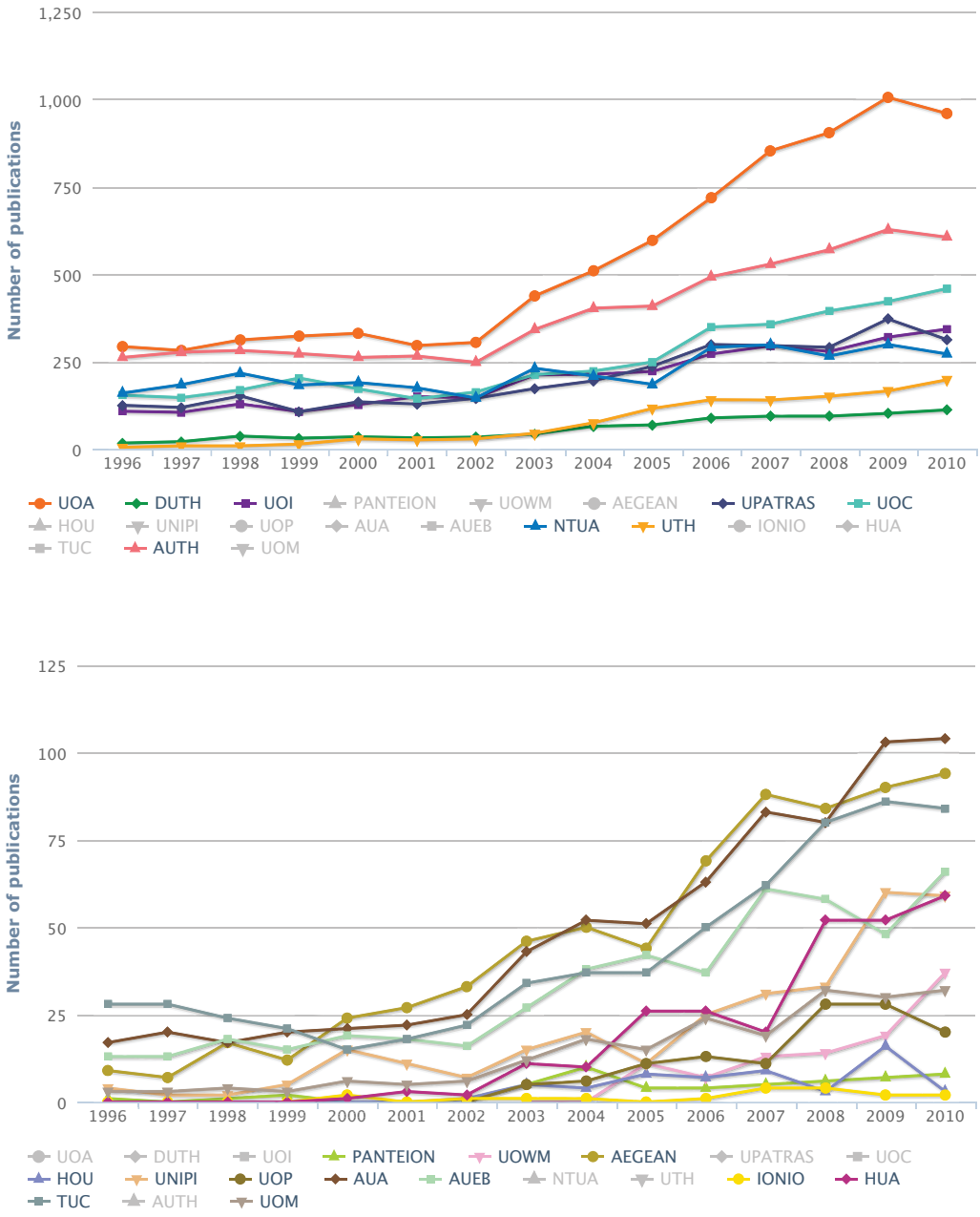


Figure 4.5.2 Number of publications with international collaboration, by University, 1996-2010 / Source: Scopus 1996-2010

Figure 4.5.3 highlights the distribution (%) of publications with national*, international** and no collaboration*** per University.

Overall, publications produced with international collaboration lag behind those produced by Greek-based institutions. Eleven Universities displayed a sharp pattern of association with domestic institutions, producing more than 50% of their publications by national collaboration. The University of Central Greece/UCG ranked first (84%) in this category.

* Number of publications with at least one national collaboration.

** Number of publications with at least one international collaboration.

*** Number of publications with no collaboration, per institution.

The degree of international collaboration was much lower. The University of Crete/UCG ranked first with 49% of its publications involving international co-authorship followed by three Universities with a percentage of or above 40% (University of Western Macedonia/UOWM, University of Ioannina/UOI and Technical University of Crete/TUC). The majority of Universities showed values in the range between 30%-40%.

Finally, the National Technical University of Athens/NTUA (44.4%), the University of Western Macedonia/UOWM (43.8%) and Athens University of Economics and Business/AUEB (41.7%) accounted for the highest share of publications produced without partnerships.

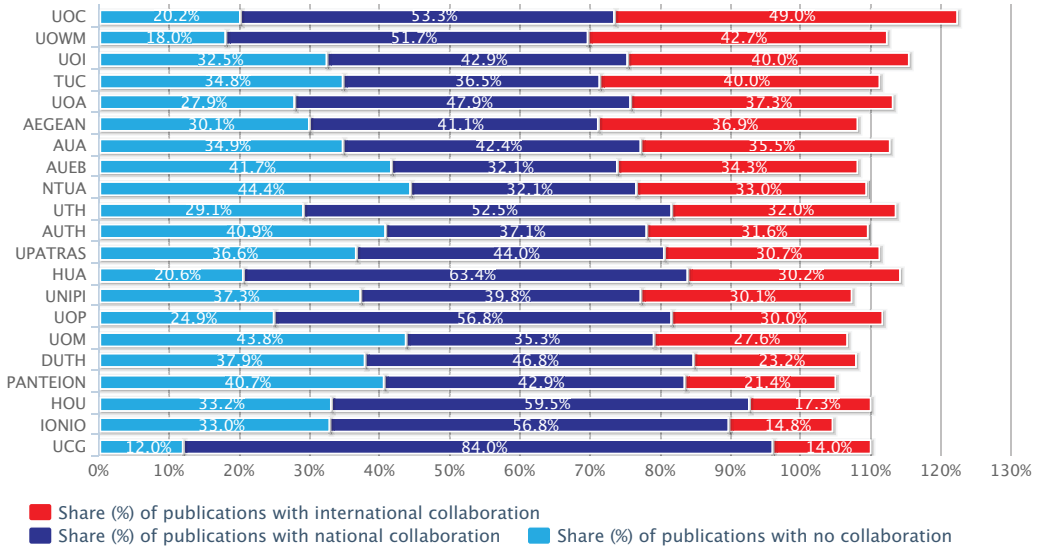


Figure 4.5.3 Share (%) of publications with national, international and no collaboration by University, 1996-2010 / Source: Scopus 1996-2010

The Technological Education Institutes (TEIs) are a significant component of the Greek Higher Education Sector. In the frame of this study, "TEIs" constitute a separate institution category which was ranked fourth, among other institutions in terms of their scientific publications output.

However, most TEIs had a relatively low publication output (<10 publications per year) and displayed unstable rates of growth. As a result, even slight variations in the number of publications could greatly affect the dependability of bibliometric indicators. Due to this observation in the nature of data, we have avoided broad conclusions regarding "TEIs" publishing activity, scientific fields of excellence and patterns of scientific collaborations. Recognizing these limitations, this study presents the main bibliographic indicators for 16 TEIs – including the Higher School of Pedagogical and Technological Education (ASPETE) –. The following table summarizes the number of TEIs' publications and their citations for the period (2006-2010).

5. Scientific Publications by Technological Education Institutes

	2006-2010	
	Number of publications	Number of citations
Higher School of Pedagogical and Technological Education – ASPETE	74	99
TEI of Athens	682	1.567
TEI of Chalkida	126	291
TEI of Crete	409	1.987
TEI of Epirus	110	385
TEI of Ionian Islands	32	117
TEI of Kalamata	99	264
TEI of Kavala	146	352
TEI of Lamia	126	336
TEI of Larissa	227	554
TEI of Messolonghi	89	142
TEI of Patras	113	505
TEI of Piraeus	183	501
TEI of Serres	86	221
TEI of Thessaloniki	374	808
TEI of West Macedonia	180	573

5.1 Publications

In the period 1996-2010, the TEIs of Athens and Thessaloniki were found to produce the majority of publications in this category. However, their output decreased in the period following 2009.

In 2010, there were 9 TEIs which produced above 20 scientific publications: (Figure 5.1.1): TEI of Athens (151), TEI of Thessaloniki (93), TEI of Crete (74), TEI of Larissa (67), TEI of Piraeus (46), TEI of West Macedonia (40), TEI of Kavala (33), TEI of Lamia (29), TEI of Kalamata (29).

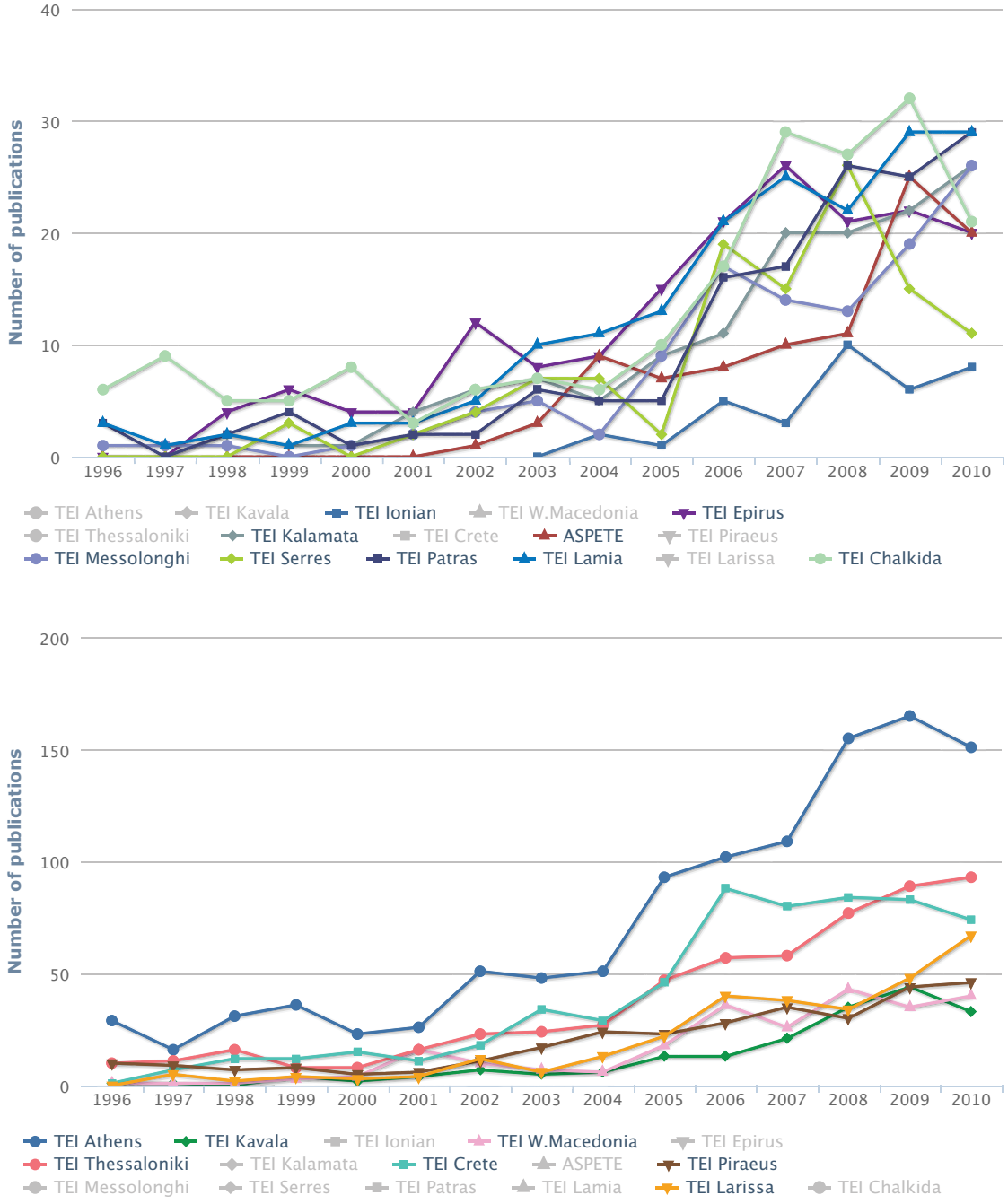


Figure 5.1.1 Development of the number of publications by TEI, 1996-2010 / Source: Scopus 1996-2010

Figure 5.1.2 plots the number of publications by TEI and their year-on-year rate of change from 1996 to 2000.

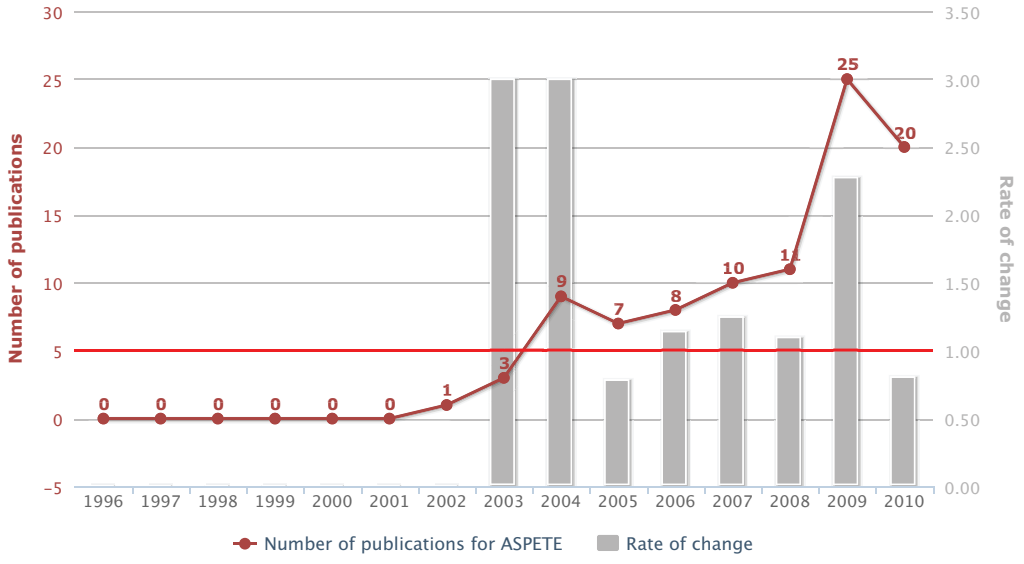


Figure 5.1.2 Number of publications and rate of change in the number of publications by ASPETE, 1996-2010 / Source: Scopus 1996-2010

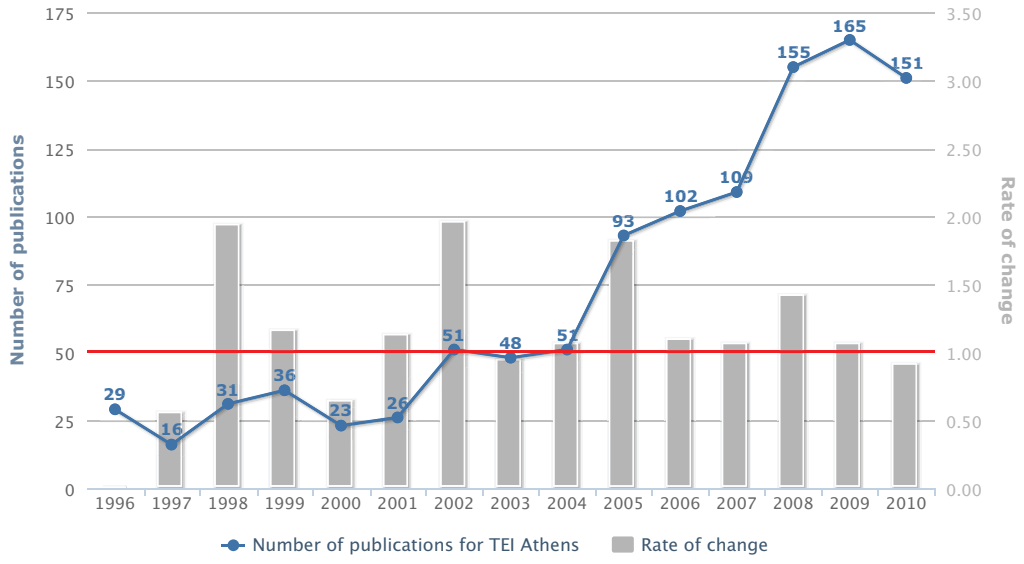


Figure 5.1.2 Number of publications and rate of change in the number of publications by TEI of Athens, 1996-2010 / Source: Scopus 1996-2010

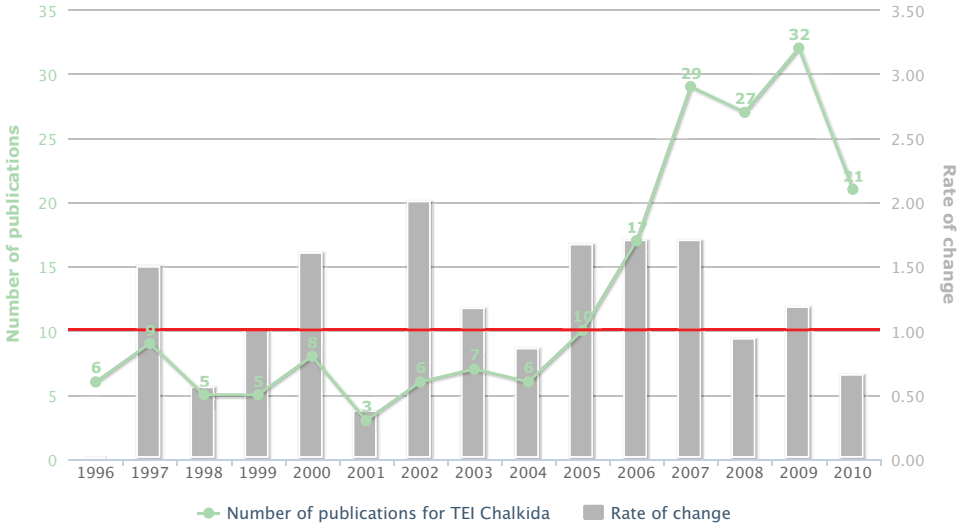


Figure 5.1.2 Number of publications and rate of change in the number of publications by TEI of Chalkida, 1996-2010 / Source: Scopus 1996-2010

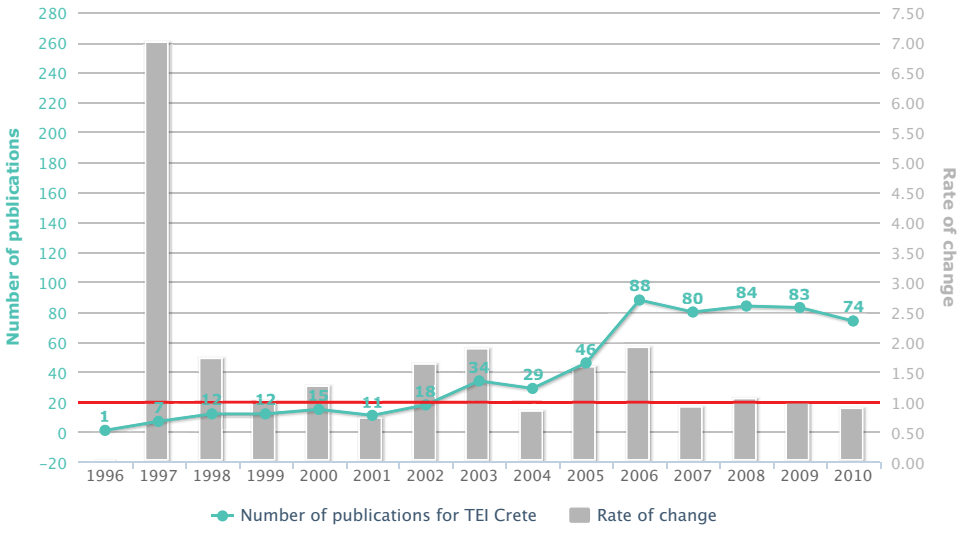


Figure 5.1.2 Number of publications and rate of change in the number of publications by TEI of Crete, 1996-2010 / Source: Scopus 1996-2010

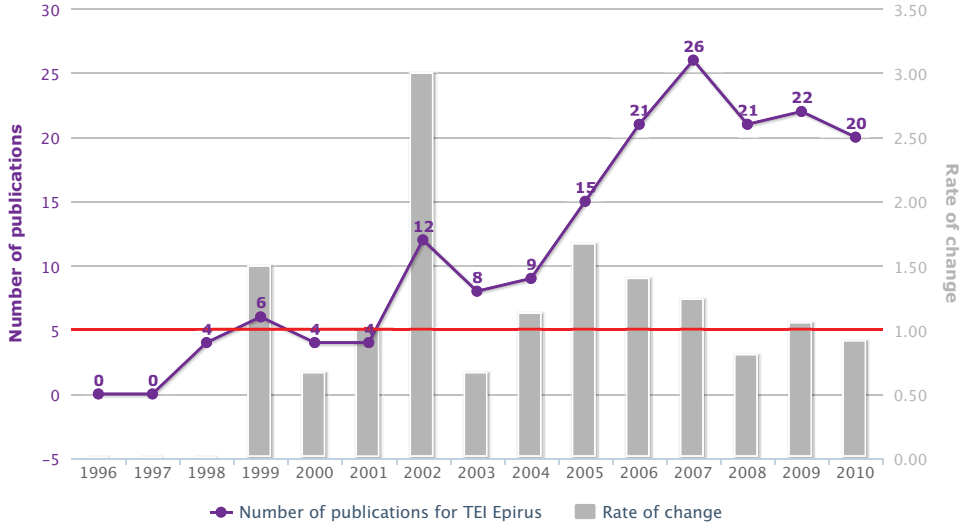


Figure 5.1.2 Number of publications and rate of change in the number of publications by TEI of Epirus, 1996-2010 / Source: Scopus 1996-2010

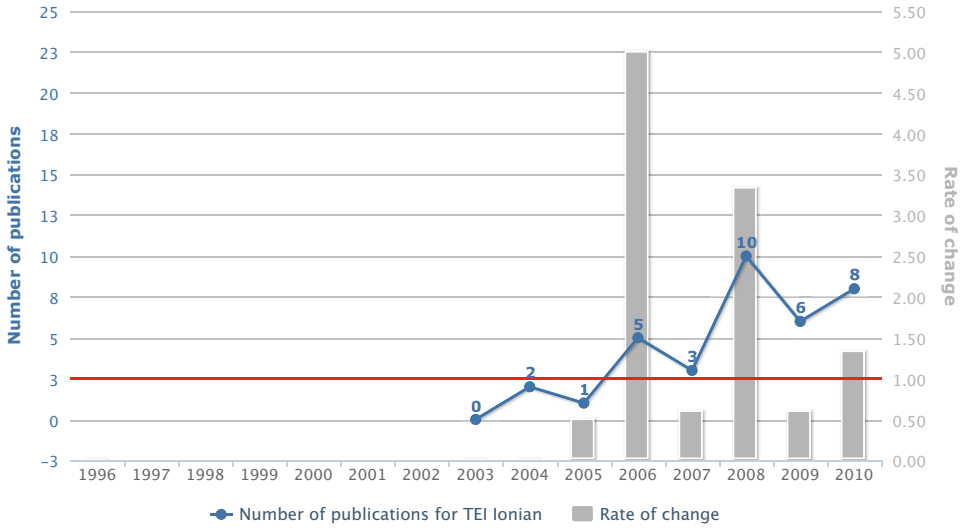


Figure 5.1.2 Number of publications and rate of change in the number of publications by TEI of Ionian Islands, 1996-2010 / Source: Scopus 1996-2010

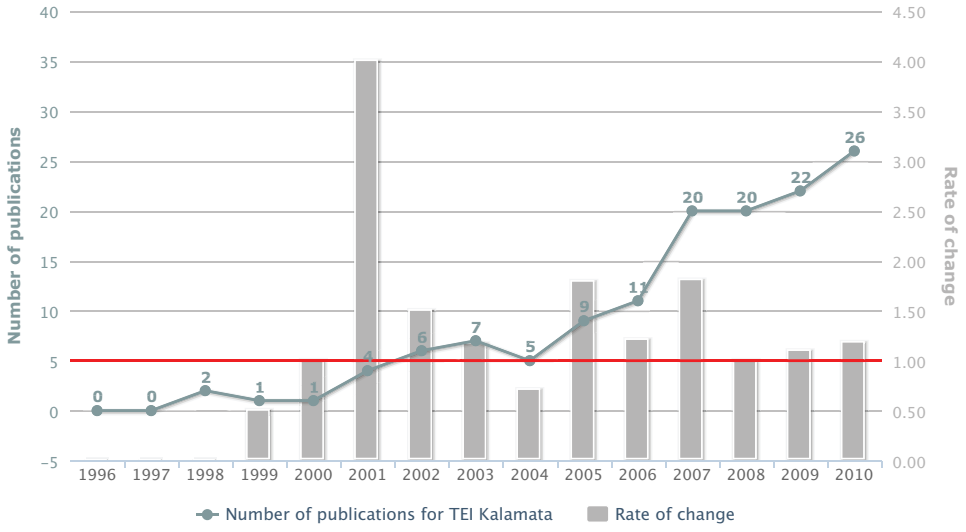


Figure 5.1.2 Number of publications and rate of change in the number of publications by TEI of Kalamata, 1996-2010 / Source: Scopus 1996-2010

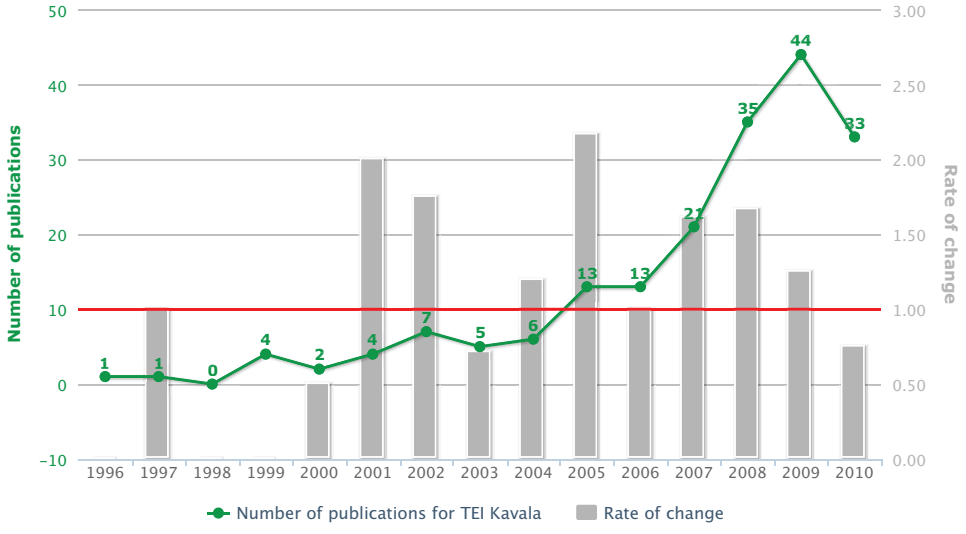


Figure 5.1.2 Number of publications and rate of change in the number of publications by TEI of Kavala, 1996-2010 / Source: Scopus 1996-2010

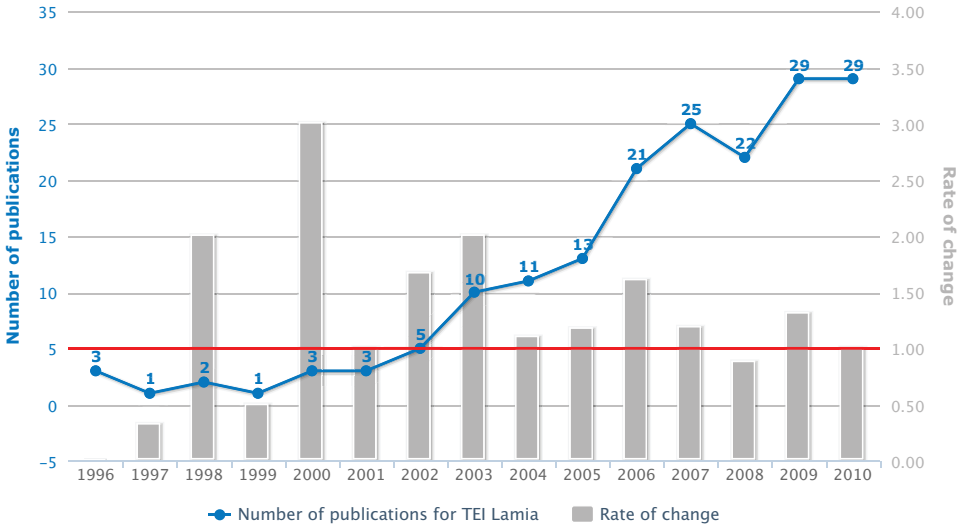


Figure 5.1.2 Number of publications and rate of change in the number of publications by TEI of Lamia, 1996-2010 / Source: Scopus 1996-2010

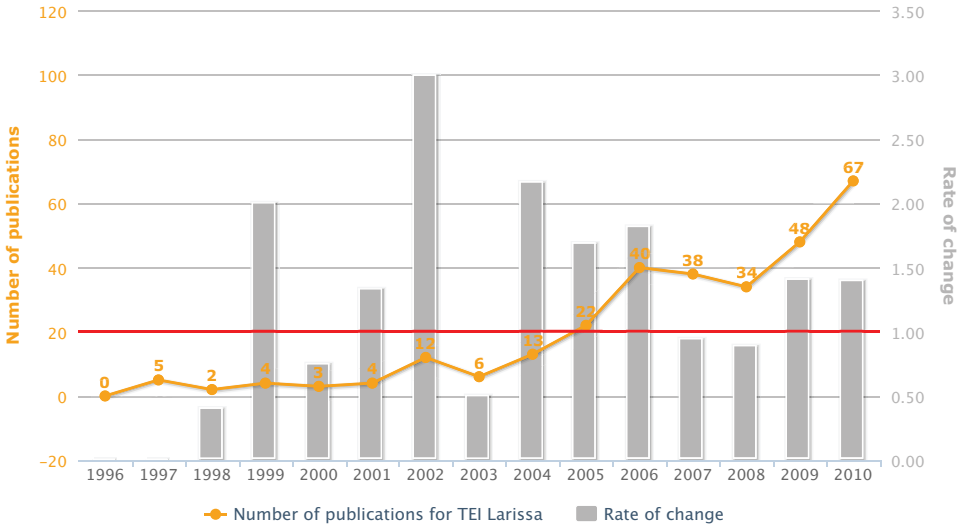


Figure 5.1.2 Number of publications and rate of change in the number of publications by TEI of Larissa, 1996-2010 / Source: Scopus 1996-2010

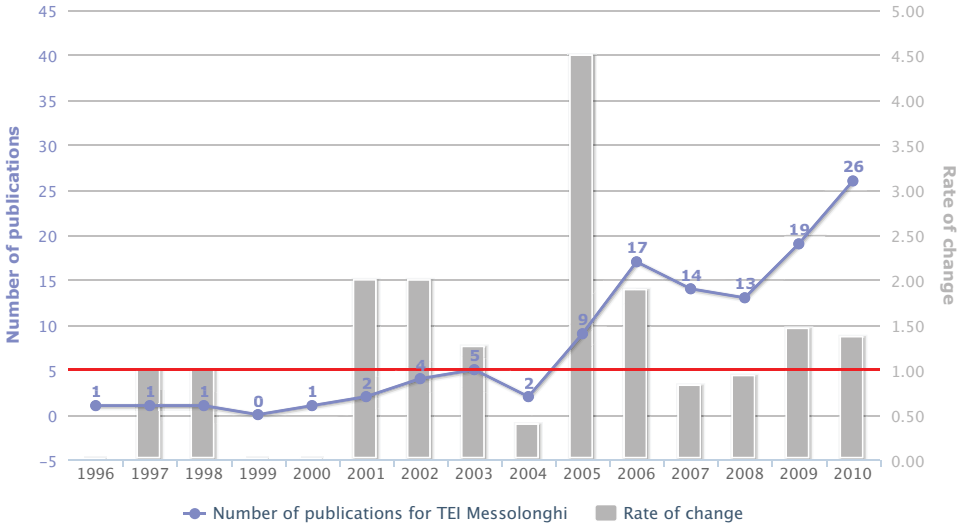


Figure 5.1.2 Number of publications and rate of change in the number of publications by TEI of Messolonghi, 1996-2010 / Source: Scopus 1996-2010

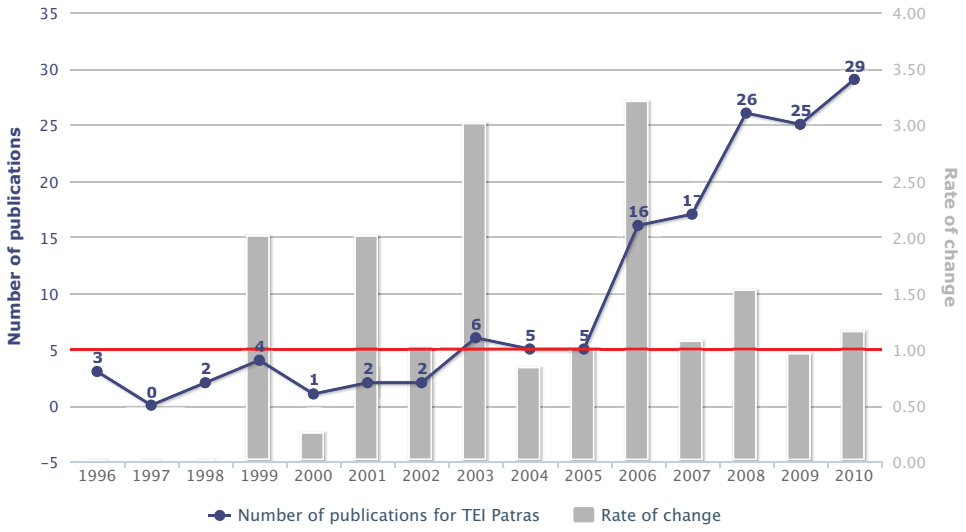


Figure 5.1.2 Number of publications and rate of change in the number of publications by TEI of Patras, 1996-2010 / Source: Scopus 1996-2010

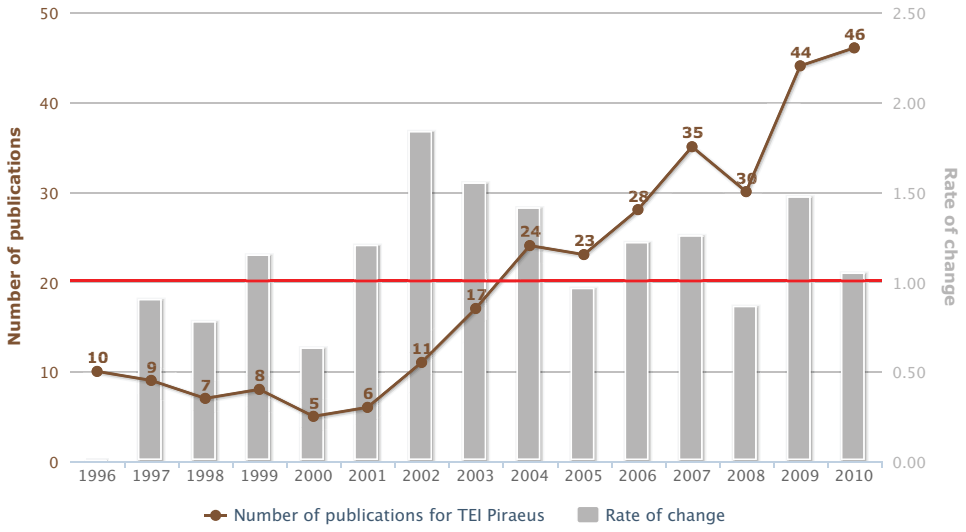


Figure 5.1.2 Number of publications and rate of change in the number of publications by TEI of Piraeus, 1996-2010 / Source: Scopus 1996-2010

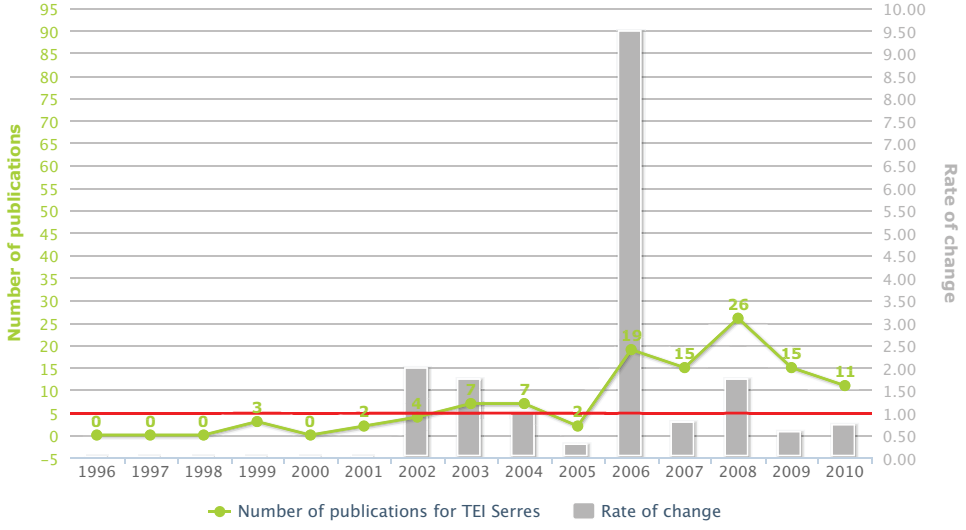


Figure 5.1.2 Number of publications and rate of change in the number of publications by TEI of Serres, 1996-2010 / Source: Scopus 1996-2010

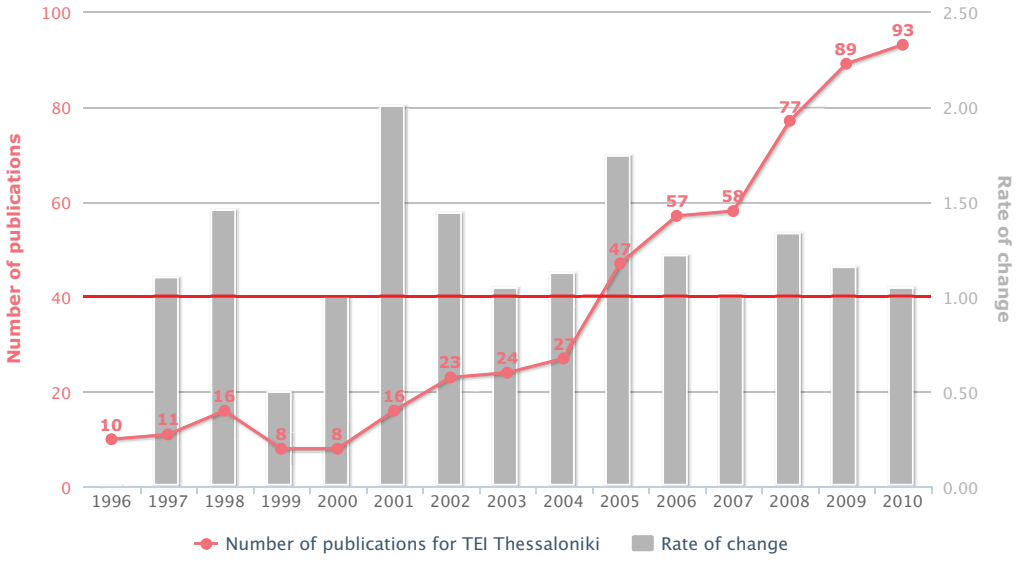


Figure 5.1.2 Number of publications and rate of change in the number of publications by TEI of Thessaloniki, 1996-2010 / Source: Scopus 1996-2010

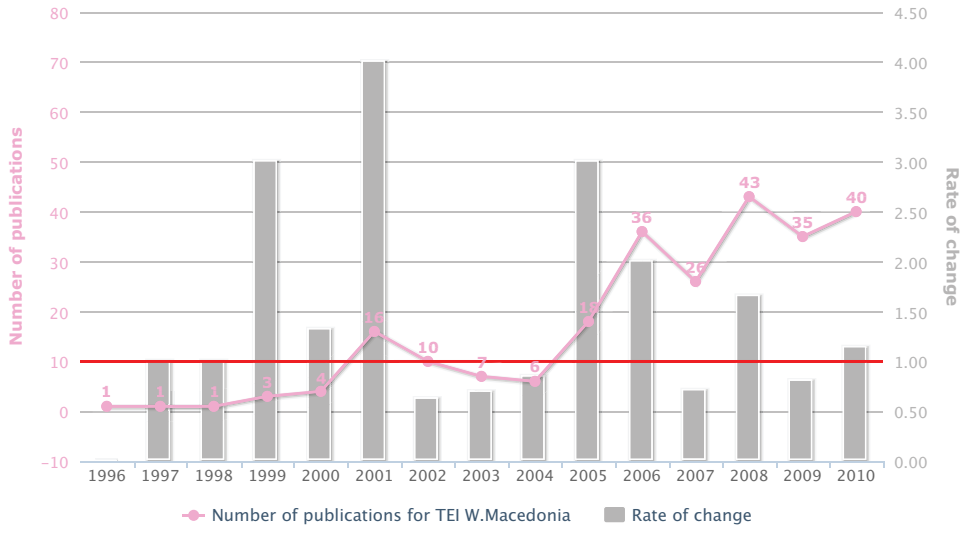


Figure 5.1.2 Number of publications and rate of change in the number of publications by TEI of West Macedonia, 1996-2010 / Source: Scopus 1996-2010

Figure 5.1.3 presents data related to the quantity of publication output by each TEI and its share in the total output of the category "TEIs" –over the period 2006-2010–. "TEIs" were ranked in a descending order as follows: TEI of Athens 682 (23,8%), TEI of Crete 409 (14,3%), TEI of Thessaloniki 374 (13%), TEI of Larissa 227 (7.9%), TEI of Piraeus 183 (6.4%), TEI of West Macedonia 180 (6.3%) and TEI of Kavala 146 (5.1%). The rest had a share of less than 5%.

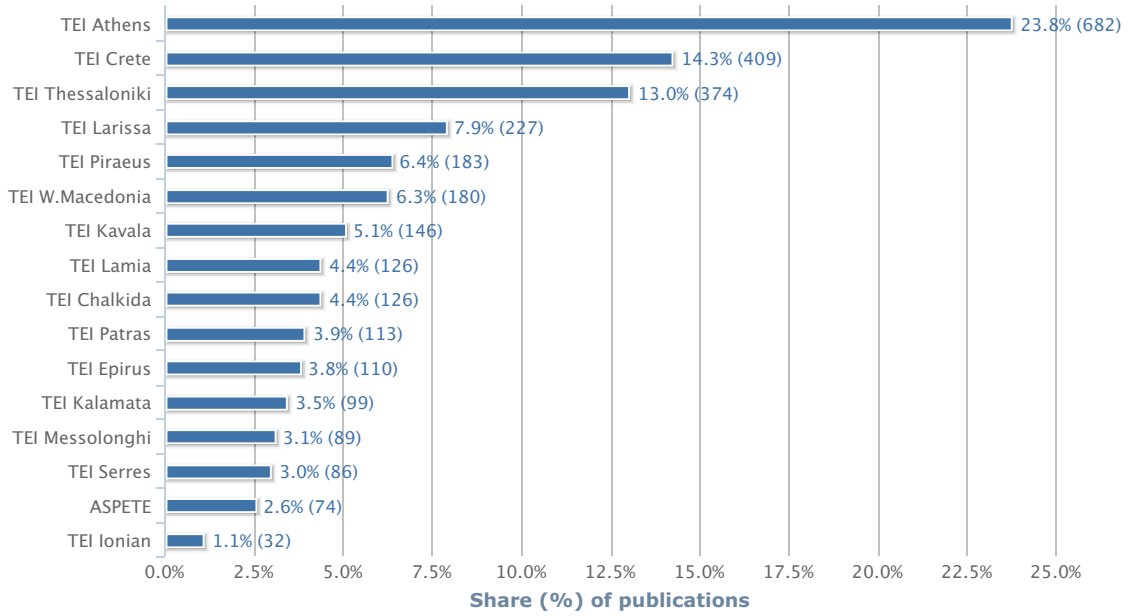


Figure 5.1.3 Number and share (%) of publications, by TEI, 2006-2010 / Source: Scopus 1996-2010

Between 2006 and 2010, 8 (out of 16 TEIs) experienced a significant growth in their publication figures. The TEI of Kavala, ASPETE, and the TEIs of Kalamata, Patras, Larissa, Piraeus, Thessaloniki and the Ionian Islands, exceeded the average growth of the category (Figure 5.1.4). However, the number of publications produced by "TEIs" was still relatively low and varied over time.

