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A rapid review of the Greek research and development system

Jonathan Grant, Tom Ling, Dimitris Potoglou, Deirdre May Culley

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Το παρόν συγχρηματοδοτήθηκε από την Ευρωπαϊκή Ένωση (Ευρωπαϊκό Κοινωνικό Ταμείο) και εθνικούς πόρους στο πλαίσιο της πράξης «Αξιολόγηση του ελληνικού συστήματος έρευνας και τεχνολογίας στην Ελλάδα» του Επιχειρησιακού Προγράμματος «Εκπαίδευση και Διά Βίου Μάθηση». 
Preface

The Ministry of Education, Lifelong Learning and Religious Affairs commissioned RAND Europe to undertake a rapid review of the Greek research and development (R&D) system. R&D systems have an impact on levels of innovation and progress, and therefore have an important role in generating economic and social outcomes. A healthy R&D system helps to drive the economy by stimulating both supply and demand for technologies and services, thereby creating employment. For this reason, this report was commissioned to identify the scope for reform and improvement within the Greek R&D system.

This review is based on a SWOT analysis of the strengths, weaknesses, opportunities and threats relating to the Greek R&D system. The analysis was informed by expert interviews, workshops with the Research Centres' leadership, document and literature review, review of external evaluations undertaken in 2005 (peer review), desk-based research and a bibliometric analysis. Based on our analysis we make two key observations:

1. The Greek R&D system is in need of reform, which should begin in the near future. The SWOT analysis identified a number of shortcomings in the current system that need to be addressed. A clear message coming from our workshops is that ‘doing nothing is not an option’. There is a widely held view that the threats to the system are significant and imminent.

2. A tangible and realistic reform agenda can be formulated. Based on the SWOT analysis, we outline a blueprint for a future strategy for the R&D system, including a set of underlying principles and seven ‘ideas’ to be considered in putting together an agenda for reform.

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Professor Tom Ling
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RCI for GSRT RCs and fields
Δείκτης RCI για τα ΕΚ της ΙΤΕΤ και τα πεδία
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ΕΚ της ΙΤΕΤ με RCI ≥ 2.0
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GSRT RCs with RCI ≥ 1.2 and < 2.0
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GSRT RCs with RCI ≥ 0.8 or < 1.2
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GSRT RCs with RCI < 0.8
ΕΚ της ΙΤΕΤ με RCI < 0.8
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Network of Greek institutions with 50+ collaborative papers
Δίκτυο ελληνικών ιδρυμάτων με 50+ άρθρα με συνεργασίες
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Network of European institutions with 100–150 collaborative papers
Δίκτυο ευρωπαϊκών ιδρυμάτων με 100–150 άρθρα με συνεργασίες
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Network of European institutions with 150–200 collaborative papers
Δίκτυο ευρωπαϊκών ιδρυμάτων με 150–200 άρθρα με συνεργασίες
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Network of European institutions with 200–250 collaborative papers
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Summary

This report presents the findings of a rapid review of the Greek research and development (R&D) system. The study was commissioned by the Ministry of Education, Lifelong Learning and Religious Affairs. By necessity the review was prepared over a short, four-month period (April–July 2011) so that it could feed into forthcoming policy decisions.

For this reason, the review focused on the publicly funded Research Centres (RCs) under the auspices of the General Secretariat for Research and Technology (GSRT). The RCs account for approximately one-fifth of research activity in Greece. We did not review research undertaken within the private sector.

The review is based on a SWOT analysis of the strengths, weaknesses, opportunities and threats relating to the Greek research and development (R&D) system. The SWOT analysis was informed by weaknesses, opportunities and threats relating to the Greek higher education sector, or the small amount of research Greece. We did not review research undertaken within the public sector, or the consolidation of the research system.

The majority of Organisation for Economic Cooperation and Development (OECD) and European Union (EU) countries have independent NRFs. A similar entity could be established in Greece to fund excellent research system, which should begin in the near future.

We have provided a summary of the SWOT analysis in Table S1. The seven ideas we propose are as follows:

1. Articulate a national R&D strategy. The government should consider publishing a high-level R&D strategy that sets out a long-term vision for the Greek R&D system, including achievable objectives and associated milestones over the short term.

2. Facilitate the consolidation of the research system. The Greek R&D system is fragmented, with small research groups not achieving critical mass. The RCs could be reorganised towards achieving critical mass with a disciplinary and/or geographical focus.

3. Establish a Greek National Research Foundation (NRF). The majority of Organisation for Economic Cooperation and Development (OECD) and European Union (EU) countries have independent NRFs. A similar entity could be established in Greece to fund excellent research system.

4. Prepare a national R&D strategy. The government should consider publishing a high-level R&D strategy that sets out a long-term vision for the Greek R&D system, including achievable objectives and associated milestones over the short term.

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research through competitive merit-based international peer review.

4. Support the next generation of research leadership. An estimated 20% of senior researchers in Greece will retire over the next five years. Combined with restrictions on recruitment, this creates a threat to the sustainability of the R&D system. Consideration should be given to establishing a fellowship scheme for the leading mid-career researchers in Greece who will comprise the next generation of research leadership.

5. Create government demand for research. Government could act as an intelligent customer for research to inform its decisions and policy making. To facilitate this demand for research-based evidence, each major policy-making department of government could have a chief scientist or researcher.

6. Create industry demand for research through public sector procurement. Innovation procurement exploits the purchasing power of the state to stimulate demand for new technologies, products, services or business processes by reducing the innovation risk for the private sector.

7. Establish a performance monitoring and evaluation framework and cycle. Once a clear strategy has been formulated, a performance monitoring and evaluation framework and cycle should be established. This would provide the evidence base to support a learning and adaptable system which can be held to account for its use of public money.

μάζα. Τη ΕΚ θα μπορούσαν να αναδιοργανωθούν με στόχο την επίτευξη κρίσιμης μάζας με επίκεντρο τον επιστημονικό τομέα ή/και τη γεωγραφική θέση.

3. Δημιουργία ενός Ελληνικού Εθνικού Ιδρύματος Ερευνών. Η πλειοψηφία των χωρών του Οργανισμού Οικονομικής Συνεργασίας και Ανάπτυξης (ΟΟΣΑ) και της Ευρωπαϊκής Ένωσης (ΕΕ) έχουν ανεξάρτητα ΕΙΕ. Μια παρόμοια οντότητα θα μπορούσε να δημιουργηθεί και στην Ελλάδα για τη χρηματοδότηση έρευνας μέσω ανταγωνιστικών αξιολογήσεων από ομότιμους επιστήμονες διεθνώς.

4. Υποστήριξη της επόμενης γενιάς ερευνητικής ηγεσίας. Ένα εκτιμώμενο 20% ανώτερων ερευνητών στην Ελλάδα θα συνταξιοδοτηθεί κατά τα επόμενα πέντε χρόνια. Σε συνδυασμό με τους περιορισμούς στις προσλήψεις, δημιουργείται μια σοβαρή απειλή για τη βιωσιμότητα του συστήματος Ε&Α. Θα μπορούσε επομένως να μελετηθεί η καθιέρωση ενός σχήματος υποτροφιών για τους καλύτερους ερευνητές στην Ελλάδα που βρίσκονται στη μέση της καριέρας τους, οι οποίοι θα αποτελέσουν την επόμενη γενιά της ερευνητικής ηγεσίας.

5. Δημιουργία κρατικής ζήτησης για έρευνα. Η κυβέρνηση θα μπορούσε να δράσει ως ένας έξυπνος πελάτης για την έρευνα με τη βοήθεια της οποίας να διαμορφώσει τις αποφάσεις της και τη χάραξη πολιτικών. Για τη διευκόλυνση αυτής της ζήτησης για στοιχεία που βασίζονται στην έρευνα, κάθε κύριο τμήμα χάραξης πολιτικών της κυβέρνησης θα μπορούσε να έχει έναν υπεύθυνο επιστήμονα ή ερευνητή.

6. Δημιουργία ζήτησης για έρευνα στη βιομηχανία μέσω προμηθειών του δημόσιου τομέα. Οι προμήθειες καινοτομιών εκμεταλλεύονται την αγοραστική δύναμη του κράτους για να ενισχύσουν τη ζήτηση νέων τεχνολογιών, προϊόντων, υπηρεσιών ή επιχειρηματικών διαδικασιών μειώνοντας τον κίνδυνο της καινοτομίας στον ιδιωτικό τομέα.