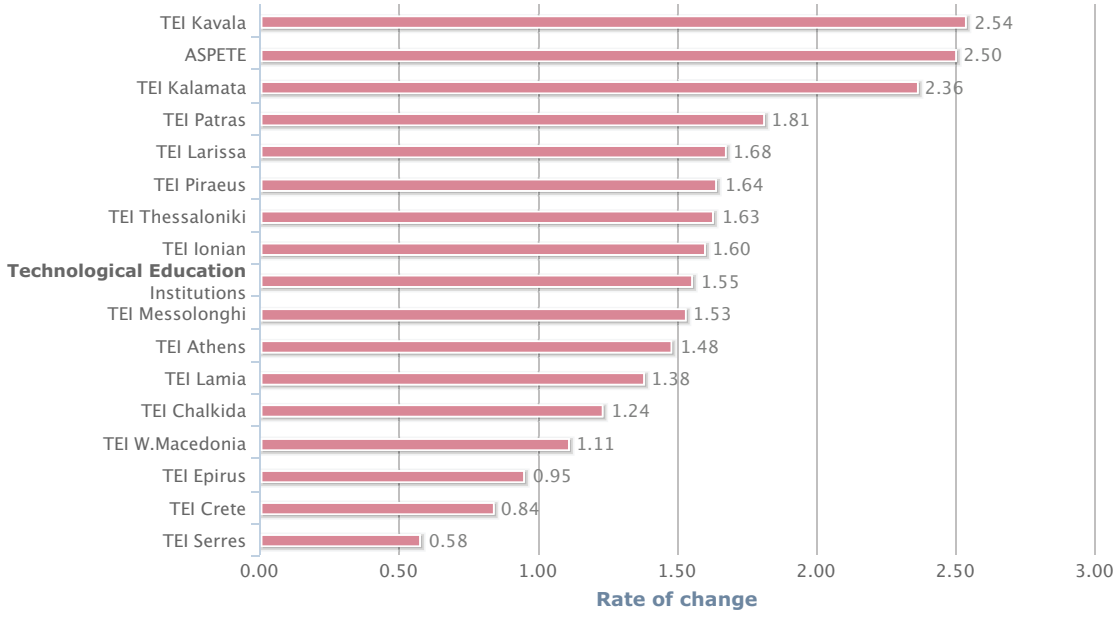


Figure 5.1.4 Change in the number of publications between 2006 and 2010, by TEI / Source: Scopus 1996-2010

5.2 Citations

Figure 5.2.1 shows, for each TEI, the percentage of cited publications over the period 1996-2010. TEIs of Athens, West Macedonia, Epirus, Kalamata, Crete and Larissa were found to have the highest percentage of cited publications, with a relatively stable progression over time. In the case of the TEI of Ionian Islands (68.8%), the TEI of Crete (67.5%) and the TEI of Kalamata (67.5%), the percentage was higher than the Greek average (65.6%). Moreover, the percentage of the TEI of Epirus (63.6%) was close to that baseline.

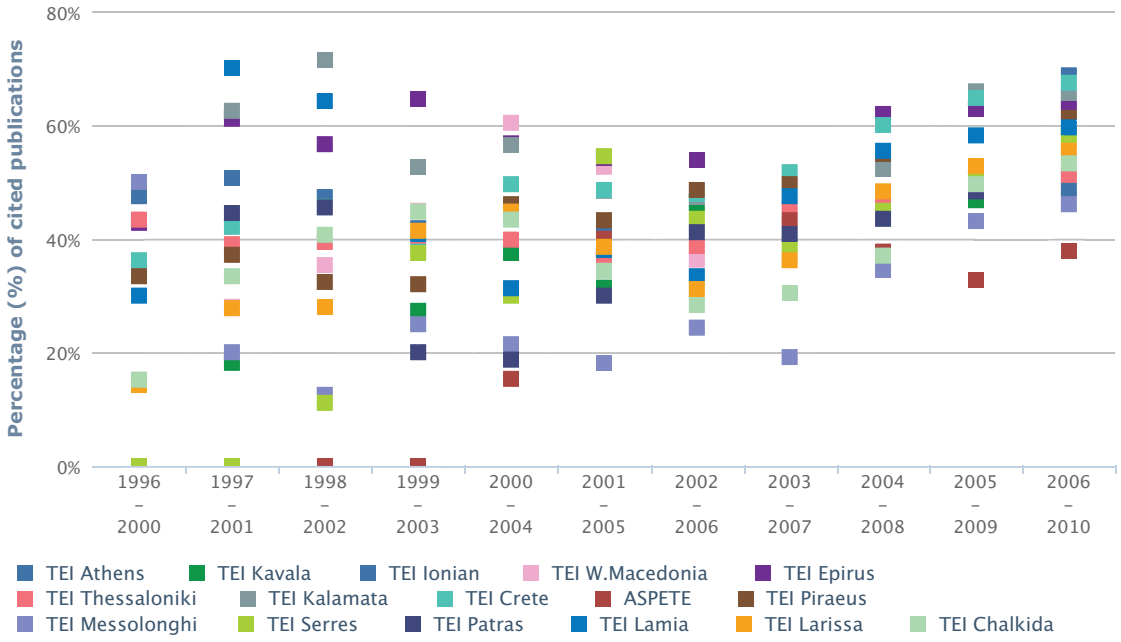
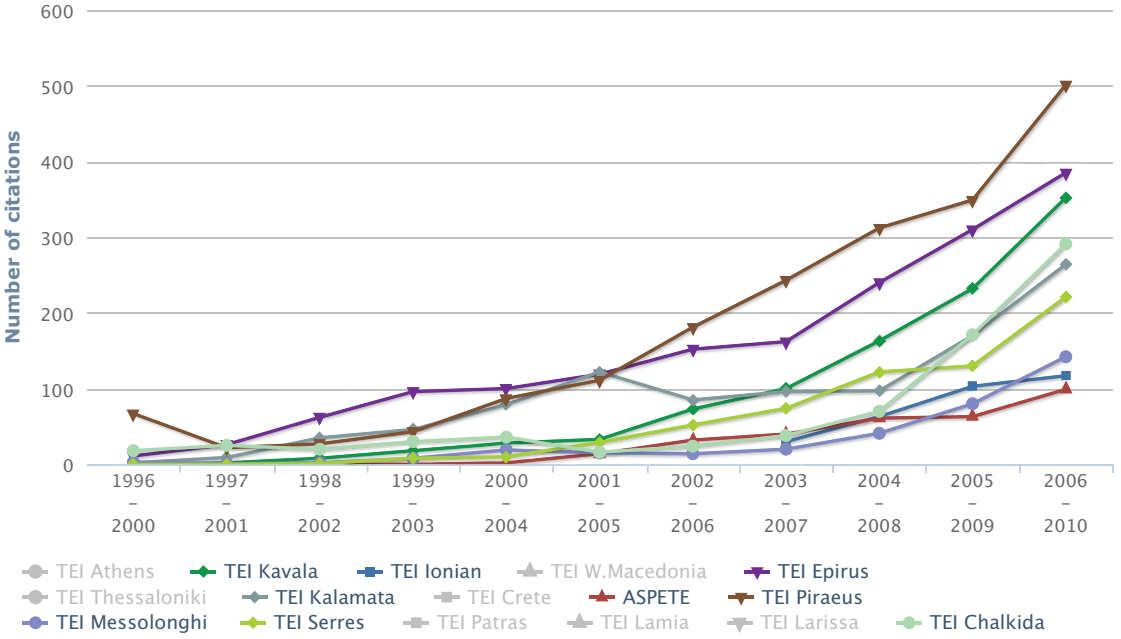


Figure 5.2.1 Percentage (%) of cited publications by TEI, 1996-2010 / Source: Scopus 1996-2010

Figure 5.2.2 demostrates that there was a positive trend in the number of citations of publications produced by "TEIs" over the period 1996-2010. The TEI of Crete displayed the greatest number of citations for its publications. The TEIs of Athens, Thessaloniki, West Macedonia, Larissa, Patras, Piraeus and Epirus followed.



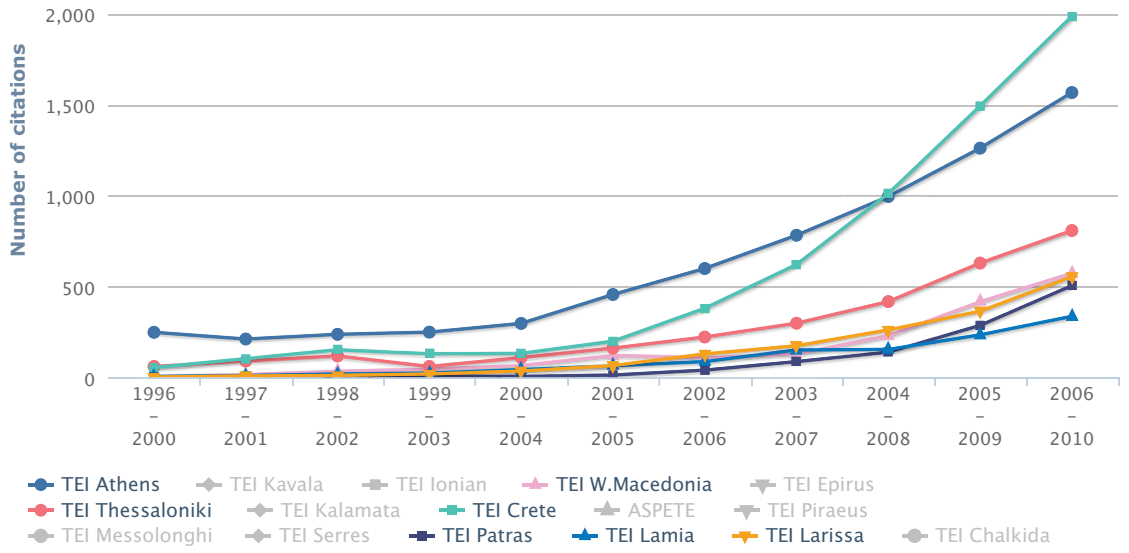


Figure 5.2.2 Number of citations by TEI, 1996-2010 / Source: Scopus 1996-2010

More specifically, according to the data displayed in Figure 5.2.3 (corresponding to the 5-year period 2006-2010), the highest number of citations and their share in the total citations across "TEIs" category, was observed for the following TEIs: Crete (24.5%; 1,987 citations), Athens (19.3%; 1,567 citations), Thessaloniki (10%; 808 citations), West Macedonia (7.1%; 573 citations), Larissa (6.8%; 554 citations), Patras (6.2%; 505 citations) and Piraeus (6.2%; 501 citations). The other TEIs had a smaller share (less than 5%).

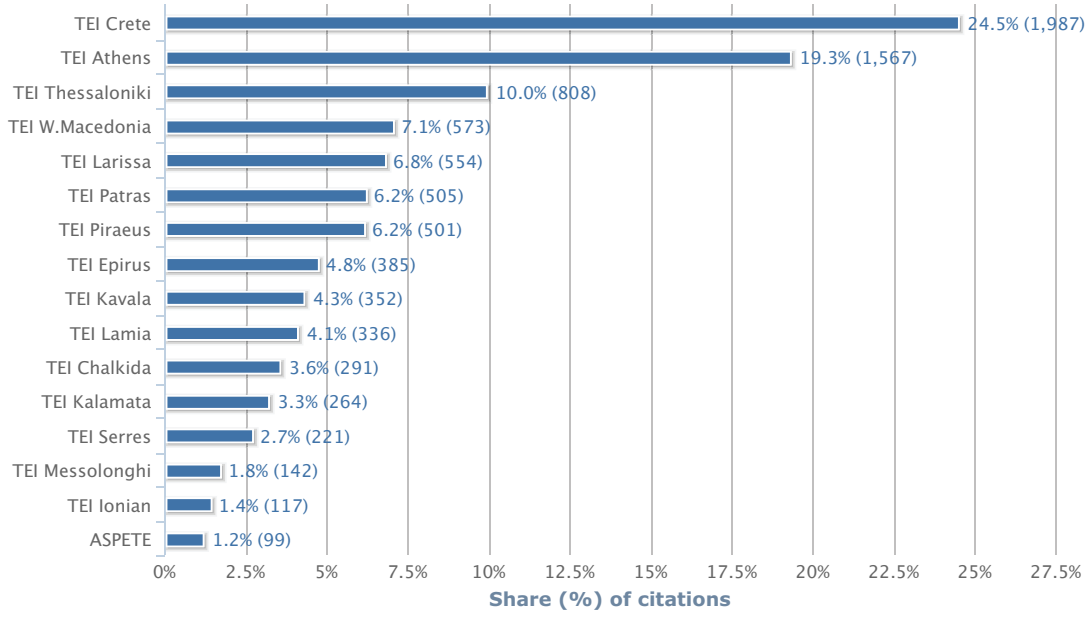


Figure 5.2.3 Number and share (%) of citations by TEI, 2006-2010 / Source: Scopus 1996-2010

5.3 Citation impact

Figure 5.3.1 presents the number of publications and citations for each TEI and the relevant field-normalised citation score corresponding to the 5-year period 2006-2010. When referring to the field normalised citation score or "citation score", we point out to the number of citations that TEIs' publications received compared to the world average of citations received over the same time period and per scientific field. The normalisation was processed at the level of each publication according to the 307 scientific subject fields. In the case that an article would be categorized in more than one subject fields, a mean value for the fields was calculated. The citation score was calculated using software developed by EKT. A value greater than 1, indicates that the impact of publications was higher than the world average.

Publications of the TEI of Crete achieved the highest citation score with a value of 1.09. Above the world average were also the publications of ASPETE (1.06) and the TEI of Patras (1.03). The publications of the TEIs of West Macedonia (0.95) and Piraeus (0.91) were close to the world baseline.

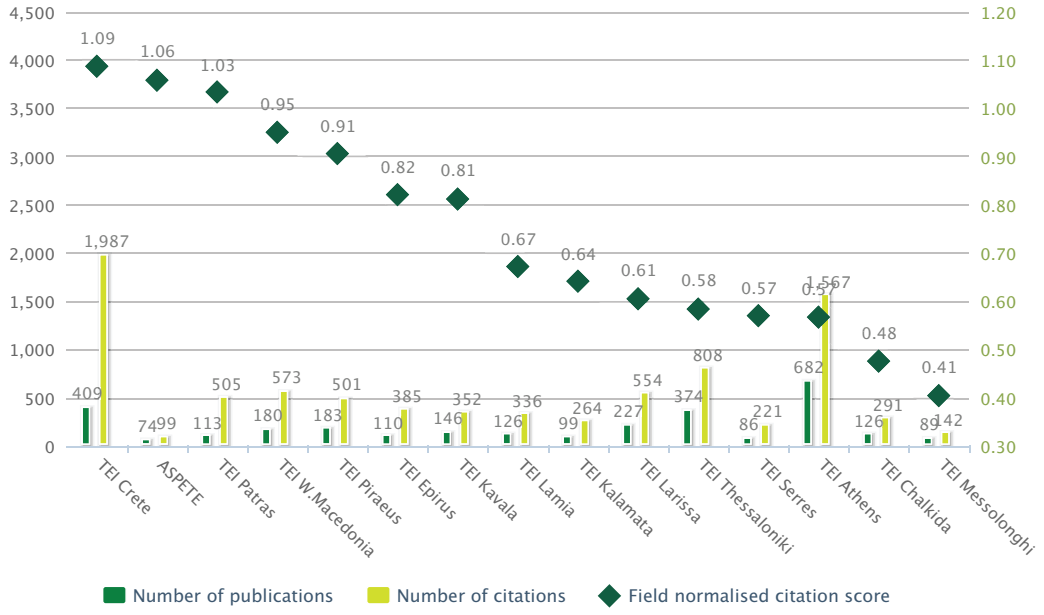


Figure 5.3.1 Publications, citations and field normalised citation score relative to the world, by TEI, 2006-2010. Data refers to the total number of publications in each TEI for all scientific fields / Source: Scopus 1996-2010

5.4 Major fields of science

The majority of publications* produced by "Technological Educational Institutes" fell under the scope of the following fields: "Natural Sciences", "Engineering and Technology", "Medical and Health Sciences" and "Agricultural Sciences". Figure 5.4.1 provides a comprehensive picture of each TEI's performance -number of publications, citations and the relevant citation scores- in these fields. It also provides information on the specific subfields with citation scores above 1.5.

* The field normalised citation score was calculated only for TEIs with more than 50 publications for the period 1996-2010.

There were 14 TEIs with scientific activity in "Natural Sciences". The publications of the TEIs of Kavala and Crete had the highest impact (citation score: 1.04 and 1.03, respectively), while the TEIs of Lamia (0.99), Patras (0.96) and Epirus (0.94) were close to the world average.

In "Engineering & Technology" publications were produced by 11 TEIs. The citation scores of publications produced by the TEI of Crete (1.25), ASPETE (1.18), and the TEIs of Patras (1.15), West Macedonia (1.15), Piraeus (1.11) and Serres (1.11) surpassed the world average.

There were 6 TEIs with scientific activity in the field "Medical & Health Sciences". The publications of the TEI of Patras were on the world average (1.00).

"Agricultural Sciences" was the field linked to the publishing profile of 6 TEIs, which, however, had low citation scores.

Finally, in the field "Social Sciences", only two TEIs (Athens and Thessaloniki) systematically produced publications, with low citation scores.

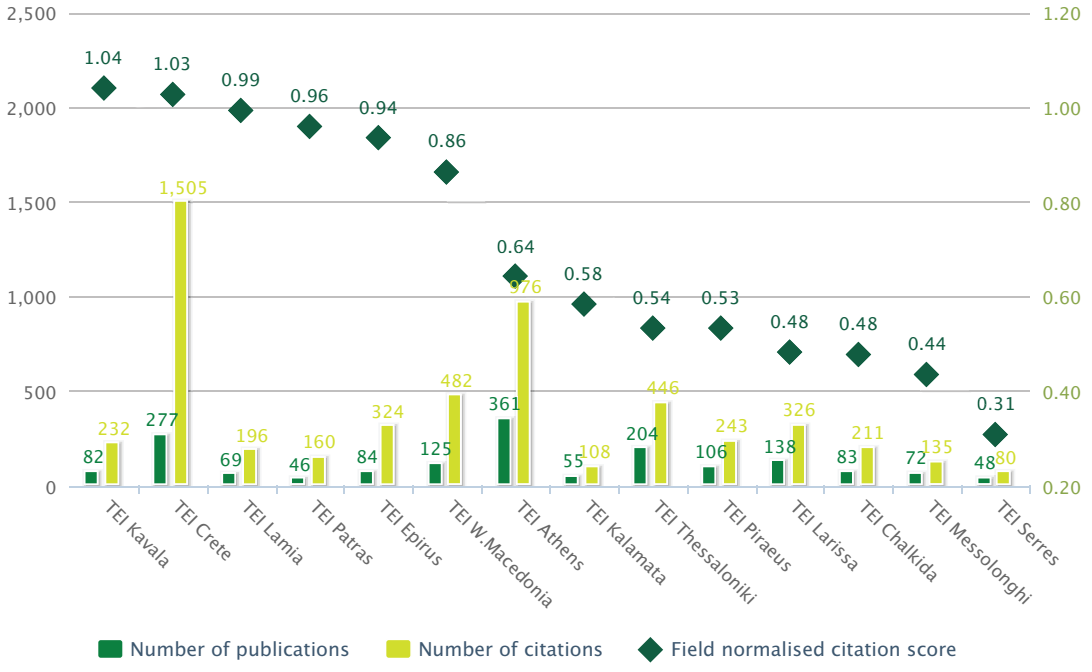


Figure 5.4.1 Publications, citations and field normalised citation score relative to the world, by TEI, in the major field of "Natural Sciences", 2006-2010 / Source: Scopus 1996-2010

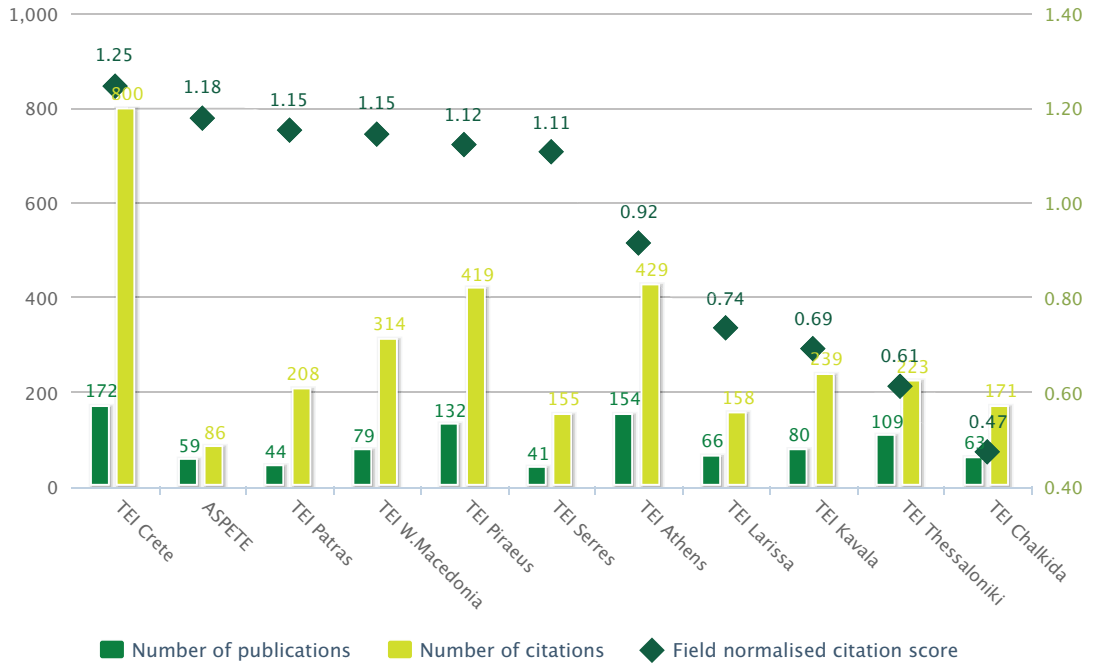


Figure 5.4.1 Publications, citations and field normalised citation score relative to the world, by TEI, in the major field of "Engineering & Technology", 2006-2010 / Source: Scopus 1996-2010

Figure 5.4.1 Publications, citations and field normalised citation score relative to the world, by TEI, in the major field of "Medical & Health Sciences", 2006-2010 / Source: Scopus 1996-2010

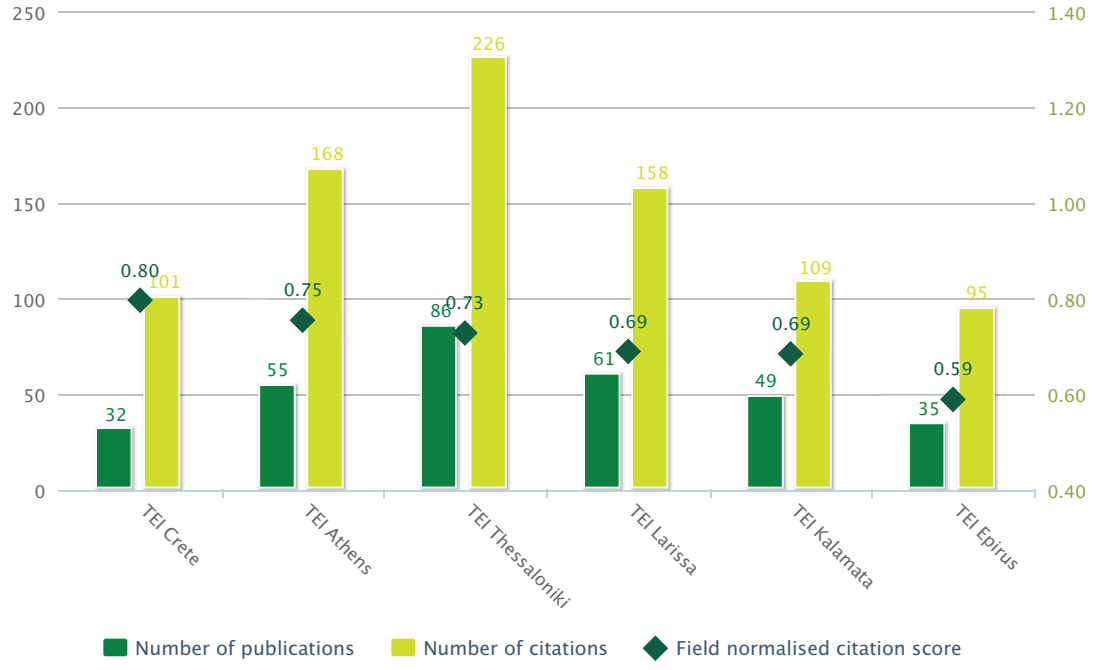


Figure 5.4.1 Publications, citations and field normalised citation score relative to the world, by TEI, in the major field of "Agricultural Sciences", 2006-2010 / Source: Scopus 1996-2010

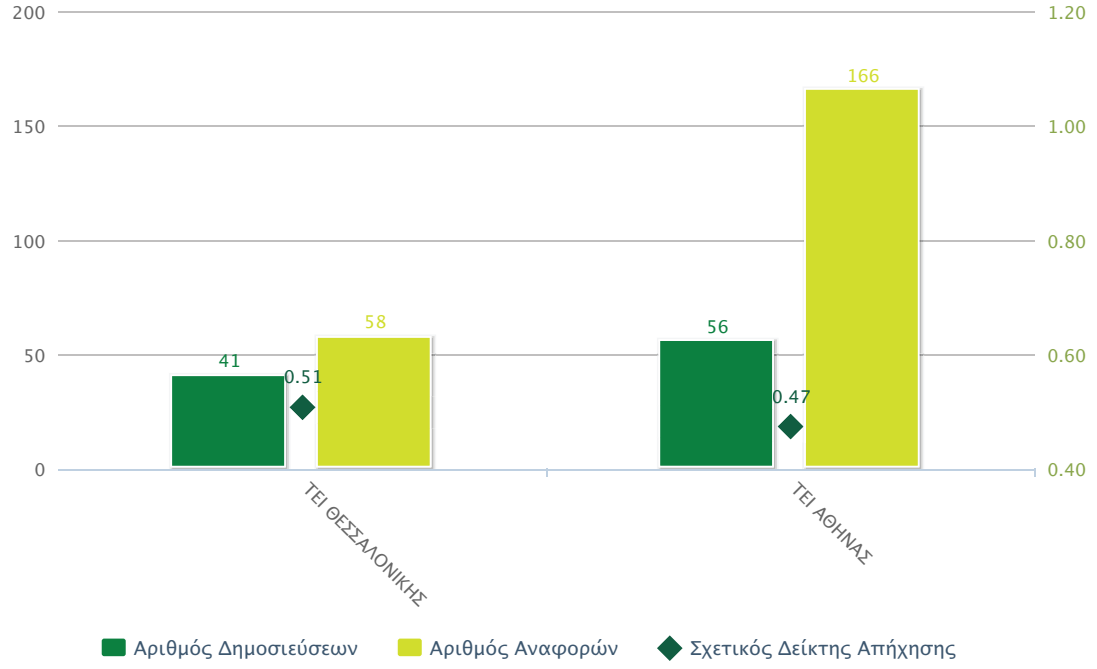


Figure 5.4.1 Publications, citations and field normalised citation score relative to the world, by TEI, in the major field of "Social Sciences", 2006-2010 / Source: Scopus 1996-2010

NATURAL SCIENCES				
Subfield of major filed of science (Frascati Manual)	**Specific scientific field (Scopus)**	**TEI**	**Field normalized citation score**	**Number of publications**
physical sciences	surfaces and interfaces	TEI CRETE	2.36	7
computer and information sciences	artificial intelligence	TEI EPIRUS	1.97	8
physical sciences	physics and astronomy (all)	TEI CRETE	1.88	27
chemical sciences	analytical chemistry	TEI ATHENS	1.77	10
chemical sciences	organic chemistry	TEI ATHENS	1.65	7
physical sciences	condensed matter physics	TEI W. MACEDONIA	1.62	9
physical sciences	condensed matter physics	TEI CRETE	1.61	43
computer and information sciences	software	TEI KAVALA	1.58	12
computer and information sciences	artificial intelligence	TEI THESSALONIKI	1.58	8
mathematics	applied mathematics	TEI EPIRUS	1.56	6
physical sciences	physics and astronomy (miscellaneous)	TEI CRETE	1.51	14

ENGINEERING AND TECHNOLOGY				
Subfield of major filed of science (Frascati Manual)	**Specific scientific field (Scopus)**	**TEI**	**Field normalized citation score**	**Number of publications**
environmental engineering	energy engineering and power technology	TEI ATHENS	3.79	7
civil engineering	civil and structural engineering	TEI PIRAEUS	2.43	10
civil engineering	civil and structural engineering	TEI CRETE	2.39	10
environmental engineering	energy (all)	TEI PIRAEUS	2.33	11
civil engineering	building and construction	ASPETE	2.27	10
civil engineering	architecture	ASPETE	2.14	9
materials engineering	surfaces, coatings and films	TEI CRETE	2.06	20
environmental engineering	fuel technology	TEI PIRAEUS	1.93	7
mechanical engineering	mechanical engineering	TEI CRETE	1.84	13
materials engineering	materials science (all)	TEI CRETE	1.79	15
environmental engineering	energy engineering and power technology	TEI PIRAEUS	1.74	12
civil engineering	civil and structural engineering	ASPETE	1.72	9
chemical engineering	process chemistry and technology	TEI W. MACEDONIA	1.65	7
materials engineering	polymers and plastics	TEI W. MACEDONIA	1.57	9
mechanical engineering	mechanical engineering	TEI PIRAEUS	1.56	10
materials engineering	surfaces, coatings and films	TEI PATRAS	1.56	6
environmental engineering	renewable energy, sustainability and the environment	TEI CRETE	1.55	22
environmental engineering	renewable energy, sustainability and the environment	TEI PIRAEUS	1.52	21
materials engineering	materials science (all)	TEI PATRAS	1.50	9
materials engineering	materials science (all)	TEI W. MACEDONIA	1.50	11

MEDICAL & HEALTH SCIENCES				
Subfield of major filed of science (Frascati Manual)	**Specific scientific field (Scopus)**	**TEI**	**Field normalized citation score**	**Number of publications**
clinical medicine	cardiology and cardiovascular medicine	TEI PATRAS	2.80	7

Figure 5.4.2 Scientific subfields of "TEIs" publications with field normalised citation score ≥1.5, 2006-2010 / Source: Scopus 1996-2010

5.5 Scientific collaboration

Figure 5.5.1 highlights the distribution (%) of publications produced as a result of collaborations at the national* and international level**. It also depicts publications whith no scientific collaboration***. Overall, the number of co authorships with national partners was higher than this of publications carried out with international partners. More specifically, all TEIs produced more than 55% of their publications with collaborations at the national level. The TEI of Kalamata had the highest ranking (88.9%). On the other hand, the degree of international collaboration was lower, ranging between 10.6% (TEI of West Macedonia) and 39.7% (TEI of Lamia). Finally, the TEI of Piraeus (32.2%) had the greatest share of publications which were not carried out under any collaboration scheme.

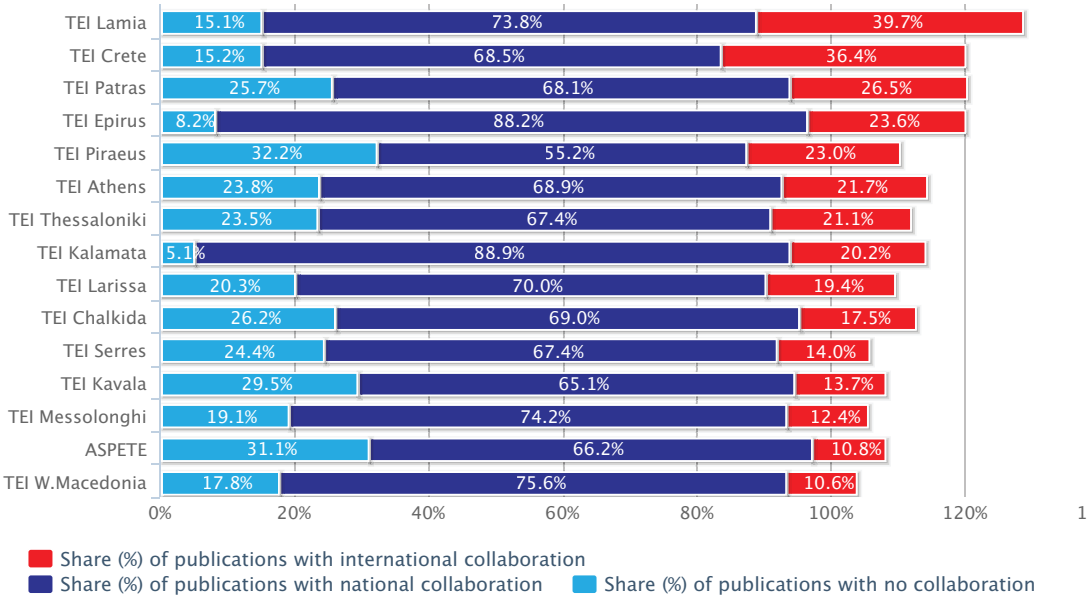


Figure 5.5.1 Share (%) of publications with national, international and no collaboration by TEI, 1996-2010 / Source: Scopus 1996-2010

* Number of publications with at least one national collaboration.

** Number of publications with at least one international collaboration.

*** Number of publications with no collaboration, per institution.

This section presents bibliometric indicators for 11 Research Centers, supervised by the General Secretariat for Research and Technology (GSRT). "GSRT Research Centers" emerges as the third most productive institution category in terms of the number of publications produced.

The table below summarizes the number of publications and citations received for publications produced from each Center for the latest period (2006-2010) of this study.

6. Scientific Publications by GSRT Research Centers

		2006-2010	
		Number of publications	Number of citations
ATHENA - Research and Innovation Center in Information, Communication and Knowledge Technologies	ATHENA	137	507
Biomedical Sciences Research Center "Alexander Fleming"	FLEMING	171	2,037
Center for Research and Technology Hellas	CERTH	464	2,677
Center For Research and Technology, Thessaly	CE.RE.TE.TH.	162	777
Foundation for Research and Technology – Hellas	FORTH	2,047	15,758
Greek Atomic Energy Commission	GAEC	46	120
Hellenic Center for Marine Research	HCMR	506	2,182
Hellenic Pasteur Institute	PASTEUR	169	1,201
National Center of Scientific Research "DEMOKRITOS"	NCSR "DEMOKRITOS"	2,004	12,229
National Hellenic Research Foundation	NHRF	599	4,750
National Observatory of Athens	NOA	555	3,046

6.1 Publications

The top performing institutions in the category "Research Centers supervised by GSRT", in terms of publications output, were the National Center for Scientific Research "DEMOKRITOS"/NCSR "DEMOKRITOS" and the Foundation for Research and Technology - Hellas (FORTH).

In 2010, GSRT Research Centers were ranked in terms of their number of publications, according to the following order: National Center for Scientific Research "DEMOKRITOS"/NCRS "DEMOKRITOS" (444), the Foundation for Research and Technology Hellas/FORTH (412), the Hellenic Centre for Marine Research/HCMR (126), the National Observatory of Athens/NOA (126), the National Hellenic Research Foundation/NHRF (124) and the Centre for Research and Technology Hellas/CERTH (108). The rest produced fewer than 50 publications (Figure 6.1.1).

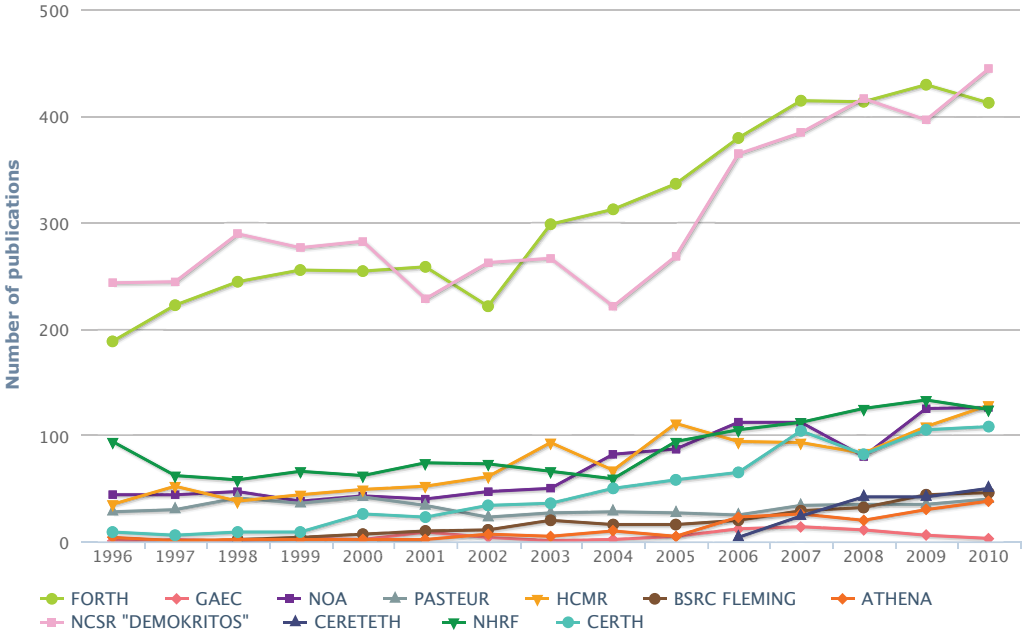


Figure 6.1.1 Development of the number of publications by GSRT Research Center, 1996-2010 / Source: Scopus 1996-2010

Figure 6.1.2 displays the number of publications and the annual rate of change for each GSRT Research Center for the years 1996-2010.

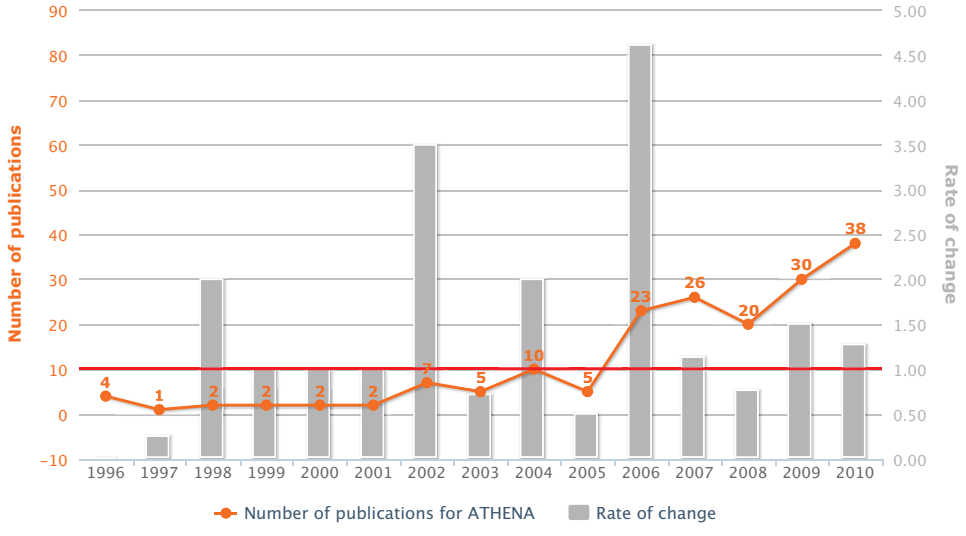


Figure 6.1.2 Number of publications and rate of change in the number of publications by ATHENA, 1996-2010 / Source: Scopus 1996-2010

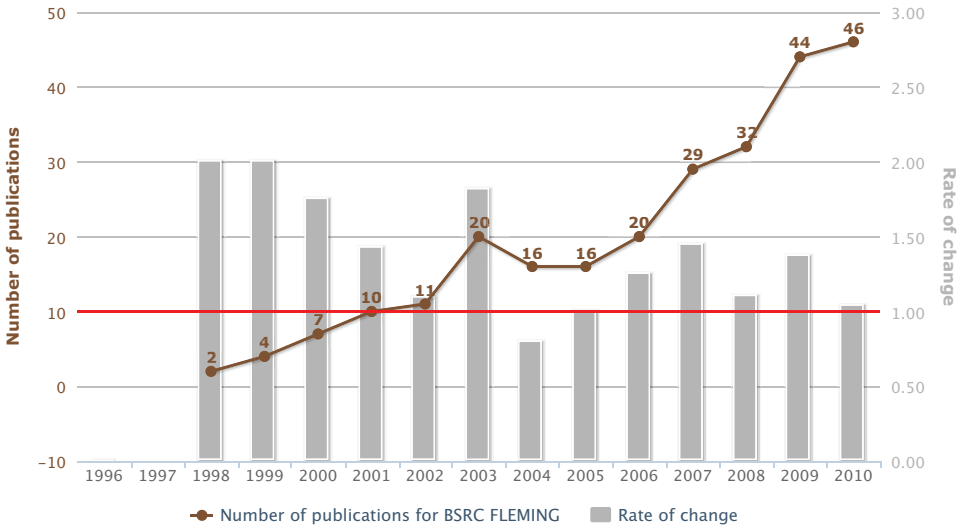


Figure 6.1.2 Number of publications and rate of change in the number of publications by Biomedical Sciences Research Center "Fleming", 1996-2010 / Source: Scopus 1996-2010

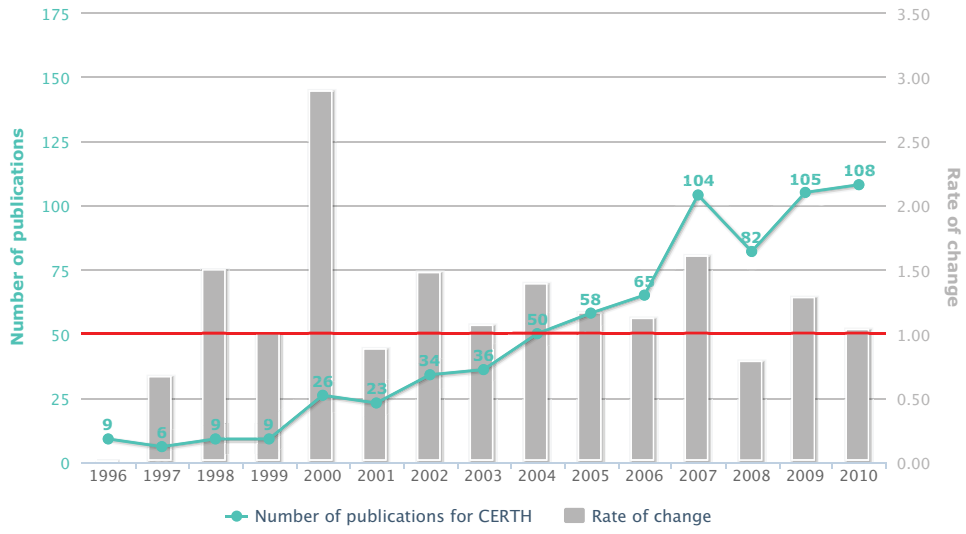


Figure 6.1.2 Number of publications and rate of change in the number of publications by Center for Research and Technology Hellas, 1996-2010 / Source: Scopus 1996-2010

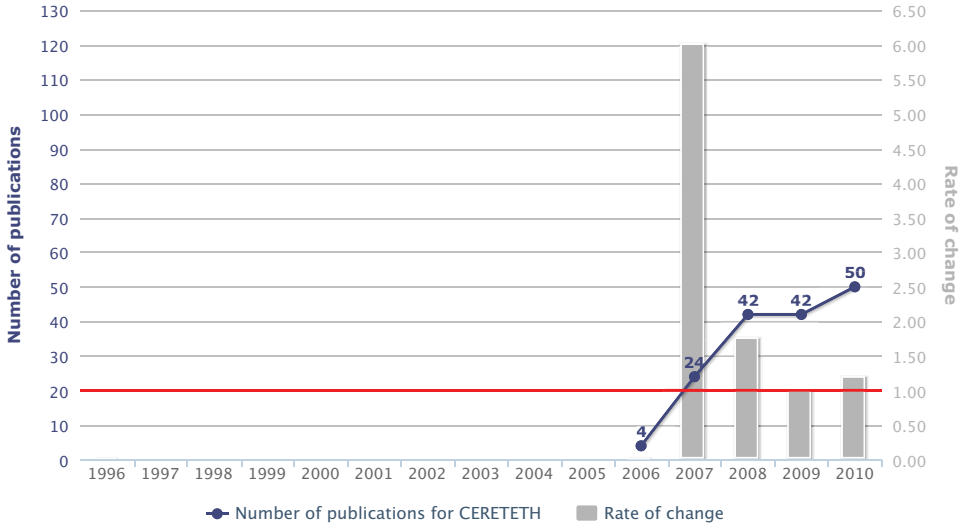


Figure 6.1.2 Number of publications and rate of change in the number of publications by Center for Research and Technology - Thessaly, 1996-2010 / Source: Scopus 1996-2010

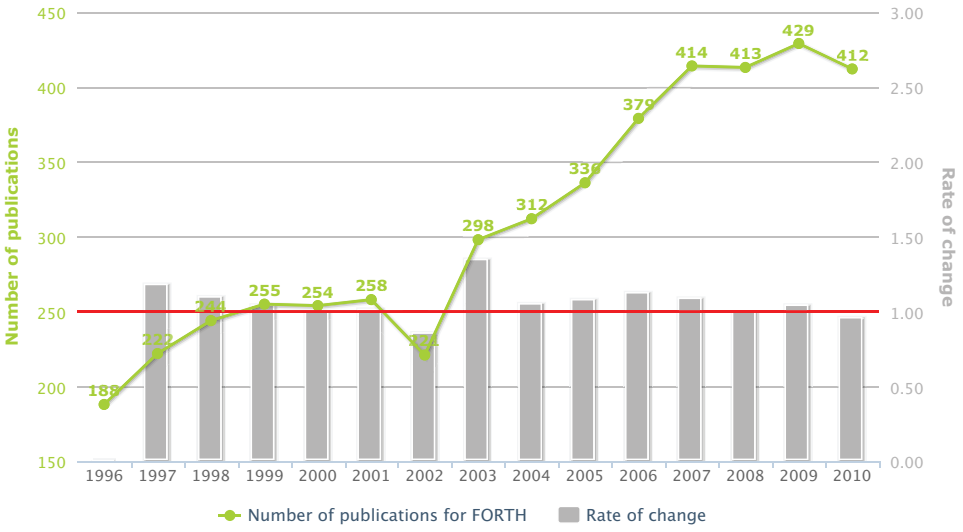


Figure 6.1.2 Number of publications and rate of change in the number of publications by Foundation for Research and Technology Hellas, 1996-2010 / Source: Scopus 1996-2010

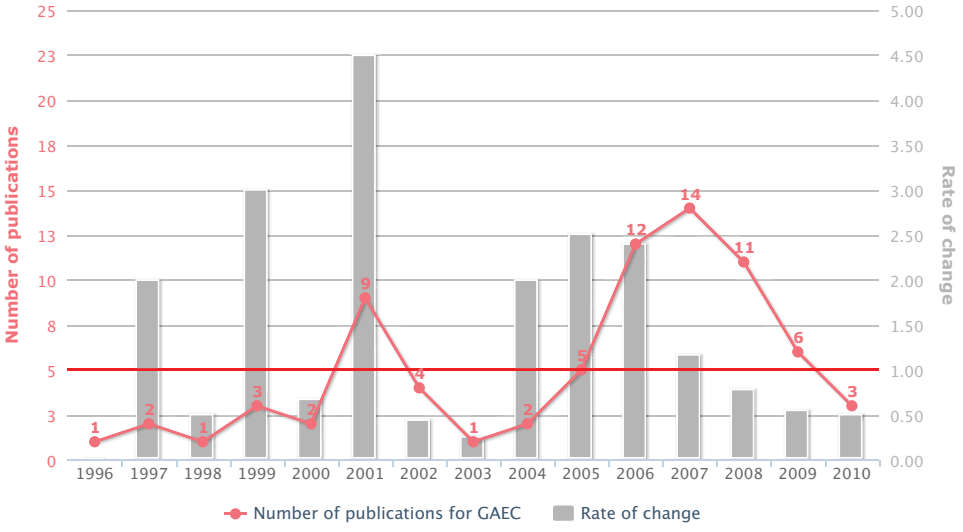


Figure 6.1.2 Number of publications and rate of change in the number of publications by Greek Atomic Energy Commission, 1996-2010 / Source: Scopus 1996-2010

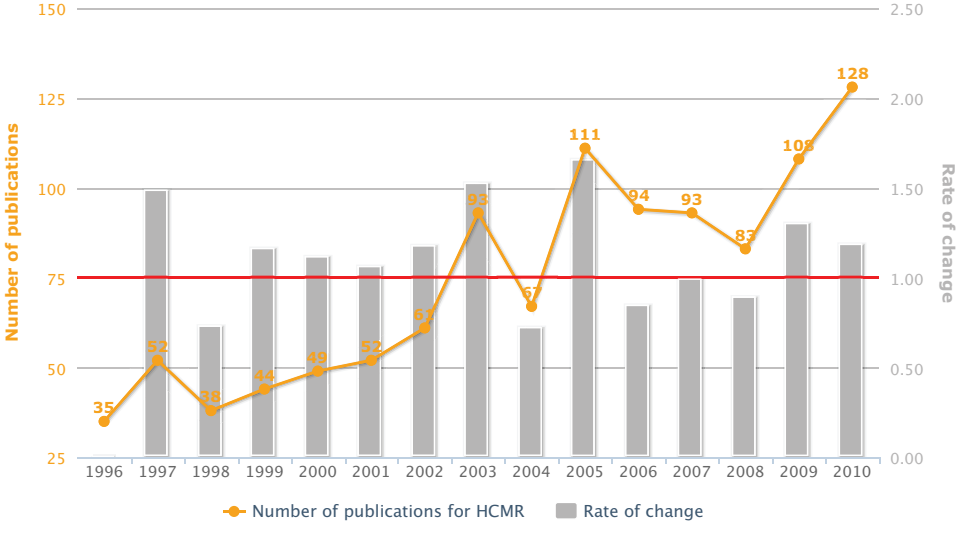


Figure 6.1.2 Number of publications and rate of change in the number of publications by Hellenic Center for Marine Research, 1996-2010 / Source: Scopus 1996-2010

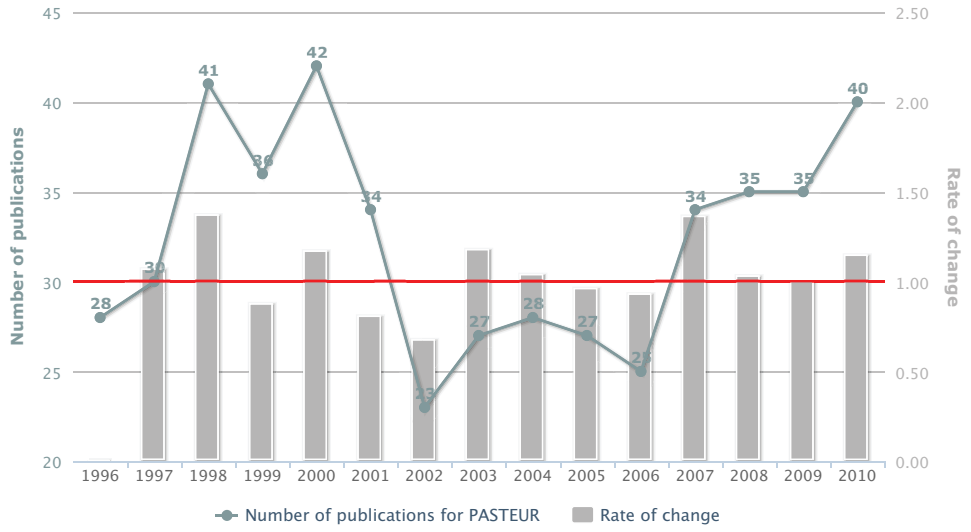


Figure 6.1.2 Number of publications and rate of change in the number of publications by Hellenic Pasteur Institute, 1996-2010 / Source: Scopus 1996-2010

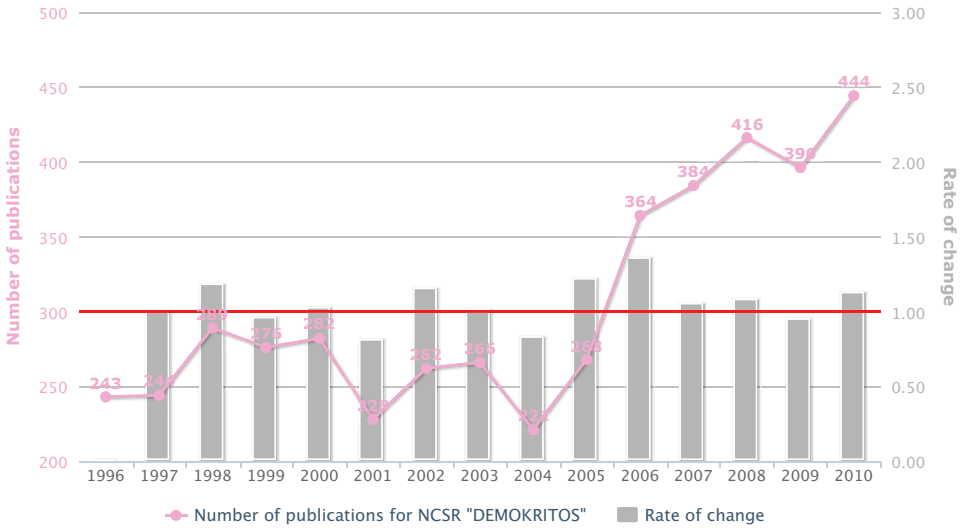


Figure 6.1.2 Number of publications and rate of change in the number of publications by National Centre for Scientific Research "Demokritos", 1996-2010 / Source: Scopus 1996-2010

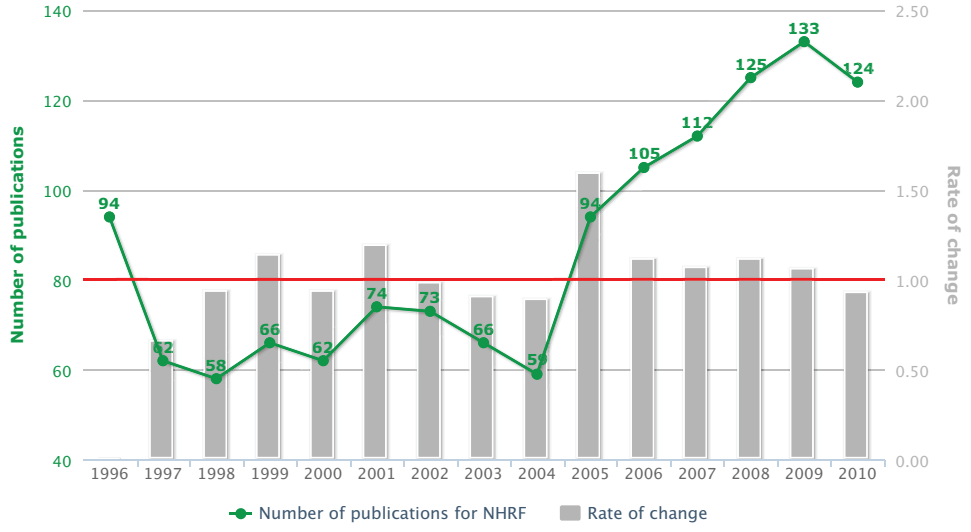


Figure 6.1.2 Number of publications and rate of change in the number of publications by National Hellenic Research Foundation, 1996-2010 / Source: Scopus 1996-2010

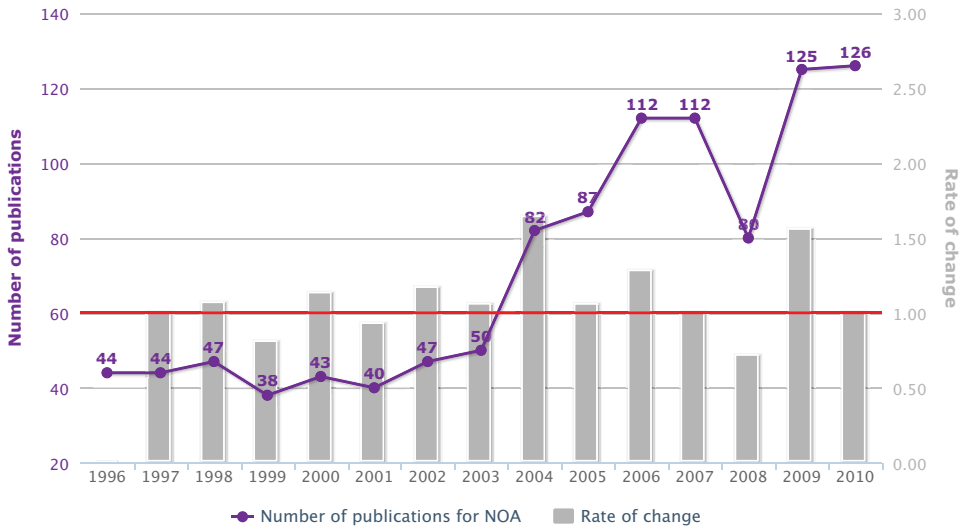


Figure 6.1.2 Number of publications and rate of change in the number of publications by National Observatory of Athens, 1996-2010

Rate of change: 1+(number of publications in year "n" - number of publications in year "n-1") / number of publications in year "n-1". The rate is 1, if the number of publications is the same across the years compared.

Figure 6.1.3 presents data for the latest 5-year period 2006-2010 and for the category "Research Centers supervised by GSRT". It demonstrates the number of publications and its share in the total number of publications of the category. The Foundation for Research and Technology Hellas/FORTH had 2,047 publications and a share of 30.7%. The National Centre for Scientific Research "DEMOKRITOS"/NCSR "DEMOKRITOS" produced 2,004 publications and had a 30% share, the National Hellenic Research Foundation/NHRF had 599 publications and 9% share, the Hellenic Center for Marine Research/HCMR 506 publications and 7.6% share, the National Observatory of Athens/NOA 555 publications and 8.3% share and the Center for Research and Technology Hellas/CERTH 464 publications and 7% share. As for the remaining Research Centers, their share accounted for less than 3%.

Comparing the rate of change in the number of publications from 2006 to 2010, we observed that 10 Research Centers displayed a positive trend. The number of publications for the Biomedical Sciences Research Center/BSCR FLEMING, the Center for Research and Technology Hellas (CERTH), ATHENA, the Hellenic Pasteur Institute/PASTEUR and the Hellenic Center for Marine Research were above the average for institutions in the category (Figure 6.1.4).

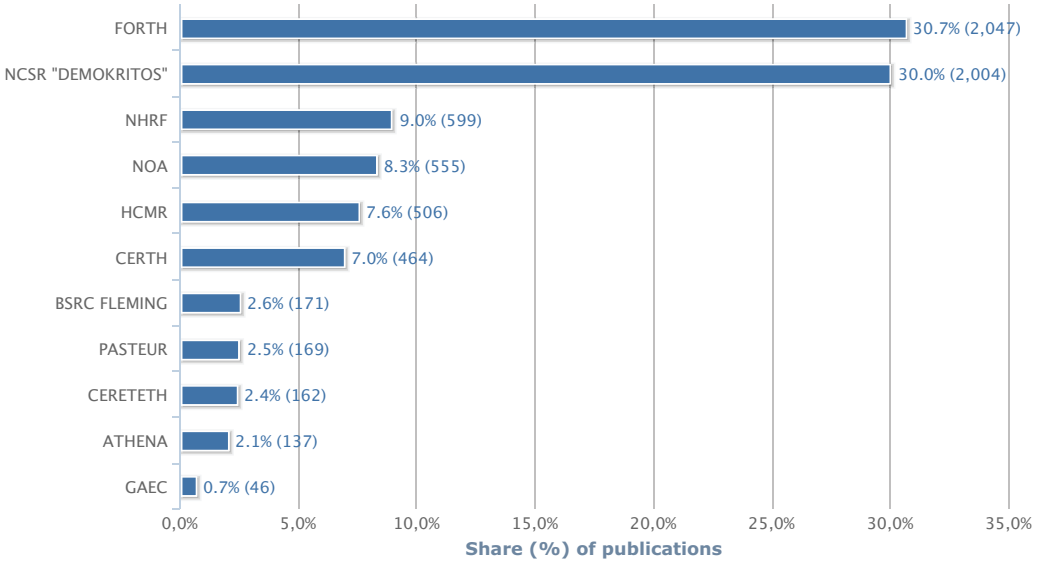


Figure 6.1.3 Number and share (%) of publications, by GSRT Research Center, 2006-2010 / Source: Scopus 1996-2010

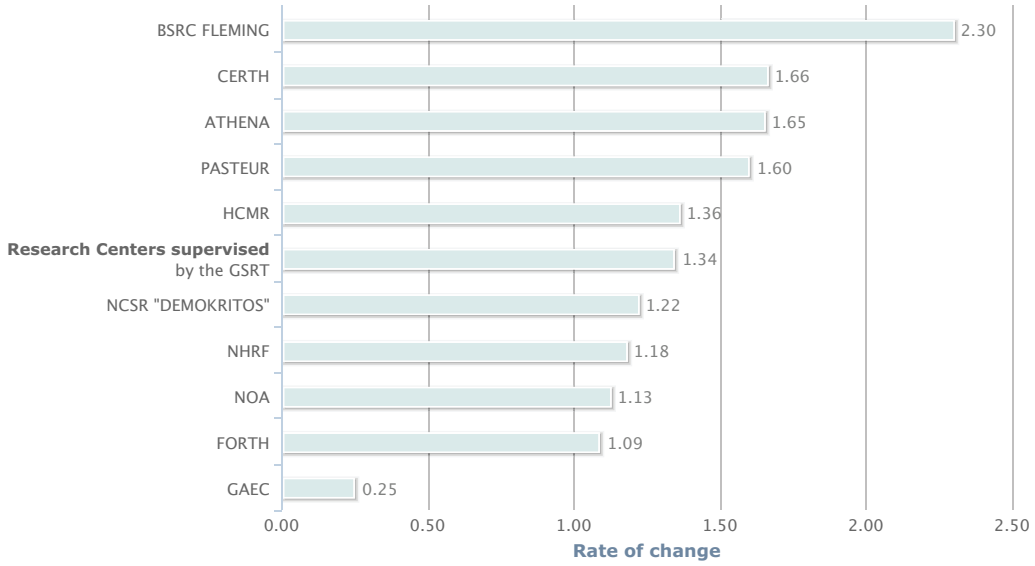


Figure 6.1.4 Change in the number of publications between 2006 and 2010, by GSRT Research Center / Source: Scopus 1996-2010

Rate of change: 1+(number of publications in year "2010" - number of publications in year "2006) / number of publications in year "2006". The rate is 1, if the number of publications is the same across the years compared. The Center for the Research and Technology Thessaly (CE.RE.TE.TH) produced its first publications in 2006 and therefore its rate of change is considerably high and is thus not included in the Figure.

6.2 Citations

Figure 6.2.1 tracks the percentage of cited publications for each GSRT Research Center and demonstrates a significant progress in the period 1996-2010. In most cases, the values recorded were above the Greek average. For the most recent 5-year period 2006-2010, the percentage of cited publications varied between 67.4% and 83% (Figure 6.2.1).

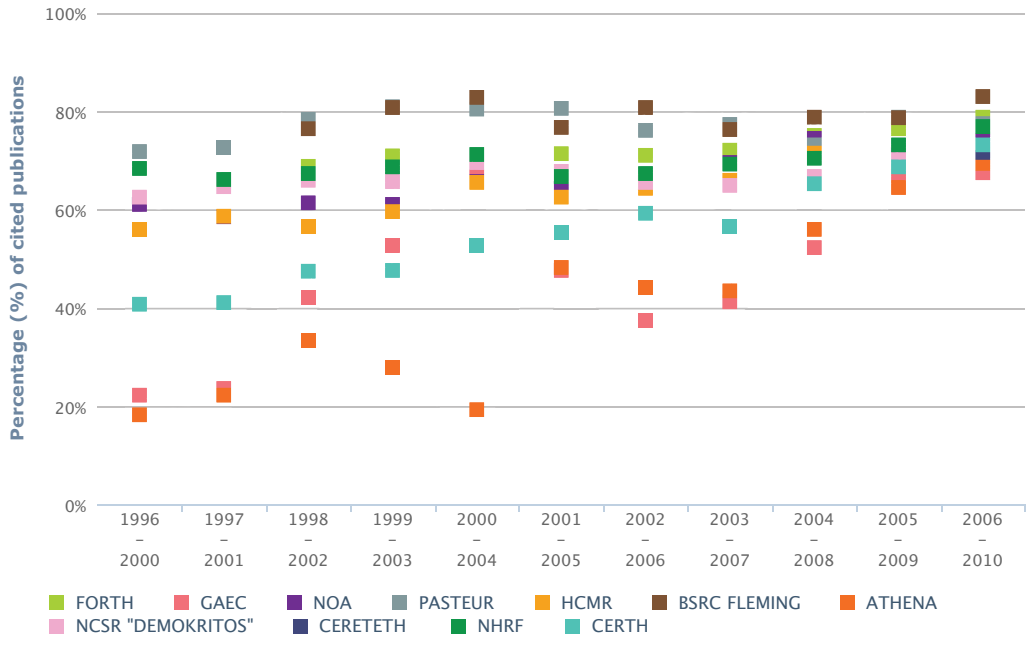


Figure 6.2.1 Percentage (%) of cited publications by GSRT Research Center, 1996-2010 / Source: Scopus 1996-2010

During 1996-2010, there was a remarkable increase in the number of citations to publications issued by "GRST Research Centers" (Figure 6.2.2). The highest numbers were attributed to the Foundation for Research and Technology Hellas/FORTH and the National Center for Scientific Research "DEMOKRITOS"/NCRS "DEMOKRITOS" –which also accounted for the highest number of publications–. These Centers were followed by the National Hellenic Research Foundation/NHRF, the National Observatory of Athens/NOA, the Center for Research and Technology Hellas/CERTH and the Hellenic Center for Marine Research/HCMR.

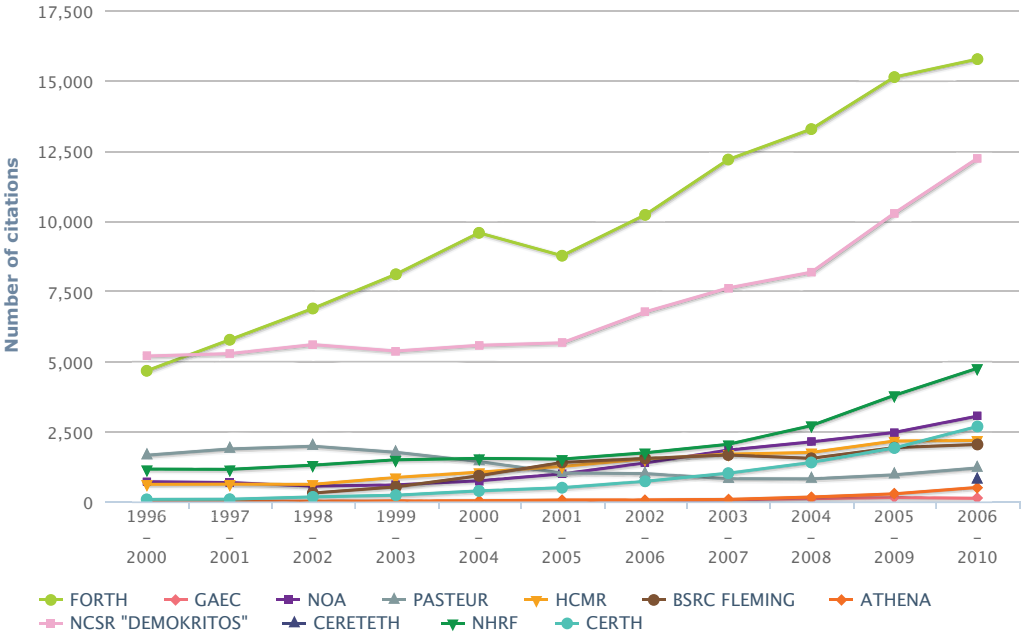


Figure 6.2.2 Number of citations by GSRT Research Center, 1996-2010 / Source: Scopus 1996-2010

Focusing on the latest 5-year period 2006-2010, Figure 6.2.3 displays the number of citations received for each GSRT Research Center and its corresponding share (%) in total citations across the category "GSRT Research Centers". The top performing Centres were the following: Foundation for Research and Technology Hellas/FORTH with 15,758 citations (36%), National Centre for Scientific Research "DEMOKRITOS"/NCRS "DEMOKRITOS" with 12,229 citations (27.9%), National Hellenic Research Foundation/NHRF with 4,750 citations (10.8%), National Observatory of Athens/NOA with 3,046 citations (7%), the Center for Research and Technology Hellas/CERTH with 2,677 citations (6.1%) and the Hellenic Centre for Marine Research/HCMR with 2,182 citations (5%). The remaining Research Centers had a share of less than 5%.

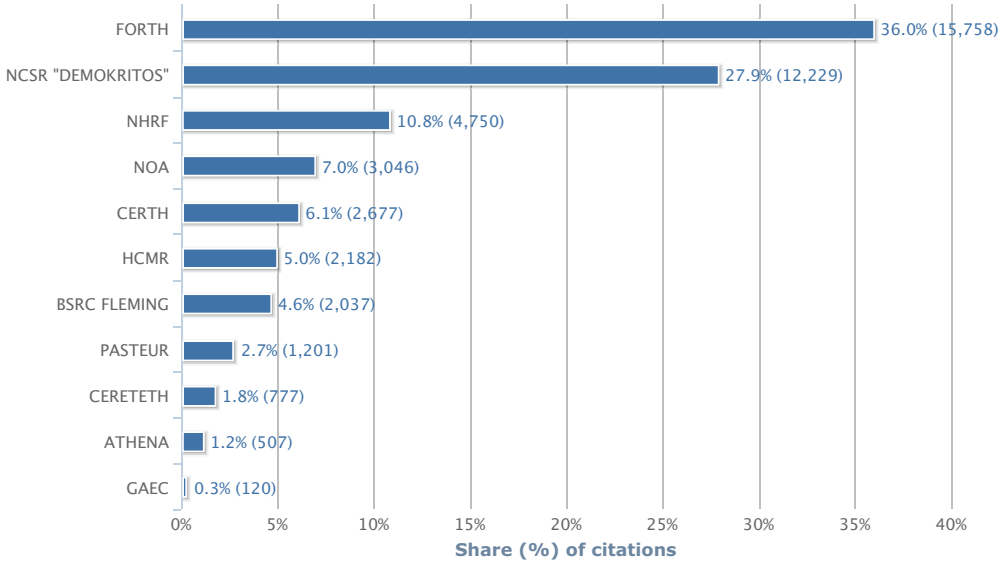


Figure 6.2.3 Number and share (%) of citations by GSRT Research Center, 2006-2010 / Source: Scopus 1996-2010

6.3 Citation impact

Figure 6.3.1 presents the number of publications and citations and the field normalised citation score of each GSRT Research Center in relation to the world average. Data refers to the most recent 5-year period 2006-2010. The field normalised citation score or "citation score" is the relative number of citations to publications of a Center compared to the world average of citations to publications of the same time period and scientific subject field. The normalisation is at the level of each publication according to the 307 scientific subject fields. If an article belongs to several subject fields, a mean value of the fields was calculated. The citation score was calculated using software developed by EKT. A value greater than 1, indicates that the impact of publications was higher than the world average.

The values of the field-normalised citation score surpassed or approached the world average in the case of 9 Research Centers.

The relatively low number of publications by the Biomedical Sciences Research Center/BSCR FLEMING accounted for the highest citation score (1.69). This was followed by the citation score achieved by the Foundation for Research and Technology Hellas/FORTH (1.30) and then the publications coming from the Center for Research and Technology Hellas/CERTH (1.29). Finally, citation scores around world baseline were calculated for the publications of the Center For Research And Technology Thessaly (1.18), the National Observatory of Athens/NOA (1.16), the Hellenic Center for Marine Research/HCMR (1.12), the National Center for Scientific Research "DEMOKRITOS"/NCRS "DEMOKRITOS" (1.11) and ATHENA (1.08). Close to the world average were also the publications of the Hellenic Pasteur Institute (1.00) and the National Hellenic Research Foundation/NHRF (0.96).

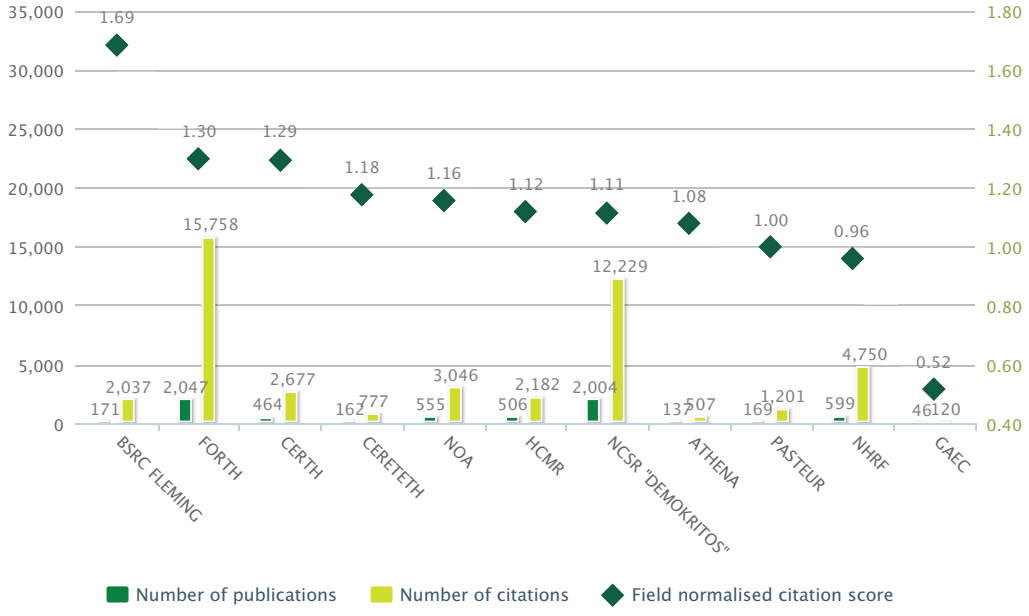


Figure 6.3.1 Publications, citations and field normalised citation score relative to the world, by GSRT Research Center, 2006-2010. Data refers to the total number of publications in each Research Center for all scientific fields / Πηγή: Scopus 1996-2010

6.4 Major fields of science

Figure 6.4.1 captures the impact of publications by GSRT Research Centers in the major fields of science*. "Natural Sciences", "Engineering and Technology", "Medical and Health Sciences" and "Agricultural Sciences" during 2006-2010. The Figure displays the number of publications and citations and the field normalised citation score for each major field, giving the overall performance of each Research Center in each major field. Figure 6.4.2 presents in detail each institution's performance.

In "Natural Sciences", the number of publications came from 9 of the 11 Research Centers. They all had high citation scores ranging from 0.78 to 1.54. They were ranked as follows: BSCR FLEMING (1.54), FORTH (1.21), HCMR (1.12), CERTH (1.09), NOA (1.08), NCSR "DEMOKRITOS" (1.07), ATHENA (1.00) and NHRF (0.95). This score is lower for CE.RE.TE.TH. (0.83) and HPI (0.78).

Six Research Centers were active in the scientific field "Engineering & Technology". The publications with a citation score higher than the world average baseline were those of NOA (citation score: 1.56), CERTH (1.51), FORTH (1.39), NCSR "DEMOKRITOS" (1.16), while those of HCMR and NHRF were close to it (0.97 and 0.91 respectively).

The majority of publications in the "Medical & Health Sciences" came from six Research Centers, with citation scores above the world average baseline: BSCR FLEMING (1.86), FORTH (1.62), CE.RE.TE.TH. and HPI (1.40 each), as well as NHRF and NCSR "DEMOKRITOS" (1.08 each).

In "Social Sciences", the only Center with a significant publication output was FORTH.

Finally, there were not any Research Centers systematically involved in publications in the field of "Agricultural Sciences" and "Humanities".

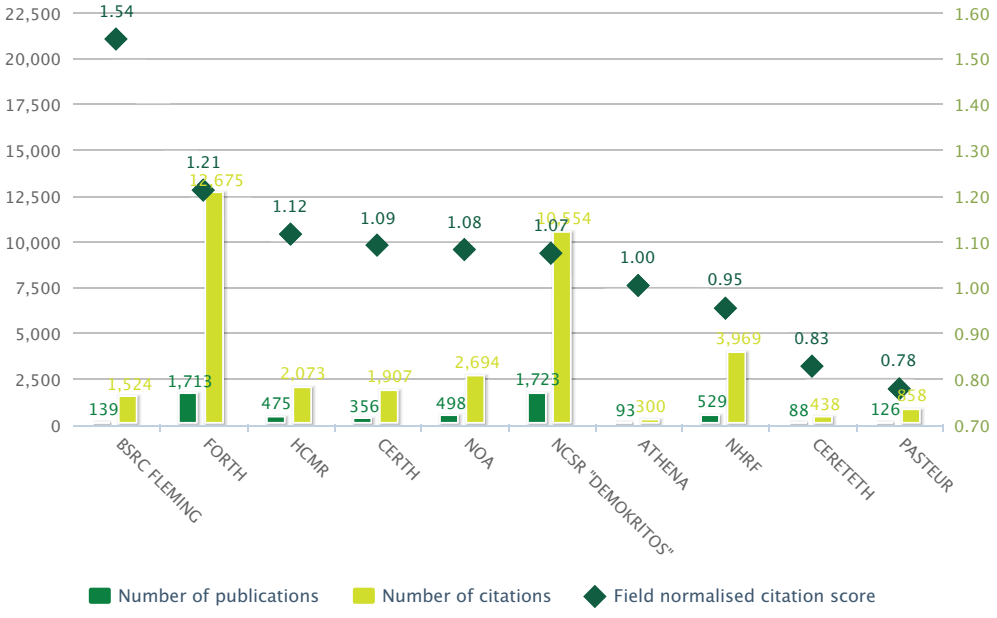


Figure 6.4.1 Publications, citations and field normalised citation score relative to the world, by GSRT Research Center, in the major field of "Natural Sciences", 2006-2010 / Source: Scopus 1996-2010

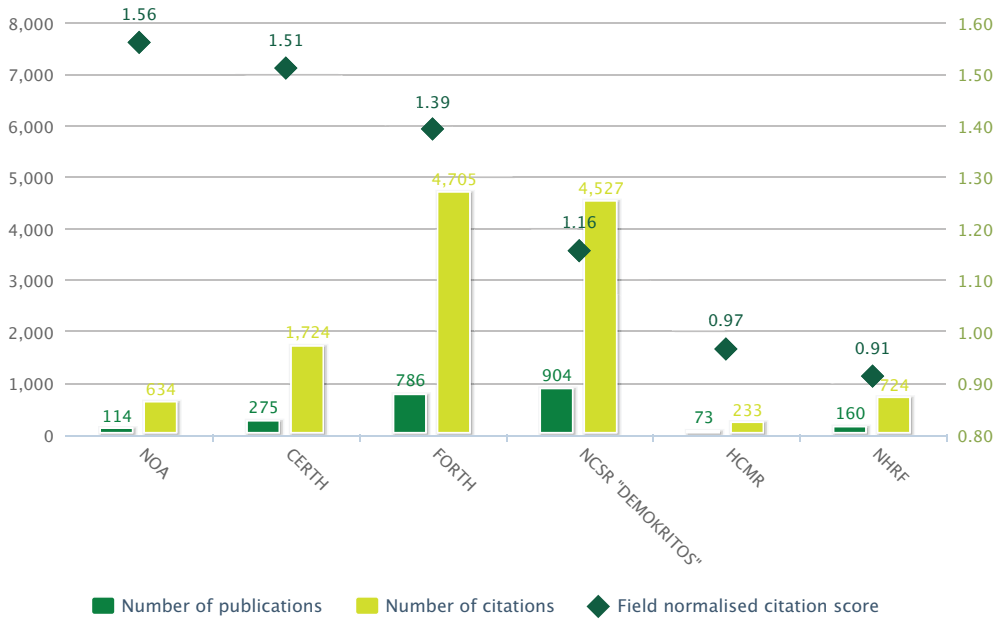


Figure 6.4.1 Publications, citations and field normalised citation score relative to the world, by GSRT Research Center, in the major field of "Engineering & Technology", 2006-2010 / Source: Scopus 1996-2010

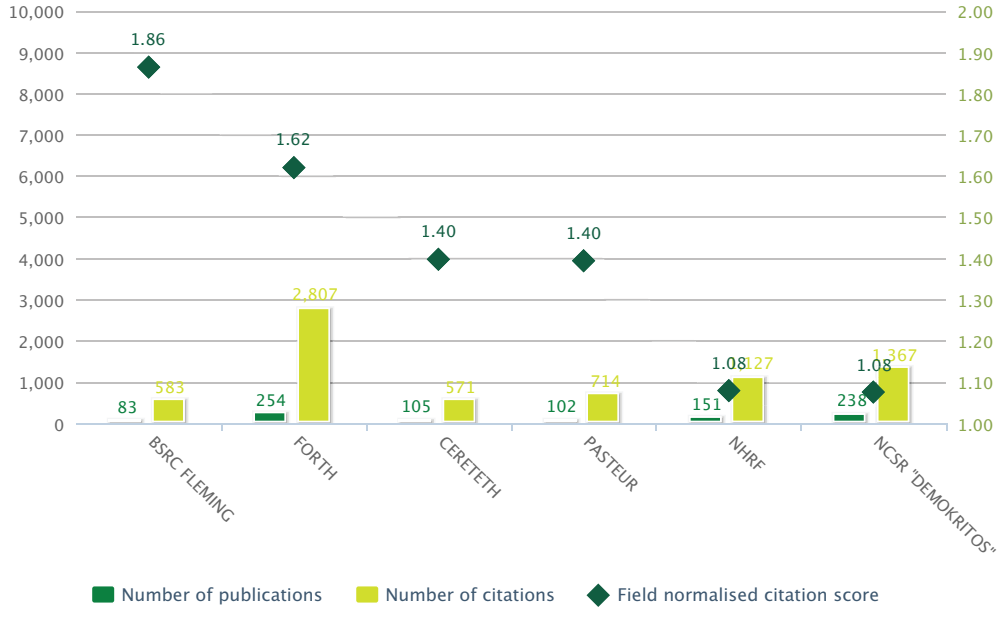


Figure 6.4.1 Publications, citations and field normalised citation score relative to the world, by GSRT Research Center, in the major field of "Medical & Health Sciences", 2006-2010 / Source: Scopus 1996-2010

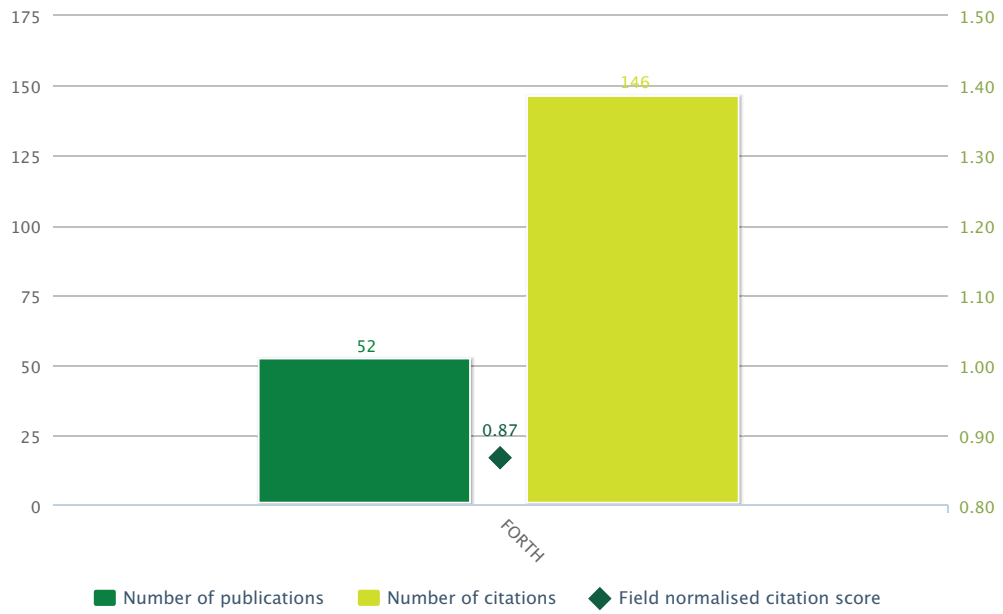


Figure 6.4.1 Publications, citations and field normalised citation score relative to the world, by GSRT Research Center, in the major field of "Social Sciences", 2006-2010 / Source: Scopus 1996-2010

NATURAL SCIENCES

Subfield of major filed of science (Frascati Manual)	Specific scientific field (Scopus)	Research Center	Field normalized citation score	Number of publications
chemical sciences	chemistry (all)	NHRF	3.09	46
computer and information sciences	artificial intelligence	CERTH	2.21	11
earth and related environmental sciences	geophysics	FORTH	2.20	17
mathematics	statistics and probability	FORTH	2.18	13
earth and related environmental sciences	atmospheric science	FORTH	2.16	37
computer and information sciences	computer networks and communications	NOA	2.14	23
biological sciences	cancer research	FORTH	2.05	19
earth and related environmental sciences	oceanography	NOA	2.03	20
earth and related environmental sciences	global and planetary change	NOA	2.02	10
computer and information sciences	computer vision and pattern recognition	NCSR «DEMOKRITOS»	1.99	19
mathematics	mathematical physics	NCSR «DEMOKRITOS»	1.97	65
biological sciences	genetics	FORTH	1.93	77
biological sciences	endocrinology	HCMR	1.87	8
biological sciences	genetics	BSRC FLEMING	1.86	27
physical sciences	surfaces and interfaces	FORTH	1.85	76
chemical sciences	organic chemistry	CERTH	1.82	22
biological sciences	biochemistry	BSRC FLEMING	1.79	31
physical sciences	instrumentation	NCSR «DEMOKRITOS»	1.77	81
chemical sciences	organic chemistry	FORTH	1.73	70
mathematics	applied mathematics	NCSR «DEMOKRITOS»	1.72	18
biological sciences	applied microbiology and biotechnology	FORTH	1.72	17
computer and information sciences	computer networks and communications	CERTH	1.72	14
chemical sciences	chemistry (all)	NCSR «DEMOKRITOS»	1.71	128
chemical sciences	filtration and separation	CERTH	1.67	18
earth and related environmental sciences	geology	NOA	1.66	12
computer and information sciences	computer vision and pattern recognition	CERTH	1.64	11
biological sciences	biotechnology	NCSR «DEMOKRITOS»	1.64	30
physical sciences	physics and astronomy (all)	NCSR «DEMOKRITOS»	1.63	147
earth and related environmental sciences	pollution	NOA	1.62	16

computer and information sciences	software	FORTH	1.61	42
biological sciences	molecular biology	BSRC FLEMING	1.60	40
computer and information sciences	software	CERTH	1.58	19
computer and information sciences	computer science applications	ATHENA	1.58	16
biological sciences	cell biology	FORTH	1.56	67
biological sciences	ecology, evolution, behavior and systematics	FORTH	1.54	13
chemical sciences	electrochemistry	CERTH	1.53	12
biological sciences	immunology	BSRC FLEMING	1.51	32

ENGINEERING AND TECHNOLOGY

Subfield of major filed of science (Frascati Manual)	Specific scientific field (Scopus)	Research Center	Field normalized citation score	Number of publications
civil engineering	building and construction	NOA	3.78	8
electrical engineering, electronic engineering, information engineering	control and systems engineering	FORTH	3.11	13
other engineering and technologies	engineering (miscellaneous)	FORTH	2.81	13
electrical engineering, electronic engineering, information engineering	signal processing	NCSR «DEMOKRITOS»	2.41	20
environmental engineering	environmental engineering	FORTH	2.40	17
environmental engineering	energy (all)	NCSR «DEMOKRITOS»	2.34	11
civil engineering	civil and structural engineering	NOA	2.23	18
industrial biotechnology	biomaterials	NCSR «DEMOKRITOS»	2.17	15
industrial biotechnology	biomaterials	FORTH	2.17	15
environmental engineering	environmental engineering	NOA	2.13	10
environmental engineering	renewable energy, sustainability and the environment	CERTH	2.12	26
other engineering and technologies	safety, risk, reliability and quality	CERTH	2.12	10
other engineering and technologies	engineering (all)	FORTH	2.10	22
environmental engineering	energy engineering and power technology	CERTH	2.03	47
environmental engineering	fuel technology	CERTH	2.02	51
materials engineering	ceramics and composites	FORTH	1.96	38
environmental engineering	environmental engineering	CERTH	1.88	13
other engineering and technologies	engineering (miscellaneous)	NCSR «DEMOKRITOS»	1.86	32
environmental engineering	renewable energy, sustainability and the environment	NOA	1.86	17
environmental engineering	renewable energy, sustainability and the environment	FORTH	1.84	15
materials engineering	mechanics of materials	FORTH	1.83	44
environmental engineering	waste management and disposal	FORTH	1.80	18
materials engineering	materials science (miscellaneous)	NCSR «DEMOKRITOS»	1.78	15
mechanical engineering	mechanical engineering	FORTH	1.76	50
chemical engineering	process chemistry and technology	FORTH	1.72	34
chemical engineering	process chemistry and technology	NCSR «DEMOKRITOS»	1.72	26
electrical engineering, electronic engineering, information engineering	computational mechanics	FORTH	1.65	18
electrical engineering, electronic engineering, information engineering	electrical and electronic engineering	CERTH	1.64	31
mechanical engineering	industrial and manufacturing engineering	CERTH	1.62	21
mechanical engineering	mechanical engineering	NCSR «DEMOKRITOS»	1.60	74
materials engineering	materials chemistry	FORTH	1.58	152
electrical engineering, electronic engineering, information engineering	hardware and architecture	FORTH	1.56	24
materials engineering	polymers and plastics	CERTH	1.53	19
chemical engineering	bioengineering	NCSR «DEMOKRITOS»	1.51	46
materials engineering	polymers and plastics	FORTH	1.50	93

MEDICAL & HEALTH SCIENCES				
Subfield of major filed of science (Frascati Manual)	**Specific scientific field (Scopus)**	**Research Center**	**Field normalized citation score**	**Number of publications**
clinical medicine	microbiology (medical)	PASTEUR	3.22	11
health sciences	epidemiology	FORTH	2.97	11
other medical sciences	medicine (all)	BSRC FLEMING	2.80	18
clinical medicine	genetics (clinical)	FORTH	2.38	18
health sciences	public health, environmental and occupational health	CERETETH	2.22	8
clinical medicine	oncology	FORTH	2.02	14
health sciences	health informatics	FORTH	1.94	20
other medical sciences	medicine (all)	NCSR «DEMOKRITOS»	1.88	22
clinical medicine	surgery	FORTH	1.80	9
other medical sciences	medicine (all)	FORTH	1.72	57
clinical medicine	orthopedics and sports medicine	CERETETH	1.64	33
health sciences	infectious diseases	PASTEUR	1.64	29
basic medicine	pharmacology	FORTH	1.54	12
health sciences	physical therapy, sports therapy and rehabilitation	CERETETH	1.53	23

Figure 6.4.2 EScientific subfields of "GSRT Research Center" publications with field normalised citation score ≥1.5, 2006-2010 / Source: Scopus 1996-2010

6.5 Scientific collaboration

Publications with national and international collaboration by "GSRT Research Centrers" displayed a rising trend– although not steady- during the period 1996-2010. Figure 6.5.1 and 6.5.2 highlight the evolution of publications with national and international collaboration year on year, by each Research Center, for the period 1996-2010.