7. Καθιέρωση πλαισίου και κύκλου παρακολούθησης και αξιολόγησης της επίδοσης. Αφού διαμορφωθεί μια σαφής στρατηγική, θα χρειαστεί να καθιερωθεί ένα πλαίσιο και ένας κύκλος παρακολούθησης και αξιολόγησης της επίδοσης. Αυτό το πλαίσιο θα μπορούσε να παρέχει τη βάση των στοιχείων για τη χρήση του δημοσίου χρήματος.
Table S1: SWOT analysis of the Greek R&D system

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<td>• Successful in securing competitive EU funding.</td>
<td>• Lack of consistent and reliable funding: irregularity of cycle of invitations to tenders (ITTs), unreliability of timing of payment.</td>
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<tr>
<td>• Examples of entrepreneurial administration.</td>
<td>• Lack of national strategy, leading to a lack of prioritisation and of a cohesive research community.</td>
</tr>
<tr>
<td>• Committed and loyal staff.</td>
<td>• Poor collaboration with industry and universities, and between research institutions.</td>
</tr>
<tr>
<td>• Some high-quality equipment and infrastructure.</td>
<td>• No level playing field (differences in legal status of RCs, funding and salary differences).</td>
</tr>
<tr>
<td>• Some internationally high-profile research.</td>
<td>• Lack of critical mass in certain areas.</td>
</tr>
<tr>
<td>• Pockets of interdisciplinary and inter-institution collaboration.</td>
<td>• Few incentives to attract/retain good (younger) researchers.</td>
</tr>
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<th>Threats</th>
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<td>• High-quality researchers responsive to funding opportunities.</td>
<td>• Lack of reform.</td>
</tr>
<tr>
<td>• Capacity for increasing collaboration with other RCs and universities (both domestically and abroad).</td>
<td>• Constraints of state budget and global economic environment.</td>
</tr>
<tr>
<td>• Reduced bureaucracy that would allow for greater flexibility and mobility between centres and universities (dual appointments).</td>
<td>• Increasing competition for EU funding.</td>
</tr>
<tr>
<td>• Untapped commercialisable products and services.</td>
<td>• Financial difficulties of RCs.</td>
</tr>
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<td>• Opportunities for government and industry to become research customers.</td>
<td>• Low morale of staff.</td>
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<td>• Potential for focusing research priorities on national needs where Greece has a comparative advantage.</td>
<td>• Ageing researchers and constraints on personnel hiring</td>
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<td>• Availability of a highly educated workforce – in Greece and as part of the Greek diaspora.</td>
<td>• Constitutional/legal limitations for restructuring.</td>
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<tr>
<td>• Recognition of the need for change.</td>
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Πίνακας S1: Ανάλυση SWOT για το ελληνικό σύστημα Ε&Α

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<thead>
<tr>
<th>Δυνατά Σημεία</th>
<th>Αδυναμίες</th>
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<tr>
<td>• Επιτυχίες στη διασφάλιση ανταγωνιστικής χρηματοδότησης από την ΕΕ.</td>
<td>• Έλλειψη συνεπούς και αξιόπιστης χρηματοδότησης: αταξία στο κύκλο προκηρύξεων διαγωνισμών (ITT), ανεξαρτησία στο χρόνο πληρωμής.</td>
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<td>• Παραδείγματα καινοτομίας.</td>
<td>• Έλλειψη εθνικής στρατηγικής, που οδηγεί σε έλλειψη προτεραιοτήτων και μιας συνεκτικής ερευνητικής κοινότητας.</td>
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<td>• Κάποιος εξοπλισμός και υποδομές υψηλής ποιότητας.</td>
<td>• Κακή συνεργασία με τη βιομηχανία και τα πανεπιστήμια και μεταξύ των ερευνητικών ιδρυμάτων.</td>
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<tr>
<td>• Θάλασσες διεπιστημονικής και διατμηματικής συνεργασίας.</td>
<td>• Έλλειψη συνδεσμών (διαφορές στο νομικό καθεστώς των ΕΚ, στη χρηματοδότηση και μισθολογικές διαφορές).</td>
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<th>Ευκαιρίες</th>
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<td>• Υψηλής ποιότητας ερευνητές που ανταποκρίνονται σε ευκαιρίες χρηματοδότησης.</td>
<td>• Έλλειψη μεταρρύθμισης.</td>
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<tr>
<td>• Δυνατότητα αύξησης της συνεργασίας με άλλα ΕΚ και πανεπιστήμια (τόσο εντός της χώρας όσο και στο εξωτερικό).</td>
<td>• Περιορισμοί του κρατικού προϋπολογισμού και του παγκόσμιου οικονομικού περιβάλλοντος.</td>
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<tr>
<td>• Μειωμένη γραφειοκρατία που θα επέτρεπε μεγαλύτερη ευελιξία και κινητικότητα ανάμεσα στα κέντρα και τα πανεπιστήμια (δυνατότητα διπλού διορισμού).</td>
<td>• Αυξανόμενος ανταγωνισμός για τη χρηματοδότηση από την ΕΕ.</td>
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<td>• Ανεκμετάλλευτα εμπορεύσιμα προϊόντα και υπηρεσίες.</td>
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<td>• Ευκαιρίες ώστε το κράτος και η βιομηχανία να γίνουν πελάτες της έρευνας.</td>
<td>• Χαμηλό ηθικό του προσωπικού.</td>
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<tr>
<td>• Δυνατότητα για επικέντρωση των ερευνητικών προτεραιοτήτων στις εθνικές ανάγκες όπου η Ελλάδα έχει συγκριτική πλεονεκτημα.</td>
<td>• Πρόσφατης της έρευνας και περιορισμοί στις προσλήψεις προσωπικού.</td>
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<td>• Διαθέσιμη τεχνολογική δυναμική ανώτερης εκπαίδευσης – στην Ελλάδα και ως μέρος της ελληνικής διασποράς.</td>
<td>• Θεσμικοί/νομικοί περιορισμοί για αναδόμηση.</td>
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<tr>
<td>• Ανεκμετάλλευτα εμπορεύσιμα προϊόντα και υπηρεσίες.</td>
<td>• Αναγνώριση της ανάγκης για αλλαγή.</td>
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This documented briefing presents the findings of a rapid review of the Greek Research and Development (R&D) system. In considering future options for reform, and within the context of a wider strategy to enhance research and innovation in Greece, in March 2011 the Ministry of Education, Lifelong Learning and Religious Affairs (hereafter the Ministry of Education) requested proposals for a review of the Greek research system. By necessity the review was prepared over a short, four-month period (April–July 2011) so that it could feed into forthcoming policy decisions. For this reason we had to proceed quickly, and to ensure timely completion we focused our review on publicly funded Research Centres (RCs) under the auspices of the General Secretariat for Research and Technology (GSRT). The RCs account for about a fifth of research activity in Greece. We did not review research undertaken within the higher education sector, or the limited research undertaken in the private sector. The review consisted of two main elements: a SWOT analysis of the strengths, weaknesses, opportunities and threats relating to the research system; and a bibliometric analysis of peer-reviewed serial research publications and citations of Greek research between 2000 and 2004. This includes key informant interviews, workshops with the RCs’ leadership, document and literature review, review of external evaluations undertaken in 2005 (peer review), desk-based research and bibliometric analysis, as described in more detail in the annex. The key
messages of the report can be found in the slides at the top of each page, with the text underneath providing further details in English and Greek. This style of document briefing highlights the major observations from the rapid review but also allows the reader to delve deeper into the detail of the report as needed.

We have organised this documented briefing into four main sections. The first provides a brief overview of the policy context of the Greek R&D system, including how the system is currently organised, an overview of the GSRT Research Centres, an analysis of R&D expenditure, and a note on the relationship between the Greek R&D system and European Commission (EC) funded research. The second section focuses on the SWOT analysis, with an overview that explains how we populated the SWOT framework and accompanying information on the details of each quadrant. The third and forth sections move from the diagnostic of the SWOT to suggesting ideas for reform. This includes a conceptual blueprint for the future, a set of underlying principles and seven ideas for consideration. The SWOT and ideas are informed by, among other sources, the bibliometric analysis described in the annex.
The Greek R&D system

At the centre of the R&D system is the GSRT, which is responsible for the formulation and implementation of R&D policy in Greece. Since November 2009 the GSRT has reported to the Ministry of Education. Prior to that, it reported to the Ministry of Development. In addition to overseeing R&D policy, the GSRT supervises the majority of the publicly funded RCs, which account for about a fifth of Greek R&D activity and form the focus of this rapid review.

Advising the Minister of Education is the National Council for Research and Technology (NCRT). The NCRT is the supreme advisory body of the state for the formulation and implementation of the national policy for research, technology and innovation. The Council is appointed by and reports directly to the Minister of Education. The council’s secretariat is provided by the GSRT. The council was established in May 2010 and the chairman, vice-chairman and members were appointed by the Minister of Education in September 2011. Recently it has overseen, for example, the recruitment of new RC directors and proposed and designed a new responsive mode funding programme. The Ministry of Education is also responsible for funding universities – which account for about a half of research activity in Greece – and the private sector, making up the final third of activity. Other ministries have their own RCs – for example, the Ministry of Rural Development and Food supervises the National Agricultural Research Foundation (NAGREF), while there is some (limited) support for

Στο κέντρο του συστήματος Ε&Α βρίσκεται η ΗΓΕΤ, η οποία είναι υπεύθυνη για τη διαμόρφωση και την εφαρμογή της πολιτικής Ε&Α στην Ελλάδα. Από το Νοέμβριο 2009 η ΗΓΕΤ υπάγεται στο Υπουργείο Παιδείας. Προηγουμένως, υπαγόταν στο Υπουργείο Ανάπτυξης. Εκτός από την επίβλεψη της πολιτικής Ε&Α, η ΗΓΕΤ εποπτεύει την πλειοψηφία των ΕΚ που χρηματοδοτούνται από το δημόσιο, και τα οποία αντιστοιχούν περίπου στο ένα πέμπτο της ελληνικής δραστηριότητας Ε&Α και αποτελούν το επίκεντρο αυτής της σύντομης ανάσκοπης. Συμβουλευτικό ρόλο προς το Υπουργείο Παιδείας έχει και το Εθνικό Συμβούλιο Έρευνας και Τεχνολογίας (ΕΣΕΤ). Το ΕΣΕΤ είναι ένας ανώτερος συμβουλευτικός οργανισμός του κράτους για τη διαμόρφωση και την εφαρμογή της εθνικής πολιτικής για την έρευνα, την τεχνολογία και την καινοτομία. Το Συμβούλιο διορίζεται από και δίνει αναφορά απευθείας στην Υπουργό Παιδείας. Η γραμματεία του συμβουλίου παρέχεται από τη ΗΓΕΤ. Το συμβούλιο διορίστηκε τον Μάιο 2010 και ο πρόεδρος, ο αντιπρόεδρος και τα μέλη διορίστηκαν την Υπουργό Παιδείας το Σεπτέμβριο 2011. Πρόσφατα είχε υπό την εποπτεία του, για παράδειγμα, την πρόοδο των νέων διευθυντών των ΕΚ και πρότεινε και σχεδίασε ένα νέο πρόγραμμα χρηματοδότησης ανταποκρινόμενο σε δεδομένες ανάγκες. Το Υπουργείο Παιδείας είναι επίσης υπεύθυνο για τη χρηματοδότηση των πανεπιστημίων - που αντιστοιχούν περίπου στο μισό της ερευνητικής δραστηριότητας στην Ελλάδα - και του ιδιωτικού τομέα, που αποτελεί το υπόλοιπο τρίτο της δραστηριότητας. Άλλα υπουργεία έχουν δικά τους ΕΚ - για παράδειγμα
research via regional councils. This occurs in two ways: via GSRT to utilise the budget of the regional councils to fund research programmes in the region; and directly from the regional councils to fund the development of infrastructure. R&D in the private sector is very low by European Union (EU) and Organisation for Economic Cooperation and Development (OECD) standards.

το Υπουργείο Αγροτικής Ανάπτυξης και Τροφίμων εποπτεύει το Εθνικό Ίδρυμα Αγροτικής Έρευνας (ΕΘΙΑΓΕ), ενώ υπάρχει κάποια (περιορισμένη) υποστήριξη για την έρευνα μέσω των τοπικών συμβούλων. Αυτό συμβαίνει με δύο τρόπους: μέσω της ΙΤΕΤ για να χρηματοδοτήσει τον προϋπολογισμό των τοπικών συμβούλων και να χρηματοδοτήσει ερευνητικά προγράμματα στην περιοχή και απευθείας από τα τοπικά συμβούλια για τη χρηματοδότηση της ανάπτυξης υποδομών. Η Έρευνα και Ανάπτυξη στον ιδιωτικό τομέα είναι πολύ μικρή σύμφωνα με τα πρότυπα της Ευρωπαϊκής Ένωσης (ΕΕ) και του Οργανισμού Οικονομικής Συνεργασίας και Ανάπτυξης (ΟΟΣΑ).
We focused our rapid review of the Greek R&D system on the research centres (RCs) of the General Secretariat of Research and Technology (GSRT). This was because:

- RCs are often central to any research system, providing a logical entry into the system
- RCs (including those not supervised by GSTR) account for around 20% of Public legal entities
- National Observatory of Athens (NOA; founded 1842)
- National Centre for Scientific Research ‘Demokritos’ (1959)
- Hellenic Centre for Marine Research (HCMR; 2003)
- National Centre for Social Research (NCSR; 1959)
- Private not-for-profit (NFP) entities
- Hellenic Pasteur Institute (1920; was a public legal entity but acquired NFP status in 1975)
- National Hellenic Research Foundation (NHRF; 1958, was a public legal entity but acquired NFP status in 1975)
- Alexander Fleming Biomedical Sciences Research Centre (1998)
- Foundation for Research and Technology Hellas (FORTH; 1983)
- Centre for Research and Technology (CERTH; 2000)
- ATHENA Research and Innovation Centre for Information, Communication and Knowledge Technologies (2001)
- Centre for Research and Technological Development (CERETETH; 2006)
- it provided a pragmatic approach, given the speed of the review.
- The vast majority of the RCs are under the supervision of the GSRT and are either public or semi-public (private not-for-profit) legal entities, as listed opposite.
- As part of the review we met the senior leadership from all the GSTR RCs, listed in Appendix B.

As noted above, the RCs of the GSRT formed the focus of our rapid review. This is in part a pragmatic selection given the time available to conduct the review, but there is also a theoretical justification – namely, publicly funded RCs are often at the centre of an R&D system and are understood as being of critical importance for encouraging the inward diffusion of research from other countries through elite research networks and internationalised corporate research.1 The vast majority (11 out of 18) of the publicly funded RCs in Greece are under the supervision of the GSRT.

The GSRT RCs were established in several waves so that two distinct generations of centres may be identified. These differ in orientation and governance. The first generation, established before 1980, were conceived in terms of a public service rationale and are (with some exceptions) public legal entities. Several of the first-generations centres were established opportunistically – for example, Demokritos was set up when a small nuclear reactor was donated to the Greek government by the USA.2 The first-generation centres include the following:


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Όπως σημειώθηκε παραπάνω, τα ΕΚ της ΙΤΕΤ αποτέλεσαν το επίκεντρο της σύντομης ανασκόπησής μας. Αυτό εν μέρει αποτελεί μια αρκετά αναλογική επιλογή διδομένου του διαθέσιμου χρόνου για τη διεξαγωγή της ανασκόπησης, αλλά υπάρχει και μια αρκετά ανικανή αιτιολόγηση – δηλαδή ότι, τα ΕΚ με δημόσια χρηματοδότηση είναι συνήθως στο κέντρο ενός συστήματος Ε&Α και θεωρούνται ως κεντρικά σημεία για την ενθάρρυνση της εσωτερικής εξάπλωσης της έρευνας από άλλες χώρες μέσω εικονικών ερευνητικών δικτύων και διεθνοποιημένης επιμέλειας της έρευνας.1 Η μεγάλη πλειοψηφία (11 από τα 18) ΕΚ με δημόσια χρηματοδότηση στην Ελλάδα είναι υπό την επίβλεψη της ΙΤΕΤ.

From the 1980s a new generation of RCs was established as private non-profit entities. In contrast to the earlier generation, many of the newer institutes were established outside Athens. They include the following:

- National Observatory of Athens (NOA, founded in 1842) operates five institutes for astronomy and astrophysics, geodynamics, environment and sustainable development, space applications and remote sensing, and astroparticle physics. (http://www.noa.gr/indexen.html)
- National Centre for Scientific Research 'Demokritos' (1959) is multidisciplinary, with institutes for biology, material science, microelectronics, informatics and telecommunications, nuclear technology (including radiation protection), nuclear physics, radioisotopes and radio-diagnostic products, and physical chemistry. Demokritos hosts the only nuclear (experimental) reactor in the country. (http://www.noa.gr/indexen.html)
- Hellenic Centre for Marine Research, established in 2003 with the merger of the National Centre for Marine Research (1945) and the Institute for Marine Biology of Crete (1987), it comprises five institutes for oceanography, marine biological resources, aquaculture, marine biology and genetics, and inland waters. (http://www.hcmr.gr/)
- National Centre for Social Research (1958), with three institutes for urban and agricultural sociology, political sociology, and social policy. (http://www2.ekke.gr/index.php?lng=en)
- Hellenic Pasteur Institute (1920) is jointly supervised by the GSRT and the Ministry of Health and is a member of the Pasteur International Network operating under a bilateral Greek–French agreement signed in 1976. It was founded as a public legal entity and acquired not-for-profit (NFP) status in 1975. (http://www.pasteurgr/?lang=en)
- National Hellenic Research Foundation (NHRF, 1958) is a multidisciplinary centre with three institutes for the arts and humanities (Greek and Roman antiquity, Neohellenic research and Byzantine research) and another three in the areas of biology, physics and chemistry. It was founded as a public legal entity but acquired NFP status in 1975. The NHRF also houses the National Documentation Centre (NDC), which supported the bibliometric analysis reported in the annex. (http://www.eie.gr/index-en.html)

From the 1980s a new generation of RCs was established as private non-profit entities. In contrast to the earlier generation, many of the newer institutes were established outside Athens. They include the following:

- Foundation for Research and Technology Hellas – FORTH (1983), with six institutes focusing on electronic structure and lasers, molecular biology and biotechnology, computer science, applied and computational mathematics, Mediterranean studies, chemical engineering and high temperature chemical process and biomedical research. (http://www.forth.gr/)
- Centre for Research and Technology Hellas – CERTH (2000) is a multidisciplinary RC with institutes for chemical processing, informatics and telematics,
transport, agrobiotechnology, solid fuels technology and applications, and biomedical and bimolecular research. (http://www.certh.gr/root.en.aspx)

- **ATHENA – Research and Innovation Centre for Information, Communication and Knowledge Technologies** (2001) is organised around four institutes focusing on language and speech processing, industrial systems, cultural and education technology, and networking technologies. (http://www.certh.gr/6DF336BC.en.aspx)

- **Alexander Fleming Biomedical Sciences Research Centre** (1998) hosts four institutes for immunology, molecular biology and genetics, cellular and developmental biology, and molecular oncology. (http://www.fleming.gr/)

- **Centre for Research and Technological Development of Thessaly – CERETETH** (2006) is a multidisciplinary centre comprising four institutes for human performance and rehabilitation, biomedical research, technology and management of agricultural ecosystems, and mechatronics. (http://www.cereteth.gr/)

The GSRT is responsible for overseeing and funding these RCs. Their role includes organising quinquennial evaluations, funding their personnel and operational costs, and overseeing budgets and financial statements.

- **The Hera Institute of Technology and Research – ITE** (1983), with six institutes focusing on electronic circuitry and lasers, molecular biology and biotechnology, mesoscopic systems, chemical chemistry, chemical reactions, physical chemistry and chemical research. (http://www.forth.gr/)

- **The Ethniko Kinto Eraneas kai Ynetologihs Anpantzehs – EKETA** (2000) is an interdisciplinary center for technological developments in chemical processes, telecommunication, transport, agrobiotechnology, solid fuels technology and applications, and biomedical and bimolecular research. (http://www.certh.gr/root.en.aspx)

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The GSRT is responsible for overseeing and funding these RCs. Their role includes organising quinquennial evaluations, funding their personnel and operational costs, and overseeing budgets and financial statements.
By international standards R&D expenditure in Greece is low. For 2006, the most recent year for which figures are available, gross expenditure on R&D (GERD) accounted for €1.223b or 0.6% of GDP. A detailed breakdown of this figure is available only for 2005, when GERD was €1.154b. GERD can be broken down according to the sector where the research was performed or the source of funds. Nearly half of all research activity (€548m/€1154m = 47%) was performed in higher education institutes (HEI). The business sector performed around a third of research (€357m/€1154 = 31%); and around a fifth (€233m/€1144 = 20%) was performed by government. (The remaining 2% is by the very small NFP sector.)