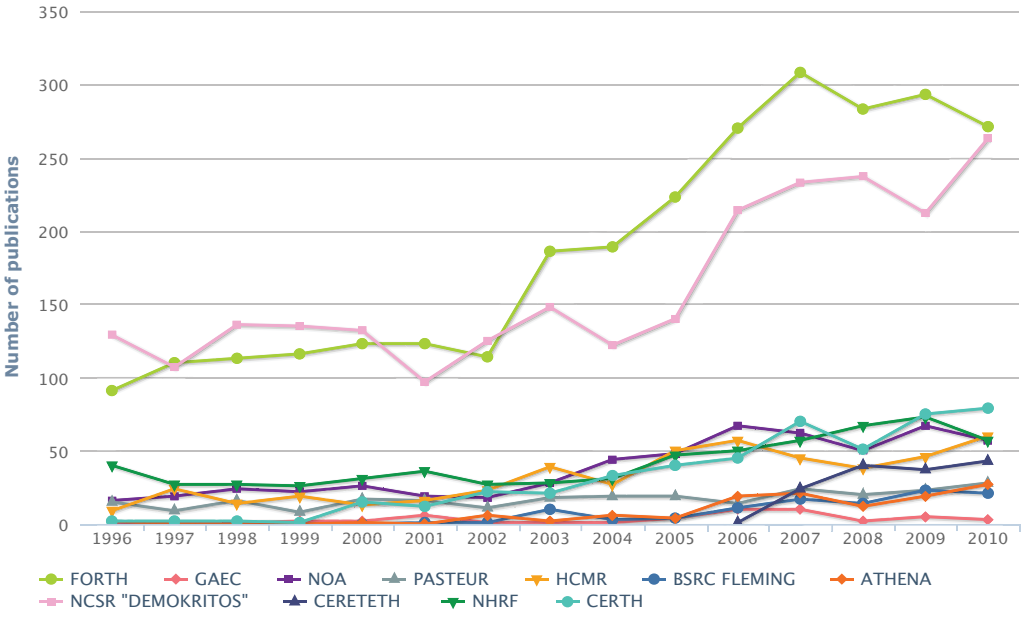


Figure 6.5.1 Number of publications with national collaboration, by GSRT Research Center, 1996-2010 / Source: Scopus 1996-2010

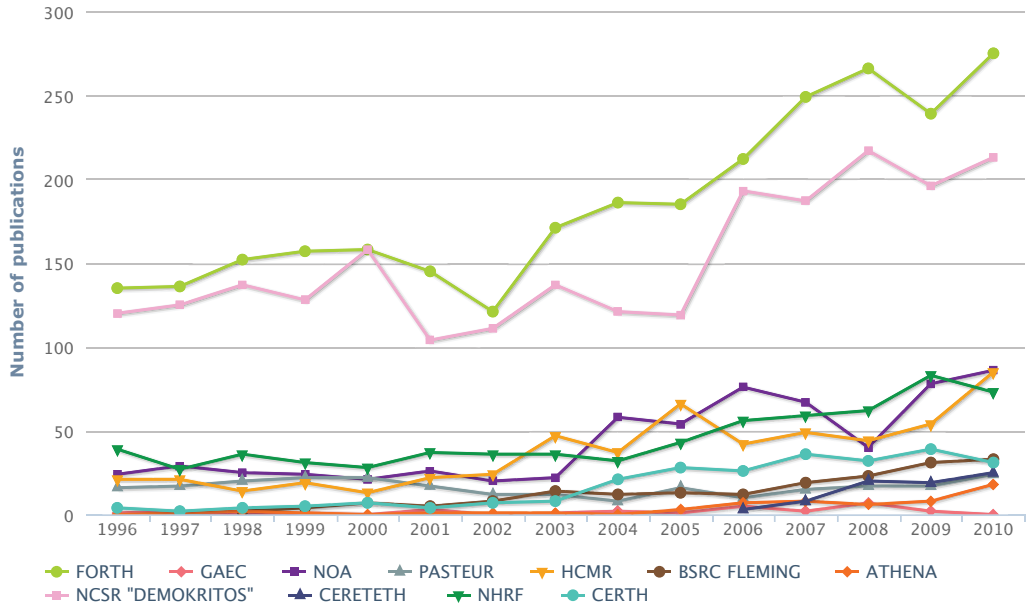


Figure 6.5.2 Number of publications with international collaboration, by GSRT Research Center, 1996-2010 / Πηγή: Scopus 1996-2010

Figure 6.5.3 highlights the distribution (%) of publications with national*, international** and no collaboration*** by each GSRT Research Center for the most recent 5-year period 2006-2010. Networking activity, was high for the majority of Research Centers. There were only a few publications without partnerships. The ATHENA Research Center presented the highest percentage (18.2%) of publications with no collaboration, a value below the Greek average (37.7%).

Publications with international collaboration were higher than those with Greek-based institutions in the case of four Research Centers: BSCR FLEMING, NOA, NHRF and HCMR. BSCR FLEMING shows the sharpest pattern of association with international institutions in publications (69%).

The percentage of nationally co-authored publications ranged from 48.6% in HCMR and 89.5% in CE.RE.TE.TH. A high percentage above 70% was recorded for ATHENA (71.5%).

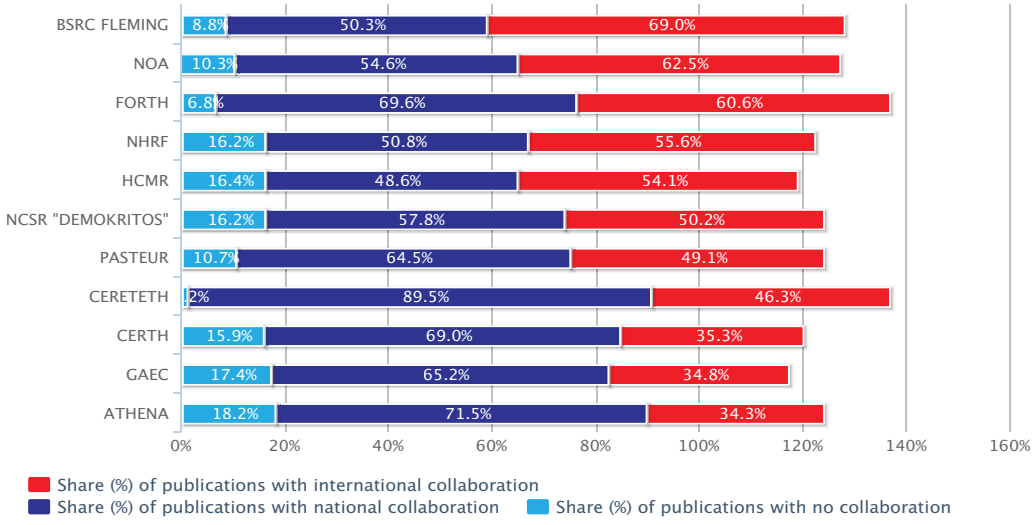


Figure 6.5.3 Share (%) of publications with national, international and no collaboration by GSRT Research Center, 1996-2010 / Source: Scopus 1996-2010

* Number of publications with at least one national collaboration.

** Number of publications with at least one international collaboration.

*** Number of publications with no collaboration, per institution.

This chapter presents bibliometric indicators corresponding to the Institution Category "Other Public Research Institutions", which includes 9 research institutions supervised by different Ministries. In particular, the category includes: the Academy of Athens, the Research Academic Computer Technology Institute, the National Agricultural Research Foundation, the Mediterranean Agronomic Institute of Chania, the Institute of Geology and Mineral Exploration, the Institute of Engineering Seismology and Earthquake Engineering, the Center for Renewable Energy Sources and Saving, the Center of Planning and Economic Research and the Benaki Phytopathological Institute.

The table below presents the number of publications and citations received for publications of each Center corresponding to the latest period (2006-2010) of this study.

7. Scientific Publications by Other Public Research Institutions

		2006-2010	
		Number of publications	Number of citations
Academy of Athens[1]	ACADEMY OF ATHENS	652	4,455
Benaki Phytopathological Institute[2]	BPI	166	370
Center for Renewable Energy Sources and Saving[3]	CRES	39	181
Center of Planning and Economic Research[4]	KEPE	38	56
Institute of Geology and Mineral Exploration[5]	IGME	73	173
Institute of Seismology Engineering & Earthquake Engineering Research & Technology[6]	ITSAK	30	82
Mediterranean Agronomic Institute of Chania	MAICH	89	478
National Agricultural Research Foundation[7]	NAGREF	692	2,305
Research Academic Computer Technology Institute[8]	RA-CTI	111	329

1 Supervised by the Ministry of Education, Lifelong learning and Religious affairs, including publications by the Medical and Biological Research Foundation (IIBEAA) as part of publications from the Academy of Athens.

2 Supervised by the Ministry of Rural Development and Food.

3 Supervised by the Ministry of Environment, Energy and Climate change. The Center for Renewable Energy Sources was supervised by GSRT up to 2008 and therefore was included in the category "Research Centers supervised by GSRT" in the previous study of EKT.

4 Supervised by the Ministry of Finance.

5 Supervised by the Ministry of Environment, Energy and Climate change.

6 Supervised by the Ministry of Infrastructure, Transport and Networks. In 2011 ITSAK merged with the Institute for Earthquake Protection Planning. Given that this study covers the publication activity of institutions up to 2010, ITSAK was studied as an individual entity.

7 Supervised by the Ministry of Rural Development and Food.

8 Supervised by the Ministry of Education, Lifelong learning and Religious affairs. In 2011, the Computer Technology Institute (CTI) was renamed as the Computer Technology Institute and Press "Diophantus". Since the present study examines publications issued until 2010, we refer to the Institure with its former name.

7.1 Publications

Over the period 1996-2010, the Academy of Athens showed a stable upward trend in the number of publications, especially after 2002, finishing with 171 publications in 2010. As for the other Public Research Institutions, their performance varied during the period; in 2010 their publication output was as follows: 125 publications by the National Agricultural Research Foundation/NAGREF, 31 by the Benaki Phytopathological Institute/BPI, 17 by the Research Academic Computer Technology Institute/RA-CTI, 15 by the Mediterranean Agronomic Institute of Chania/MAICH and the Institute of Geology and Mineral Exploration/IGME, 9 by the Center of Planning and Economic Research/KEPE, and 5 publications by both the Institute of Engineering Seismology & Earthquake Engineering/ITSAK and the Center for Renewable Energy Sources and Saving/CRES.

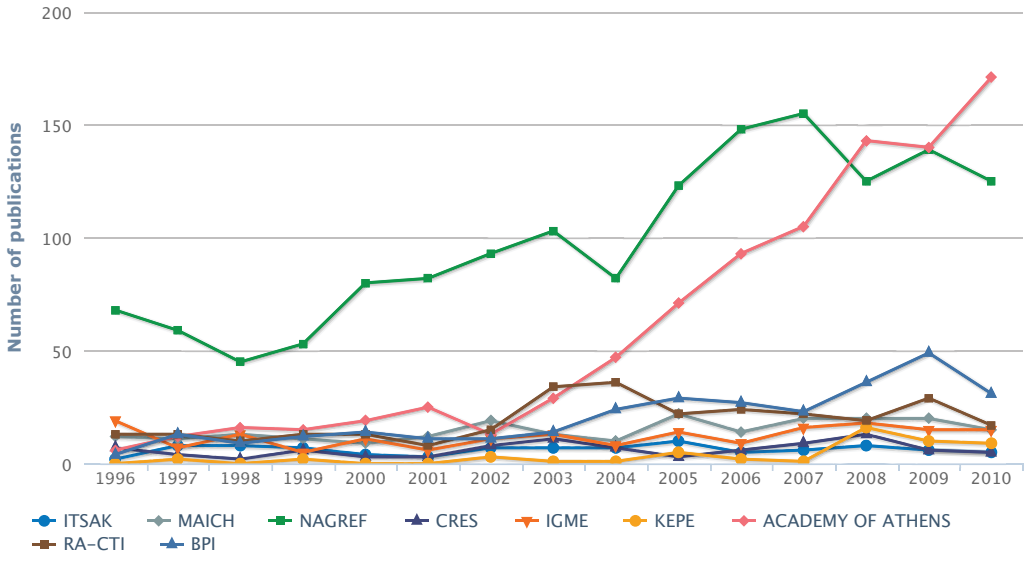


Figure 7.1.1 Development of the number of publications by Public Research Institution, 1996-2010 / Source: Scopus 1996-2010

Figure 7.1.2 displays the number of publications and the annual rate of change for publications of each Public Research Institution for the years 1996-2010.

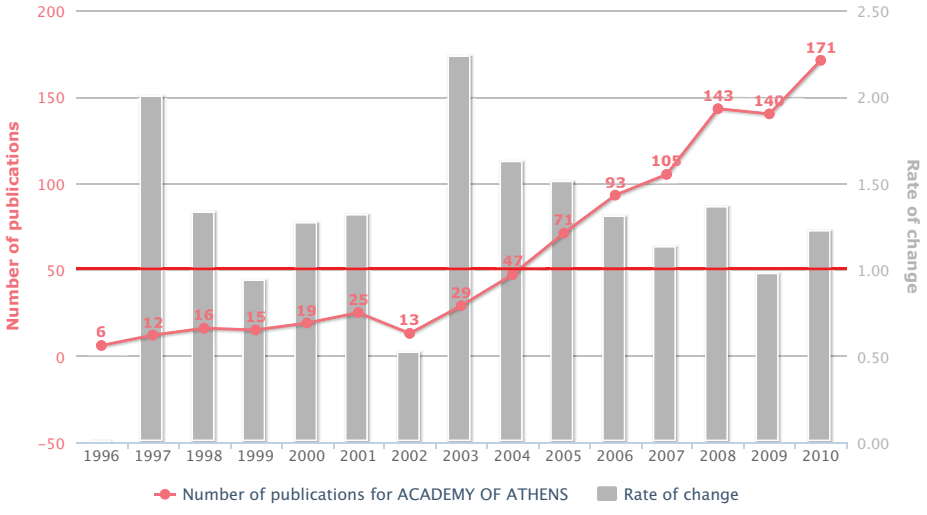


Figure 7.1.2 Number of publications and rate of change in the number of publications by Academy of Athens, 1996-2010 / Source: Scopus 1996-2010

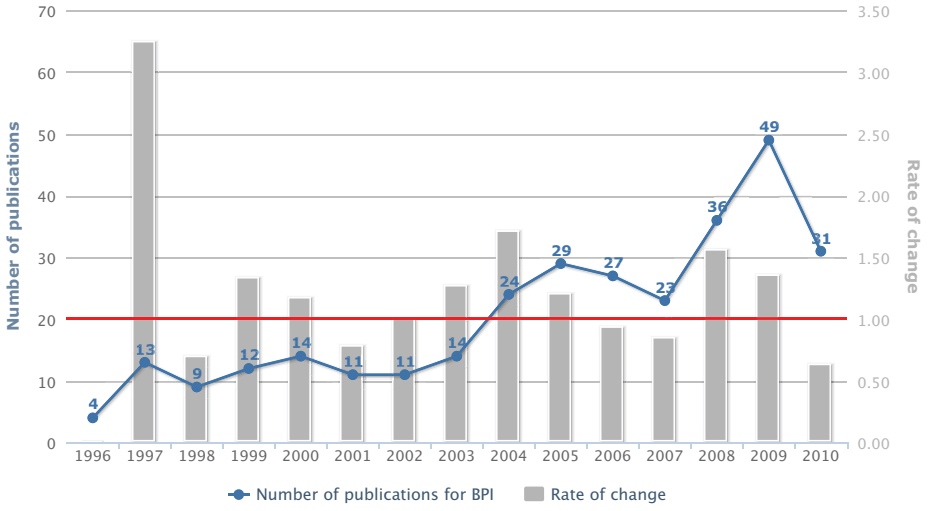


Figure 7.1.2 Number of publications and rate of change in the number of publications by Benaki Phytopathological Institute, 1996-2010 / Source: Scopus 1996-2010

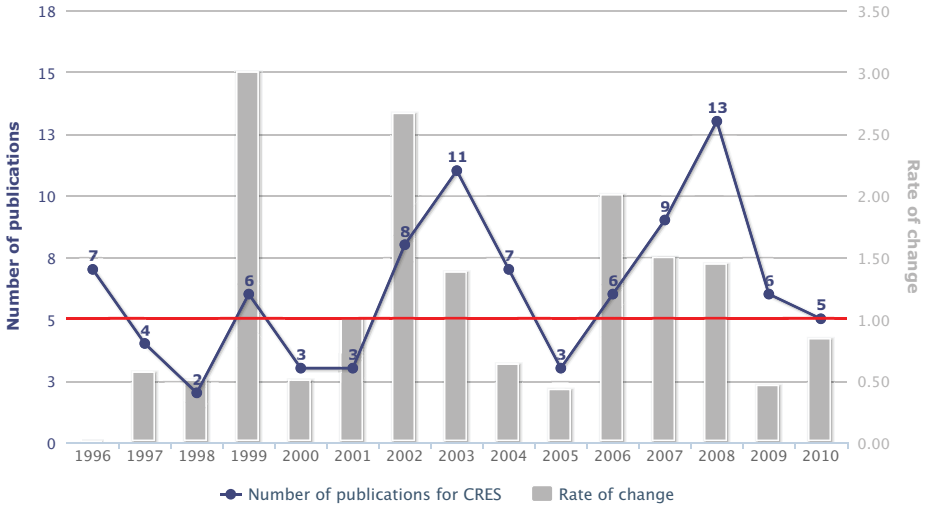


Figure 7.1.2 Number of publications and rate of change in the number of publications by Centre for Renewable Energy Sources and Saving, 1996-2010 / Source: Scopus 1996-2010

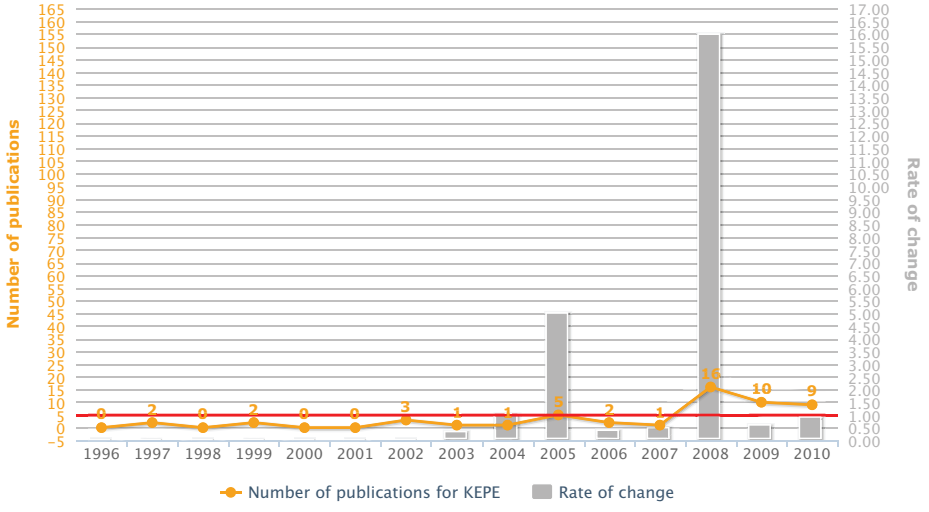


Figure 7.1.2 Number of publications and rate of change in the number of publications by Centre of Planning and Economic Research, 1996-2010 / Source: Scopus 1996-2010

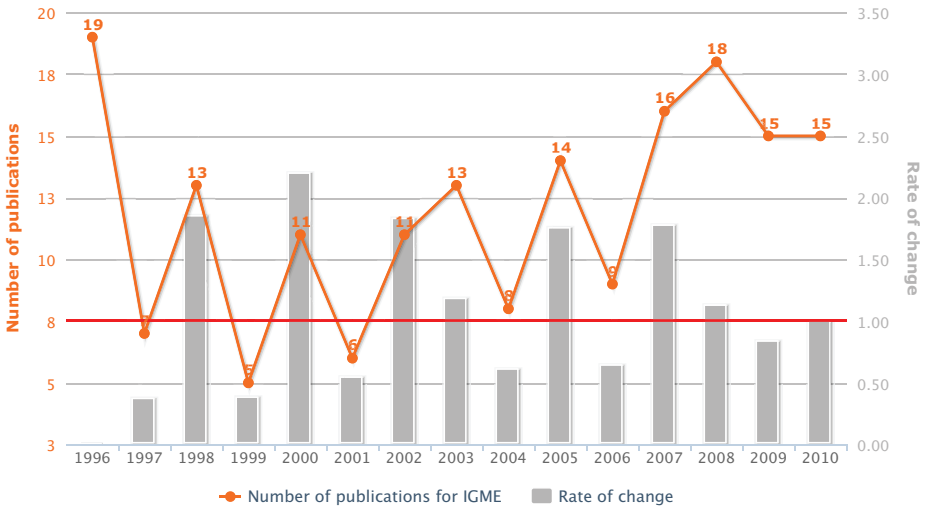


Figure 7.1.2 Number of publications and rate of change in the number of publications by Institute of Geology and Mineral Exploration, 1996-2010 / Source: Scopus 1996-2010

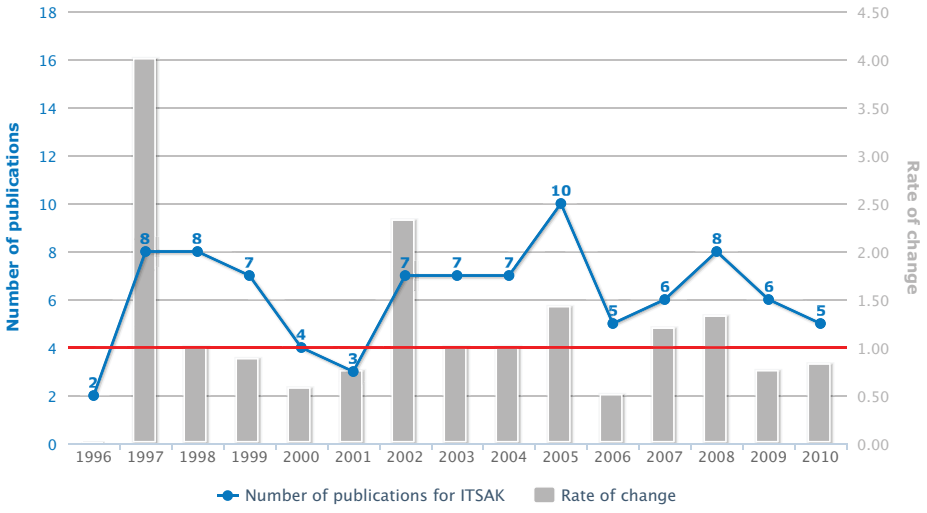


Figure 7.1.2 Number of publications and rate of change in the number of publications by Institute of Seismology Engineering & Earthquake Engineering Research & Technology, 1996-2010 / Source: Scopus 1996-2010

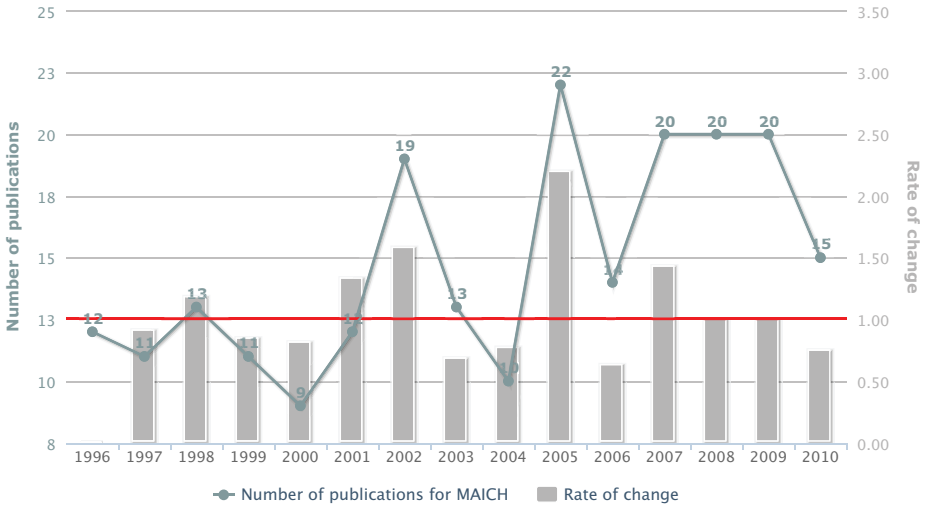


Figure 7.1.2 Number of publications and rate of change in the number of publications by Mediterranean Agronomic Institute of Chania, 1996-2010 / Source: Scopus 1996-2010

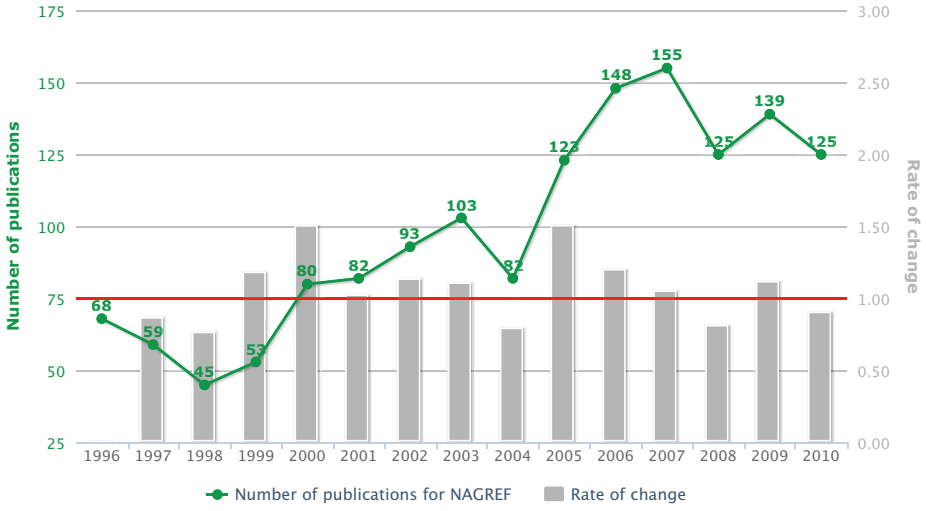


Figure 7.1.2 Number of publications and rate of change in the number of publications by National Agricultural Research Foundation, 1996-2010 / Source: Scopus 1996-2010

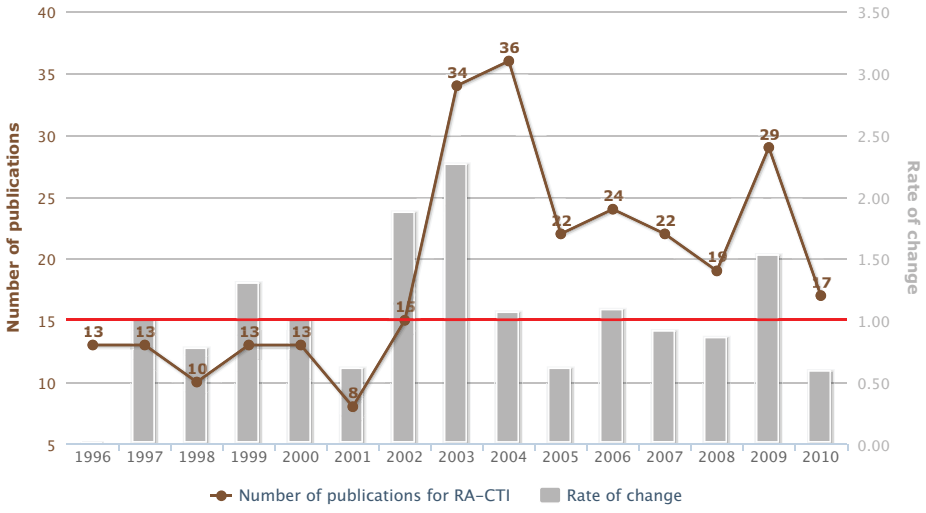


Figure 7.1.2 Number of publications and rate of change in the number of publications by Research Academic Computer Technology Institute, 1996-2010 / Source: Scopus 1996-2010

Rate of change: 1+(number of publications in year "n" - number of publications in year "n-1") / number of publications in year "n-1". The rate is 1, if the number of publications is the same across the years compared.

Figure 7.1.3 shows the publication output of each Public Research Center. For the most recent 5-year period 2006-2010: the National Agricultural Research Foundation/NAGREF produced 692 publications, the Academy of Athens had 652, the Benaki Phytopathological Institute/BPI produced 166, the Research Academic Computer Technology Institute/RA-CTI had 111, the Mediterranean Agronomic Institute of Chania/MAICH had 89, the Institute of Geology and Mineral Exploration/IGME had 73, the Center for Renewable Energy Sources and Saving/CRES produced 39, the Center of Planning and Economic Research/KEPE had 38 and the Institute of Engineering Seismology and Earthquake Engineering/ITSAK had 30.

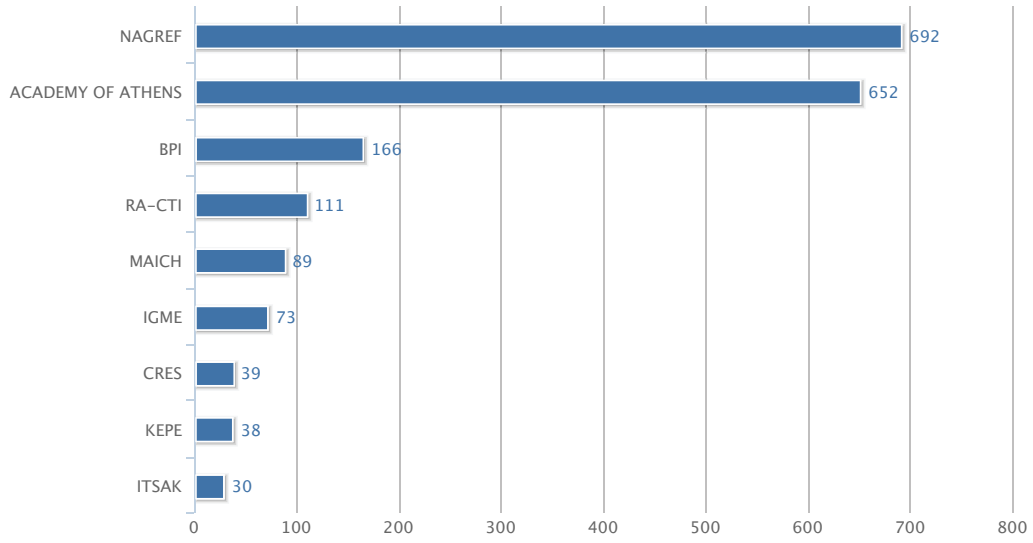


Figure 7.1.3 Number of publications by Public Research Institution, 2006-2010 / Source: Scopus 1996-2010

Regarding the rate at which the number of publications changed from 2006 to 2010, we observe growth (rate of change >1) for 4 Public Research Institutions (KEPE, ACADEMY OF ATHENS, IGME and ITSAK).

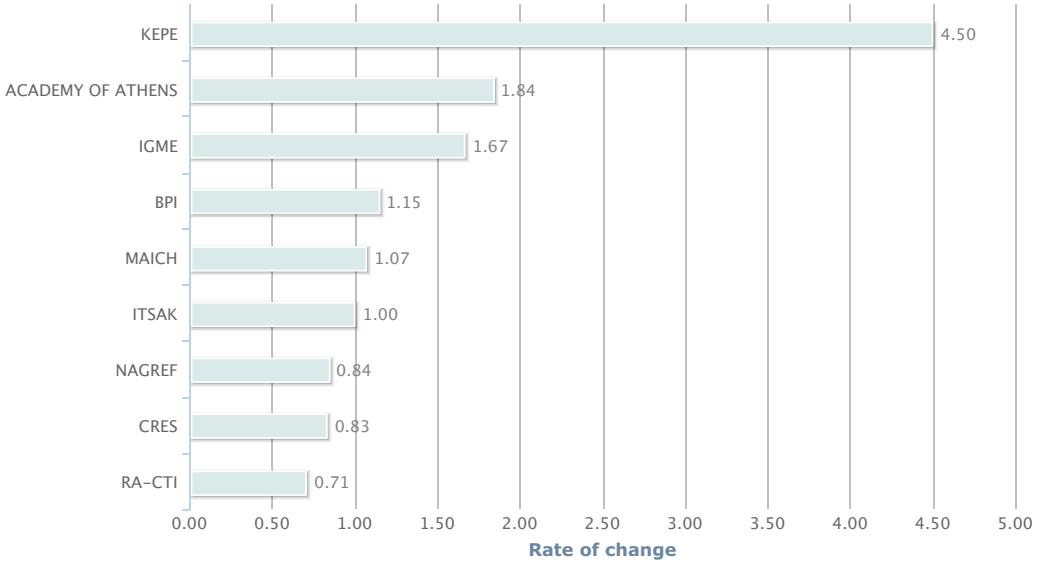


Figure 7.1.4 Change in the number of publications between 2006 and 2010, by Public Research Institution / Source: Scopus 1996-2010

Rate of change: 1+(number of publications in year "2010" - number of publications in year "2006") / number of publications in year "2006". The rate is 1, if the number of publications is the same across the years compared.

7.2 Citations

Figure 7.2.1 tracks the percentage of cited publications for each "Public Research Institution" for the 1996-2010 period. For the most recent 5-year period 2006-2010, the percentage of cited publications of four "Public Research Institutions" (CRES, ACADEMY OF ATHENS, MAICH and ITSAK) exceeded the Greek average (Figure 7.2.1).

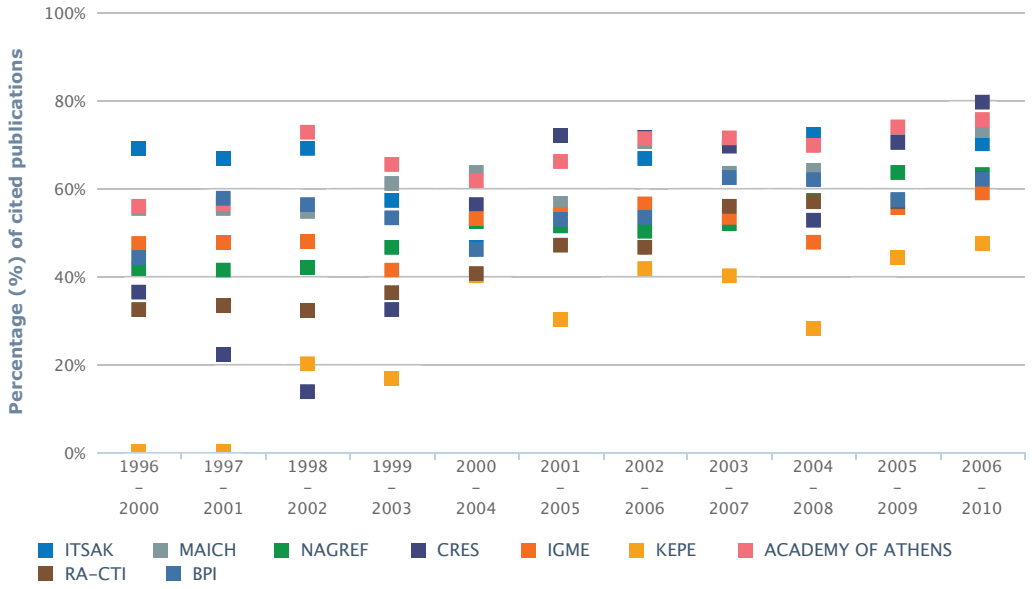


Figure 7.2.1 Percentage (%) of cited publications by Public Research Institution, 1996-2010 / Source: Scopus 1996-2010

Figure 7.2.2 displays the number of citations received by publications produced per "Public Research Institution". Overall, there was an increase in the number of citations.

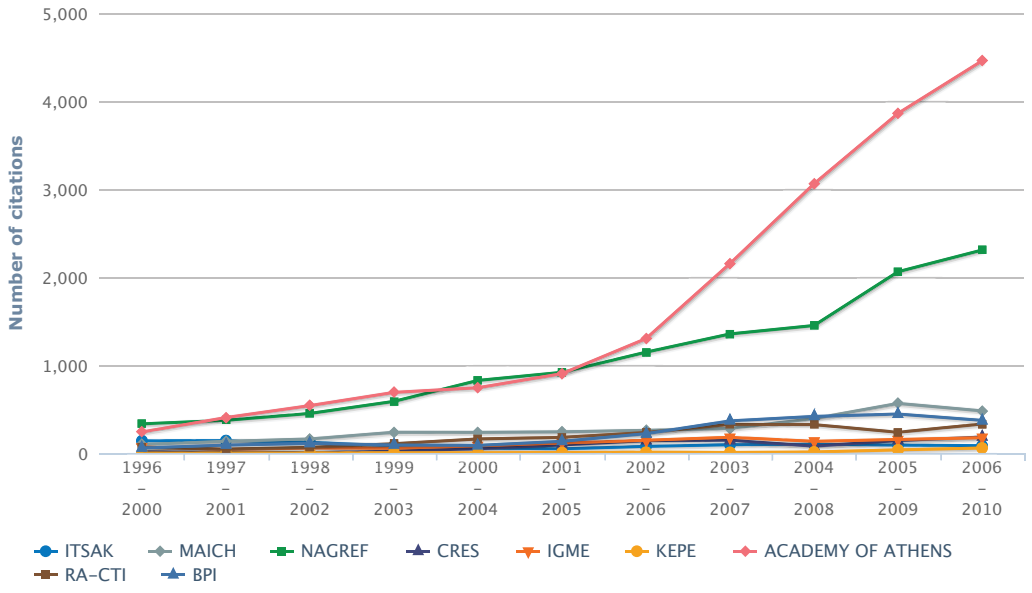


Figure 7.2.2 Number of citations by Public Research Institution, 1996-2010 / Source: Scopus 1996-2010

The number of citations for publications of each "Public Research Institution" (during 2006-2010), is also illustrated in Figure 7.2.3. The publications produced by the ACADEMY OF ATHENS received 4,455 citations. NAGREF follows with 2,305 citations, MAICH 478, BPI with 370, RA-CTI with 329, CRES with 181, IGME with 173, ITSAK with 82 and KEPE with 56 citations.

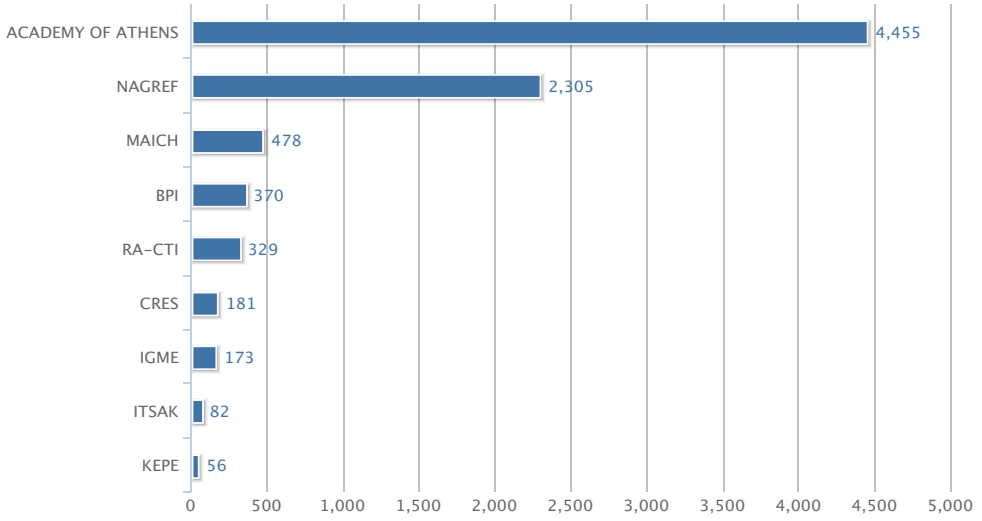


Figure 7.2.3 Number of citations by Public Research Institution, 2006-2010 / Source: Scopus 1996-2010

7.3 Citation impact

Figure 7.3.1 presents the number of publications and citations as well as the field normalised citation score for each "Public Research Institution"* in relation to the world average. Data refers to the latest 5-year period 2006-2010. The field normalised citation score or "citation score" is the relative number of citations to publications of an institution compared to the world average of citations to publications of the same time period and scientific subject field. The normalisation was done at the level of each publication according to the 307 scientific subject fields. In the case that a publication was attributed to more than one scientific field, a mean value of the fields was calculated. The citation score was calculated using software developed by EKT. A value greater than 1, indicates that the impact of publications was higher than the world average.

The values of the field-normalised citation score were above the world average in the case of the small number of publications of CRES (1.27), the ACADEMY OF ATHENS (1.13) and the small number of publications of MAICH (1.03).

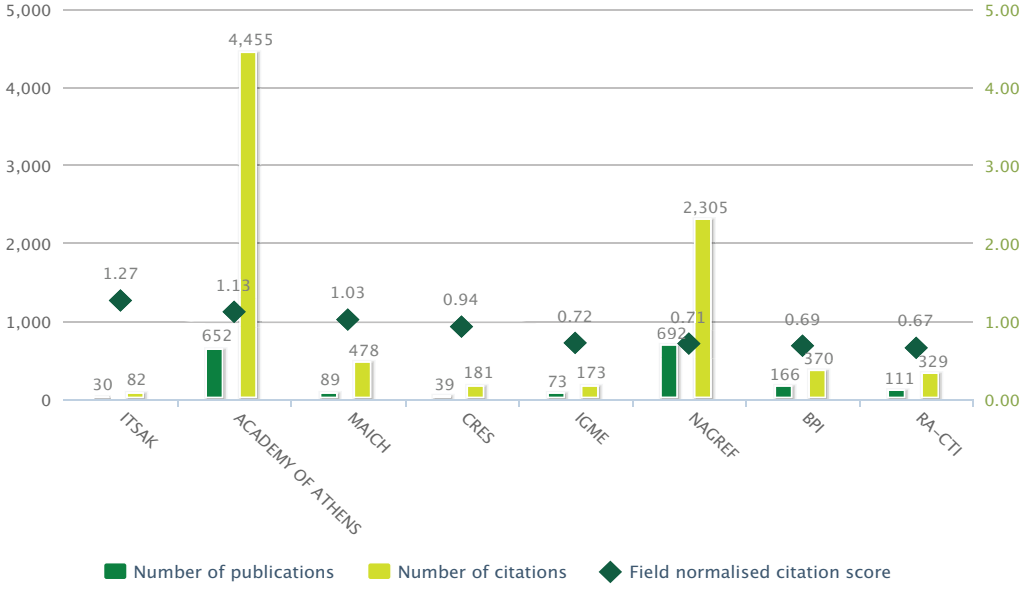


Figure 7.3.1 Publications, citations and field normalised citation score relative to the world, by Public Research Institution, 2006-2010. Data refers to the total number of publications in each Public Research Institution for all scientific fields / Source: Scopus 1996-2010

* The field-normalised citation score was calculated only for Public Research Institutions which had more than 75 publications for the period 1996-2010, –more than 5 publications per year–.