It may be reasonably assumed that the 20% performed by government – termed ‘R&D expenditure in the government sector’ or GOVERD – is the research performed by the RCs. Hence a breakdown of GOVERD by source of funds provides an indicative assessment of the funding of the GSRT RCs, and this is shown in the second pie-chart in the slide. The two main sources are government (funding €159m/€233 = 68%) and the EC (€65m/€233m = 28%). The private sector funds only €3m worth of research.

Katά τα διεθνή πρότυπα οι δαπάνες για Ε&Α στην Ελλάδα είναι χαμηλές. Για το 2006, το πιο πρόσφατο έτος για το οποίο διατίθενται στοιχεία, η ακαθάριστη εγχώρια δαπάνη για Έρευνα και Ανάπτυξη (ΑΕΔΕΤΑ) αναλογούσε σε €1,223 δις ή 0,6% του ΑΕΠ. Λεπτομερή στοιχεία αυτού του ποσού διατίθεται μόνο για το 20053, όταν η ΑΕΔΕΤΑ ήταν €1,154 δις. Η ΑΕΔΕΤΑ μπορεί να αναλυθεί σύμφωνα με τον τομέα όπου έγινε η έρευνα ή με την πηγή της χρηματοδότησης. Σχεδόν η μισή από το σύνολο της ερευνητικής δραστηριότητας (€548εκατ./€1154εκατ. = 47%) διεξήχθη σε ανώτερα εκπαιδευτικά ιδρύματα (ΑΕΙ). Ο επιχειρηματικός τομέας διεξήγαγε περίπου το ένα τρίτο της έρευνας (€357εκατ./€1154 = 31%) και περίπου το ένα πέμπτο (€233/€1144 = 20%) διεξήχθη από το κράτος. (Το υπόλοιπο 2% είναι από τον πολύ μικρό τομέα των ΜΚΙ.)

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When compared to the science and technology expenditure statistics from other countries, the salient points of this analysis are these:

1. Gross expenditure on R&D is one of the lowest in the EU, in absolute terms and as a percentage of GDP, and is well below the 1.5% target set by the EC.
2. R&D in the business sector is notably weak, with business expenditure on R&D (BERD) being one of the lowest in the OECD/EC.
3. EU funding is comparatively high as a percentage of GERD when compared to other EC countries.
4. The RCs are almost exclusively dependent on government and EU funding.

χράτος (με χρηματοδότηση €159εκατ./€233 = 68%) και η ΕΕ (€65εκατ./€233εκατ. = 28%). Ο ιδιωτικός τομέας χρηματοδοτεί μόνο με €3εκατ. για την έρευνα.

Συγκρίνοντας τα στοιχεία αυτά με τις στατιστικές δαπανών για την επιστήμη και τις τεχνολογίες από άλλες χώρες, τα σημαντικά σημεία της ανάλυσης αυτής είναι τα εξής:

1. Η ακαθάριστη εγχώρια δαπάνη για Έρευνα και Ανάπτυξη είναι από τις χαμηλότερες στην ΕΕ, σε απόλυτες τιμές και ως ποσοστό του ΑΕΠ και είναι κατά πολύ κάτω από το 1,5% του στόχου που έχει τεθεί από την ΕΕ.
2. Η Έρευνα και Ανάπτυξη στον επιχειρηματικό τομέα είναι ιδιαίτερα αδύναμη, με τη δαπάνη των επιχειρήσεων για έρευνα και τεχνολογική ανάπτυξη (ΔΕΠΕΤΑ) να είναι από τις χαμηλότερες στον ΟΟΣΑ/ΕΕ.
3. Η χρηματοδότηση της ΕΕ είναι συγκριτικά υψηλή ως ποσοστό του ΑΕΔΕΤΑ σε σύγκριση με άλλες χώρες της ΕΕ.
4. Τα ΕΚ εξαρτώνται σχεδόν αποκλειστικά από την κρατική χρηματοδότηση και τη χρηματοδότηση της ΕΕ.
A rapid review of the Greek research and development system

The Greek R&D system is heavily dependent on EC support – a third of public sector research (e.g. universities and RCs) is funded by the EC. As illustrated opposite, Greece ‘punches above its weight’ in participations in EC-funded FPs. In a system where public and private R&D expenditure is low this support is welcomed. However, there are three significant risks associated with dependence on EC funding:

1. There could be a substitution effect, with the state withdrawing funding if there is confidence that the EC would pick it up.
2. Greek researchers will by necessity follow the priorities of the EC over Greece’s.
3. EU funding will become more inaccessible for Greek researchers because the Greek state is not able to provide the level of co-funding needed.

The EC supports about 18% of research activity in Greece, and 28% of that occurs in the GSRT RCs. This illustrates a (potential over) reliance on the EC, via framework programmes (FPs) and structure funds. The Laboratory of Industrial and Energy Economics at the National Technical University of Athens maintains a database of FP collaborations and participations. The STEP-to-RJVs database contains information on 24,638 collaborative research projects funded by the EU in FP1–FP7 (1984–2009) and 54,641 organisations with 177,238 participations, mainly from EU countries. Over the seven FPs funded to date, Greece has been involved in over 7,248 funded projects – and co-ordinated 893 (or 12%) – worth over €3.2b, ranking it eighth across all EC countries. As we shall see in the SWOT analysis, this is a defining strength of the Greek R&D system, but it is not free from associated concern. One of the comments we heard from a number of our interviewees was that this financial support may have had two unintended consequences: first, Greek research was more focused on EU

H ΕΕ υποστηρίζει περίπου 18% της ερευνητικής δραστηριότητας στην Ελλάδα και 28% αυτής που διεξάγεται στα ΕΚ της ΓΓΕΤ. Αυτό σκιαγραφεί μια (ενδεχομένως υπερβολική) εξάρτηση από την ΕΕ, μέσω των προγραμμάτων πλαισίου (ΠΠ) και της δομημένης χρηματοδότησης. Το Εργαστήριο Βιομηχανικής και Ενεργειακής Οικονομίας του Εθνικού Μετσόβιου Πολυτεχνείου διατηρεί μια βάση δεδομένων των συνεργασιών και των συμμετοχών σε ΠΠ. Η βάση δεδομένων STEP-to-RJVs περιέχει πληροφορίες για 24,638 ερευνητικά προγράμματα της ΕΕ στα ΠΠ1-ΠΠ7 (1984–2009) και 54,641 οργανισμούς με 177,238 συμμετοχές, κυρίως από χώρες της ΕΕ. Από τα επτά ΠΠ που έχουν χρηματοδοτηθεί έως σήμερα, η Ελλάδα έχει μεταμετάσχει σε περισσότερα από 7,248 χρηματοδοτούμενα προγράμματα – και συντόνισε 893 (ή 12%) – αξίας ανώ των €3,2 δις, κατατάσσοντας την στην έκτη θέση της ΕΕ. Οπως θα δούμε και στην ανάλυση SWOT, αυτό είναι ένα καθοριστικό δυνατό σημείο για το ελληνικό σύστημα E&Α, αλλά προκαλεί και μια σχετική ανησυχία. Ενα από τα

Priorities than on those of Greece; second, EC funding may have inadvertently replaced funding by the Greek government. Less speculatively and looking to the future, this level of support is unlikely to sustain itself with increased competition within the EU, and EC policy aims of increasing the leverage of FP funding.
SWOT analysis

**Strengths**
- Successful in securing competitive EU funding
- Examples of entrepreneurial administration
- Committed and loyal staff
- Some high-quality equipment and infrastructure
- Pockets of interdisciplinary and inter-institution collaboration

**Weaknesses**
- Lack of consistent and reliable funding; irregularity of cycle of ITTs; unreliability of timing of payment
- Lack of national strategy, leading to a lack of prioritisation, and of a cohesive research community
- Poor collaboration with industry and universities, and between research institutions, with an overreliance on state funding
- No level playing field (differences in legal status of RCs, funding and salary differences)
- Lack of critical mass in certain areas
- Few incentives to attract/retain good (younger) researchers
- Heavy bureaucracy and micro-management
- Low-profile support for technology transfer and a lack of entrepreneurial culture

**Opportunities**
- High-quality researchers responsive to funding opportunities
- Capacity for increasing collaboration with other centres and universities (both domestically and abroad)
- Reduced bureaucracy that would allow for greater flexibility and mobility between RCs and universities (dual appointments)
- Untapped commercialisable products and services
- Opportunities for government and industry to become ‘research customers’
- Focus research priorities on national needs where Greece has a comparative advantage
- Availability of a highly educated workforce, in Greece and as part of the Greek diaspora

**Threats**
- Lack of reform
- Constraints on the state budget and global economic environment
- Increasing competition for EU funding
- Financial difficulties of RCs
- Low morale of staff
- Ageing researchers and constraints on personnel hiring
- Constitutional/legal limitations to restructuring

A SWOT analysis is a simple planning tool that can identify internal and external factors which need to be considered when formulating new policy objectives, plans or strategies. It forms the basis of this rapid review by identifying strengths and weaknesses internal to the research system, and the opportunities and threats presented by the external environment. The SWOT presented above, and elaborated on the following slides, is for the RCs supervised by GSRT. However, we would suggest that some elements of it are generalisable across the Greek R&D system. The SWOT is derived by synthesising all the evidence streams that we gathered as part of the rapid review and described in more detail in Appendix B. These include key informant interviews, workshops with the RC’s leadership, a document and literature review, review of the evaluations from 2005, desk-based research, and the bibliometric analysis presented in the annex. In the following four slides we take the four quadrants of the SWOT in turn and describe each in more detail, including their evidential basis.
Strengths

- Successful in securing competitive EU funding
- Examples of entrepreneurial administration
- Committed and loyal staff
- Some high-quality equipment and infrastructure
- Some internationally high-profile research
- Pockets of interdisciplinary and inter-institute collaboration

We identified the following strengths of the Greek R&D system:

- **Successful in securing competitive EU funding.** As already commented on in Page 12, one of the defining characteristics of the Greek R&D system is its success in securing EC funding, most notably through successive framework programmes. Around a fifth of Greek R&D activity is funded from abroad, with the vast majority coming from the EC either via FP funding or through structural funds. Analysis of the STEP-to-RJVs database maintained by the Department of Industrial and Energy Economics at the National Technical University of Athens demonstrates that Greek research institutes are central actors in the network of participation in all FP programmes. For example, out of the RCs we focused on as part of this rapid review, FORTH and Demokritos are within the top 1% of the most central actors (i.e. collaborators) across the whole of the EU in the fields of Quality of Life, Information Society, Competitive and Sustainable Growth and Energy. Also, CERTH is within the top 1% of the most central actors in Quality of Life and Information Society, and within the top 5% in the

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field of Socio-economic Research. This ranking is out of 54,641 organisations.

- **Examples of entrepreneurial administration.** It is easy to dismiss the Greek R&D system as overly bureaucratic (it is – this appears below as a weakness). However, prompted by a need to deal creatively with the problems of bureaucracy, an entrepreneurial research administration and management culture has arisen within some of the RCs. We heard of one example where an RC director had set up separate bank accounts for each externally funded research project to ensure that there is no cross-subsidisation. We would caution against interpreting this entrepreneurship as rule breaking; indeed, in previous work we published it is clear that researchers successfully exploit flexibility in the scientific and administrative management of research projects to the benefit of both themselves and their funders.6

- **Committed and loyal staff.** One of the themes coming out of the synthesis of the 2005 peer-review evaluations, which was confirmed in our workshop with the RC leadership and other staff, is the commitment of researchers to the Greek R&D system. Given its current state, the fact that qualified staff can be recruited and retained within the system is a testament to their loyalty. That said, it would be interesting to further understand why researchers who are suitably qualified to work in better resourced and more functional R&D systems – such as in North America and in other European countries – are motivated to continue to work in Greece.

- **Some high-quality equipment and infrastructure.** Although it is not universally available, we were told of examples of state-of-the-art well-functioning equipment and infrastructure. Examples include the manned submersible THETIS and the ROV Super Achilles at the Hellenic Centre for Marine Research and the 1.2m Cassegrain and the 2.3m Ritchey-Cretien telescopes at NOA, as well as the TANDEM 5MV electrostatic ion accelerator and 5MW nuclear research reactor at Demokritos. We were also told that at times it is easier to get funding for equipment than it is for research projects.

- **Some internationally high-profile research.** The bibliometric analysis identifies a number of ‘enclaves of excellence’ where research from the RCs is competing internationally. These include, by way of example, optics at FORTH, electrical and electronic engineering at Demokritos and telecommunications at NOA.7 Likewise, of the 40 institutes reviewed as part of the 2005 peer-review evaluations, 25 were rated as excellent by the

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7 Please see Slide 26 for caveats and limitations to bibliometric analysis: the absence of mentioning either a field or an RC does not necessarily imply that it is not excellent.
Strengths

• **Pockets of interdisciplinary and inter-institute collaboration.** As will be commented on in the section discussing weaknesses, the Greek R&D system is seemingly insular, with low levels of research collaboration between institutes, universities and the private sector and with other countries. That said, it is worth pointing out that some exceptions exist. It is notable, for example, that Demokritos is at the centre of the network diagram of research collaborations across European institutes (Page 69), indicating that it is involved in many collaborations. Likewise, in the bespoke analysis of the STEP-to-RJVs database that we requested, it is apparent that around 5% of Greek collaborations within the FP are with other Greek organisations, and that this is higher than the EU27 average, although slightly lower than the EU12 average (5.5%) for the FP1–FP7 period.

• **άριστα δυνατά**

| • Κάποια διεθνώς γνωστή έρευνα. Η βιβλιομετρική ανάλυση εντοπίζει έναν αριθμό επιστημονικών «θυλάκων αριστείας» όπου η έρευνα από τα ΕΚ συγκεντρώνεται διεθνώς. Αυτοί περιλαμβάνουν, για παράδειγμα, την οπτική στο ΙΤΕ, την ηλεκτρική και ηλεκτρονική μηχανική στο Δημόκριτο και τις τηλεπικοινωνίες στο ΕΑΑ. Όμως, από τα 40 ινστιτούτα που εξετάστηκαν ως μέρος των αξιολογήσεων από ομότιμους κριτές το 2005, 25 ταξινομήθηκαν ως αρίστα από τις διεθνείς επιτροπές αξιολογήσεων ομότιμων, με βαθμολογία 4 στα 5 ή περισσότερο.

| • Θύλακες και διατμηματική συνεργασία. Όπως θα σχολιαστεί και στην ενότητα όπου συζητούνται οι αδυναμίες, το ελληνικό σύστημα Ε&Α φαίνεται εσωστρεφές, με χαμηλό επίπεδο ερευνητικής συνεργασίας ανάμεσα σε ινστιτούτα, πανεπιστήμια, τον ιδιωτικό τομέα και άλλες χώρες. Ωστόσο, αξίζει να τονίσουμε ότι υπάρχουν και κάποιες εξαιρέσεις. Είναι αξιοσημείωτο, για παράδειγμα, ότι ο Δημόκριτος βρίσκεται στο κέντρο του διαγράμματος δικτύου για τις ερευνητικές συνεργασίες ανάμεσα στα ευρωπαϊκά ινστιτούτα (Σελίδα 43), υποδεικνύοντας ότι συμμετέχει σε πολλές συνεργασίες. Όμως, στην αποκλειστική ανάλυση της βάσης δεδομένων STEP-to-RJVs που ζητήσαμε, είναι προφανές ότι γύρω στο 5% των ελληνικών συνεργασιών ενός του ΠΠ είναι με άλλους ελληνικούς οργανισμούς και ότι αυτό είναι υψηλότερο από το μέσο όρο της Ευρωπαϊκής Ένωσης των 27, αλλά λίγο χαμηλότερο από το μέσο όρο της Ευρωπαϊκής Ένωσης των 12 (5.5%) για την περίοδο των ΠΠ1–ΠΠ7.

7 Παρακαλούμε ανατρέξει στη Διαφάνεια 26 για προειδοποιήσεις και περιορισμούς στην βιβλιομετρική ανάλυση. Η απουσία αναφοράς ενός τομέα ή ενός ΕΚ δεν σημαίνει απαραίτητα ότι δεν είναι αριστεία.
Weaknesses

- Lack of consistent and reliable funding: irregularity of cycle of ITTs; unreliability of timing of payment
- Lack of national strategy, leading to a lack of prioritisation and of a cohesive research community
- Poor collaboration with industry and universities, and between research institutions, with overreliance on state funding
- No level playing field (differences in legal status of RCs, funding and salary differences)
- Lack of critical mass in certain areas
- Few incentives to attract/retain good (younger) researchers
- Heavy bureaucracy and micro-management
- Low-profile support for technology transfer and a lack of entrepreneurial culture

We identified the following weaknesses in the Greek R&D system:

- **Lack of consistent and reliable funding: irregularity of cycle of ITTs; unreliability of timing of payment.** The sporadic nature of project, programme and fellowship funding was a recurrent theme emerging from our key informant interviews and workshops with the leadership of the RCs. The last open call for research proposals, Thales, was on 24 July 2009, although the new Aristeia programme was launched on 31 May 2011. Moreover, we heard of a number of examples where funding decisions had been delayed and/or committed research funds had not been paid (on time). One RC director reported the case of a post-doctoral research fellow who had applied for funding in October 2010, but at the time of our meeting in March 2011 had not heard the outcome – therefore the person concerned had recently accepted a senior lectureship position at a leading UK university. For researchers to plan effectively, they need to know when invitations to tender (ITTs) will be issued and when decisions will be made, and to have confidence that grants will be paid. In the USA, for example, the National Institute of Health (NIH) runs three cycles of funding a year, with a very clear and transparent grant process that sets out dates for submissions, notice of decisions and so on (see http://grants.nih.gov/grants/grants_process.htm).
Weaknesses

Lack of national strategy, leading to a lack of prioritisation and of a cohesive research community. The Greek government has not established a clear R&D strategy that sets out its research priorities, the process for meeting those priorities and the principles that will underpin those processes. The consequence of this is that there is an inconsistent supply of various funding initiatives that are not sustained over time. The RCs (and arguably the wider R&D system) have grown opportunistically, leading to a degree of fragmentation and duplication between centres and institutes. Possibly as a consequence of this dynamic, we sensed in our discussions the lack of a cohesive research community within which researchers and the government would work together in taking active ownership in shaping the future Greek R&D system. In this vacuum, researchers often turn to the research priorities of the EC – which may, or may not, align with the research needs of Greece and/or the Greek government.