7.4 Major fields of science

Figure 7.4.1 describes the impact of publications by "Public Research Institutions" in the major scientific fields with the highest publication activity*, during 2006-2010 ("Natural Sciences", "Engineering and Technology", "Medical and Health Sciences" and "Agricultural Sciences"). The Figure displays the number of publications and citations and the field normalised citation score for each major field, thus giving information about the overall performance of each Research Institution in each major field. The citation scores were calculated, after normalisation at the level of each publication. Figure 7.4.2 provides a more detailed picture of the Institutions' performance.

In the area of "Natural Sciences", the ACADEMY OF ATHENS, NAGREF, IGME, BPI, MAICH and RA-CTI accounted for the highest number of publications. The citation score for the ACADEMY OF ATHENS was above the world average (1.13).

Four "Public Research Institutions" were active in the scientific field "Engineering & Technology": ACADEMY OF ATHENS, CRES, NAGREF and RA-CTI. The publications coming from the ACADEMY OF ATHENS achieved a citation score above the world average (1.11).

In the scientific field "Medical & Health Sciences", the majority of publications came from the ACADEMY OF ATHENS, with a citation score of 1.09, –slightly above the world average–.

In "Agricultural Sciences", three "Public Research Institutions" were active, with the publications of MAICH exceeding the world baseline average of citation score (1.16).

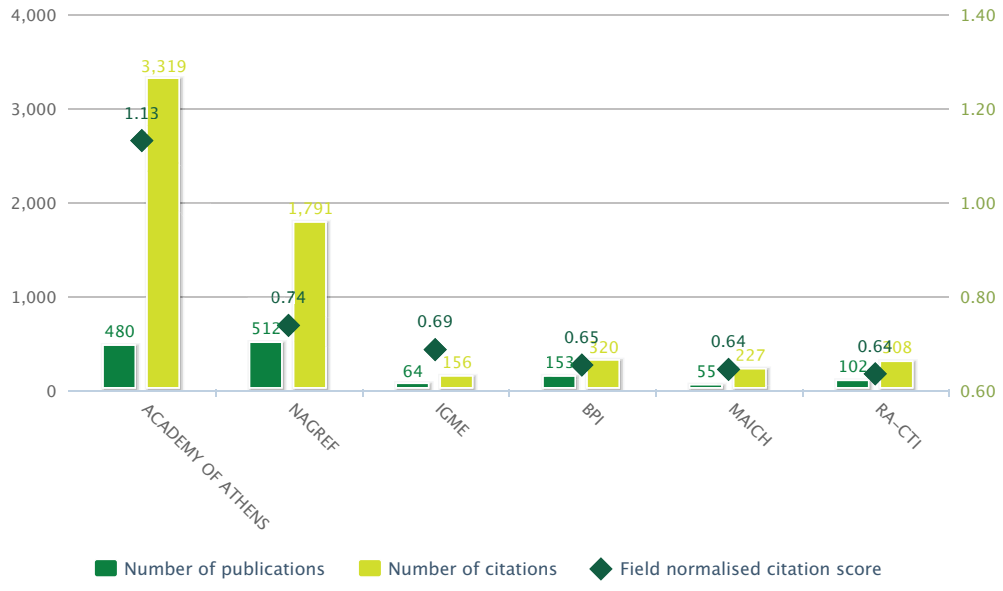


Figure 7.4.1 Publications, citations and field normalised citation score relative to the world, by Public Research Institution, in the major field of "Natural Sciences", 2006-2010 / Source: Scopus 1996-2010

* The field-normalised citation score was calculated only for Public Research Institutions with more than 75 publications for the period 1996-2010.

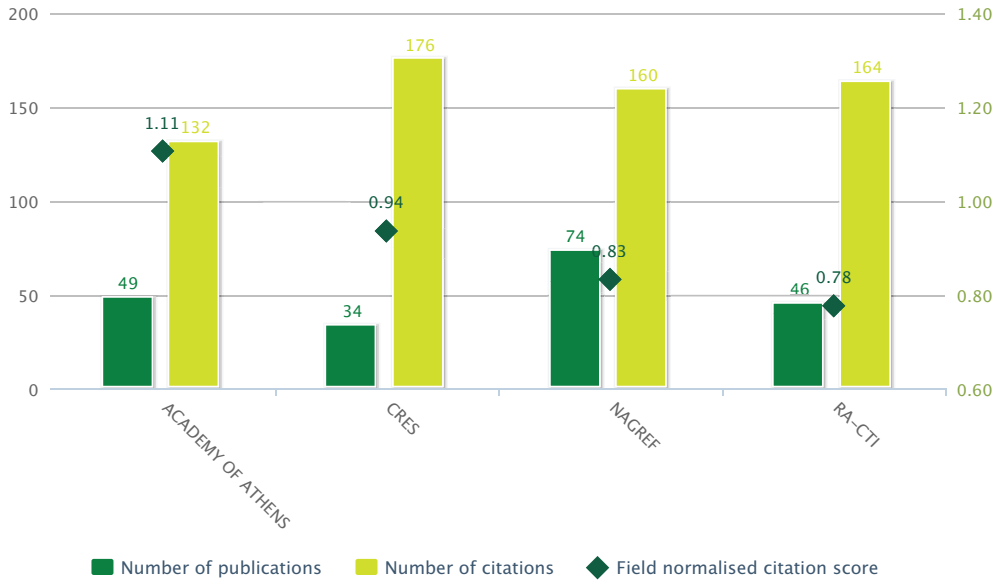


Figure 7.4.1 Publications, citations and field normalised citation score relative to the world, by Public Research Institution, in the major field of "Engineering & Technology", 2006-2010 / Source: Scopus 1996-2010

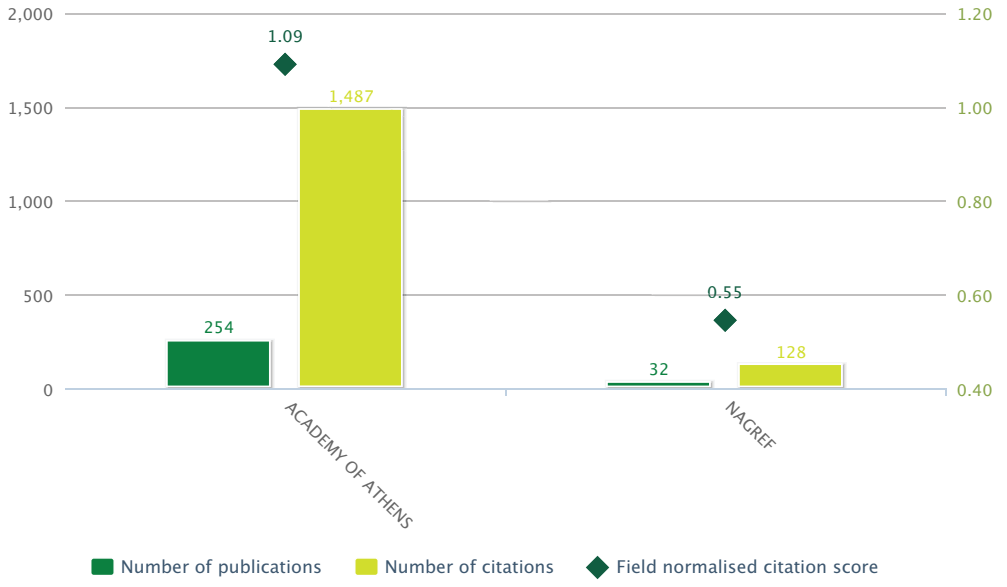


Figure 7.4.1 Publications, citations and field normalised citation score relative to the world, by Public Research Institution, in the major field of "Medical & Health Sciences", 2006-2010 / Source: Scopus 1996-2010

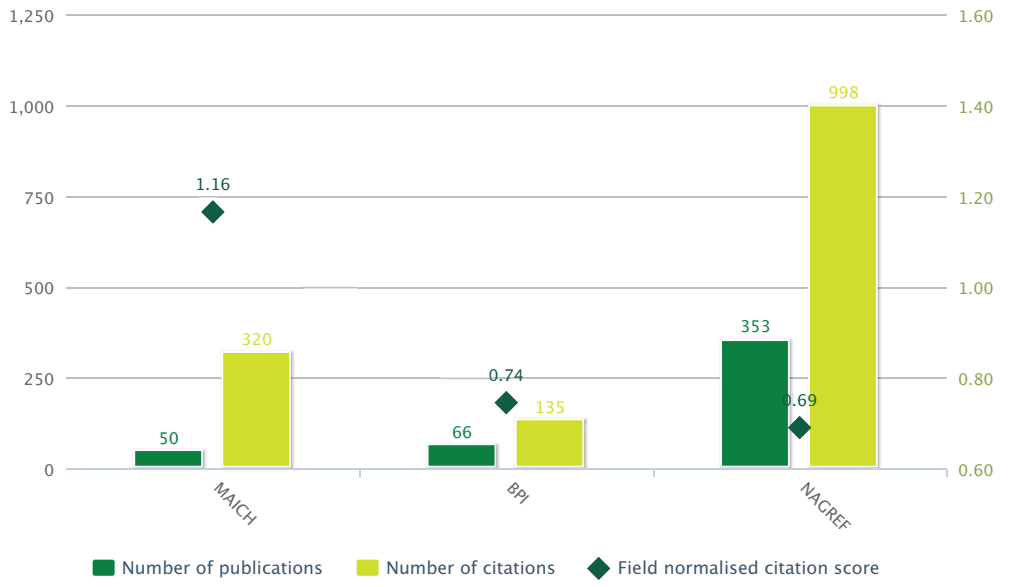


Figure 7.4.1 Publications, citations and field normalised citation score relative to the world, by Public Research Institution, in the major field of "Agricultural Sciences", 2006-2010 / Source: Scopus 1996-2010

NATURAL SCIENCES

Subfield of major filed of science (Frascati Manual)	Specific scientific field (Scopus)	Research Center	Field normalized citation score	Number of publications
biological sciences	insect science	NAGREF	1.90	23
physical sciences	nuclear and high energy physics	ACADEMY OF ATHENS	1.78	59
biological sciences	immunology	ACADEMY OF ATHENS	1.72	19
biological sciences	endocrinology	ACADEMY OF ATHENS	1.68	17
earth and related environmental sciences	geophysics	ACADEMY OF ATHENS	1.63	17
earth and related environmental sciences	earth and planetary sciences (all)	ACADEMY OF ATHENS	1.59	11
biological sciences	genetics	ACADEMY OF ATHENS	1.51	51

MEDICAL & HEALTH SCIENCES

Subfield of major filed of science (Frascati Manual)	Specific scientific field (Scopus)	Research Center	Field normalized citation score	Number of publications
basic medicine	neuroscience (all)	ACADEMY OF ATHENS	2.54	11
clinical medicine	surgery	ACADEMY OF ATHENS	1.61	9
clinical medicine	hematology	ACADEMY OF ATHENS	1.52	22

Figure 7.4.2 Scientific subfields of "Public Research Institutions" publications with field normalised citation score ≥1, 2006-2010 / Source: Scopus 1996-2010

7.5 Scientific collaboration

Figures 7.5.1 and 7.5.2. present the number of publications produced as a result of national and international collaboration for each Public Research Institution and their trends over time.

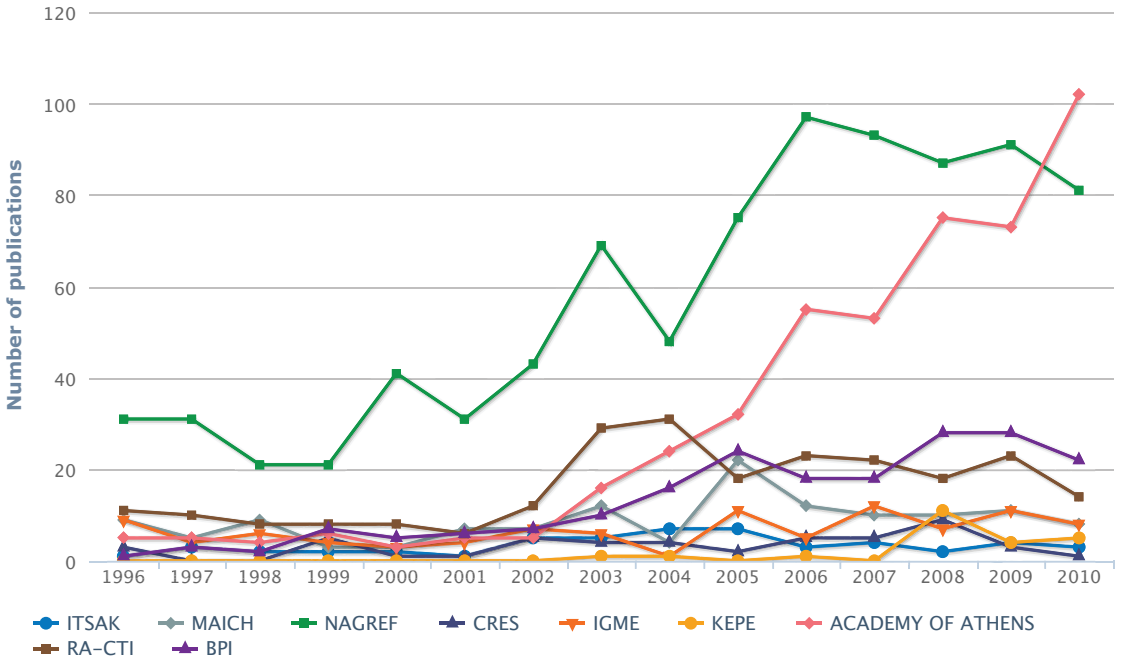


Figure 7.5.1 Number of publications with national collaboration, by Public Research Institution, 1996-2010 / Source: Scopus 1996-2010

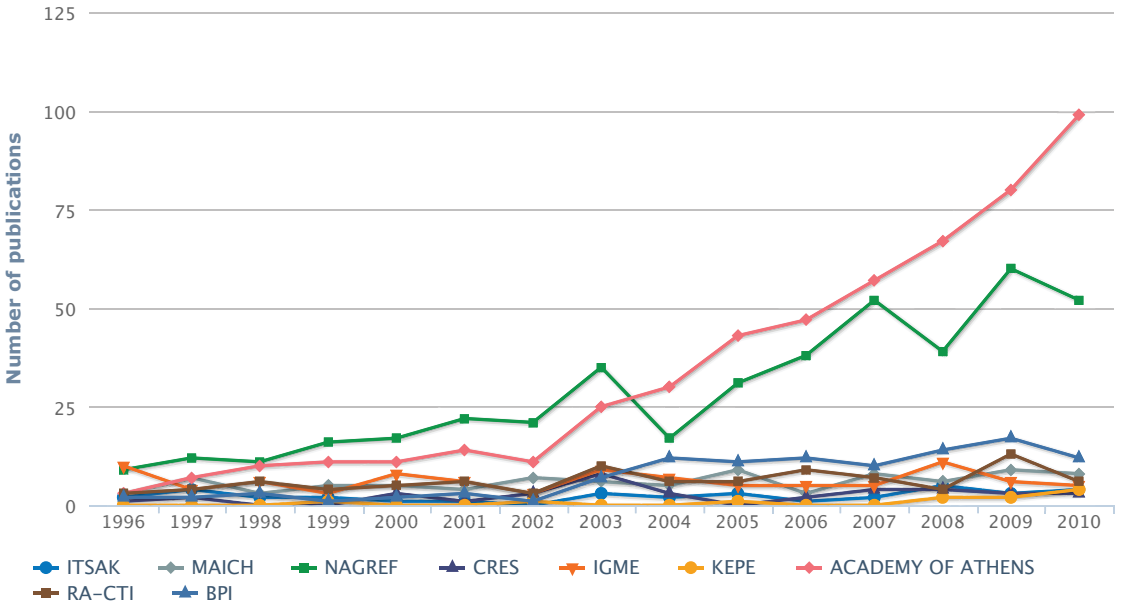


Figure 7.5.2 Number of publications with international collaboration, by Public Research Institution, 1996-2010 / Source: Scopus 1996-2010

Figure 7.5.3 highlights the distribution (%) of publications produced as a result of national*, international** and no collaboration*** for each of the 8 "Public Research Institutions" over the period 2006-2010.

There were only a few publications produced without partnerships. Publications produced with national collaboration outpaced those produced as a result of international collaboration for all Research Institutions.

MAICH had the highest percentage of publications produced without collaboration -reaching 18%, a value which is lower than the Greek average of 37.7%-.

The share of publications with national collaboration exceeded 50% for all institutions; among them, RA-CTI had the highest share (90.1%).

The share of publications with international collaboration was lower, ranging from 34.8% (NAGREF) to 53.7% (ACADEMY OF ATHENS).

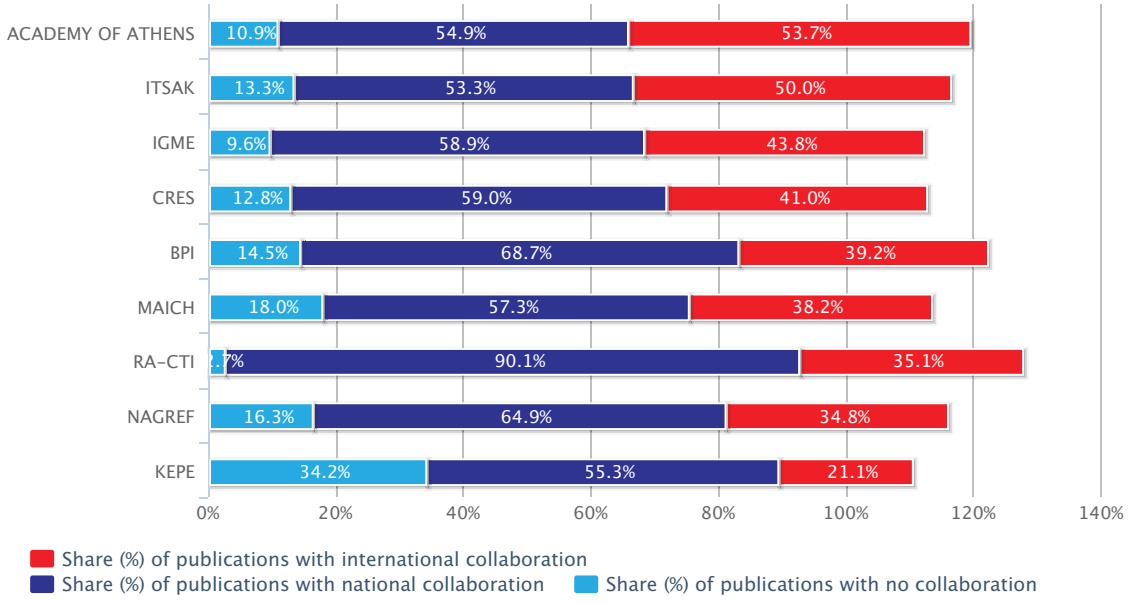


Figure 7.5.3 Share (%) of publications with national, international and no collaboration by Public Research Institution, 1996-2010 / Source: Scopus 1996-2010

* The number of publications with at least one national collaboration.

** The number of publications with at least one international collaboration.

*** The number of publications by a single Greek institution.

"Public Health Institutions" were the third most productive Institution Category in terms of publication output. Public Hospitals dominated the category. This chapter provides analytical data and bibliometric indicators for 16 hospitals, each having more than 90 publications over the period 2006-2010. The category "Public Health Institutions" includes the hospitals supervised by the Ministry of National Defense (MOD hospitals) -counted as one institution-.

The table below presents the number of publications and citations of 16 Public Health Institutions for the latest period (2006-2010) of this study.

8. Scientific Publications by Public Health Institutions

		2006-2010	
		Number of publications	Number of citations
"Aghia Sophia" Children's Hospital	AGHIA SOPHIA	122	645
"Agios Savvas" Regional Hospital for Cancer Treatment	AGIOS SAVVAS	284	1,471
Evaggelismos Hospital Athens	EVAGGELISMOS	722	3,212
G. Gennimatas General Hospital of Athens	G. GENNIMATAS	219	832
G. PAPAGEORGIOU General Hospital	G. PAPAGEORGIOU	159	651
G. Papanikolaou General Hospital of Thessaloniki	G. PAPANIKOLAOU	286	1,772
General Hospital of Athens LAIKO	LAIKO	631	2,923
Hospitals supervised by Ministry of National Defence	MOD HOSPITALS	634	3,008
IPPOKRATIO General Hospital of Athens	IPPOKRATIO ATHENS	168	906
IPPOKRATIO General Hospital of Thessaloniki	IPPOKRATIO THESSALONIKI	93	305
KORGIALENIO-BENAKIO Hospital of Athens	KORGIALENIO	105	281
Metaxa Cancer hospital of Piraeus	METAXA	211	699
Onassis Cardiac Surgery Center	O.C.S.C.	343	1,881
SOTIRIA General Hospital of Athens	SOTIRIA	341	1,877
THEAGENIO Cancer Hospital of Thessaloniki	THEAGENIO	235	1,201
Tzaneio General Hospital of Piraeus	TZANEIO	212	641

8.1 Publications

Over the period 1996-2010, Evaggelismos Hospital in Athens, the General Hospiral of Athens/LAIKO and the "Hospitals supervised by the Ministry of National Defense"/MOD HOSPITALS had the greatest volume of publications consistently across the Category "Public Health Institutions". In terms of publication activity, the relative performance of the rest of the institutions in this category varied (Figure 8.1.1).

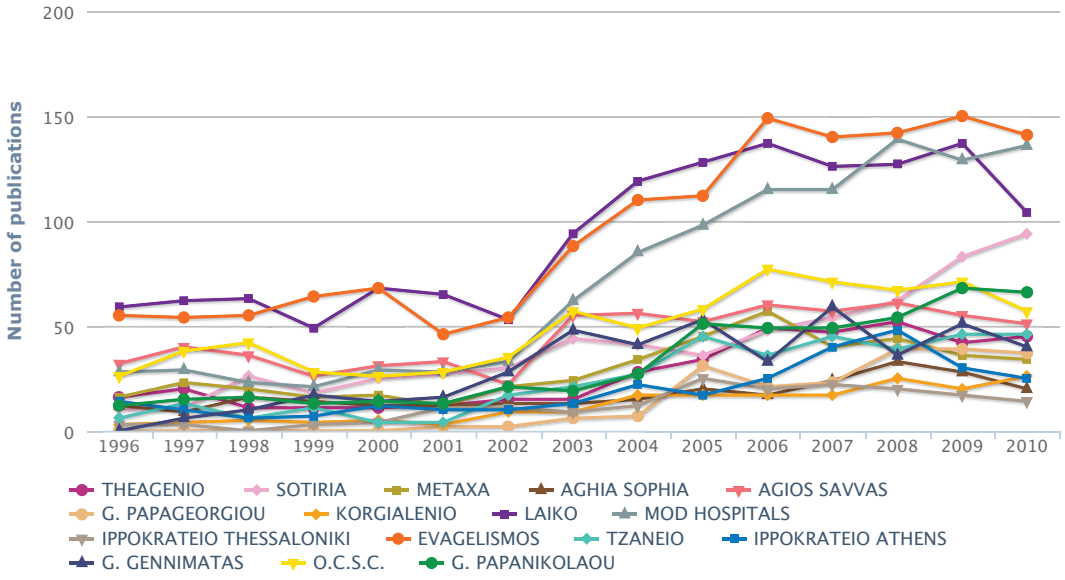


Figure 8.1.1 Development of the number of publications by Public Health Institution 1996-2010 / Source: Scopus 1996-2010

Figure 8.1.2 presents the number of publications and its rate of change for each of the 16 Health Institutions from 1996 to 2010.

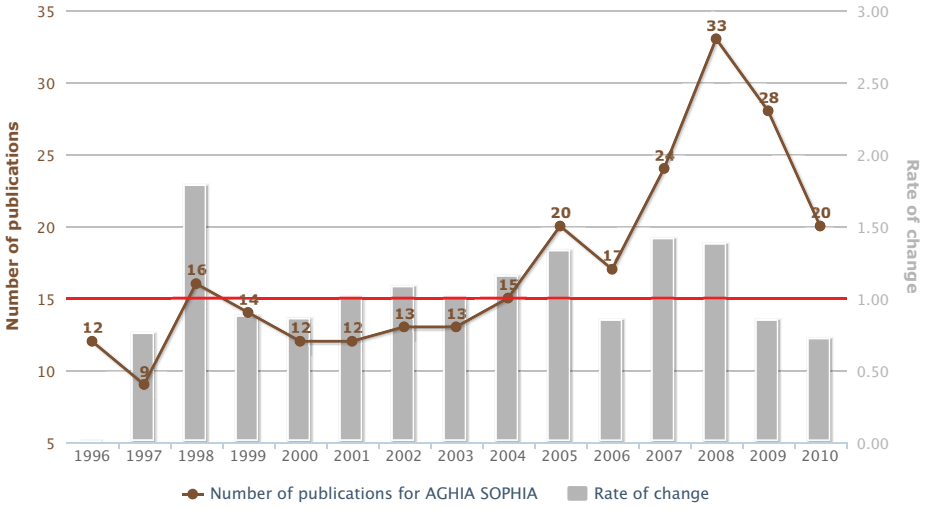


Figure 8.1.2 Number of publications and rate of change in the number of publications by Aghia Sophia Children's Hospital, 1996-2010 / Source: Scopus 1996-2010

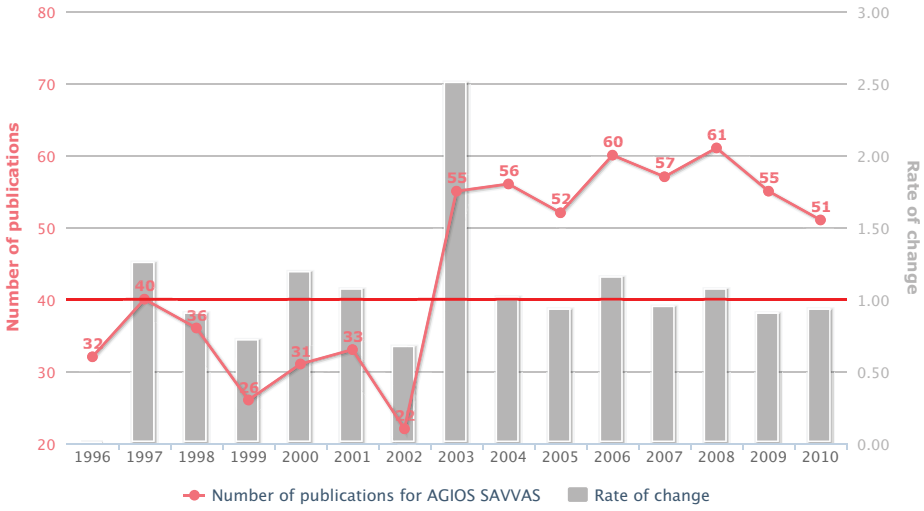


Figure 8.1.2 Number of publications and rate of change in the number of publications by Agios Savvas Regional Hospital for Cancer Treatment, 1996-2010 / Source: Scopus 1996-2010

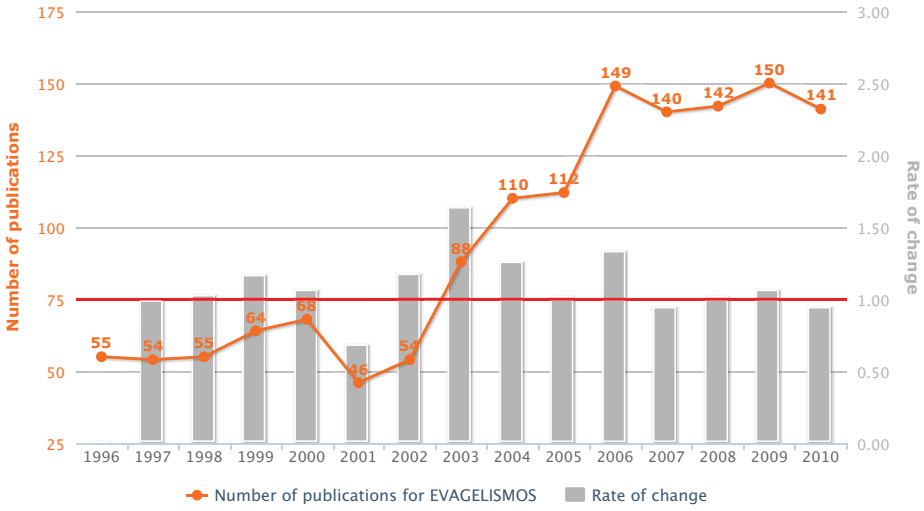


Figure 8.1.2 Number of publications and rate of change in the number of publications by Evaggelismos Hospital Athens, 1996-2010 / Source: Scopus 1996-2010

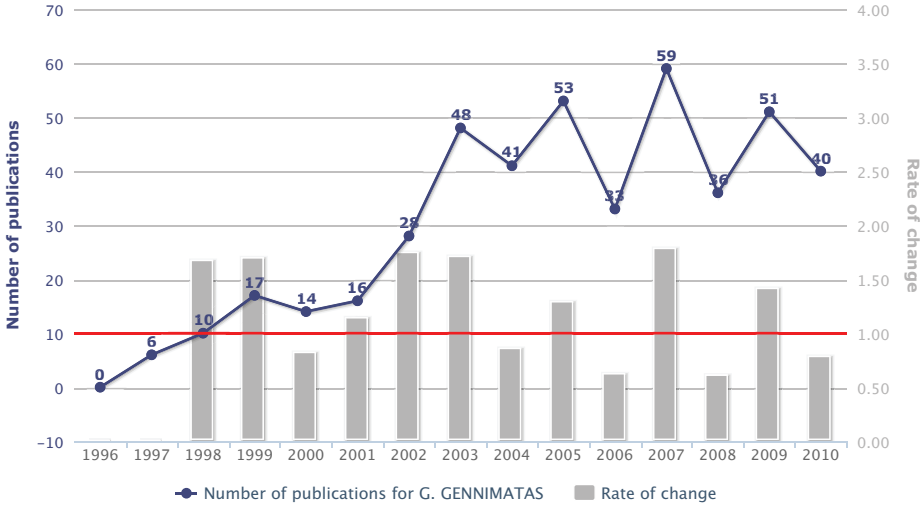


Figure 8.1.2 Number of publications and rate of change in the number of publications by G. Gennimatas General Hospital of Athens, 1996-2010 / Source: Scopus 1996-2010

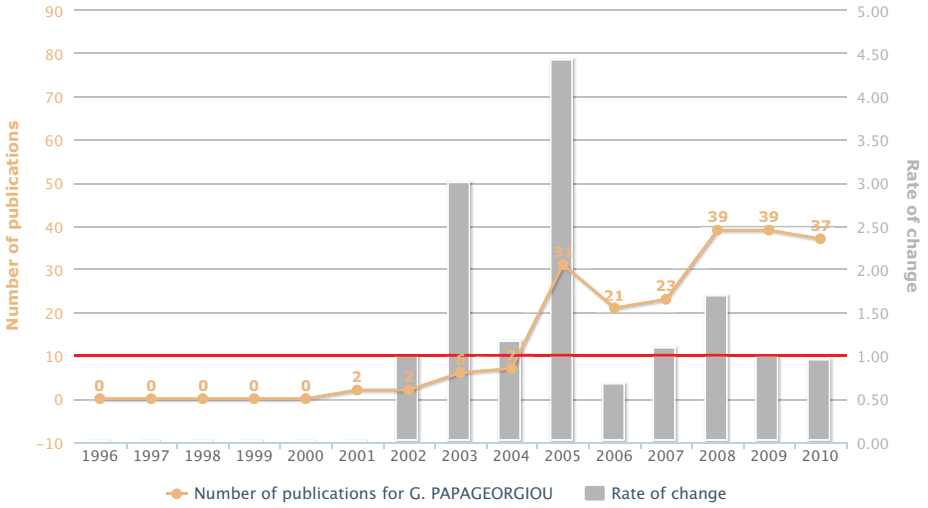


Figure 8.1.2 Number of publications and rate of change in the number of publications by G. Papageorgiou General Hospital, 1996-2010 / Source: Scopus 1996-2010

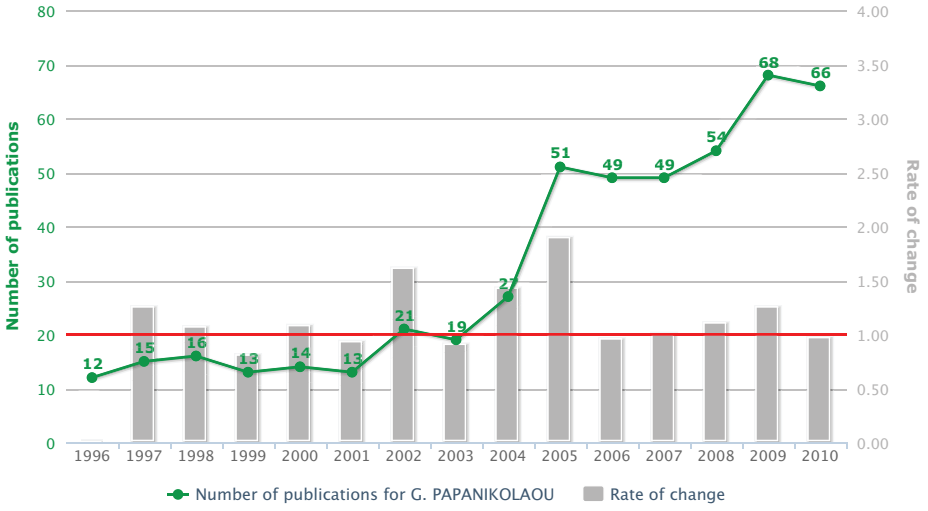


Figure 8.1.2 Number of publications and rate of change in the number of publications by G. Papanikolaou General Hospital of Thessaloniki, 1996-2010 / Source: Scopus 1996-2010

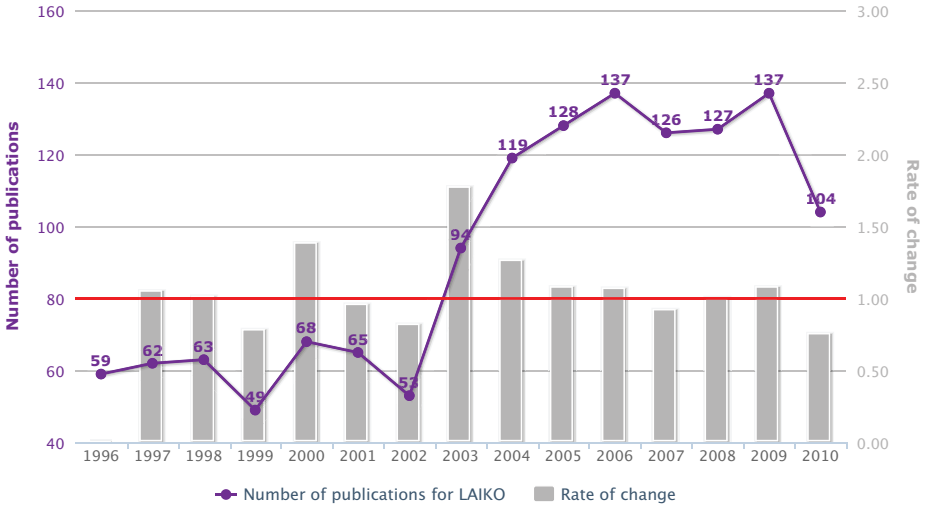


Figure 8.1.2 Number of publications and rate of change in the number of publications by General Hospital of Athens Laiko, 1996-2010 / Source: Scopus 1996-2010

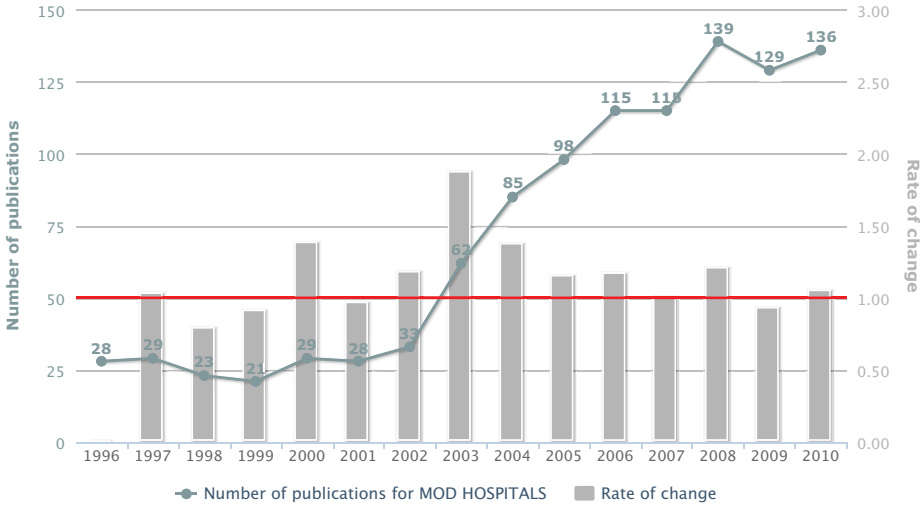


Figure 8.1.2 Number of publications and rate of change in the number of publications by Hospitals supervised by Ministry of National Defense, 1996-2010 / Source: Scopus 1996-2010

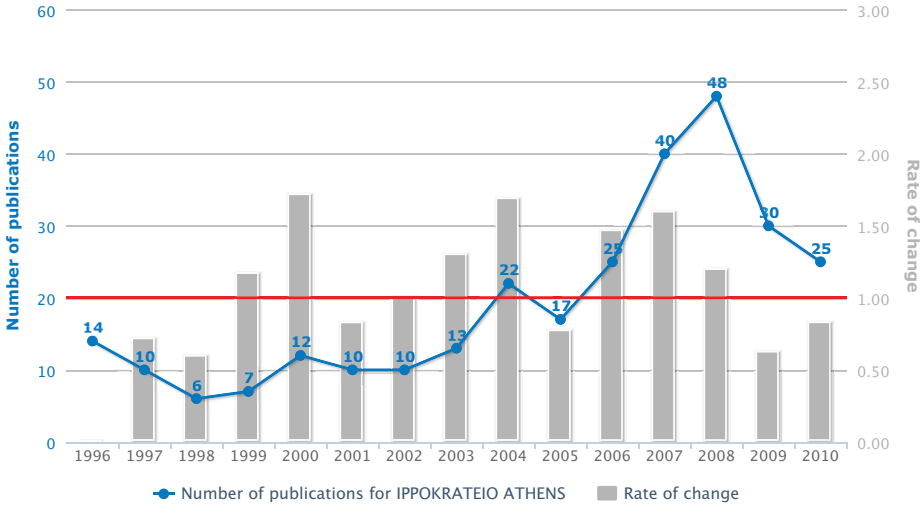


Figure 8.1.2 Number of publications and rate of change in the number of publications by Ippokrateio General Hospital of Athens, 1996-2010 / Source: Scopus 1996-2010

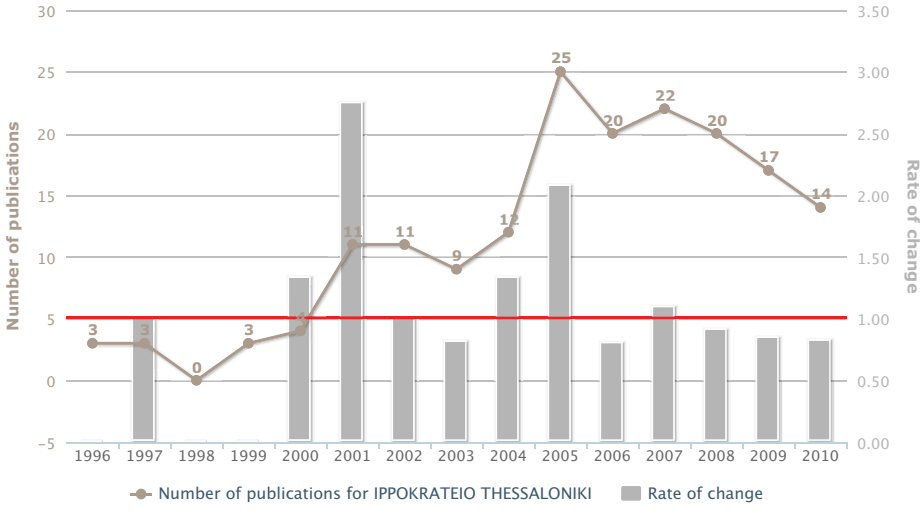


Figure 8.1.2 Number of publications and rate of change in the number of publications by Ippokrateio General Hospital of Thessaloniki, 1996-2010 / Source: Scopus 1996-2010

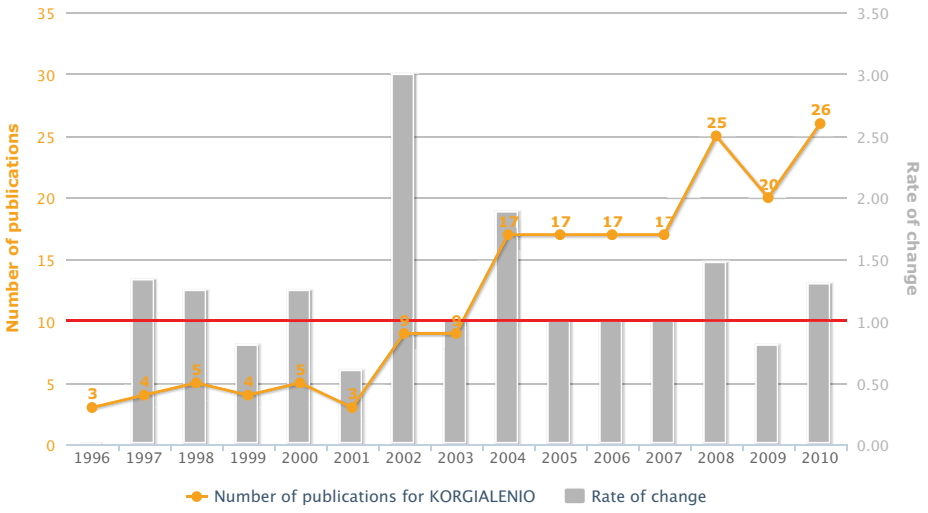


Figure 8.1.2 Number of publications and rate of change in the number of publications by Korgialenio-Benakio Hospital of Athens, 1996-2010 / Source: Scopus 1996-2010

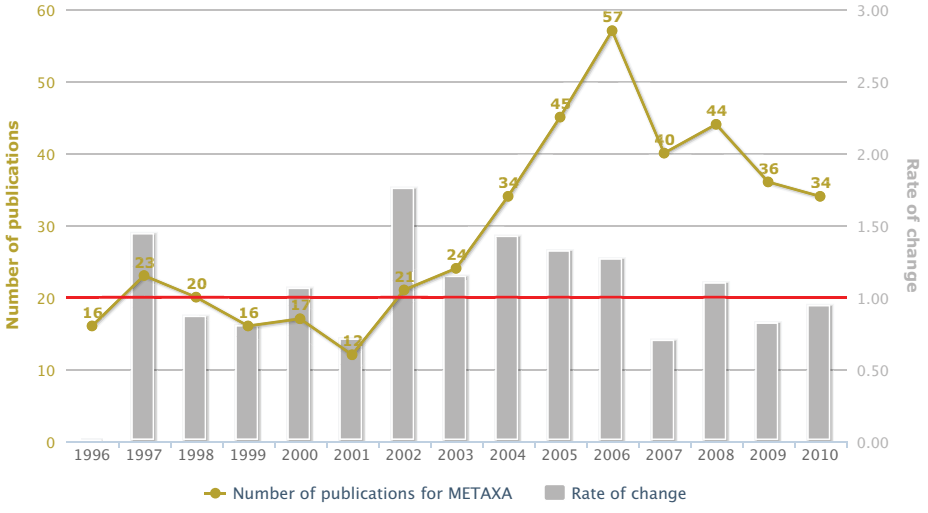


Figure 8.1.2 Number of publications and rate of change in the number of publications by Metaxa Cancer hospital of Piraeus, 1996-2010 / Source: Scopus 1996-2010

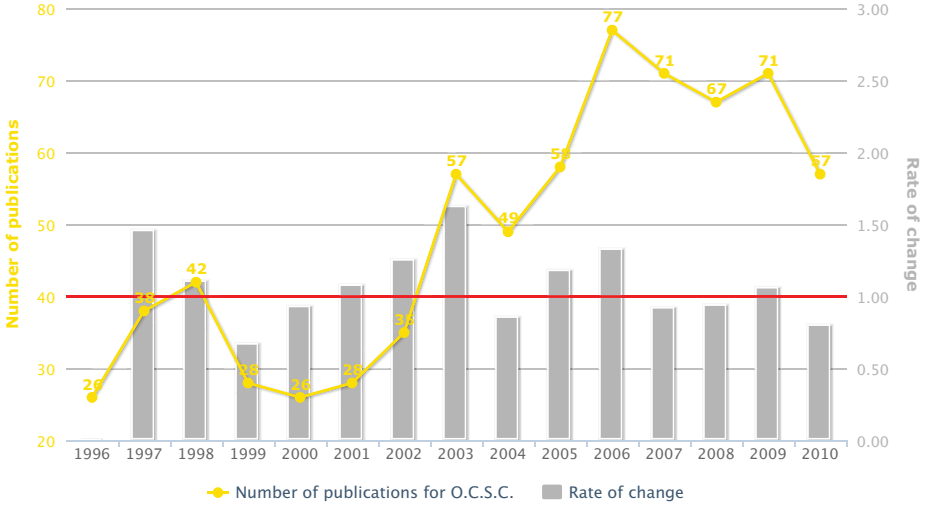


Figure 8.1.2 Number of publications and rate of change in the number of publications by Onassis Cardiac Surgery Centre, 1996-2010 / Source: Scopus 1996-2010

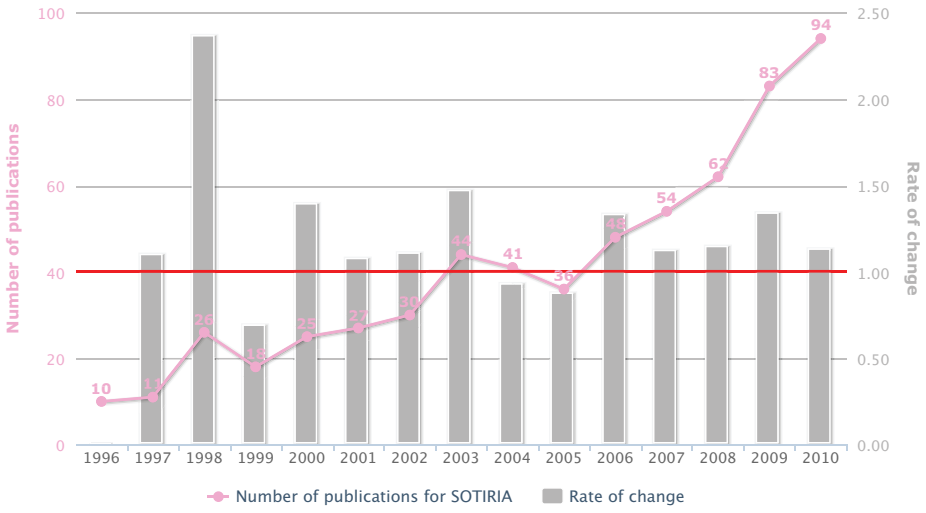


Figure 8.1.2 Number of publications and rate of change in the number of publications by Sotiria General Hospital of Athens, 1996-2010 / Source: Scopus 1996-2010

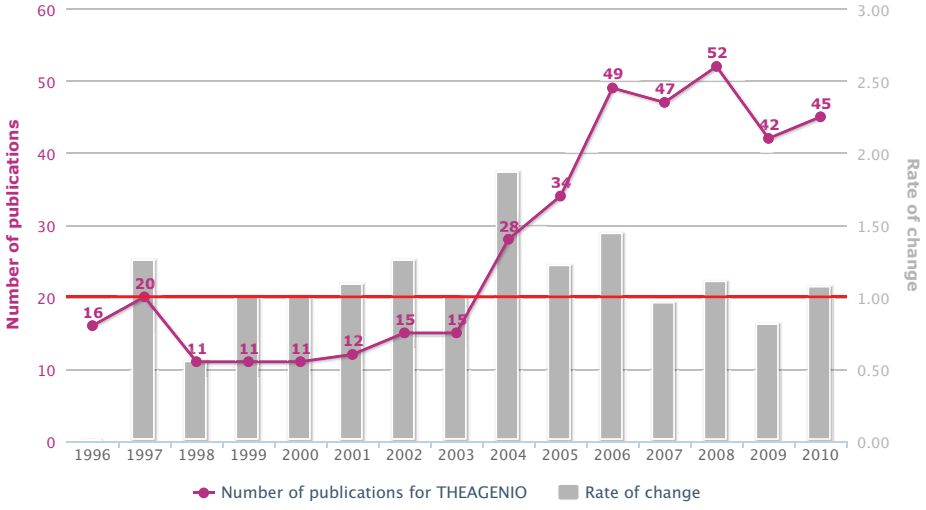


Figure 8.1.2 Number of publications and rate of change in the number of publications by Theagenio Cancer Hospital of Thessaloniki, 1996-2010 / Source: Scopus 1996-2010

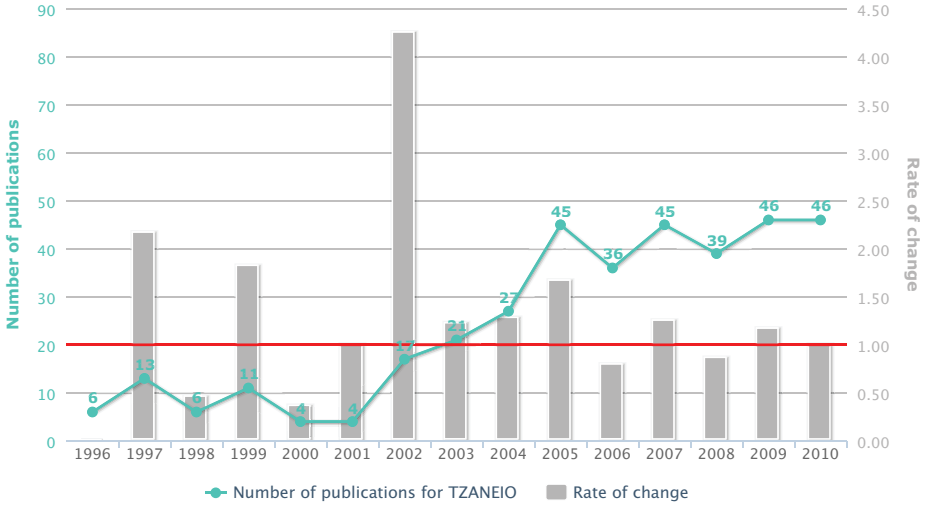


Figure 8.1.2 Number of publications and rate of change in the number of publications by Tzaneio General Hospital of Piraeus, 1996-2010 / Source: Scopus 1996-2010

Rate of change: 1+[(number of publications in year "n" - number of publications in year "n-1") / number of publications in year "n-1"]. The rate is 1, if the number of publications is the same accross the years compared.