Poor collaboration with industry and universities, and between research institutions, with an overreliance on state funding. Between research institutions, with an overreliance on state funding. The differences of the EC – which may, or may not, align with the research needs of Greece and/or the Greek government. The Greek government has not established a clear R&D strategy that sets out its research priorities, the process for meeting those priorities and the principles that will underpin those processes. The consequence of this is that there is an inconsistent supply of various funding initiatives that are not sustained over time. The RCs (and arguably the wider R&D system) have grown opportunistically, leading to a degree of fragmentation and duplication between centres and institutes. Possibly as a consequence of this dynamic, we sensed in our discussions the lack of a cohesive research community within which researchers and the government would work together in taking active ownership in shaping the future Greek R&D system. In this vacuum, researchers often turn to the research priorities of the EC – which may, or may not, align with the research needs of Greece and/or the Greek government.

No level playing field (differences in legal status of RCs, tax incentives, tax exemption). There are also differences in salaries for researchers with the equivalent expertise and experience. The core issue is one of (perceived) status, although there are also differences in salaries for researchers with the equivalent expertise and experience.


• Lack of critical mass in certain areas. A recurrent theme in the synthesis of the 2005 evaluations was that research groups with RCs are too small and cannot reach critical mass. Critical mass in research is hard to define but easy to recognise. It is the minimum capacity (e.g. staff, equipment, money, management and governance systems and practices) needed to compete effectively at an international level in a given area of research. It will vary from one area to another – for example, contributing to social science theory or philosophy may be successful with much smaller units than primary research in astronomy is. The lack of critical mass is compounded by the institutional fragmentation of RCs. For example, across the 11 RCs under the supervision of the GSRT, there are 17 institutes in the medical and health sciences, 6 in energy and environment, 9 in engineering science, 4 in humanities, 6 in mathematics and information science, 9 in the natural sciences and 4 in social sciences. As a result critical mass is not achieved, and the quality of research may be compromised. Evidence for this is the relatively low number of citations that Greek research publications achieve – during the five-year period from 2000 to 2004, Greek publications received on average 3.82 citations per paper, while the corresponding average for other EU member states was 5.03 and for OECD countries it was 5.20.10

• Few incentives to attract/retain good (younger) researchers. Drawing on insights from our interviews, it is clear that researchers are attracted by reliable and competitive funding for salaries, projects and institutions. In addition, younger scientists are attracted by a career structure both made recruitment more difficult.

• Heavy bureaucracy and micro-management. There was a widespread view among interviewees that the RCs suffered from having to engage with a highly bureaucratic system of funding, reporting and overall micro-management. Examples of this include the need to get authorisation from approximately five individuals to attend an academic conference. We were also told that the recruitment process for staff could be slow and inefficient – even for temporary appointments. There was a view that job descriptions had to be approved and that they would often accordingly be less precise than was required. Consequently, more applicants are typically reviewed than is necessary.

• Low-profile support for technology transfer and a lack of entrepreneurial culture. We were told that there

Weaknesses | Αδυναμίες 19

• Πολλή γραφειοκρατία και μικροδιαχείριση. Υπήρχε μια ευρέως διαδεδομένη άποψη μεταξύ των ερωτηθέντων ότι τα ΕΚ πάσχουν από το ότι απαιτείται εμπλοκή σε ένα ιδιαίτερα γραφειοκρατικό σύστημα χρηματοδοτήσεων, εκθέσεων και γενικά μικροδιαχείρισης. Παραδείγματα αυτού περιλαμβάνουν την ανάγκη λήψης εγκρίσεων από περίπου πέντε άτομα για την συμμετοχή σε ένα ακαδημαϊκό συνέδριο. Μας είπαν επίσης ότι η διαδικασία πρόσληψης του προσωπικού μπορεί να είναι αργή και ανεπαρκής – ακόμη και για προσωρινούς διορισμούς. Υπήρχε μια άποψη ότι οι περιγραφές των θέσεων εργασίας έπρεπε να εγκριθούν και ότι συνήθως είναι λιγότερο ακριβείς από όσο απαιτούνταν. Κατά συνέπεια, συνήθως εξετάζονται περισσότεροι υποψήφιοι από ότι χρειάζεται.

• Μικρή υποστήριξη για μεταβίβαση τεχνολογίας και έλλειψη επιχειρηματικής κουλτούρας. Μας είπαν ότι υπάρχει περιορισμένη δυνατότητα στο σύστημα για να υποστηρίξει τη μεταβίβαση της τεχνολογίας. Οι νομικές συμβουλές θεωρούνται σπάνιες και τα γραφεία μεταβίβασης τεχνολογίας είναι σπάνια στα περισσότερα ΕΚ. Ωστόσο, ακούσαμε επίσης από το Δίκτυο ΠΡΑΞΗ/Help-Forward Network11 ότι έχει δυνατότητες που υποχρεωθείται να χρησιμοποιηθούν. Με αυτό σχετίζεται και η (εκλαμβανόμενη) έλλειψη «επιχειρηματικής κουλτούρας» και η σχετική αδυναμία αναγνώρισης και εκμετάλλευσης εμπορικών ευκαιριών που προκύπτουν από ιδέες και ευρήματα που παράγει η ερευνητική διαδικασία. Ωστόσο, αναφέρθηκαν κάποιες μεμονωμένες περιπτώσεις πολύ θετικών προσπαθειών για δικτύωση με τη βιομηχανία και δημιουργίας καινοτομικών συμπλεγμάτων (όπως η Πρωτοβουλία Συνεργατικών Σχηματισμών Corallia).

We identified the following opportunities for the Greek R&D system:

- **High-quality researchers responsive to funding opportunities.** Researchers in the RCs were both responsive to funding opportunities and successful at leading or contributing to proposals. They have a set of skills that can be used as future research opportunities arise. Evidence of this capacity is in their successes in securing highly competitive EC FP funding. If experience in ‘grantsmanship’ can be applied to nationally funded research programmes it suggests that competition would be high and this would drive up research quality.

- **Capacity for increasing collaboration with other centres and universities (both domestically and abroad).** There is an opportunity to increase collaboration across institutional boundaries as well as with other countries. This could help drive up research quality and increase the (virtual) critical mass of research groups by creating an environment capable of sustaining excellent research. Furthermore, collaboration could result in economies of scope and scale, linking teaching, research and administrative functions across existing institutional boundaries. Interviewees expressed a strong interest in collaborating in teaching and research – for example, between RCs and nearby universities.

- **Reduced bureaucracy that would allow for greater flexibility and mobility between centres and universities.**
Untapped commercialisable products and services. There appeared to be a number of potentially commercialisable activities pursued by RCs that had not yet been exploited, although it is not clear whether they had any commercial value. One opportunity for commercialisation was the outstanding work done by the Institute of Byzantine Research at the National Hellenic Research Foundation, in which a team of researchers had been digitalising primary historical documents and manuscripts, enabling them to be studied all over the world. More generally, we were told that many RCs and institutes give a low priority to the commercialisation of their research products. In some cases efforts have been made to create clusters or networks involving research and commercial bodies (along with intermediaries), and this initiative could be extended. Wider evidence suggests that the clusters or networks involving research and commercial bodies (along with intermediaries), and this initiative could be extended. Wider evidence suggests that co-location of research and commercial interests within clusters can be an effective way to encourage more market-oriented research, and to take research more quickly into marketable products and services.

Opportunities for government and industry to become 'research customers'. For a research system to run effectively it needs to have an effective supply side (the funding of research, a talent pool and the infrastructure to undertake research) and a demand side that 'asks' the right questions, uses the research and, ultimately, extracts the economic value from the research. There are opportunities to implement policies that will stimulate government and industry demand for research and these are discussed in further detail in the next section, on policy ideas. This could present a win–win situation in which research funding is made more secure by demonstrating its relevance to the public sector, and the public sector draws upon better scientific advice in making decisions. However, there would be a risk if the public sector became too powerful a driver of research activity, both to the independence of research and (since customers find it hard to predict future needs) in the longer term to the availability of good-quality science to support public bodies.

Focus research priorities on national needs where Greece has a comparative advantage. We were told that the absence of any clear national research priorities, combined with the gravitational pull of EC research funding, has prompted a discussion on refocusing research activities on the national priorities of Greece. These


might include economic, cultural and social priorities. Specialisation can either be within a discipline or provide a focus for interdisciplinary work. We were told that there was considerable scope to provide more focus in research activities which would support excellence in a specific area, over and above the range and breadth of topics covered. During the course of this review the Greek government has identified five areas of strategic importance – agro-food, information and communication technologies, materials/chemicals, energy/environment and health/biomedicine – that will now need to be moved into the mainstream of existing and new R&D policy and more clearly specified in the context of priorities.

- **Availability of a highly educated workforce, in Greece and as part of the Greek diaspora.** Greece may have suffered from the departure of many highly successful Greek scientists to work overseas, but that creates an opportunity to attract them back to Greece. The Greek diaspora is estimated to be almost the size of the Greek population (10 million), spread across 140 countries. There is an opportunity to engage this community in supporting the future of Greek science.

- **Recognition of the need for change.** The leadership of the RCs broadly shared the view that there was an urgent need for change. It is hard to know how far reaching this view is, but it at least suggests that there is an opportunity created by the recognition of the need to reform the Greek R&D system.