Focusing on the latest 5-year period 2006-2010, Figure 8.1.3 presents the number of publications for each of the 16 Health Institutions, as well as for each institution's share of publications in the category "Public Health Institutions". The "Evaggelismos Hospital of Athens"/EVAGGELISMOS had 722 publications and a share of 9.1%. This was followed by the "Hospitals supervised by the Ministry of National Defense"/MOD HOSPITALS with 634 publications and the both with a share of 8%. The share for the rest institutions accounted for less than 5% of publications in the category.

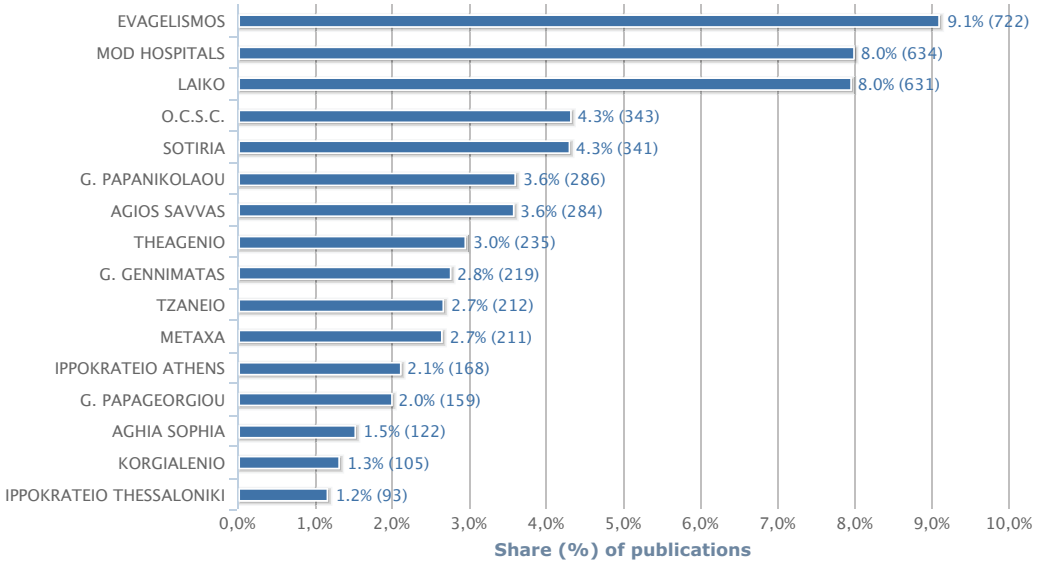


Figure 8.1.3 Number and share (%) of publications, by Public Health Institution, 2006-2010 / Source: Scopus 1996-2010

Figure 8.1.4 shows that, during the period 2006-2010, the rate of change in publication output in the "Public Health Institutions" Category was higher for the following hospitals: the SOTIRIA General Hospital of Athens/SOTIRIA, the G. PAPAGEORGIOU General Hospital/G. PAPAGEORGIOU, the KORGIALENIO-BENAKIO Hospital of Athens/KORGIALENIO, the G. Papanikolaou General Hospital of Thessaloniki/G. PAPANIKOLAOU, the Tzaneio General Hospital of Piraeus/TZANEIO, the G. Gennimatas General Hospital of Athens/G. GENNIMATAS, the Hospitals supervised by Ministry of National Defense/MOD HOSPITALS, and the "Aghia Sophia" Children's Hospital/AGHIA SOPHIA. However, for the majority of institutions, the number of publications was rather low and ranged over time.

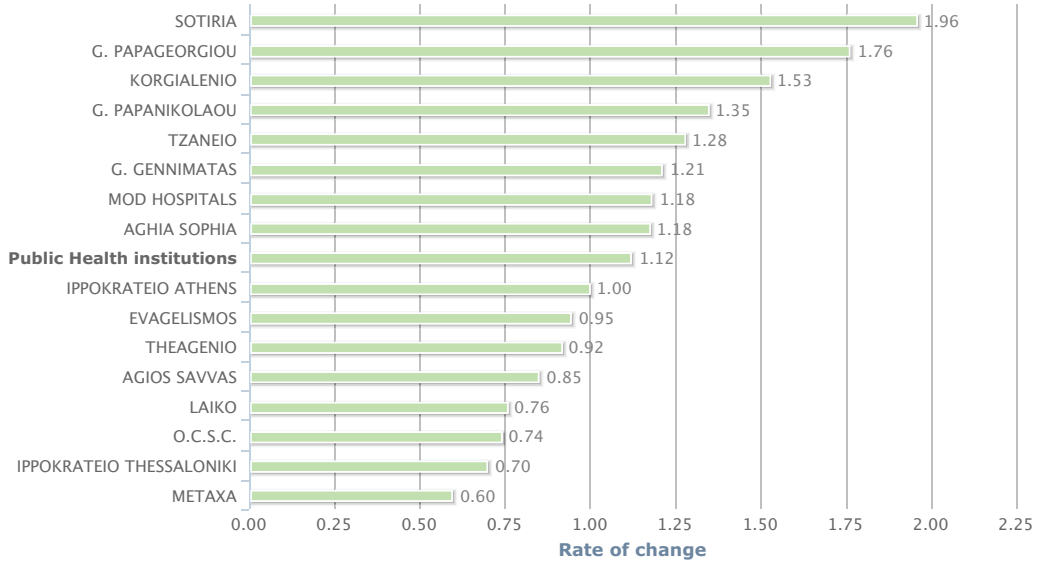


Figure 8.1.4 Change in the number of publications between 2006 and 2010, by Public Health Institution / Source: Scopus 1996-2010

Rate of change: 1+[(number of publications in year "2010" - number of publications in year "2006") / number of publications in year "2006"]. The rate is 1, if the number of publications is the same accross the years compared.

8.2 Citations

Throughout the period 1996-2010, the percentage of cited publications for the hospitals listed was rather high– usually above the Greek average–. For the 5-year period 2006-2010, it varied from 51.6% for the G. PAPAGEORGIOU General Hospital/G. PAPAGEORGIOU to 74.6% for the Onassis Cardiac Surgery Center/O.C.S.C. (Figure 8.2.1).

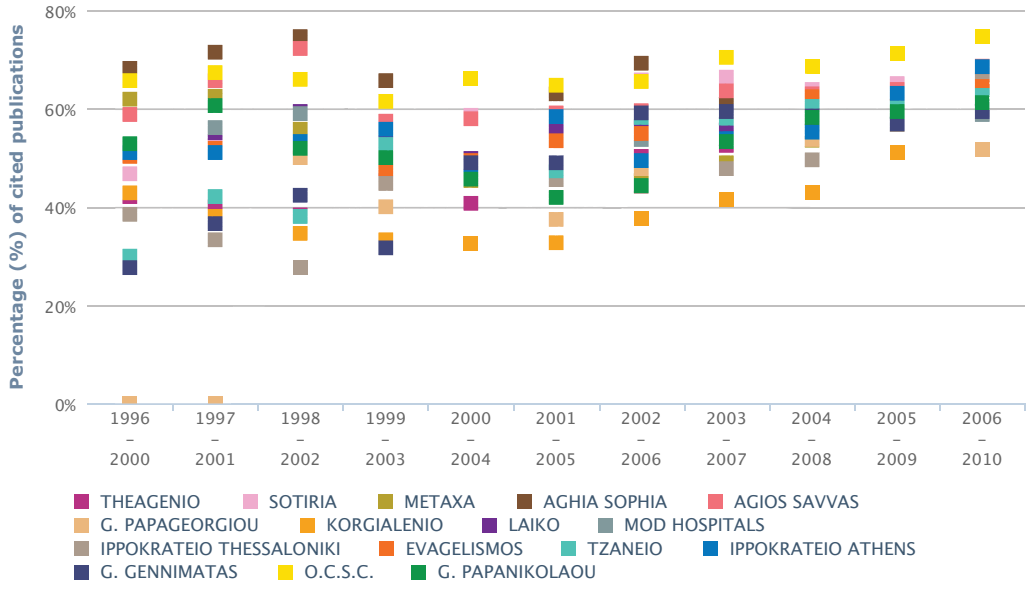


Figure 8.2.1 Percentage (%) of cited publications by Public Health Institution, 1996-2010 / Source: Scopus 1996-2010

Figure 8.2.2 presents the growth trends in number of citations for the sixteen Public Health Institutions during 1996-2010.

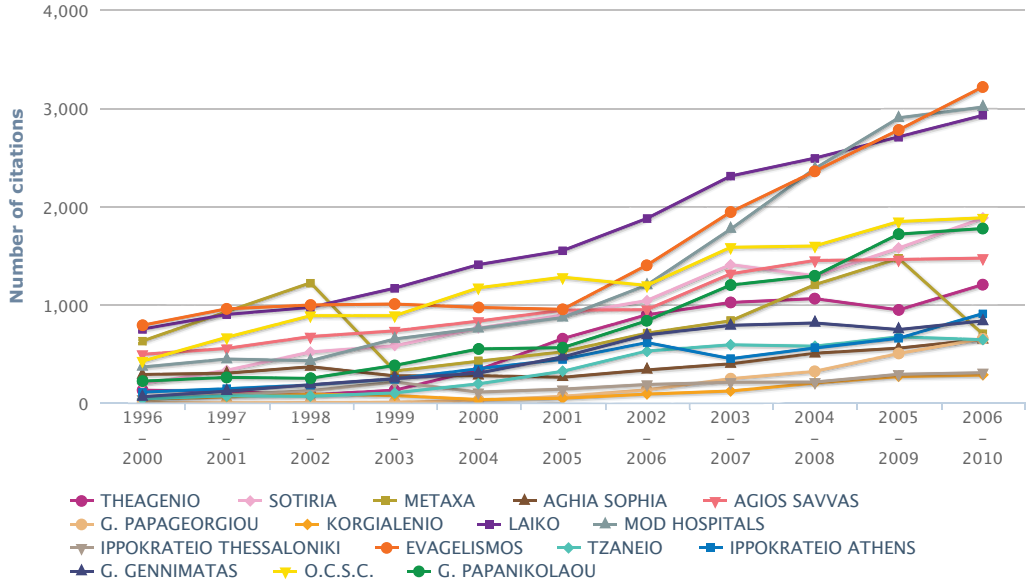


Figure 8.2.2 Number of citations by Public Health Institution, 1996-2010 / Source: Scopus 1996-2010

An examination of citation output and the share of citations in the "Public Health Institutions" Category for each institution for the period 2006-2010 revealed that the Evaggelismos Hospital of Athens/EVAGGELISMOS (3,212 citations and share of 8.8%) was first. It was followed by the Hospitals supervised by Ministry of National Defense/MOD HOSPITALS (3,008 citations and share of 8.2%), the General Hospital of Athens/LAIKO (2,923 citations and share of 8%), the Onassis Cardiac Surgery Center/O.C.S.C. (1,881 citations and share of 5.1%) and the SOTIRIA General Hospital of Athens (1,877 citations and share of 5.1%). The share of other institutions accounted for less than 5% of citations in this category (Figure 8.2.3).

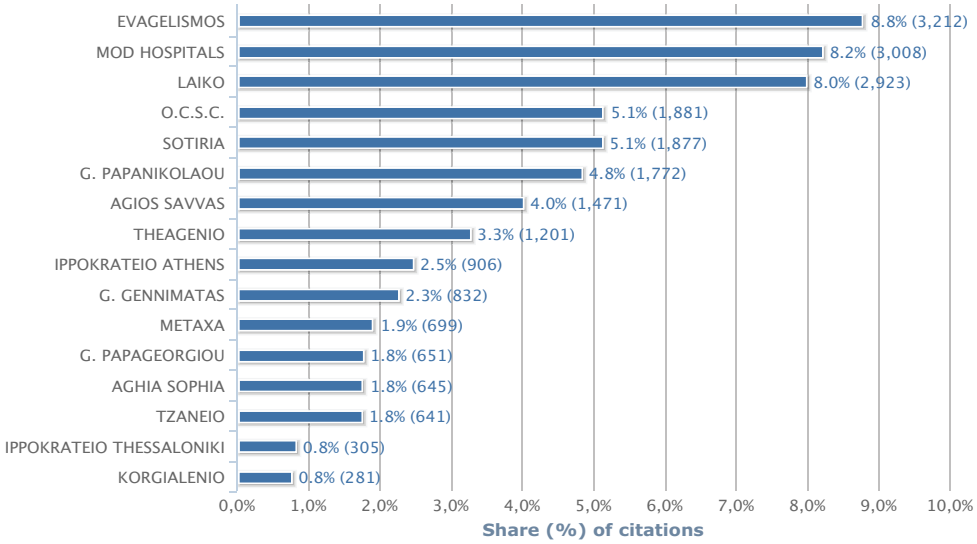


Figure 8.2.3 Number and share (%) of citations by Public Health Institution, 2006-2010 / Source: Scopus 1996-2010

8.3 Citation impact

Figure 8.3.1 presents the number of publications and citations and the field normalised citation score for each institution in relation to the world average. Data refers to the latest 5-year period 2006-2010. The field normalised citation score or "citation score" is the relative number of citations to publications of an institution compared to the world average of citations to publications of the same time period and scientific subject field. The normalisation was applied at the level of each publication according to the 307 scientific subject fields. In the case that a publication was attributed to several subject fields, a mean value of the fields was calculated. The citation score was calculated using software that EKT developed. A value greater than 1, indicated that the impact of publications was higher than the world average.

The citation score was the highest (and above the world average) for the SOTIRIA General Hospital of Athens and the "Ippokratio" Regional General Hospital of Athens (citation score: 1.06 and 1.03). Other hospitals with citation scores above 0.90 were the G. Papanikolaou General Hospital of Thessaloniki (0.99) and "Aghia Sophia" Children's Hospital (0.98).

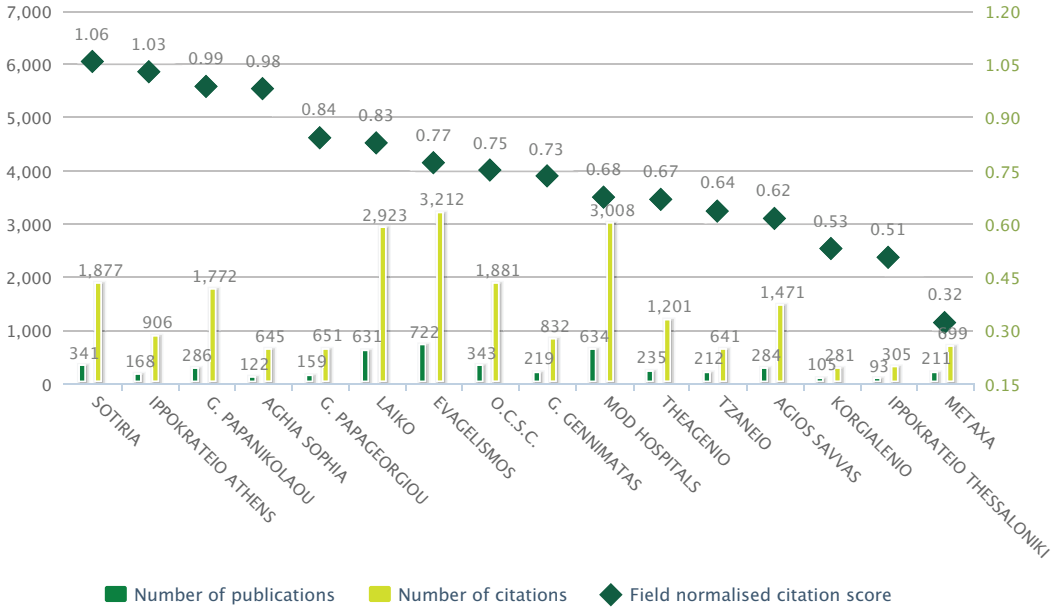


Figure 8.3.1 Publications, citations and field normalised citation score relative to the world, by Public Health Institution, 2006-2010. Data refers to the total number of publications in each Public Health Institution for all scientific fields / Source: Scopus 1996-2010

8.4 Major fields of science

Figure 8.4.1 presents values related to the impact of publications by "Public Health Institutions" in the major scientific fields with higher publication activity (more specifically, in the "Medical & Health Sciences" and "Natural Sciences")*, for the 5-year period from 2006 to 2010. The Figure displays the number of publications and citations and the field normalised citation score for each major field, thus giving information on the overall performance of each institution in each major field. The citation scores were normalized and then calculated at the level of each publication. Figure 8.4.2 provides a detailed picture of each institution's performance.

As expected, Public Health Institutions were mostly active in the scientific field "Medical & Health Sciences". The publications with an impact higher than 0.90 were those of SOTIRIA (citation score: 0,98), AGHIA SOFIA (0.98), Papanikolaou General Hospital of Thessaloniki (0.97) and the IPPOKRATIO General Hospital of Athens (0.96).

There was a low number of publications in the field of "Natural Sciences", mainly coming from SOTIRIA (citation score: 1.38), the IPPOKRATIO General Hospital of Athens (1.22), Papanikolaou General Hospital of Thessaloniki (1.11), G. Gennimatas General Hospital of Athens (1.07) and the LAIKO General Hospital of Athens/LAIKO(1.02).

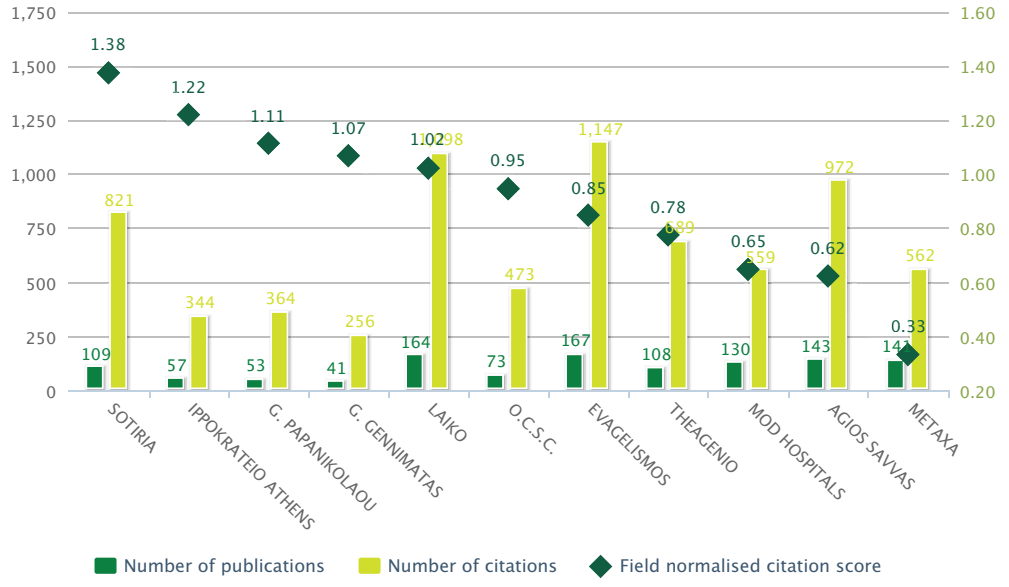


Figure 8.4.1 Publications, citations and field normalised citation score relative to the world, by Public Health Institution, in the major field of "Natural Sciences", 2006-2010 / Source: Scopus 1996-2010

* The field-normalised citation score was only calculated for Public Health Institutions which produced more than 75 publications for the period 1996-2010, –or 5 publications annually–.

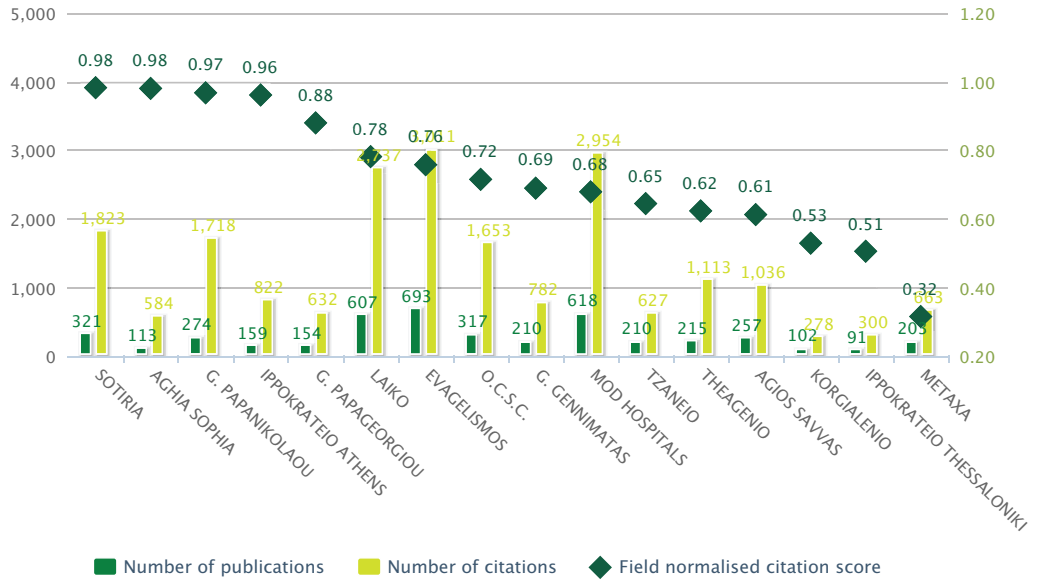


Figure 8.4.1 Publications, citations and field normalised citation score relative to the world, by Public Health Institution, in the major field of "Medical & Health Sciences", 2006-2010 / Source: Scopus 1996-2010

NATURAL SCIENCES

Subfield of major field of science (Frascati Manual)	Specific scientific field (Scopus)	Hospital	Field normalized citation score	Number of publications
biological sciences	endocrinology	SOTIRIA	3.10	9
biological sciences	biochemistry	LAIKO	3.09	8
biological sciences	physiology	EVAGELISMOS	2.58	11
biological sciences	physiology	SOTIRIA	2.06	17
biological sciences	endocrinology	IPPOKRATEIO ATHENS	2.04	9
biological sciences	clinical biochemistry	SOTIRIA	1.87	11
biological sciences	physiology	IPPOKRATEIO ATHENS	1.83	8
biological sciences	immunology	IPPOKRATEIO ATHENS	1.61	8
biological sciences	endocrinology	EVAGELISMOS	1.54	16

MEDICAL & HEALTH SCIENCES

Subfield of major field of science (Frascati Manual)	Specific scientific field (Scopus)	Hospital	Field normalized citation score	Number of publications
clinical medicine	obstetrics and gynecology	AGHIA SOPHIA	4.30	11
clinical medicine	endocrinology, diabetes and metabolism	IPPOKRATEIO ATHENS	2.37	9
other medical sciences	medicine (all)	G. PAPAGEORGIOU	2.28	15
clinical medicine	urology	G. PAPAGEORGIOU	2.03	8
clinical medicine	internal medicine	EVAGELISMOS	1.92	11
clinical medicine	critical care and intensive care medicine	LAIKO	1.91	8
basic medicine	biochemistry (medical)	LAIKO	1.85	9
clinical medicine	internal medicine	SOTIRIA	1.83	47
other medical sciences	medicine (all)	G. PAPANIKOLAOU	1.76	31
clinical medicine	hematology	G. PAPANIKOLAOU	1.57	32
clinical medicine	critical care and intensive care medicine	G. PAPANIKOLAOU	1.52	8
clinical medicine	microbiology (medical)	TZANEIO	1.51	9
clinical medicine	radiology, nuclear medicine and imaging	TZANEIO	1.50	8

Figure 8.4.2 Scientific subfields of "Public Health Institutions" publications with field normalised citation score ≥1.5, 2006-2010 / Source: Scopus 1996-2010

8.5 Scientific collaboration

Figure 8.5.1 highlights the share of publications produced as a result of national*, international** and no collaboration*** for each of the 16 Public Health Institutions over the period 2006-2010.

The majority of publications resulted from national collaborations –over 60% of total publications in most cases–. Tzaneio General Hospital of Piraeus/TZANEIO had the highest percentage of publications with national collaborations (79.7%).

The percentage of publications with international collaboration was lower, ranging from 12.7% (the Tzaneio General Hospital of Piraeus/TZANEIO) to 31.8% (the Onassis Cardiac Surgery Centre).

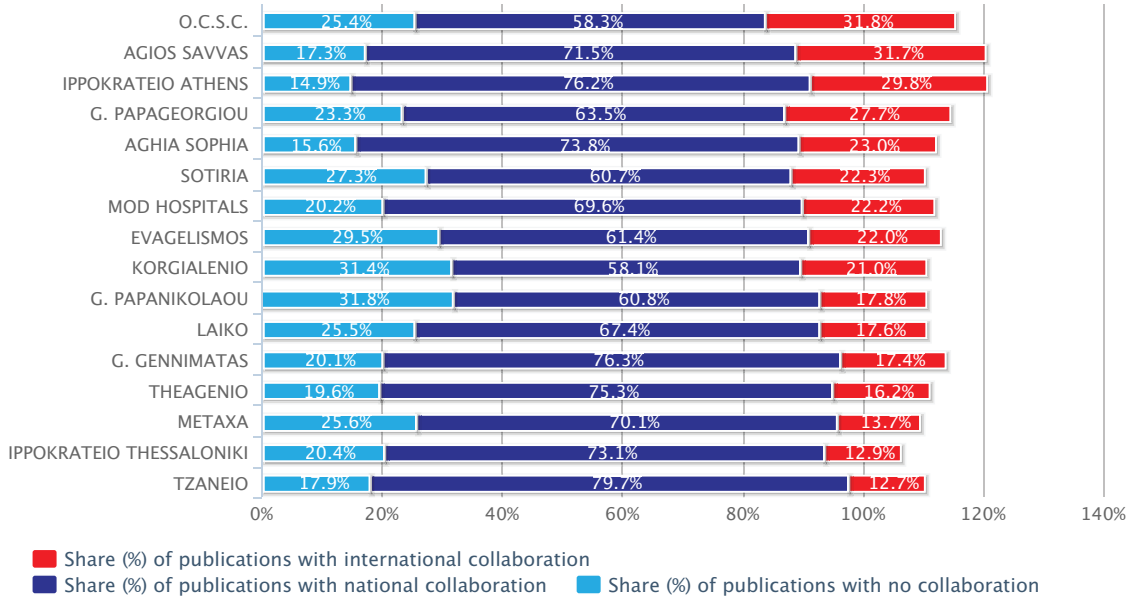


Figure 8.5.1 Share (%) of publications with national, international and no collaboration by Public Health Institution, 1996-2010 / Source: Scopus 1996-2010

* The number of publications with at least one national collaboration.

** The number of publications with at least one international collaboration.

*** The number of publications by a single Greek institution.

The category "Private Health Institutions" includes Private Health Institutions active in the health sector such as private hospitals, clinics, diagnostic centers, research centers etc. When compared to other institution categories –presented in the previous chapters–, this category made the least contribution to the total number of Greek publications. However, the category displays the highest citation impact indicator values.

This chapter includes analytical data for the key players in this category. More specifically, these are: the Alfa Institute of Biomedical Sciences, the Athens Medical Group, Euroclinic Athens, the Hellenic Cooperative Oncology Group, the Henry Dunant hospital, the HYGEIA Group (which includes Hygeia General Hospital, MITERA and LETO Maternity Hospitals), the IASO Group, Metropolitan Hospital and St. Luke's Hospital.

The table below presents the number of publications produced by the institutions and citations that their publications received for the period 2006-2010.

9. Scientific Publications by Private Health Institutions

		2006-2010	
		Number of publications	Number of citations
Alfa Institute of Biomedical Sciences	AIBS	329	3,351
Athens Medical Group	Iatriko	67	196
Euroclinic Athens	Euroclinic	93	482
Hellenic Cooperative Oncology Group	HeCOG	47	286
HENRY DUNANT hospital	HENRY DUNANT	396	6,145
HYGEIA Group	Hygeia	249	1,290
IASO Group	IASO	91	285
Metropolitan Hospital	Metropolitan	110	1,010
St. Luke's Hospital	St. LUKE	59	204

9.1 Publications

The HENRY DUNANT hospital (HENRY DUNANT), the HYGEIA Group (Hygeia) and the Alfa Institute of Biomedical Sciences (AIBS) stand out in this category –in terms of their publication output–. However, their number of publications leveled off in 2010, amounting to 67, 44 and 41 respectively (Figure 9.1.1). There were fewer publications from the IASO Group (23), the METROPOLITAN Hospital (20), St. Luke's Hospital (16), the EUROCLINIC Group and the Hellenic Cooperative Oncology Group (15 each) and the Athens Medical Group (12).

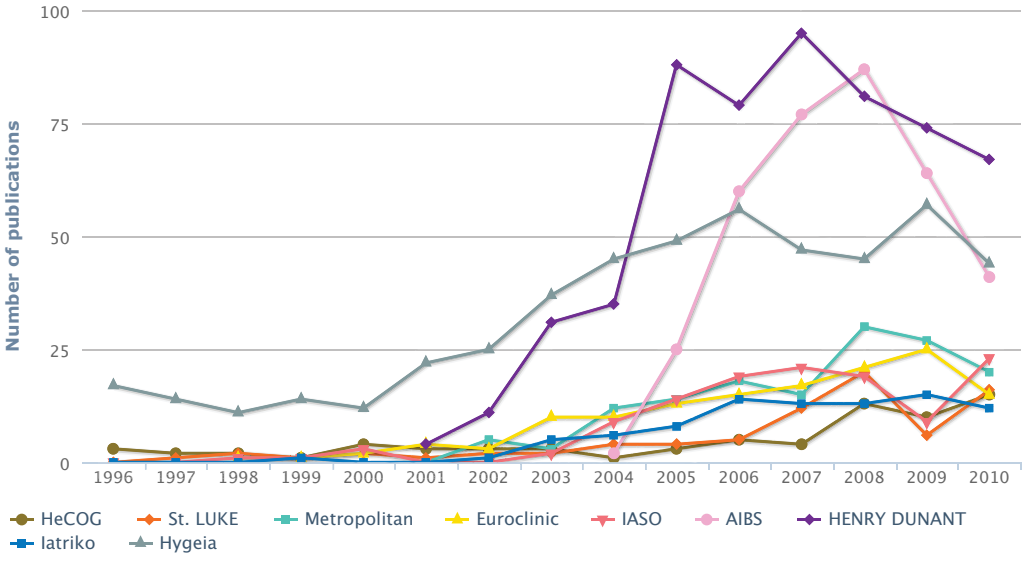


Figure 9.1.1 Development of the number of publications by Private Health Institution 1996-2010 / Source: Scopus 1996-2010

Figure 9.1.2 presents the number of publications and its rate of change for each Private Health Institution from 1996 to 2010.

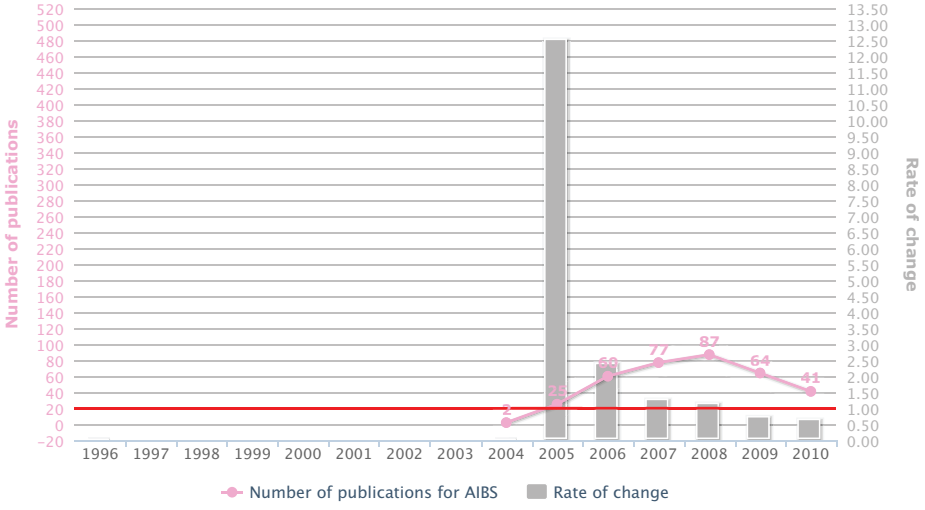


Figure 9.1.2 Number of publications and rate of change in the number of publications by AIBS, 1996-2010 / Source: Scopus 1996-2010

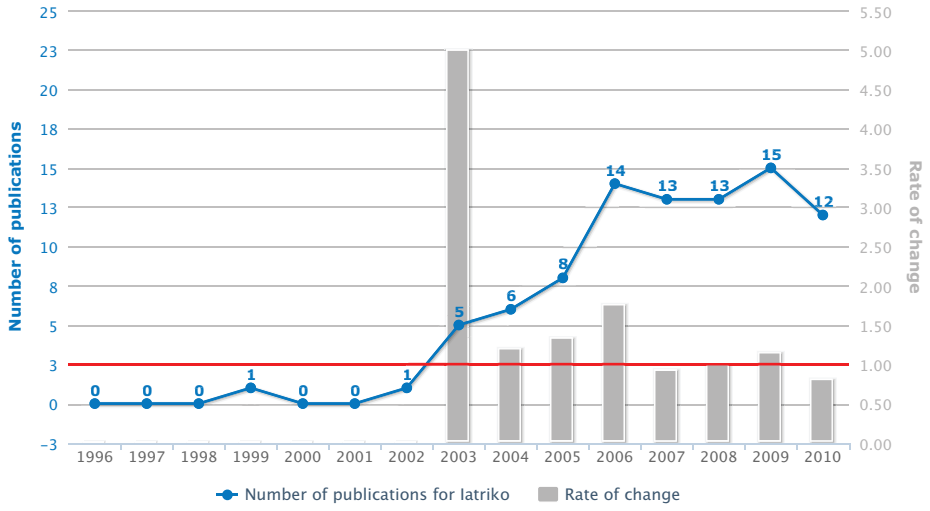


Figure 9.1.2 Number of publications and rate of change in the number of publications by Athens Medical Group, 1996-2010 / Source: Scopus 1996-2010

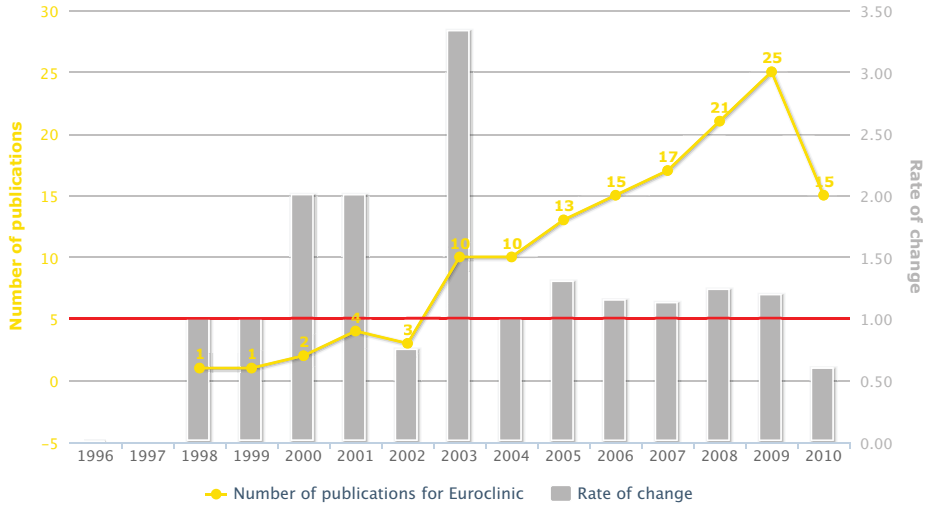


Figure 9.1.2 Number of publications and rate of change in the number of publications by Euroclinic Athens, 1996-2010 / Source: Scopus 1996-2010

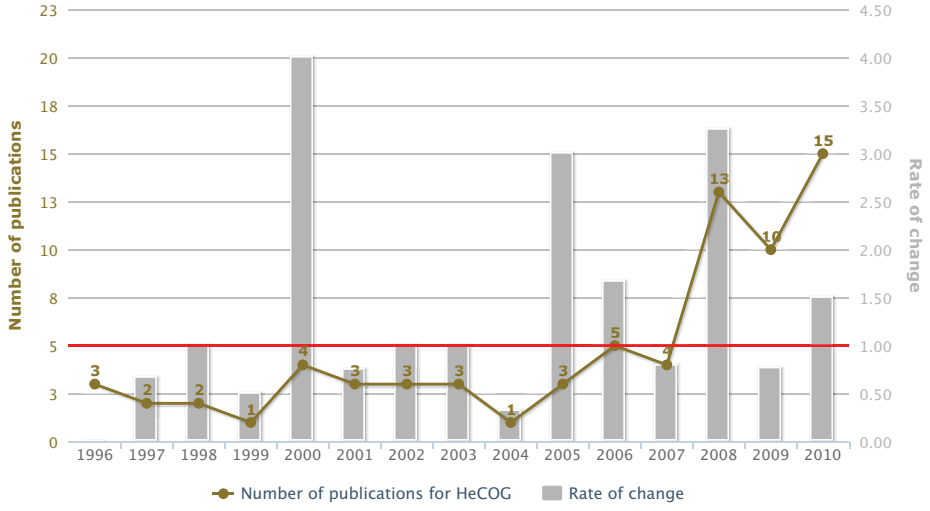


Figure 9.1.2 Number of publications and rate of change in the number of publications by Hellenic Cooperative Oncology Group, 1996-2010 / Source: Scopus 1996-2010

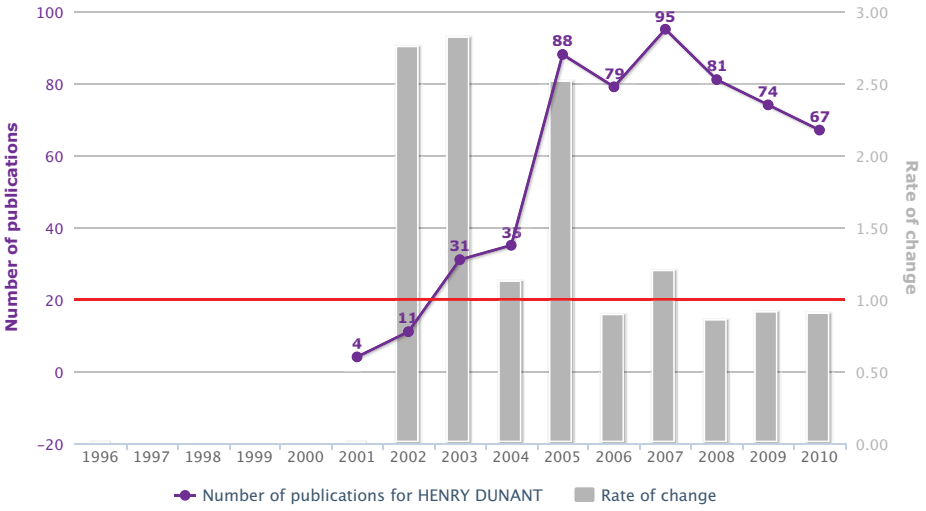


Figure 9.1.2 Number of publications and rate of change in the number of publications by Henry Dunant, 1996-2010 / Source: Scopus 1996-2010