- **Eπικέντρωση των ερευνητικών προτεραιοτήτων στις εθνικές ανάγκες όπου η Ελλάδα έχει συγκριτικό πλεονεκτήμα.** Μας είπαν ότι η απουσία ξεκάθαρων εθνικών ερευνητικών προτεραιοτήτων σε συνδυασμό με την ισχυρή έλξη της ερευνητικής χρηματοδότησης από την ΕΕ οδήγησε σε μια συζήτηση για να επικεντρωθούν και πάλι οι ερευνητικές δραστηριότητες στις εθνικές προτεραιότητες της Ελλάδας. Αυτές μπορεί να περιλαμβάνουν οικονομικές, πολιτιστικές και κοινωνικές προτεραιότητες. Η εξειδίκευση μπορεί να είναι είτε σε έναν κλάδο ή να επικεντρώνεται σε διεπιστημονική εργασία. Μας είπαν ότι υπήρχαν σημαντικά περιθώρια μεγαλύτερης επικέντρωσης στις ερευνητικές δραστηριότητες που θα υποστήριζαν την αριστεία σε ένα συγκεκριμένο τομέα, πέρα και πάνω από το εύρος και το φάσμα των θεμάτων που καλύπτονταν. Κατά τη διάρκεια αυτής της ανασκόπησης, η ελληνική κυβέρνηση εντόπισε πέντε τομείς στρατηγικής σημασίας – αγρο-τροφικός, τεχνολογίες πληροφορικής και επικοινωνίας, υλικά/χημικά, ενέργεια/περιβάλλον και υγεία/βιοϊατρική - που θα χρειαστεί νώρια να μετακινηθούν στις επικρατούσες τάσεις της υπάρχουσας και νέας πολιτικής Ε&Α και να προσδιοριστούν με περισσότερη σαφήνεια στο πλαίσιο των προτεραιοτήτων.

- **Διαθεσιμότητα εργατικού δυναμικού ανώτερης εκπαίδευσης, στην Ελλάδα και ως μέρος της ελληνικής διασποράς.** Η Ελλάδα μπορεί να έχει υποφέρει από το γεγονός ότι πολλοί ιδιαίτερα επιτυχημένοι Έλληνες επιστήμονες έχουν αναχωρήσει για να εργαστούν στο εξωτερικό, αλλά αυτό δημιουργεί μια ευκαιρία για να τους προσελκύσει να επιστρέψουν στην Ελλάδα. Η ελληνική διασπορά εκτιμάται ότι είναι περίπου στο μέγεθος του ελληνικού πληθυσμού (10 εκατομμύρια) και εξαπλώνεται σε 140 χώρες. Είναι επομένως μια ευκαιρία η κοινότητα αυτή να αρχίσει να συμμετέχει στην υποστήριξη του μέλλοντος της ελληνικής επιστήμης.

- **Αναγνώριση της ανάγκης για αλλαγή.** Η ηγεσία των ΕΚ συμφωνεί με την άποψη ότι είναι επιτακτική η ανάγκη για αλλαγή. Είναι δύσκολο να γνωρίζουμε μέχρι σε κάποιο βαθμό πόσο μπορεί να φτάσει η άποψη αυτή, αλλά τουλάχιστον υποδεικνύει ότι υπάρχει μια ευκαιρία που δημιουργείται από την αναγνώριση της ανάγκης για μεταρρύθμιση του ελληνικού συστήματος Ε&Α.
We identified the following threats to the Greek R&D system:

- **Lack of reform.** A clear message coming from a number of our workshops with the RC leadership is that ‘doing nothing is not an option.’ There is a widespread perception that the threats are significant and pose an imminent risk. The Greek R&D system is seen to be in need of reform and it is hard to resist this conclusion. However, given the interdependencies within the system – and thus the complexity of any reform – it is easy to shy away from change. In the view of many we spoke to, this would be a disastrously missed opportunity. However, reform needs to be thought through, articulated clearly and kept focused. Within the scope of this study, we did not find evidence of any immediate consensus about what a reformed system should look like. Some ideas for reform are proposed in the following section; these are informed by the review and draw from our expertise and experience of R&D systems.

- **Constraints on the state budget and global economic environment.** Reforming a research system in times of relative plenty is hard enough. Doing so in the face of budgetary constraints and within a difficult economic environment is even harder. The threat to a reform process is that opposition to any proposed set of reforms may be even stronger in the current environment.

- **Increasing competition for EU funding.**

- **Financial difficulties of RCs.**

- **Low morale of staff.**

- **Ageing researchers and constraints on personnel hiring.**

- **Constitutional/legal limitations to restructuring.**

Εντοπίσαμε τις ακόλουθες απειλές στο ελληνικό σύστημα Ε&Α:

- **Ελλειψη μεταρρύθμισης.** Ένα σαφές μήνυμα που προκύπτει από αρκετές από τις ημερίδες μας με την ηγεσία των ΕΚ είναι ότι «το να μην κάνουμε τίποτα δεν αποτελεί επιλογή». Υπάρχει μια διαδεδομένη αντίληψη ότι οι απειλές είναι σημαντικές και αποτελούν άμεσο κίνδυνο. Το ελληνικό σύστημα Ε&Α θεωρείται ότι χρειάζεται μεταρρύθμιση και είναι δύσκολο να αντισταθούμε σε αυτό το συμπέρασμα. Ωστόσο, δεδομένων των αλληλεξαρτήσεων εντός του συστήματος – και άρα της πολυπλοκότητας οποιασδήποτε μεταρρύθμισης – η αποφυγή των αλλαγών είναι εύκολη. Κατά την άποψη πολλών από όσους μιλήσαμε, μια τέτοια χαμένη ευκαιρία θα ήταν καταστροφική. Ωστόσο, η μεταρρύθμιση θα πρέπει να μελετηθεί διεξοδικά, να διατυπωθεί με σαφήνεια και να παραμείνει επικεντρωμένη. Στα πλαίσια της παρούσης μελέτης, δεν βρήκαμε στοιχεία άμεσης συναίνεσης για το πώς θα έπρεπε να είναι μια τέτοια μεταρρύθμιση. Στην επόμενη ενότητα προτείνονται ιδέες μεταρρύθμισης. Αυτές διαμορφώνονται από την ανασκόπηση και διαδικασία της ανάπτυξης και την πείρα μας στα συστήματα Ε&Α.

- **Επιρροές του κρατικού προϋπολογισμού και του παγκόσμιου οικονομικού περιβάλλοντος.** Η μεταρρύθμιση ενός ερευνητικού συστήματος σε καιρούς ελλείψεων αφορούν είναι αρκετά δύσκολη. Και κάτι έτσι στις συνθέσεις με τους περιορισμούς στον προϋπολογισμό και σε έναν οικονομικό έναν οικονομικό περιβάλλον.
Increasing competition for EU funding. Successful EC bids have been an important element in the continuing viability of the existing research system. The combined effects of enlargement of the EU and the downward pressure on research (and teaching) budgets in some European countries will increase competition for EC funding. At the same time EC R&D policy is shifting towards requiring more leverage from domestic/private sources. Finally, although research funding from the EU appears to be secure in the short term, it is not known if this will continue into the medium term.

Financial difficulties of RCs. The RCs told us of real and imminent financial difficulties, creating a compressed timetable for reform. The short time scales create the threat that in order to meet immediate financial targets, strategic long-term goals may be ignored. This reinforces the concern identified above by our key informants – namely, that there is a pressing need not only to react quickly but also to do so in a way that will sustain a vibrant and successful R&D sector.

Ageing researchers and constraints on personnel hiring. A sustainable workforce of high-quality research staff set to leave in the coming decade will not, if reform is not enacted soon there could be a significant brain drain in which talent is lost.

Balancing this is the need to provide scientists with the flexibility and freedom that they do not currently have. T o achieve such a balance, the career structure and stability to allow them to focus on their research interests. If reform is not enacted soon there could be a significant brain drain in which talent is lost.

The RCs told us of real and imminent financial difficulties, which may threaten some approaches to reform. Care should be taken either to create new legal entities or to find ways of reshaping existing legal powers, if some of the concepts outlined earlier are to be taken forward.

Constitutional/legal limitations to restructuring. The pattern of RCs and the wider R&D system have evolved in a very particular constitutional and legal context which may threaten some approaches to reform. Care should be taken either to create new legal entities or to find ways of reshaping existing legal powers, if some of the concepts outlined earlier are to be taken forward.
και της γήρανσης του προφίλ του ερευνητικού δυναμικού. Το υψηλό ποσοστό ερευνητικού προσωπικού που αναμένεται να αποχωρήσει στην επόμενη δεκαετία, δεν πρόκειται να αντικατασταθεί πλήρως, με βάση τις τρέχουσες ρυθμίσεις.
• Θεσμικοί/νομικοί περιορισμοί για αναδόμηση. Η μορφή των ΕΚ και το ευρύτερο σύστημα Ε&Α έχουν εξελιχθεί σε ένα πολύ συγκεκριμένο συνταγματικό και νομικό πλαίσιο που μπορεί να απειλήσει κάποιες από τις προσεγγίσεις της μεταρρύθμισης. Θα χρειαστεί προσοχή είτε για τη δημιουργία νέων νομικών προσώπων ή για την εύρεση τρόπων ανασχηματισμού των υπαρχούσων νομικών εξουσιών, εάν κάποιες από τις ιδέες που αναφέρονται νωρίτερα προωθηθούν.
From issues to ideas

- In reviewing the SWOT we have come up with a set of ideas that the Ministry of Education may wish to consider in reforming the Greek R&D system.
- Underpinning these ideas are a conceptual blueprint of the Greek R&D system and a set of fundamental principles, as described in the following slides.
- These ideas are drawn largely from our experience of reviewing R&D systems and need further development and refinement if they are to be implemented.

- Articulate a national research strategy
- Facilitate the consolidation of the research system.
- Establish a Greek NRF.
- Support the next generation of research leadership.
- Create government demand for research.
- Create industry demand for research through procurement.
- Establish an evaluation framework and cycle.