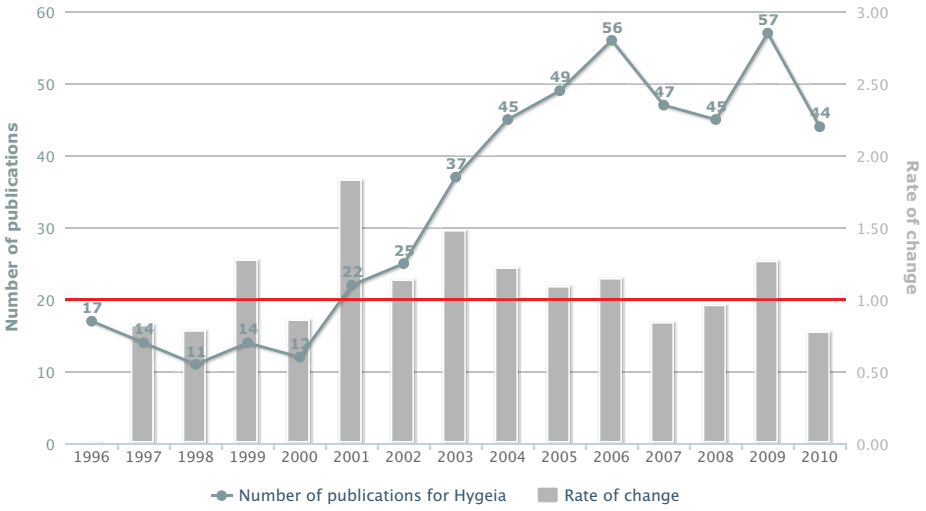


Figure 9.1.2 Number of publications and rate of change in the number of publications by Hygeia, 1996-2010 / Source: Scopus 1996-2010

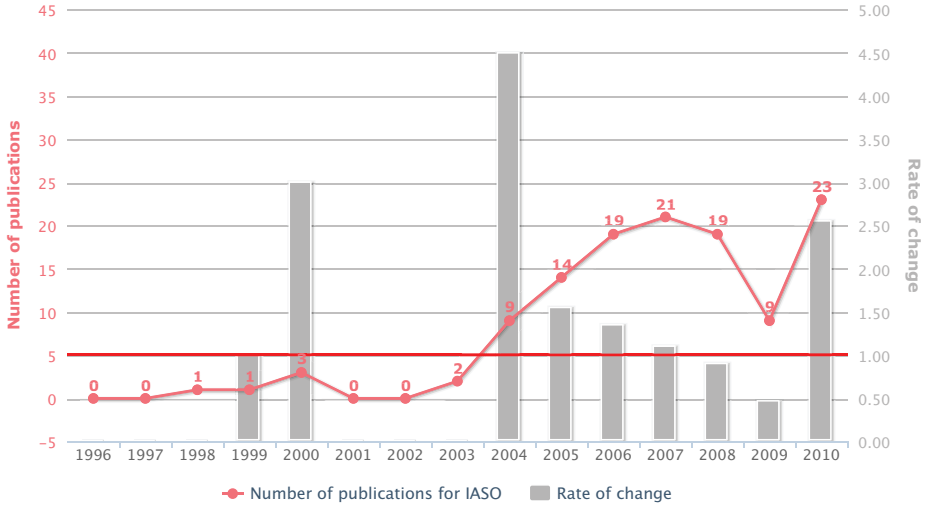


Figure 9.1.2 Number of publications and rate of change in the number of publications by IASO, 1996-2010 / Source: Scopus 1996-2010

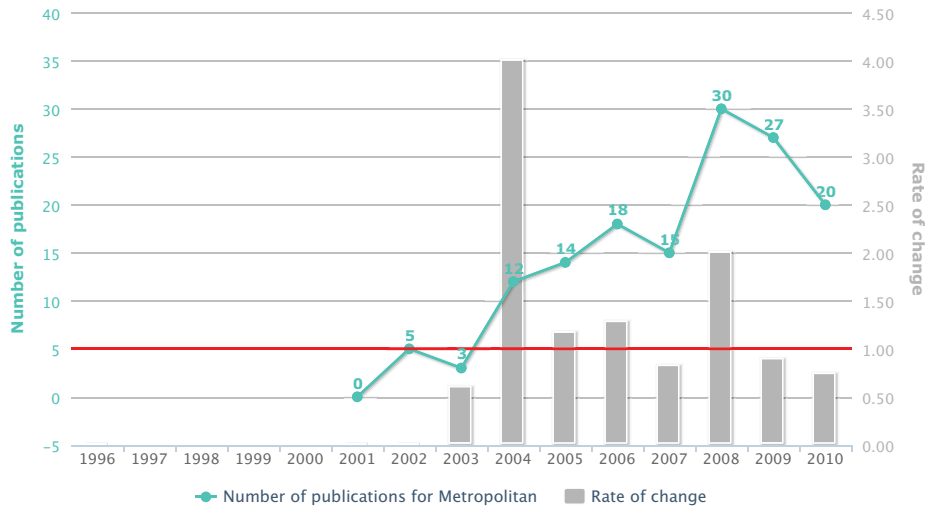


Figure 9.1.2 Number of publications and rate of change in the number of publications by Metropolitan Hospital, 1996-2010 / Source: Scopus 1996-2010

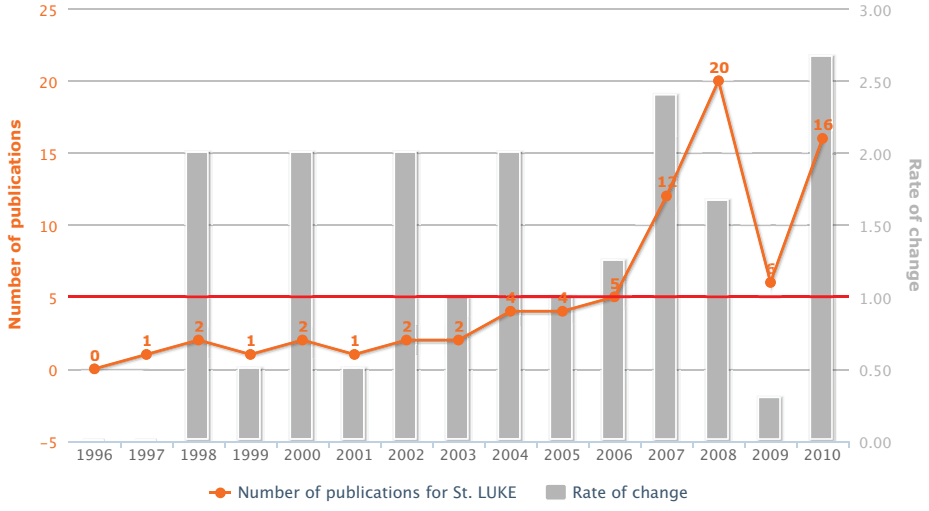


Figure 9.1.2 Number of publications and rate of change in the number of publications by St. Luke, 1996-2010 / Source: Scopus 1996-2010

Rate of change: 1+(number of publications in year "n" - number of publications in year "n-1") / number of publications in year "n-1". The rate is 1, if the number of publications is the same across the years compared.

Figure 9.1.3 presents the scientific output and each institution's share of publications in the category "Private Health Institutions" for the period 2006-2010. The HENRY DUNANT hospital (HENRY DUNANT) ranked first with 396 publications and a share of 27.5%. The Alfa Institute of Biomedical Sciences (AIBS) followed with 329 publications and a share of 22.8%. The HYGEIA Group (Hygeia) had 249 publications and a share of 17.3%, the METROPOLITAN Group had 110 publications and a share of 7.6%, the EUROCLINIC Group had 93 publications and a share of 6.5% and IASO Hospital had 91 publications and a share of 6.3%. The share of other institutions accounted for less than 5% of the publications in this category.

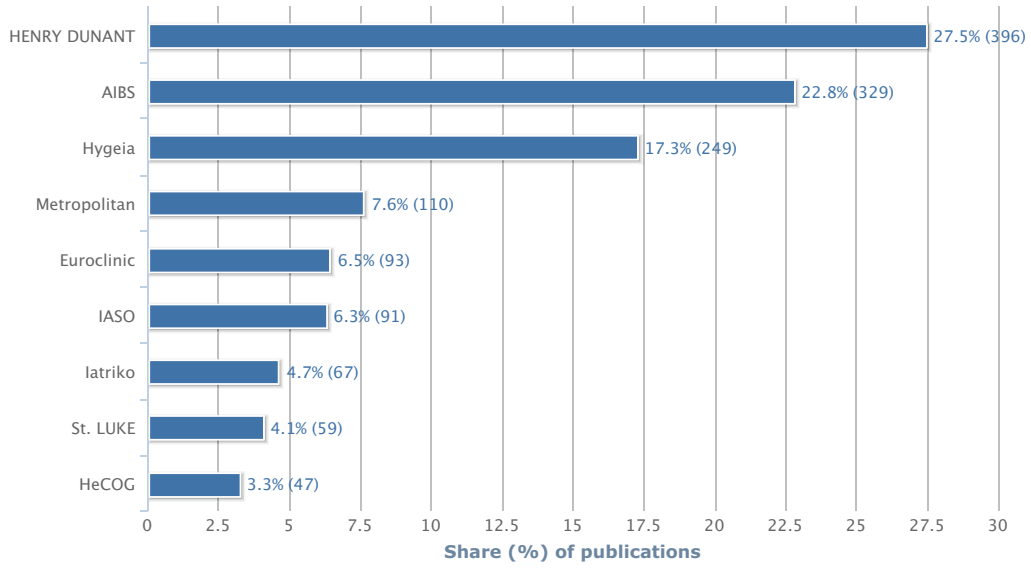


Figure 9.1.3 Number and share (%) of publications, by Private Health Institution, 2006-2010 / Source: Scopus 1996-2010

The rate of change in the publications of St. Luke's Hospital (St. Luke) and the Hellenic Cooperative Oncology Group (HeCOG) exceeded that of the "Private Health Institutions" category. It should be noted, though, that the actual number of publications for these hospitals was rather low. An increase in the number of publications is also noted for IASO Hospital, METROPOLITAN Hospital and EUROCLINIC Hospital.

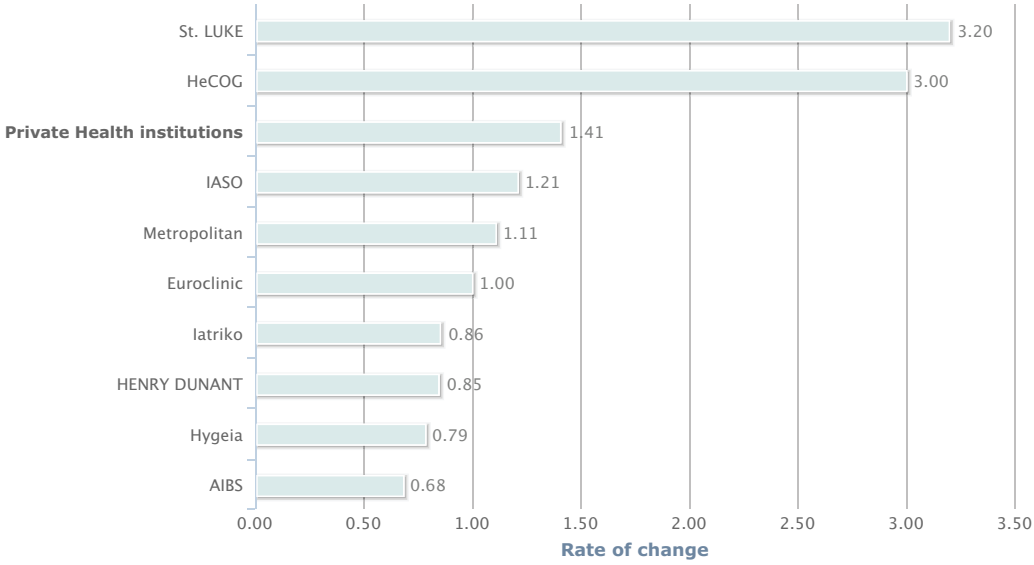


Figure 9.1.4 Change in the number of publications between 2006 and 2010, by Private Health Institution / Source: Scopus 1996-2010

Rate of change: 1+(number of publications in year "2010" - number of publications in year " 2006") / number of publications in year "2006". The rate is 1, if the number of publications is the same across the years compared.

9.2 Citations

Figure 9.2.1 presents the share of cited publications in different institutional categories. For the period 2006-2010, the Alfa Institute of Biomedical Sciences (AIBS), the HENRY DUNANT hospital (HENRY DUNANT), EUROCLINIC Group, the Hellenic Cooperative Oncology Group (HeCOG) and METROPOLITAN Hospital accounted for a share of 85.1%, 78.8%, 73.1%, 72.3% and 71.8% respectively - exceeding the Greek average of 65.6%-.

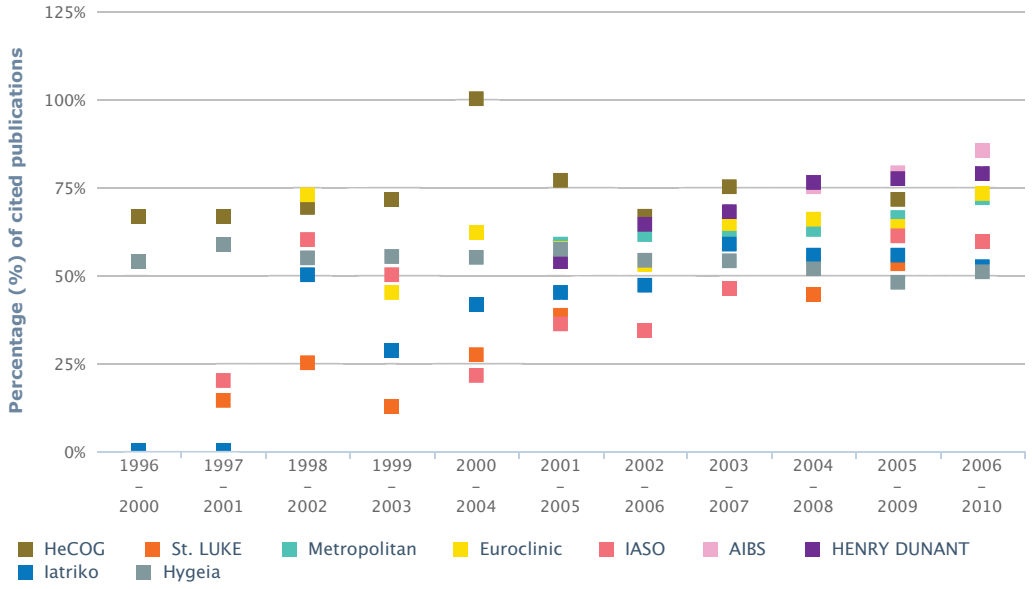


Figure 9.2.1 Percentage (%) of cited publications by Private Health Institution, 1996-2010 / Source: Scopus 1996-2010

Figure 9.2.2 displays growth trends in the number of citations for the "Private Health Institutions" during 1996-2010.

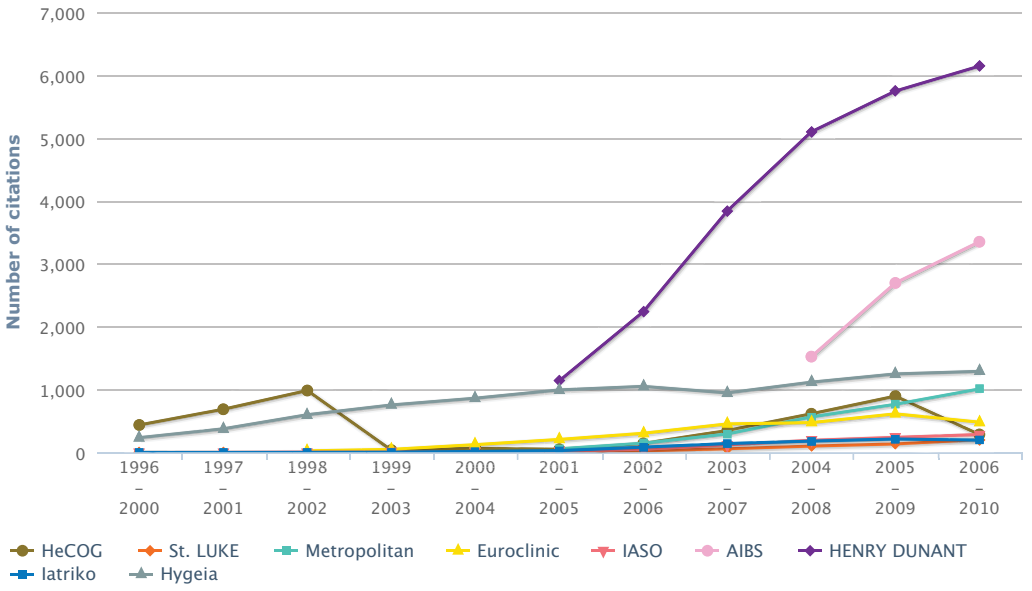


Figure 9.2.2 Number of citations by Private Health Institution, 1996-2010 / Source: Scopus 1996-2010

As regards the citations and the share of citations received by institutions in the "Private Health Institutions" Category, the HENRY DUNANT hospital (HENRY DUNANT) ranked first throughout the period 2006-2010, with 6,145 citations and a share of 53.6%. This was followed by the Alfa Institute of Biomedical Sciences (AIBS) -3,351 citations and a share of 29.2%-, the HYGEIA Group -with 1,290 citations and a share of 11.2%- and by METROPOLITAN Hospital -with 1,010 citations and a share of 8.8%-. The share of other institutions accounted for less than 5% of citations in this Category (Figure 9.2.3).

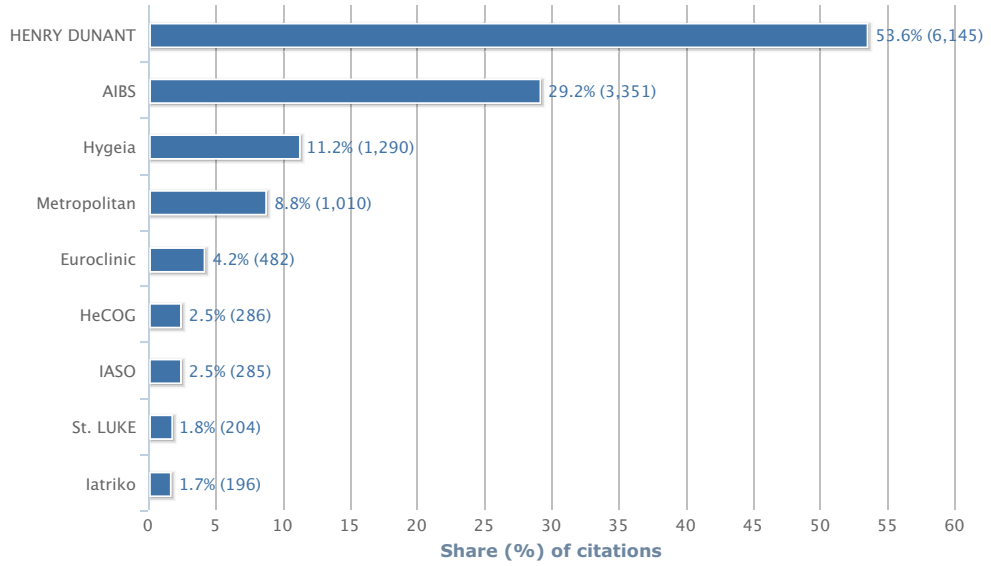


Figure 9.2.3 Number and share (%) of citations by Public Health Institution, 2006-2010 / Source: Scopus 1996-2010

9.3 Citation impact

Figure 9.3.1 presents the publications, citations and field-normalized citation score for each institution*, compared to the world average, for the period 2006-2010.

The citation scores were the highest for the HENRY DUNANT hospital (HENRY DUNANT), the Alfa Institute of Biomedical Sciences (AIBS) and METROPOLITAN Hospital. Their scores –1.88, 1.56 and 1.41 respectively– surpassed the world average.

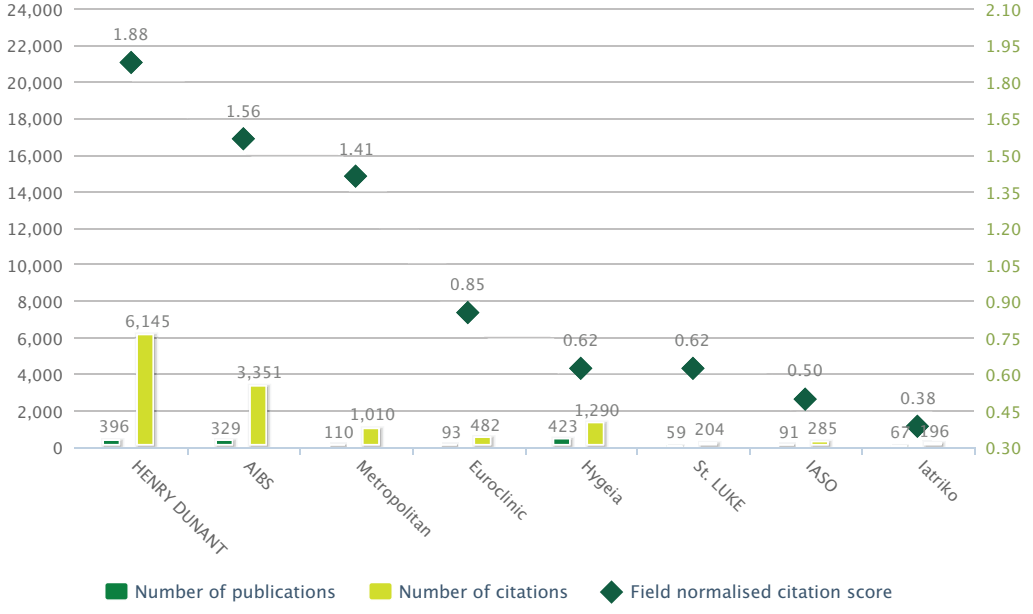


Figure 9.3.1 Publications, citations and field normalised citation score relative to the world, by Private Health Institution, 2006-2010. Data refers to the total number of publications in each Private Health Institution for all scientific fields / Source: Scopus 1996-2010

* The field-normalised citation score is calculated only for Private Health Institutions with more than 75 publications for the period 1996-2010, or 5 publications annually.

9.4 Major fields of science

Figure 9.4.1 captures, for the five-year period 2006 to 2010, the impact of publications by "Private Health Institutions" in the scientific fields that demonstrate higher publication activity*:"Medical & Health Sciences" and "Natural Sciences". The field-normalised citation scores reflect the average impact of the publications of a Private Health Institution in each major scientific field. Figure 9.4.2 presents the publications and the scientific sub-fields of publications with high citation scores for each Private Health Institution.

Private Health Institutions were mostly active in the scientific field of "Medical & Health Sciences". The publications with an impact higher than the world average baseline came from the institutions of HENRY DUNANT (citation score of 2.10), AIBS (1.62) and METROPOLITAN (1.47).

There was a low number of publications in the field of "Natural Sciences", mainly from AIBS and HENRY DUNANT and with field-normalised citation scores of 1.41 and 1.05 respectively.

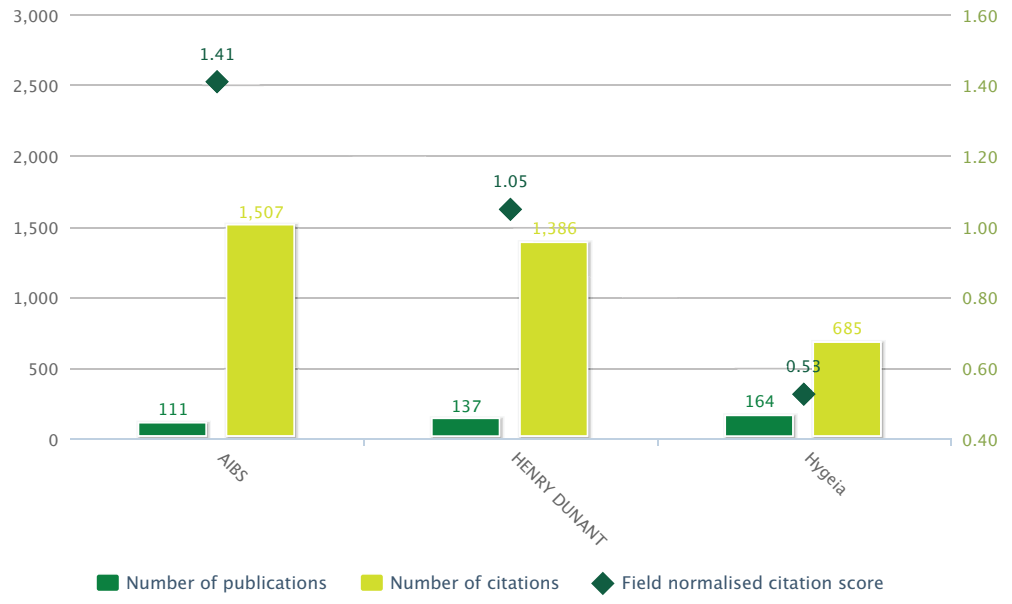


Figure 9.4.1 Publications, citations and field normalised citation score relative to the world, by Private Health Institution, in the major field of "Natural Sciences", 2006-2010 / Source: Scopus 1996-2010

* The field-normalised citation score is calculated only for Private Health Institutions with more than 75 publications for the period 1996-2010, or 5 publications annually.

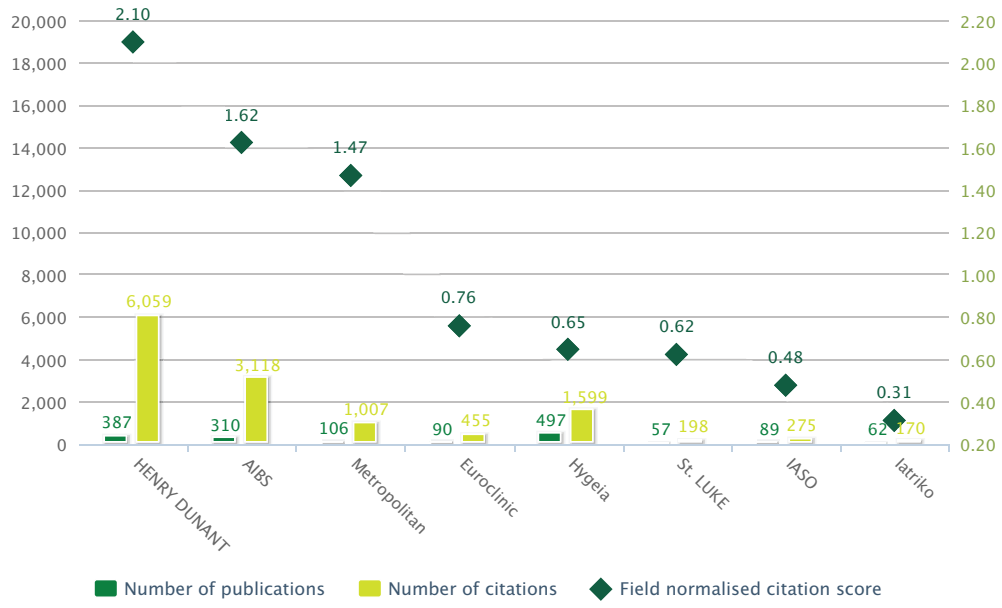


Figure 9.4.1 Publications, citations and field normalised citation score relative to the world, by Private Health Institution, in the major field of "Medical & Health Sciences", 2006-2010 / Source: Scopus 1996-2010

NATURAL SCIENCES				
Subfield of major field of science (Frascati Manual)	**Specific scientific field (Scopus)**	**Hospital**	**Field normalized citation score**	**Number of publications**
biological sciences	microbiology	AIBS	1.81	45
biological sciences	microbiology	HENRY DUNANT	1.73	25
biological sciences	biochemistry, genetics and molecular biology (all)	AIBS	1.67	9

MEDICAL & HEALTH SCIENCES				
Subfield of major field of science (Frascati Manual)	**Specific scientific field (Scopus)**	**Hospital**	**Field normalized citation score**	**Number of publications**
clinical medicine	gastroenterology	HENRY DUNANT	5.48	31
other medical sciences	medicine (all)	HENRY DUNANT	4.69	35
clinical medicine	critical care and intensive care medicine	HENRY DUNANT	3.52	12
clinical medicine	hepatology	HENRY DUNANT	3.44	22
clinical medicine	critical care and intensive care medicine	AIBS	3.18	16
clinical medicine	gastroenterology	METROPOLITAN	2.66	12
health sciences	infectious diseases	HENRY DUNANT	2.05	62
clinical medicine	hematology	HENRY DUNANT	1.90	12
basic medicine	pharmacology	AIBS	1.90	40
clinical medicine	pulmonary and respiratory medicine	HENRY DUNANT	1.80	19
health sciences	infectious diseases	AIBS	1.77	83
other medical sciences	medicine (all)	AIBS	1.74	45
basic medicine	pharmacology (medical)	HENRY DUNANT	1.69	35
basic medicine	pharmacology (medical)	AIBS	1.66	39
basic medicine	pharmacology	HENRY DUNANT	1.62	41
clinical medicine	radiology, nuclear medicine and imaging	HENRY DUNANT	1.51	9
clinical medicine	pulmonary and respiratory medicine	AIBS	1.51	19

Figure 9.4.2 Scientific subfields of "Private Health Institutions" publications with field normalised citation score ≥1.5, 2006-2010 / Source: Scopus 1996-2010

9.5 Scientific collaboration

Figure 9.5.1 highlights the share of publications with national*, international** and no collaboration*** for each of the Private Health Institutions over the period 2006-2010. The majority of publications were a result of national and international collaborations. The most active in this respect were METROPOLITAN (90%) and AIBS (93.3%), respectively.

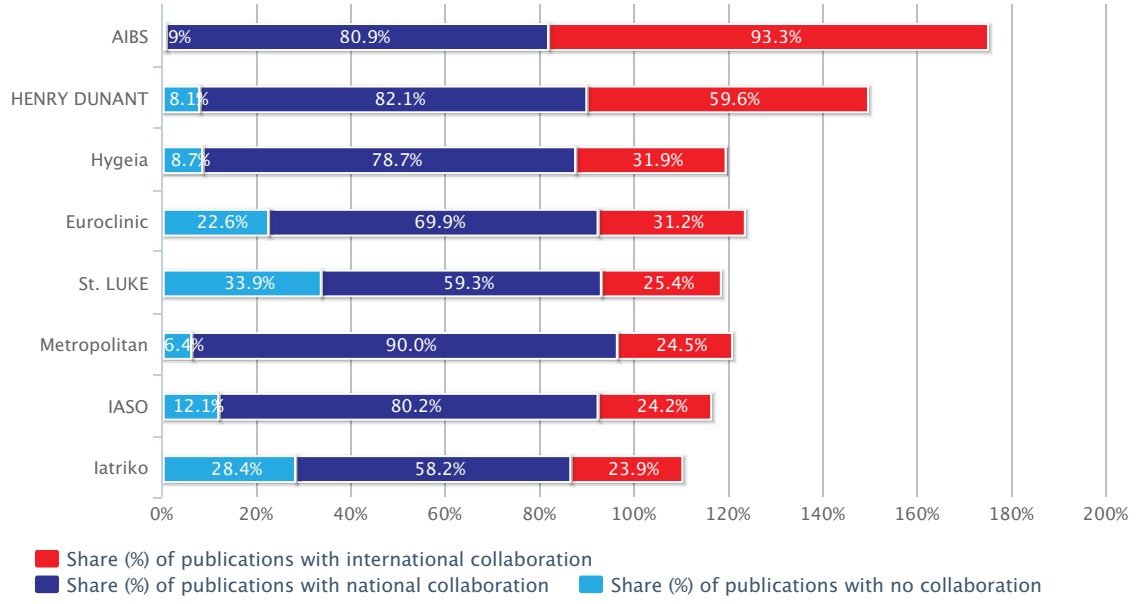


Figure 9.5.1 Share (%) of publications with national, international and no collaboration by Private Health Institution, 1996-2010 / Source: Scopus 1996-2010

* The number of publications with at least one national collaboration.

** The number of publications with at least one international collaboration.

*** The number of publications by a single Greek institution.

Appendixes

Appendix I: METHODOLOGY

Introduction

Bibliometrics deal with the quantitative analysis of scientific literature and particularly with the analysis of citations that scientific publications receive within the international research community. Bibliometric indicators include publication and citation counts, scientific impact indices, collaboration degree, scientific fields of excellence etc.

Bibliometric analysis is a significant tool for the evaluation of research activity, for individual institutions as well as for national research systems or sectors. Bibliometrics offer a sound basis to measure the scientific output and performance, its international impact, the research networks among institutions and nations, the knowledge flows and links among scientific disciplines. The number of studies using bibliometric analysis is constantly growing at international level.

Within this context, EKT has launched a study series based on bibliometric analyses of Greek publications in international scientific journals. More specifically:

The study entitled 'Greek Scientific Publications 1993-2008 / a Bibliometric Analysis of Greek Publications in International Scientific Journals', which was published in 2010, was the first in the Series and therefore the first to give a comprehensive picture, and demonstrate the particularities, of Greek scientific publishing activity and its results on international level, covering a long period (1993-2008).

In 2012, 'Greek Scientific Publications 1996-2010 / a Bibliometric Analysis of Greek Publications in International Scientific Journals' was published. This study analyses the production and the impact of Greek publications during the fifteen-year period between 1996 and 2010, focusing also on data from the latter part of the period that highlight recent trends and developments. The study is available in both Greek and English.

The above studies are based on data taken from the Web of Science Databases.

The present study is the third in the Series and it is based on data from the Scopus Database. The presentation of indicators from the two internationally established databases (Web of Science: for the previous studies of EKT, and Scopus: for the present study), serves EKT's purpose of providing a fuller picture of significant indicators that depict both the current state and the evolution of Greece's scientific production, and also increases the number of Greek publications and scientific fields covered.

The following paragraphs present the methodological framework in detail:

Bibliometric Indicators

The study presents the following bibliometric indicators that are widely used throughout international literature:

- Number of publications
- Share (%) of publications
- Percentage (%) of cited publications
- Number of citations
- Share (%) of citations
- Citation impact
- Relative citation impact
- Field normalised citation score

For detailed information on bibliometric indicators and methods of their calculation see Annex II.

Bibliometric Databases

Web of Science (from Thomson Reuters), Scopus (from Elsevier) and Google Scholar are among the most well recognizable and internationally established publication and citation databases.

Google Scholar offers access to a huge number of digital sources including scientific articles, conference proceedings, reports etc. Nonetheless, it is not recommended for bibliometric analysis since it lacks detailed metadata necessary for the attribution of publications to research organisations, scientific fields or countries. In addition, it does not offer quality criteria for the inclusion of the different scientific items presented.

Both Web of Science and Scopus ensure the availability of detailed metadata and the quality of publications they include. The Web of Science system (WoS) is the oldest database, including scientific publications from as early as 1900. It extracts data from more than 12,000 peer-review journals. In the newer Scopus database, over 18,500 titles of scientific journals are indexed, with the number continuously expanding, but without data on citations before 1996.

The present study is based on data from the Scopus international database developed by Elsevier.

More specifically, the Scopus database contains detailed data and information on scientific publications and citations and supports the web tool, available at http://www.scopus.com/. Elsevier developed, specifically for the purposes of this study, a diverse and enriched data set of Scopus - Greece, thus making possible the calculation of the indicators which are hosted in the study.

Fields of Science

The Scopus database provides the classification of publications in 307 scientific subject fields. The database allocates each publication to a specific subject field according to the journal in which the publication appears in. It should be noted that a journal may be classified in more than one scientific subject field and so is the case for its publications.

The classification scheme provided by the Scopus database, was used in this study for the calculation of bibliometric indicators such as field normalization citation score (normalization process). It is also used to present the specific subject fields where Greek institutions excelled.

Furthermore, Greek publications were classified into 6 major scientific fields and their 42 sub-fields, according to the revised version of the Frascati classification scheme of fields of science and technology which allows for data comparability at an international context. It also provides a more consistent framework for the identification of major fields of science in which Greek Institutions are active.

To this end, the 307 subject fields of the Scopus database were mapped and included into the following major fields and sub-fields of science of the Frascati Manual:

1. **Natural Sciences** *(Mathematics / Computer and information sciences / Physical sciences / Chemical sciences / Earth and related environmental sciences / Biological sciences / Other natural sciences)*
2. **Engineering & Technology** *(Civil engineering / Electrical engineering - electronic engineering - information engineering / Mechanical engineering / Chemical engineering / Materials engineering / Medical engineering / Environmental engineering / Environmental biotechnology / Industrial Biotechnology / Nano-technology / Other engineering and technologies)*
3. **Medical & Health Sciences** *(Basic medicine / Clinical medicine / Health sciences / Health biotechnology / Other medical sciences)*
4. **Agricultural Sciences** *(Agriculture, forestry, and fisheries / Animal and dairy science / Veterinary science / Agricultural biotechnology / Other agricultural sciences)*
5. **Social Sciences** *(Psychology / Economics and business / Educational sciences / Sociology / Law / Political Science / Social and economic geography / Media and communications Other social sciences)*

6. **Humanities** *(History and archaeology / Languages and literature / Philosophy, ethics and religion / Art (arts, history of arts, performing arts, music) / Other humanities)*

The detailed mapping of the 307 subject fields of the Scopus database with the 6major fields and 42 sub-fields of science of the Frascati Manual was provided in Annex III.

Institution Categories

Bibliometric indicators for Greek scientific publications were calculated at three different levels of aggregation:

- Country level
- Eight (8) specific categories of institutions
- Individual institutions.

Greek institutions were classified into categories according to the sector of activities in which they belong –e.g. higher education, research, health services etc.–, as well as their legal status as public or private institutions. The classification of institutions as public or private was based on the latest version (October 2011) of the "Registry of institutions and services of the Greek Public Administration". It is to be noted that the Registry according to those institutions which serve the public interest, are also considered as public institutions even if they may operate according to the private law.

Specifically, institutions were grouped in the following categories*:

Higher Education Institutions – University Sector: this category includes Greek Universities and Technical Universities, which are referred to as "Universities". It also includes University Research Institutes (EPI) and university hospitals. Annex IV provides the list of the institutions included in this category. Chapter 4 discusses findings regarding bibliometric indicators which represented them.

Higher Education Institutions – Technological Education Institutes: this category consists of the Technological Education Institutes as well as the Higher School of Pedagogical and Technological Education (ASPETE). Annex IV provides the list of the institutions included in this category. Chapter 5 discusses findings regarding bibliometric indicators which represented them.

Research Centers supervised by the General Secretariat of Research and Technology (GSRT): this category includes research institutions supervised by the General Secretariat for Research and Technology. Annex IV provides the list of the institutions included in this category. Chapter 6 discusses findings regarding bibliometric indicators which describe them.

Other Public Research Institutions: the category includes 9 research institutions supervised by various Ministries as following:

- Academy of Athens: Publications by the Academy of Athens also include the publications by the Medical and Biological Research Foundation (IIBEAA) / Ministry of Education, Religious Affairs, Culture and Sport.
- Research Academic Computer Technology Institute (RA-CTI)/ Ministry of Education, Religious Affairs, Culture and Sport. In 2011 was renamed in: Computer Technology Institute and Press "Diophantus". Since the study covers up to 2010, the institution was mentioned by its previous name.
- National Agricultural Research Foundation (NAGREF)/ Ministry of Rural Development and Food. NAGREF was renamed to Hellenic Agricultural Organization "Dimitra" after the merger of four organizations in 2011. Since the study covers up to 2010, the institution was mentioned by its previous name.
- Institute of Geology and Mineral Exploration (IGME)/ Ministry of Environment, Energy and Climate change. In 2011 IGME merged with the National Centre for Environment and Sustainable Development in a single organization named as National Center for Sustainable Development. Since the study covers up to 2010, the institution was mentioned by its previous name.

* Aiming at a more coherent presentation of the study's results, Greek institutions were classified into 8 Categories instead of 11 –as in the study's previous edition-. In this edition, 11 categories merged to 8 on the basic of their characteristics-. More accurately, institutions in the categories "YPETHA bodies", "Banks" and "Museums" have been incorporated into the remaining 8 categories.

- Institute of Engineering Seismology and Earthquake Engineering (ITSAK)/ Ministry of Infrastructure, Transport and Networks. In 2011 ITSAK merged with the Institute for Earthquake Protection Planning. Given that this study covers institutions' publication activity until 2010, ITSAK was examined as an autonomous body.
- Center for Renewable Energy Sources / Ministry of Environment, Energy and Climate change.
- Center of Planning and Economic Research/ Ministry of Finance.
- Benaki Phytopathological Institute/ Ministry of Rural Development and Food.
- Mediterranean Agronomic Institute of Chania / Ministry of Rural Development and Food.

Annex IV provides the list of the institutions included in this category. Chapter 7 discusses findings regarding their bibliometric indicators.

Public Health Institutions: this category includes public hospitals of the National Health System, hospitals and institutions supervised by the Ministry of Health and Social Solidarity and by the Ministry of National Defense. University hospitals and clinics were excluded from this category since they were included in the category "Universities". More specifically, institutions in this category include the National School of Public Health (ESDY), the Research Center for Biomaterials (EKEBYL), the Hellenic National Diabetic Center (HNDC), the Hellenic Center for disease control and prevention (HCDCP), the Child Health Institute (CHI), the Onassis Cardiac Surgery Center etc.

It should be noted that the matching of publications with certain institutions of the category was incomplete because relevant information appeared in abbreviation or was missing. As a result, a 9.5% of publications for this institutions category could not be identified. Annex IV provides the list of 16 institutions examined in this category. Chapter 8 discusses findings regarding bibliometric indicators which describe them.

Private Health Institutions: the category includes private institutions with activities in the health sector such as private hospitals, clinics, diagnostic centers, research centers etc. It should be noted that about 30% of publications in this category – mainly those produced by small diagnostic centers and research centers- were not identified due to missing information. Annex IV provides the list of 9 institutions examined in this category. Chapter 9 discusses findings regarding bibliometric indicators which describe them.

Other Public Institutions: this category includes those institutions listed in the "Register of Institutions and Services of the Greek Public Administration" which could not be classified in the previous categories institutions supervised by the Ministry of Defense –with the exception of hospitals– as well as public museums. In detail, this category includes Ministries, public institutions and enterprises they supervise, the Hellenic Army Academy (Evelpidon), the Hellenic Naval Academy, the Hellenic Air Force Academy (Icarus School), the School of Nursering officers, military schools, the Hellenic National Meteorological Service etc.

This category also includes institutions which are not supervised directly by the public sector but were included in the aforementioned Register, being institutions providing goods and services of public interest.

The most important institutions in terms of publication activity were the following: Military Academies, institutions of public administration, Public Power Corporation (PPC), the Hellenic Aerospace Industry (HAI), the Ormilia Foundation, General Chemical State Laboratory, the Ceramics and Refractories Technological Development Company S.A. (CERECO), the Hellenic Telecommunications Organisation SA (OTE), the Ephoreia for Palaeoanthropology and Speleology for Southern Greece (having highly cited publications) and other public museums.

Other Private Institutions: this category includes private educational institutions, banks, museums, non profit organizations, non governmental organizations and enterprises of the private sector. Institutions outstanding in this category are the Athens Information Technology, the American College of Greece - DEREE, the American School of Classic Studies in Athens, the CITY College of the University of Sheffield, the ALBA Graduate Business School, museums, banks and other enterprises.

Sector	Category	Abbreviation	Description
Higher Education	Universities	Universities	Universities and Technical Universities, University Research Institutes (U.R.I.) and University Hospitals
	Technological Education Institutes	TEI	Technological Education Institutes
Research	Research centers supervised by the General Secretariat of Research and Technology	GSRT Research Centers	Research centers supervised by the General Secretariat of Research and Technology
	Other Public Research Institutions	Other Public Research Institutions	Other Public Research Institutions supervised by various Ministries
Health	Public Health Institutions	Public Health Institutions	Public Health Institutions of the national health system, hospitals, Institutions supervised by the Ministry of Health and Social Solidarity and Hospitals supervised by the Ministry of Defence
	Private Health Institutions	Private Health Institutions	Private Institutions active in the health sector such as private hospitals, diagnostic centers, research centers etc.
Other Public Institutions		Other Public Institutions	Ministries, Museums, Higher Military Education Institutions, Other Public Institutions and Public Enterprises
Other Private Institutions		Other Private Institutions	Other Private Institutions such as Private Educational Institutions, Museums, Banks, non-profit organisations, non-governmental organisations and private enterprises

Data Processing

For the purpose of this study, EKT developed its own software which enables data cleaning and integrity check for bibliometric databases, calculation of non-trivial bibliometric indicators and presentation of the results using interactive visualizations.

Specifically, the software enables:

- calculation of complex bibliometric indicators such as the field normalised citation score per scientific field, the count and type of collaborations among institutions etc.
- classification of Greek publications adopting the Frascati/OECD taxonomy for scientific areas and mapping of the Frascati/OECD taxonomy with that employed by the bibliometric databases.
- production of analytical customized reports per institution category, per institution etc.
- effective cleaning of data and identification of Greek organizations. Cleaning the provided data was critical and the cleaning process allowed the export of reliable indicators. In many cases organizations appeared in the Scopus database with multiple names which in addition to the lack of unique identifiers and authority files, would reduce the reliability of data at organization level. EKT developed specialized software for this purpose and implemented systematic procedures for cleaning the primary data. These procedures included identifying alternative names for Greek organizations and the homogenization of data -resulting in a new database version-. EKT's previous bibliometric study, describes this procedure in detail.
- automated generation of interactive charts –embedded in the study's online edition- so that the study's results could be communicated in a comprehensive way.

The software developed by EKT employed a set of tools that allowed the processing of primary data of different types (XML, relational databases), their representation as an independent data model and their processing and categorization. The data model facilitated the calculation of descriptive and complex bibliometric indicators which were visualized using interactive charts and exported to multiple formats (CSV, Excel, JSON) for use in different media (text files, spreadsheets).

Furthermore, the software was heavily parameterized, in order to allow parallel execution of different data workflows, which significantly accelerated the calculation processes. Note that the system was designed to be largely independent of specific software and technologies, both in the incorporation of raw data and in the production of intermediate and final results.

Moreover, the system was developed with the aim to contribute to the automation of the production of bibliometric indicators by EKT, and to allow any update necessary for the calculation of new indicators.

Finally, special attention was given to the visualisation of bibliometric indicators. Findings are also presented in the form of an online book which enhances accessibility and dissemination of the results and offers a range of navigation, interactive and browsing functions to its readers.

Types of publications

In this study we based on data related with articles, research notes and reviews and we excluded editorials, letters, correction notes and abstracts. Throughout the international literature, these types of scientific publications -articles, research notes and reviews- are treated as the most important sources for knowledge production and science development and are used for the production of bibliometric indicators.

It is also important to note that in the field of natural sciences, the publication type "letter" corresponds to short articles with novel scientific results and usually high numbers of expected citations. When calculating bibliometric indicators, such "letters" are usually classified as publications or as research notes. However, In the Scopus database the type "letter" refers to types of publications such as letters to the journals' editors, letters including corrections or comments about past articles etc.

Time frame for analysis of citations

The number of citations that a publication is likely to receive depends on its impact in the research community but also on the time period that has passed since it was first published. Older publications usually have more citations.

To normalize differences observed between high numbers of citations received by older publications and small in the latest publications, citation counting in this study was made using overlapping 5-year windows. Particularly, we recorded citations received in a certain 5-year period for publications edited within the same 5 year period.

As a result, trends in the number of citations and relevant bibliometric indicators were presented on the basis of 11 overlapping 5 year periods throughout the overall period of analysis (1996-2010).

Self citations are also included, since the author's practice of citing her/his previous work in a publication is a common practice among researchers, we included self-citations in the overall number of citations per publications.

Counting of publications

In most cases, publications have more than one author. Their authors are likely to be affiliated with different institutions in different countries. In addition, bibliometric databases might classify a journal under more than one scientific fields. As a result, the distribution of publications into 6 major fields of science and their sub-fields, may cause overlapping. However, we should note that data analysis showed that 80% of publications were classified under a single scientific field.

Publication counts presented in this study are «whole counts» i.e. in the case of multi authored publications each participating institution or country got a whole count and not a fraction of the publication. Similarly, in the case of a publication classified in more than one scientific field, each scientific field or sub-field got a whole count of the publication.

As a result, within a given frame of reference, the sum of publications compiled from different units of analysis -institutions, institution categories or scientific fields –was higher than the actual total numbers of publications.

The "share" (%) of publications of each analytical unit was calculated as the number of its publications divided by the actual total number of publications of the frame of reference and not by the sum of individual units. Consequently, "shares" express the participation of a given unit of analysis in the total output of its frame of reference and not its contribution to it. For example, a publication share of 80% for the institution category "Universities" means that in the 80% of Greek publications we record Universities as participating organizations.

The same rule applies when calculating the share (%) of citations and the share of scientific fields.

Finally, the same methodology is used for calculating the number of collaborations at national and international level. Collaboration is defined as co-authorship involving different institutions. International collaboration refers to Greek publications co-authored with institutions in another country (-ies). Exclusively international collaboration refers to Greek publications co-authored only with institutions in another country (-ies). National collaboration refers to Greek publications co-authored with Greek institutions. Exclusively national collaboration refers to Greek publications co-authored only with Greek institutions. No collaboration refers to Greek publications not involving co-authorship across institutions and includes articles either by only one author or articles being the product of intra-institutional collaboration.

Citation Impact Indicators

In bibliometric analysis, a range of indicators are used for evaluating the impact (or influence) of the published work on the scientific community. These indicators are principally based on the number of citations of publications for a specific time period.

The citation impact, –a widely used indicator-, is the average number of citations per publication. The indicator is calculated as the ratio of the number of citations recorded for a specific time period to the total number of publications of the same time period. The relative citation impact is used for comparative analysis of publications and compares the citations to publications per unit of analysis (e.g. Greece) in relation to the citations to publications within a certain frame of reference (e.g. OECD countries).The relative citation impact is calculated as the ratio of the corresponding citation impacts. When the value of the relative citation impact is greater than 1, the publications of the analysed unit have a greater impact than those within the reference frame.

A number of scientific studies have confirmed that factors such as the different citation practices in various scientific fields or the type of publication affect significantly the citation indicators.

Indeed, publication and citation practices vary among disciplines. There often exist differences between fields of research in terms of citation practices, the life-span of publications, publishing and citation patterns.

For instance, in medicine and molecular biology the annual publication output is high and the level of citations increases significantly within a relative short time period following the publication. On the contrary, in the Social Sciences the publication rate is rather low and many studies may still be cited decades after their release. In the Humanities, the greatest part of publications is books, monographs and articles usually published in national journals, which affects citation patterns. Other scientific areas, such as the ICT, have conference proceedings as their main publication source. Hence, comparison between indicators of different scientific fields and sub-fields may lead to misleading results.

To tackle the issue of different citation practices, it was decided to use the **field normalised citation score,** which is an incremental improvement of the Crown indicator.

The field normalised citation score or citation score is the key indicator used in this study to estimate the impact of the publications of the analytical units examined (e.g. institution category, institution, subject filed etc.) in relation to the world. The field normalised citation score was calculated using software

developed by the National Documentation Center (EKT) allowing for calculations at the level of each publication for each of the 307 subject fields provided by the Scopus database.

More specifically, the number of citations of each of the unit's publications is normalised by dividing it with the world average of citations to publications of the same publication year and subject field. The citation score is the mean value of all normalised citation scores for the unit's publications. As an example, the citation score of the institution category "Universities" was the mean value of the citation scores calculated for each of the Universities publications; the citation score of each publication was represented by its citations divided by the world average of citations to publications of the same publication year and the subject field it belonged to.

Rate of Change

Results regarding the bibliometric indicators throughout the period 1996-2010 were displayed either on an annual basis or within rolling 5-year periods.

The progression and growth for indicators was evaluated using the rate of change determined as follows:

$$\Delta t_2 - t_1 = 1 + \frac{n2 - n1}{n1}$$

where

$\Delta t_2 - t_1$ is the rate of change

$n1$, $n2$ are the values of the indicator for the years (or period of years) t_1 and t_2, respectively.

The indicator is equal to 1 if the values $n1$, $n2$ remain the same for the years (or period of years) t_1 and t_2.

Least number of publications

Field normalised citation scores were calculated per institution, institution category or scientific field only in the case of a "considerable" number of publications i.e. a number that would ensure the reliability of analysis and minimize the influence of random factors without excluding from the analysis organizations with a rather low publications output. Data analysis showed that a threshold of 75 publications for the period 1996-2010, corresponding to 5 publications per year, constituted a good compromise. Given the low number of publications by Greek institutions in most of the cases, the above threshold aims to ensure the reliability of information about the majority of institutions.

Interpretation of results

The study's aim was to provide reliable bibliometric data, an important source of information for the Greek research landscape. Along with the indicators used, there exists a wide range of indicators for the measurement of research activity -such as the number of patents, licenses, research projects, social impact etc.-. Within this range, bibliometric indicators are among the most significant metrics.

However, to avoid fragmented and invalid comparisons, a combined interpretation of bibliometric indicators is required on the part of the reader. Hence, when interpreting indicators such as the rate of change, the relative citation impact or citation score, the percentage of cited publications or the percentile breakdown of highly cited publications, one has to also consider the number of publications as well as their systematic production over time.

The overall aim of the analysis carried out, was not just to identify trends and tendencies but also to highlight outstanding aspects which characterize the output of Greek publications. To this end, we applied a wide range of indicators to compile a comprehensive picture. In order to minimize the influence of random factors, we had to make the following choices and decisions:

- To reflect information regarding current research activity, figures present information and indicators corresponding to the last 5-year period 2006-2010 so that to control abnormal annual variations.
- We provide a trend analysis, when applicable, throughout the period 1996-2010.
- To ensure the reliability of results, indicators were calculated only for institutions with a publication output above the threshold (75 publications for the period 1996-2010).
- The calculations did not take into account certain extremely random cases. For example, when calculating citation scores per scientific subfields we excluded extremely highly cited publications produced by institutions with low and unstable number of publications in the field.
- Finally, the study involved a robust infrastructure and appropriate software tools, which will support future bibliometric studies, part of the series. By ensuring consistency in procedures, methodology and software used, we make possible the accurate mapping of research activity for each given period and we may enable comparisons across data.

At last, we should mention that the average number of publications per researcher or per full time equivalent is an indicator widely used in comparative evaluation of research activity of institutions. This indicator allows comparisons in terms of "productivity" and gives more reliable results regarding each institution's performance. Since there was a lack of data about the country's base of researchers, the study presents indicators regarding the volume of publications per institution or institution category which cannot be used as a measure for the evaluation of institutional performance/productivity.

Appendix II: INDICATORS

Table of Bibliometric Indicators used

INDICATOR	DESCRIPTION	USAGE
Number of publications	The number of scientific publications is calculated on the basis of:	*An indication of the volume of research output for:*
	• country total.	• *Greece.*
	• institution category.	• *each institution category.*
	• scientific field.	• *each scientific field.*
	• institution.	• *each institution.*
Share of publications (%)	It is calculated as a percentage of:	*An indication for the participation of:*
	• Greek publications in relation to EU and OECD publications.	• *Greece within all EU and OECD publications.*
	• publications per institution category in relation to the total number of Greek publications.	• *each institution category within all Greek publications.*
	• publications falling under one scientific field in relation to the total number of Greek publications.	• *each scientific field within all scientific fields.*
	• publications issued by an institution in relation to the total number of publications in the same category of institutions.	• *each institution within the category it belongs to.*
Percentage of cited publications (%)	The percentage of publications that have received at least one citation. It is calculated using overlapping 5-year periods for the following units of analysis:	*An indication for the levels of visibility / recognition of scientific publications produced by:*
	• country total.	• *Greece.*
	• institution category.	• *each institution category.*
	• institution.	• *each institution.*

INDICATOR	DESCRIPTION	USAGE
Number of citations	The number of citations within a specific time period to articles published by the analysed unit during the same time period. It is calculated using overlapping 5-year periods on the following levels:	*An indication of the influence and visibility of scientific publications produced by:*
	• country total.	• *Greece.*
	• institution category.	• *each institution category.*
	• scientific field.	• *each scientific field.*
	• institution.	• *each institution.*
Share of citations (%)	It is calculated using overlapping 5-year periods as the percentage of citations received by the publications of:	*An indication for the influence and visibility of:*
	• Greece in relation to the number of citations that EU and OECD's publications received.	• *Greece within the EU and OECD.*
	• citations in one institution category in relation to the total number of citations for Greek publications.	• *each institution category within Greece.*
	• citations found in each scientific field in relation to the total number of citations for Greek publications.	• *each scientific field within all scientific fields.*
	• citations in each institution in relation to the total number of citations for the category of institutions.	• *each institution within the category it belongs to.*
Citation impact	The citation impact is the average number of citations per publication and is calculated as the ratio of the number of citations recorded for a specific time period to the total number of publications of the same time period. Calculations have been performed using overlapping 5-year periods. As this indicator does not take into account the variations of citation practices within the different scientific fields, it was only used for the calculation of the citation impact of all Greek scientific publications.	*An indication for the impact of publications.*

INDICATOR	DESCRIPTION	USAGE
Relative citation impact	The relative citation impact compares the citations to publications per unit of analysis [e.g. Greece] in relation to the citations to publications within a certain frame of reference [e.g. the EU countries]. It is calculated as the ratio of the corresponding citation impacts. When the value of the relative citation impact is greater than 1, the publications of the analysed unit have a greater impact than those within the reference frame. The indicator does not take into account the variations of citation practices within the different scientific fields. In this study the relative citation impact was only used to establish Greece's place amongst the member countries of the EU and the OECD and was calculated as the ratio of the citation impact for all Greek publications to the citation impact for the countries of the EU and the OECD.	*With reference to all Greek publications in all scientific fields, comparison can be made between the impact of Greek publications and those of EU and OECD publications.*
Field normalised citation score (abv: citation score)	This indicator expresses the citation impact normalised according to subject field. It compares the average number of citations to the publications of an analysed unit to the average number of citations to international publications from the same year, in the same research field. The Field Normalised Citation Score or citation score is the key indicator used in this study to estimate the impact of the publications of an analyzed unit in relation to world. It was calculated using software particularly developed by EKT. The specific software permitted normalisation of the citation values on an individual article level on the basis of the distribution of publications over the 307 subject fields designated by Scopus. When the value of the citation score is greater than 1, the publications of the analysed unit have a greater impact than the world average. In the study citation scores were calculated after normalisation for:	*An indication for the impact of publications taking into account differences in citation practices across scientific fields. The impact of publications relative to world is derived for:*
	• the sum of Greek publications.	• *Greece.*
	• Greek publications by scientific field.	• *Greece within the 6 major scientific fields.*
	• the sum of publications for an institution category.	• *each institution category.*
	• the publications for an institution category by scientific field.	• *each institution category within the 6 major scientific fields.*
	• the sum of publications for an institution.	• *each institution.*
	• publications of an institution by scientific field.	• *each institution within the 6 major scientific fields.*

Appendix III: SCIENTIFIC FIELDS

Classification of the Subject fields of the Scopus database into the six major scientific fields and the Field categories of the Frascati manual/ OECD

Major Fields of Science & Technology Frascati Manual	Field Categories Frascati Manual	Subject fields - Scopus Database
Natural Sciences	Mathematics	• Algebra and Number Theory
		• Analysis
		• Applied Mathematics
		• Computational Mathematics
		• Control and Optimization
		• Discrete Mathematics and Combinatorics
		• Geometry and Topology
		• Logic
		• Mathematics (all)
		• Mathematical Physics
		• Mathematics (miscellaneous)
		• Modeling and Simulation
		• Numerical Analysis
		• Statistics and Probability
	Computer and Information Sciences	• Computer Science (miscellaneous)
		• Computer Science (all)
		• Artificial Intelligence
		• Computational Theory and Mathematics
		• Computer Graphics and Computer-Aided Design
		• Computer Networks and Communications
		• Computer Science Applications
		• Computer Vision and Pattern Recognition
		• Human-Computer Interaction
		• Information Systems
		• Software
		• Theoretical Computer Science
	Physical Sciences	• Acoustics and Ultrasonics
		• Astronomy and Astrophysics
		• Atomic and Molecular Physics, and Optics
		• Condensed Matter Physics
		• Fluid Flow and Transfer Processes
		• Instrumentation
		• Nuclear and High Energy Physics
		• Physics and Astronomy (miscellaneous)
		• Physics and Astronomy (all)

Major Fields of Science & Technology Frascati Manual	Field Categories Frascati Manual	Subject fields - Scopus Database
Natural Sciences	Physical Sciences	• Radiation
		• Spectroscopy
		• Statistical and Nonlinear Physics
		• Surfaces and Interfaces
	Chemical Sciences	• Analytical Chemistry
		• Catalysis
		• Chemistry (miscellaneous)
		• Chemistry (all)
		• Colloid and Surface Chemistry
		• Electrochemistry
		• Filtration and Separation
		• Inorganic Chemistry
		• Organic Chemistry
		• Physical and Theoretical Chemistry
	Earth and related Environmental Sciences	• Atmospheric Science
		• Computers in Earth Sciences
		• Earth and Planetary Sciences (miscellaneous)
		• Earth-Surface Processes
		• Ecological Modeling
		• Ecology
		• Economic Geology
		• Environmental Chemistry
		• Environmental Science (all)
		• Environmental Science (miscellaneous)
		• Geochemistry and Petrology
		• Geology
		• Geophysics
		• Global and Planetary Change
		• Health, Toxicology and Mutagenesis
		• Management, Monitoring, Policy and Law
		• Nature and Landscape Conservation
		• Oceanography
		• Paleontology
		• Pollution
		• Space and Planetary Science
		• Stratigraphy
	Biological Sciences	• Aging
		• Animal Science and Zoology
		• Applied Microbiology and Biotechnology
		• Aquatic Science
		• Biochemistry
		• Biochemistry, Genetics and Molecular Biology (all)

Major Fields of Science & Technology Frascati Manual	Field Categories Frascati Manual	Subject fields - Scopus Database
Natural Sciences	Biological Sciences	• Biochemistry, Genetics and Molecular Biology (miscellaneous)
		• Biophysics
		• Biotechnology
		• Cancer Research
		• Cell Biology
		• Clinical Biochemistry
		• Developmental Biology
		• Ecology, Evolution, Behavior and Systematics
		• Endocrinology
		• Genetics
		• Immunology
		• Immunology and Microbiology (all)
		• Immunology and Microbiology (miscellaneous)
		• Insect Science
		• Microbiology
		• Molecular Biology
		• Molecular Medicine
		• Parasitology
		• Physiology
		• Plant Science
		• Structural Biology
		• Virology
Engineering & Technology	Civil Engineering	• Architecture
		• Building and Construction
		• Civil and Structural Engineering
		• Computational Mechanics
	Electrical Engineering, Electronic Engineering, Information Engineering	• Control and Systems Engineering
		• Electrical and Electronic Engineering
		• Hardware and Architecture
		• Media Technology
		• Signal Processing
	Mechanical Engineering	• Aerospace Engineering
		• Automotive Engineering
		• Industrial and Manufacturing Engineering
		• Mechanical Engineering
		• Nuclear Energy and Engineering
	Materials Engineering	• Ceramics and Composites
		• Electronic, Optical and Magnetic Materials
		• Materials Chemistry
		• Materials Science (all)
		• Materials Science (miscellaneous)
		• Mechanics of Materials

Major Fields of Science & Technology Frascati Manual	Field Categories Frascati Manual	Subject fields - Scopus Database
Engineering & Technology	Materials Engineering	• Metals and Alloys
		• Polymers and Plastics
		• Surfaces, Coatings and Films
	Environmental Engineering	• Energy (all)
		• Energy (miscellaneous)
		• Energy Engineering and Power Technology
		• Environmental Engineering
		• Fuel Technology
		• Geotechnical Engineering and Engineering Geology
		• Ocean Engineering
		• Renewable Energy, Sustainability and the Environment
		• Waste Management and Disposal
		• Water Science and Technology
	Industrial Biotechnology	• Biomaterials
	Other Engineering and Technologies	• Engineering (all)
		• Engineering (miscellaneous)
		• Safety, Risk, Reliability and Quality
	Medical engineering	• Biomedical Engineering
	Chemical Engineering	• Bioengineering
		• Chemical Engineering (all)
		• Chemical Engineering (miscellaneous)
		• Process Chemistry and Technology
Medical & Health Sciences	Basic Medicine	• Anatomy
		• Behavioral Neuroscience
		• Biochemistry (medical)
		• Biological Psychiatry
		• Cellular and Molecular Neuroscience
		• Cognitive Neuroscience
		• Developmental Neuroscience
		• Drug Discovery
		• Embryology
		• Endocrine and Autonomic Systems
		• Histology
		• Neurology
		• Neuroscience (all)
		• Neuroscience (miscellaneous)
		• Pathology and Forensic Medicine
		• Pharmaceutical Science
		• Pharmacology
		• Pharmacology (medical)
		• Pharmacology, Toxicology and Pharmaceutics (all)
		• Pharmacology, Toxicology and Pharmaceutics (miscellaneous)

Major Fields of Science & Technology Frascati Manual	Field Categories Frascati Manual	Subject fields - Scopus Database
Medical & Health Sciences	Basic Medicine	• Physiology (medical)
		• Sensory Systems
		• Toxicology
	Clinical Medicine	• Anesthesiology and Pain Medicine
		• Cardiology and Cardiovascular Medicine
		• Complementary and Alternative Medicine
		• Critical Care and Intensive Care Medicine
		• Dental Assisting
		• Dental Hygiene
		• Dentistry (all)
		• Dentistry (miscellaneous)
		• Dermatology
		• Emergency Medicine
		• Endocrinology, Diabetes and Metabolism
		• Gastroenterology
		• Genetics (clinical)
		• Geriatrics and Gerontology
		• Hematology
		• Hepatology
		• Immunology and Allergy
		• Internal Medicine
		• Microbiology (medical)
		• Nephrology
		• Neurology (clinical)
		• Obstetrics and Gynecology
		• Oncology
		• Ophthalmology
		• Oral Surgery
		• Orthodontics
		• Orthopedics and Sports Medicine
		• Otorhinolaryngology
		• Pediatrics, Perinatology and Child Health
		• Periodontics
		• Psychiatry and Mental Health
		• Pulmonary and Respiratory Medicine
		• Radiology, Nuclear Medicine and Imaging
		• Rehabilitation
		• Reproductive Medicine
		• Rheumatology
		• Surgery
		• Transplantation
		• Urology

Major Fields of Science & Technology Frascati Manual	Field Categories Frascati Manual	Subject fields - Scopus Database
Medical & Health Sciences	Health Sciences	• Advanced and Specialized Nursing
		• Assessment and Diagnosis
		• Care Planning
		• Chemical Health and Safety
		• Chiropractics
		• Community and Home Care
		• Complementary and Manual Therapy
		• Critical Care Nursing
		• Emergency Medical Services
		• Emergency Nursing
		• Epidemiology
		• Family Practice
		• Fundamentals and Skills
		• Gerontology
		• Health Informatics
		• Health Information Management
		• Health Policy
		• Health Professions (all)
		• Health Professions (miscellaneous)
		• Infectious Diseases
		• Issues, Ethics and Legal Aspects
		• Leadership and Management
		• LPN and LVN
		• Maternity and Midwifery
		• Medical and Surgical Nursing
		• Medical Assisting and Transcription
		• Medical Laboratory Technology
		• Medical Terminology
		• Nurse Assisting
		• Nursing (all)
		• Nursing (miscellaneous)
		• Nutrition and Dietetics
		• Occupational Therapy
		• Oncology (nursing)
		• Optometry
		• Pathophysiology
		• Pediatrics
		• Pharmacology (nursing)
		• Pharmacy
		• Physical Therapy, Sports Therapy and Rehabilitation
		• Podiatry
		• Psychiatric Mental Health

Major Fields of Science & Technology Frascati Manual	Field Categories Frascati Manual	Subject fields - Scopus Database
Medical & Health Sciences	Health Sciences	• Public Health, Environmental and Occupational Health
		• Radiological and Ultrasound Technology
		• Research and Theory
		• Respiratory Care
		• Review and Exam Preparation
		• Speech and Hearing
	Other Medical Sciences	• Medicine (all)
		• Medicine (miscellaneous)
Agricultural Sciences	Agriculture Forestry, and Fisheries	• Agronomy and Crop Science
		• Forestry
		• Horticulture
		• Soil Science
	Veterinary Science	• Equine
		• Food Animals
		• Small Animals
		• Veterinary (all)
		• Veterinary (miscellaneous)
	Agricultural biotechnology	• Food Science
Social Sciences	Psychology	• Applied Psychology
		• Clinical Psychology
		• Developmental and Educational Psychology
		• Experimental and Cognitive Psychology
		• Neuropsychology and Physiological Psychology
		• Psychology (all)
		• Psychology (miscellaneous)
		• Social Psychology
	Economics and Business	• Accounting
		• Business and International Management
		• Business, Management and Accounting (all)
		• Business, Management and Accounting (miscellaneous)
		• Decision Sciences (all)
		• Decision Sciences (miscellaneous)
		• Economics and Econometrics
		• Economics, Econometrics and Finance (all)
		• Economics, Econometrics and Finance (miscellaneous)
		• Finance
		• Industrial Relations
		• Information Systems and Management
		• Management Information Systems
		• Management of Technology and Innovation
		• Management Science and Operations Research
		• Marketing

Major Fields of Science & Technology Frascati Manual	Field Categories Frascati Manual	Subject fields - Scopus Database
Social Sciences	Economics and Business	• Organizational Behavior and Human Resource Management
		• Statistics, Probability and Uncertainty
		• Strategy and Management
		• Tourism, Leisure and Hospitality Management
	Educational Sciences	• Education
	Sociology	• Anthropology
		• Cultural Studies
		• Demography
		• Gender Studies
	Law	• Law
	Political Sciences	• Political Science and International Relations
		• Public Administration
	Social and Economic Geography	• Geography, Planning and Development
		• Transportation
		• Urban Studies
	Media and Communications	• Communication
		• Library and Information Sciences
	Other Social Sciences	• Development
		• Health (social science)
		• Human Factors and Ergonomics
		• Life-span and Life-course Studies
		• Safety Research
		• Social Sciences (all)
		• Social Sciences (miscellaneous)
		• Sociology and Political Science
Humanities	History and Archaeology	• Archeology
		• Archeology (arts and humanities)
		• Conservation
		• History
	Languages and Literature	• Classics
		• Language and Linguistics
		• Linguistics and Language
		• Literature and Literary Theory
	Philosophy, Ethics and Religion	• History and Philosophy of Science
		• Philosophy
		• Religious Studies
	Arts	• Arts and Humanities (all)
		• Museology
		• Music • Visual Arts and Performing Arts

Appendix IV: INSTITUTIONS

Institutions examined

Sector	Category	Abbreviation	Description
Higher Education	Universities	Universities	Universities and Technical Universities, University Research Institutes (U.R.I.) and University Hospitals
	Technological Education Institutes	TEI	Technological Education Institutes
Research	Research centers supervised by the General Secretariat of Research and Technology	GSRT Research Centers	Research centers supervised by the General Secretariat of Research and Technology
	Other Public Research Institutions	Other Public Research Institutions	Other Public Research Institutions supervised by various Ministries
Health	Public Health Institutions	Public Health Institutions	Public Health Institutions of the national health system, hospitals, Institutions supervised by the Ministry of Health and Social Solidarity and Hospitals supervised by the Ministry of Defence
	Private Health Institutions	Private Health Institutions	Private Institutions active in the health sector such as private hospitals, diagnostic centers, research centers etc.
Other Public Institutions		Other Public Institutions	Ministries, Museums, Higher Military Education Institutions, Other Public Institutions and Public Enterprises
Other Private Institutions		Other Private Institutions	Other Private Institutions such as Private Educational Institutions, Museums, Banks, non-profit organisations, non-governmental organisations and private enterprises

1. Universities

1. Athens School of Fine Arts	ASFA
2. Aristotle University of Thessaloniki	AUTH
3. Agricultural University of Athens	AUA
4. Demokritos University of Thrace	DUTH
5. International Hellenic University[1]	IHU
6. National & Kapodistrian University of Athens	UOA
7. Hellenic Open University	HOU
8. National Technical University of Athens	NTUA
9. Ionian University	IONIO
10. Athens University of Economics and Business	AUEB
11. University of the Aegean	AEGEAN
12. University of Western Greece[2]	UWG
13. University of Western Macedonia	UOWM
14. University of Thessaly	UTH
15. University of Ioannina	UOI
16. University of Crete	UOC
17. University of Macedonia of Economic and Social Sciences	UOM
18. University of Patras	UPATRAS
19. University of Piraeus	UNIPI
20. University of the Peloponnese	UOP
21. University of Central Greece	UCG
22. Panteion University of Social and Political Sciences	PANTEION
23. Technical University of Crete	TUC
24. Harokopio University of Athens	HUA

[1] Due to a low number of publications, the International Hellenic University and the Athens School of Fine Arts have not been examined.
[2] University of Western Greece was founded in 2009 and it includes three Departments. Until 2009, these Departments (Department of Administration, Department of Natural Resources and Department of Business) were part of the University of Ioannina. Given that it was not possible to isolate publications produced by these Departments from the sum of publications produced by the University of Ioannina, University of Western Greece was not represented in the detailed analysis.

University publications also include the publications produced by affiliated Research Institutes as well as the publications by the following University Hospitals:

1. Eginition Hospital
2. Aretaieio Hospital
3. University General Hospital "ATTIKON"
4. University General Hospital of Thessaloniki AHEPA
5. University Hospital of Alexandroupolis / Academic General Hospital of Alexandroupolis
6. Univeristy General Hospital of Heraklion / Venizelio-Panakio Hospital of Heraklion
7. General University Hospital of Larissa
8. University Hospital of Ioannina / Hadjukosta General Hospital of Ioannina
9. General University Hospital of Patras / "Agios Andreas" General Hospital Patras

2. Technological Educational Institutions - TEI

1. School of Pedagogical and Technological Education - ASPETE
2. TEI (Technological Educational Institution) of Athens
3. TEI (Technological Educational Institute) of West Macedonia
4. TEI (Technological Educational Institute) of Epirus
5. A.T.E.I. (Alexandreio Technological Educational Institute) of Thessaloniki
6. TEI (Technological Educational Institute) of Ionian Islands
7. TEI (Technological Educational Institute) of Kavala
8. TEI (Technological Educational Institute) of Kalamata
9. TEI (Technological Educational Institute) of Crete
10. TEI (Technological Educational Institute) of Lamia
11. TEI (Technological Educational Institute) of Larissa
12. TEI (Technological Educational Institute) of Messolonghi
13. TEI (Technological Educational Institute) of Patras
14. TEI (Technological Educational Institute) of Piraeus
15. TEI (Technological Educational Institute) of Serres
16. TEI (Technological Educational Institute) of Chalkid

3. Research Centers supervised by the General Secretariat of Research and Technology (GSRT)

1. Athena - Research and Innovation Center in Information, Communication and Knowledge Technologies[1]	ATHENA
2. National Observatory of Athens	NOA
3. National Hellenic Research Foundation	NHRF
4. The Center for Research and Technology Hellas[2]	CERTH
5. National Center of Scientific Research DEMOKRITOS	NCSR DEMOKRITOS
6. Hellenic Center for Marine Research	HCMR
7. National Center for Social Research[3]	EKKE
8. Greek Atomic Energy Commission	GAEC
9. Hellenic Pasteur Institute	HPI
10. Biomedical Sciences Research Center "Alexander Fleming"	B.S.R.C. Fleming
11. Foundation for Research and Technology - Hellas	FORTH
12. Center For Research And Technology Thessaly	CE.RE.TE.TH

[1] In the publications produced by ATHENA and CERTH we included publications produced by independent Institutes that subsequently merged with ATHENA and CERTH.

[2] In the publications produced by ATHENA and CERTH we included publications produced by independent Institutes that subsequently merged with ATHENA and CERTH.

[3] Due to a low number of publications, we do not present analytical information for the National Center of Social Research.

4. Other Public Research Institutions

1. Academy of Athens[1]	Academy of Athens
2. Benaki Phytopathological Institute	BPI
3. Center for Renewable Energy Sources and Saving[2]	CRES
4. Center of Planning and Economic Research	KEPE
5. Institute of Geology and Mineral Exploration	IGME
6. Institute of Engineering Seismology and Earthquake Engineering Research and Technical Institute[3]	ITSAK
7. Mediterranean Agronomic Institute of Chania	MAICH
8. National Agricultural Research Foundation	NAGREF
9. Research Academic Computer Technology Institute[4]	RA-CTI

[1] In publications by the Academy of Athens, we also included publications by the Medical and Biological Research Foundation (IIBEAA).
[2] Today, the Center for Renewable Energy Sources (KAPE) is supervised by the Ministry of Environment, Energy and Climate change. Given that KAPE was supervised by GSRT since 2008, in our previous study (Greek Scientific Publications 1993-2008), the Institute was included in the category "GSRT Research Centers".
[3] In 2011, the Institute of Engineering Seismology and Earthquake Engineering Research and Technical Institute (ITSAK) merged with the Institute for Earthquake Protection Planning. Given that the study extends until 2010, we refer to the institute with its former name as "ITSAK".
[4] In 2011, Computer Technology Institute (CTI) was renamed in Computer Technology Institute and Press "Diophantus". Given that the study extends until 2010, we refer to the institute with its former name - CTI.

5. Public Health Institutions

1. "Agios Savvas" Regional Hospital for Cancer Treatment	AGIOS SAVVAS
2. "Aghia Sophia" Children's Hospital	AGHIA SOPHIA
3. G. Gennimatas General Hospital of Athens	G. GENNIMATAS
4. G. Papanikolaou General Hospital of Thessaloniki	G. PAPANIKOLAOU
5. Evaggelismos Hospital Athens	EVAGGELISMOS
6. THEAGENIO Cancer Hospital of Thessaloniki	THEAGENIO
7. "Ippokratio" Regional General Hospital of Athens	IPPOKRATIO ATHENS
8. IPPOKRATIO General Hospital of Thessaloniki	IPPOKRATIO THESSALONIKI
9. KORGIALENIO-BENAKIO Hospital of Athens	KORGIALENIO
10. General Hospital of Athens LAIKO	LAIKO
11. Metaxa Cancer hospital of Piraeus	METAXA
12. Hospitals supervised by Ministry of National Defence	MOD HOSPITALS
13. G. PAPAGEORGIOU General Hospital	G. PAPAGEORGIOU
14. SOTIRIA General Hospital of Athens	SOTIRIA
15. Tzaneio General Hospital of Piraeus	TZANEIO
16. Onassis Cardiac Surgery Center	O.C.S.C.

6. Private Health Institutions

1. Alfa Institute of Biomedical Sciences	AIBS
2. Hellenic Cooperative Oncology Group	HeCOG
3. METROPOLITAN Hospital	METROPOLITAN
4. St. Luke's Hospital	St. Luke
5. Henry Dunant hospital	Henry Dunant
6. EUROCLINIC Group	EUROCLINIC GROUP
7. IASO Hospital	IASO
8. Athens Medical Group	ATHENS MEDICAL GROUP
9. HYGEIA Group[1]	Hygeia

[1] The HYGEIA Group includes HYGEIA General Hospital, MITERA and LETO Maternity Hospitals.

Appendix V: EU AND OECD MEMBER STATES

Member States of the European Union (27) and the OECD (2010)

In 2010, the OECD was enlarged with the participation of four new member states: Estonia, Israel, Slovenia and Chile. Greece's performance was ranked in relation to the following OECD countries:

OECD Member States

1. Australia	18. Canada
2. Austria	19. Luxembourg
3. Belgium	20. Mexico
4. France	21. New Zealand
5. Germany	22. Norway
6. Denmark	23. South Korea
7. Switzerland	24. Netherlands
8. Greece	25. Hungary
9. Estonia	26. Poland
10. United States	27. Portugal
11. United Kingdom	28. Slovakia
12. Japan	29. Slovenia
13. Ireland	30. Sweden
14. Iceland	31. Czech Republic
15. Spain	32. Turkey
16. Israel	33. Finland
17. Italy	34. Chile

European Union Member States

1. Austria
2. Belgium
3. Bulgaria
4. France
5. Germany
6. Denmark
7. Greece
8. Estonia
9. United Kingdom
10. Ireland
11. Spain
12. Italy
13. Cyprus
14. Latvia
15. Lithuania
16. Louxembourg
17. Malta
18. Netherlands
19. Hungary
20. Poland
21. Portugal
22. Romania
23. Slovakia
24. Slovenia
25. Sweden
26. Czech Republic
27. Finland

References

Adams, J. (2009). The Use of Bibliometric Indicators to Measure Research Quality in UK Higher Education Institutions, Arc. Immunol. Ther. Exp., 57, 19-32.

Adams, J., King, C., Miyairi, N., and Pendlebury, D. (2010). Global research report Japan. Evidence by Thomson Reuters.

Archambault, E. (2009). 30 Years in Science: Secular Movements in Knowledge Creation. Science Metrix Discussion Paper.

Archambault, É., D. Campbell, Y. Gingras, and V. Larivière (2009). Comparing bibliometric statistics obtained from the web of science and scopus. Journal of the American Society for Information Science and Technology 60 (7), 1320-1326.

European Commission Directorate-General for Research (2010). Assessing europe's University-Based research.

"Falagas, M. E., E. I. Pitsouni, G. A. Malietzis, and G. Pappas (2008). Comparison of PubMed, Scopus, Web of Science, and Google Scholar: strengths and weaknesses. FASEB J. 22 (2), 338-342.University Bibliometrics - an Analysis of Publication Outputs 1997-2003. Ministry of Research Science and Technology, New Zealand; 2006."

Fingerman, S. (2006). Web of science and scopus: Current features and capabilities. Issues in Science & Technology Librarianship (38).

Grant, J., Ling, T., Potoglou, D., and Culley, D. M. (2011). A rapid review of the Greek research and development system. RAND.

Harley, D., Acord, S. K., Earl-Novell, S., Lawrence, S., and King, C. J. (2010). Assessing the future landscape of scholarly communication: An exploration of faculty values and needs in seven disciplines. UC Berkeley, Center for Studies in Higher Education.

Ion, T. (2010). A profusion of measures. Nature (465), 864-866.

Jacso, P. (2005). As we may search – comparison of major features of the web of science, scopus, and google scholar citation-based and citation-enhanced databases. Current Science 89 (9), 1537-1547.

JISC (2005). JISC disciplinary differences report.

Karlsson S, Wadskog D. (2007). A bibliometric survey of Swedish scientific publications between 1982 and 2004.

Katsaros, D., V. Matsoukas, and Y. Manolopoulos (2008). Evaluating Greek departments of computer science/engineering using bibliometric indices. In Proceedings 12th Panhellenic Conference in Informatics.

Kermarrec AM, Faou E, Merlet JP, Robert P, Segoufin L. (2007) What do Bibliometrics Indicators Measure. INRIA report.

Lane, J. (2010). Let's make science metrics more scientific. Nature (464). 488-489.

Lazaridis, T. (2009). Ranking university departments using the mean h-index. Scientometrics 82 (2), 211-216.

Lehvo A, Nuutinen A. (2006). Finnish Science in International Comparison: A bibliometric analysis. Academy of Finland.

L'observatoire Des Sciences Et Des Techniques (2010). Indicateurs de sciences et de technologies.

Lundberg J. (2006). Bibliometrics as a Research Assessment Tool: Impact beyond the Impact Factor. Karolinska Institutet. Stockholm, Sweden.

Lundberg, J. (2007). Lifting the crown—citation z-score. Journal of Informetrics 1 (2), 145-154.

Luwel M. (2000, February). A Bibliometric Profile of Flemish Research in Natural, Life and Technical Sciences. Scientometrics 47 (2), 281-302.

Maron, N. L. and Smith, K. K. (2008). Current models of digital scholarly communication: Results of an investigation conducted by ITHAKA for the association of research libraries. Association of Research Libraries, pages 49.

Moed, H. (1996). Differences in the construction of SCI based bibliometric indicators among various producers: A first over view. Scientometrics 35 (2), 177-191.

Moed, H. F. (2007). The use of bibliometric indicators in research evaluation and policy. In Evolution of Scientific Publications: the Point of View of Scientists, Colloquium of the Institut de France, Académie des sciences.

Moed, H. F. and M. S. Visser (2007) Developing bibliometric indicators of research performance in computer science: an exploratory study. Research Report to the Council for Physical Sciences of the Netherlands Organisation for Scientific Research (NOW).

Moed, H., R. De Bruin, and T. Van Leeuwen (1995, July). New bibliometric tools for the assessment of national research performance: Database description, overview of indicators and first applications. Scientometrics 33 (3), 381-422.

National Documentation Centre (2010). Greek scientific publications 1993-2008: A bibliometric analysis of Greek publications in international scientific journals.

National Science Board. 2012. Science and Engineering Indicators 2012. Arlington, VA: National Science Foundation (NSB 12-01).

Netherlands Observatory of Science and Technology (2010). Science and technology indicators 2010.

Observatoire des Sciences et des Techniques (2009). Methodological note: Bibliometrics as a tool for the analysis of the scientific production of a country. EU FP6 project ESTIME. http://www.estime.ird.fr/article268.html.

OECD (2002). Frascati Manual: Proposed Standard Practice for Surveys on Research and Experimental Development.

OECD (2007). Revised Field of Science and Technology (FoS) Classification in the Frascati Manual.

OECD Science (2011). Technology and industry scoreboard 2011.

Office of the Government of the Czech Republic, Research and Development Council (2008). Analysis of the existing state of research, development and innovation in the Czech Republic and a comparison with the situation abroad in 2008.

"Pendlebury, D. (2008). White Paper Using Bibliometrics: A Guide to Evaluating Research Performance with Citation Data. Thomson Reuters; 2008."

Pereira TTS (2000). A Bibliometric Study of the Portuguese Research System in Biotechnology. INETI report.

Persson O, Luukkonen T, Hälikkä S. (2000). A bibliometric study of Finnish science. VTT Group.

Rehn C, Kronman U, Wadskog D. (2007). Bibliometric indicators: definitions and usage at Karolinska Institutet.

Research Information Network (2009). Communicating knowledge: How and why UK researchers publish and disseminate their findings. Report commissioned by RIN and JISC.

Royal Society Science Policy Centre (2011). Knowledge, networks and nations: Global scientific collaboration in the 21st century.

Schonfeld, R. C. and Housewright, R. (2010). Ithaka faculty survey 2009: Key strategic insights for libraries, publishers, and societies. Ithaka S+R.

SciVerse Scopus (2011). Content coverage guide.

Sparks, S. (2005). JISC disciplinary differences report. Report commissioned by JISC Scholarly Communications Working Group.

UK's Department of Business, Innovation and Skills (2011). International comparative performance of the UK research base.

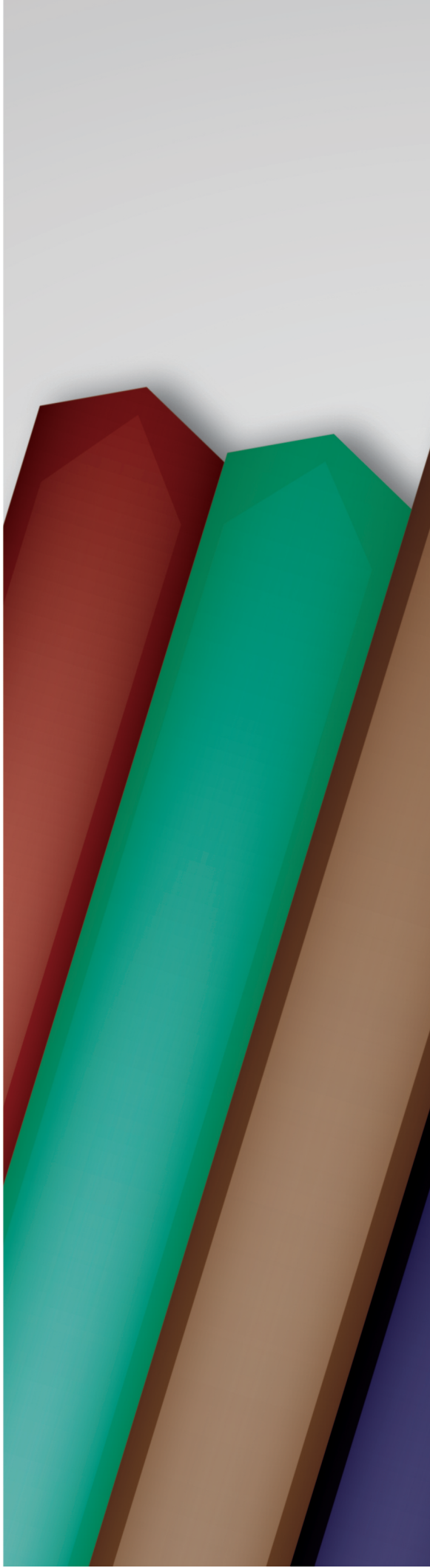
Unesco (2010). Unesco science report 2010: The current status of science around the world.

Universities UK (2007). The use of bibliometrics to measure research quality in UK higher education institutions.

Zachos, G. (1991). Research output evaluation of two university departments in greece with the use of bibliometric indicators. Scientometrics 21 (2), 195-221.

Zontanos, K. and Katranidis, S. (2009). An evaluation of the Greek Universities Economics Departments.

Ministry of Administrative Reform and E-Governance, Directorate General of Administrative Organisation and Reform, Registry of Institutions and Services of Greek Administration, 2011.



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