The SWOT analysis raises a large number of issues to be considered in relation to reforming the Greek R&D system. In order to help prioritise these issues, we have developed an outline blueprint that provides a conceptual view of a future R&D system. We then identify seven ideas to be considered in putting together an agenda for reform. The next slide outlines the blueprint, and this is followed by a more detailed discussion of the ideas.
The diagram above attempts to provide a conceptual blueprint for a reformed R&D system in Greece. At the centre are the institutions performing the research – broadly RCs, companies and universities. On the left-hand side is the supply to research the active organisations. This supply is in the form of people, places and project opportunities. Clearly the research system will not operate without excellent, motivated researchers who are focused on developing new knowledge and innovation that will benefit Greece, in terms of scholarly endeavour, social wellbeing and economic development. To maximise this human capital researchers will need – in some (but not all) cases – state-of-the-art facilities and equipment to carry out the work. As noted in the SWOT analysis, this already exists in some places and will need to be maintained and developed further in the future. We would note that, in addition to equipment, in a number of disciplines – including the social sciences and arts and humanities – the infrastructure may be data and databases that also need to be supported. The third element of the supply side is project opportunities, and these depend upon funding. As identified in the SWOT analysis (and developed below in Idea 3), it is essential that this funding supports merit-based excellence, is allocated transparently and is run on a regular funding cycle.

On the right-hand side of the diagram is the demand for research. This comes from the EU and other countries, from the Greek government and from industry. Over recent
years, in science policy there has been recognition that many countries have neglected the demand side instruments in forming R&D and innovation systems. This is also the case for Greece. The demand for research is heterogeneous, coming from many sectors in many forms. Within the context of Greece, we would suggest that the three main constituents of the demand subsystem are the EU, the Greek government and industry locally and globally. As discussed in the SWOT analysis, Greece does comparatively well out of EU funding, although this is under threat with increased competition and changes in EU policy requiring greater leverage. However, as is developed below (Ideas 5 and 6), more needs to be done to stimulate the demand for research from government and from the private sector.

κατανέμεται με διαφάνεια και να λειτουργεί σε ένα τακτικό κύκλο χρηματοδότησης. Στη δεξιά πλευρά του διαγράμματος βρίσκεται η ζήτηση για έρευνα. Αυτή προέρχεται από την ΕΕ και άλλες χώρες, από το ελληνικό κράτος και από τη βιομηχανία. Κατά τα τελευταία χρόνια, στην επιστημονική πολιτική αναγνωρίστηκε ότι πολλές χώρες παραμέλησαν τα οργάνα της πλευράς ζήτησης στο σχηματισμό συστημάτων Ε&Α και καινοτομίας. Αυτή είναι η κατάσταση και στην Ελλάδα. Η ζήτηση για έρευνα είναι ετερογενής, προερχόμενη από πολλούς τομείς σε πολλές μορφές. Στα πλαίσια της Ελλάδας, θα λέγαμε ότι τα τρία βασικά στοιχεία του υποσυστήματος ζήτησης είναι η Ευρωπαϊκή Ένωση, το ελληνικό κράτος και η τοπική και παγκόσμια βιομηχανία. Όπως συζητήθηκε στην ανάλυση SWOT, η Ελλάδα τα πάει συγκριτικά καλά με τη χρηματοδότηση από την ΕΕ, παρόλο που αυτή απειλείται με τον αυξανόμενο ανταγωνισμό και τις αλλαγές στην πολιτική της ΕΕ που απαιτεί μεγαλύτερο πλεονέκτημα χρηματοδότησης. Ωστόσο, όπως αναλύεται παρακάτω (Ιδέες 5 και 6), χρειάζεται να γίνουν περισσότερα για την τόνωση της ζήτησης για έρευνα από το κράτος και από τον ιδιωτικό τομέα.
Blueprint is underpinned by a set of principles

- **Excellence**
  - fund the best research, based on competitive merit-based peer review of research proposals and people

- **Autonomy**
  - make the research community responsible for managing and delivering research outputs and outcome

- **Accountability**
  - ensure that all research outputs and outcomes are evaluated on a regular basis and link success to funding

Underpinning the blueprint is a set of principles for a future Greek R&D system. Complex networks such as R&D systems cannot easily be steered by bureaucratic means but may benefit from co-operation, trust and collaboration. These soft, intangible features of the system can be strengthened by clearly articulating a set of principles to which all stakeholders will be expected to adhere. The proposed principles are excellence, autonomy and accountability.

To strengthen Greek research, it will be necessary to fund the best research, wherever it may be, on an open, competitive basis for individuals and organisations that are truly excellent in international terms. In practice this will mean developing methods – such as international peer review – to identify and support the best research proposals. In practical terms it means continuing and strengthening the use of extensive peer review, which will place the responsibility for allocating research funds on the research community. Ultimately, this means the research community taking responsibility for delivering the research outcomes that are needed in Greece. This level of researcher autonomy is common in many countries but is part of an implicit arrangement whereby researchers are given the freedom to run the research system in exchange for the wider social and economic benefits that arise from research. However, with such autonomy must come accountability. In addition, to enjoy support for the use of public research funds, autonomy must be accompanied by performance monitoring and evaluation.
Αντάλλαγμα ευρύτερα κοινωνικά και οικονομικά οφέλη που προκύπτουν από την έρευνα. Ωστόσο, με τέτοια αυτονομία θα πρέπει να υπάρχει και υπευθυνότητα. Επιπλέον, για τη δυνατότητα χρήσης της δημόσιας χρηματοδότησης για την έρευνα, η αυτονομία πρέπει να συνοδεύεται από παρακολούθηση και αξιολόγηση της επίδοσης.
Idea 1: Articulate a national R&D strategy

- The Greek government should consider publishing a high-level R&D strategy that would:
  - establish a long-term (10+ year) vision for the Greek R&D system
  - set out a series of achievable objectives over the shorter term (i.e. 3-5 years)
  - propose a number of research priorities
  - identify a set of principles that would underpin the national research strategy
  - provide an implementation plan.

- The strategy would primarily be a communication tool that the research community could use to hold the government to account on delivery and vice versa.

- However, if well formulated, a strategy has the potential to transform the R&D system by mitigating some of the weakness and threats identified in the SWOT analysis and exploiting some of the strengths and opportunities.

- A key characteristic of a strategy would be the need to ensure that it had longevity to allow policies to be implemented and embedded within the system.

A clear articulation of the blueprint for a reformed R&D system needs to be complemented by a strategy for how that will be achieved, including the terms of establishing research priorities, new institutional arrangements and time scales for implementing reform. In our interviews and workshops, a number of participants commented on the absence of a government-led science and innovation policy and a lack of overarching strategic orientation for the R&D system. Consideration should be given to formulating a five-year strategy that explicitly sets out a vision, mission and set of strategic goals for the Greek R&D system. The goals could relate to the ideas discussed in the contents that follow, but would need further discussions and consultation with the research community. For each goal it would be important to have a statement of what is going to change (for example, In five years’ time we aim to have ...) and to develop a set of detailed and ‘living’ implementation plans for the different components of the strategy that are made publicly available and updated on a regular basis.

Μια σαφής διατύπωση του προσχεδίου για ένα μεταρρυθμισμένο σύστημα Ε&Α χρειάζεται να συνοδεύεται από μια στρατηγική για το πώς θα επιτευχθεί κατά τέτοιο, περιλαμβανομένων των όρων για την καθέρωση ερευνητικών πολιτικών, νέων ιδιωτικών ρυθμίσεων και χρονοδιαγραμμάτων για την εφαρμογή της μεταρρύθμισης. Στις συνεντεύξεις και ημερίδες μας, αρκετοί από τους συμμετέχοντες σχολίασαν την απουσία μιας πολιτικής για την επιστήμη και την καινοτομία που να προέρχεται από το κράτος και την έλλειψη κυρίαρχου στρατηγικού προσανατολισμού για το σύστημα Ε&Α. Θα μπορούσε επίσης να μελετηθεί η δημιουργία μιας πενταετούς στρατηγικής που θα παρουσιάζει σεφώς ένα όραμα, μια αποστολή κι ένα σύνολο στρατηγικών στόχων για το ελληνικό σύστημα Ε&Α. Οι στόχοι θα ήταν σημαντικά να υπάρχουν και να βρίσκονται παρακάτω, αλλά θα χρειαζόταν επιπλέον συζήτησης και διαβουλεύσεως με την ερευνητική κοινότητα. Για κάθε στόχο θα ήταν σημαντικό να υπάρχει ένα δηλώματα για το πώς θα προχωρήσει και να αναπτυχθεί ένα σύνολο αναλυτικών και «ζωντανών» σχεδίων εφαρμογής για τη διαφορετική στοιχεία της στρατηγικής που θα διατίθενται δημόσια και θα ενημερώνονταν συνεχώς.
Idea 2: Facilitate the consolidation of the research system

- The Greek R&D system is fragmented, with small research groups not achieving critical mass. This is likely to affect quality.
- The RCs could be reorganised to achieve critical mass with either disciplinary and/or geographical focus.
- This need not mean a single entity as some variety and competition may stimulate excellence (and critical mass may also have upper limits).
- Such a reorganisation could be managed (and owned) by the research community, with a process put in place that allows the mergers of RCs. For example:
  - the government could invite applications for 2-4 comprehensive centres that would be multidisciplinary, and geographically dispersed around Greece
  - applicants would establish their track record of research excellence and set out a five-year strategic plan for the future
  - applicants could propose the merger of other RCs, institutes or groups, but this would have to be the decision of the research leadership, based on research excellence
  - RCs that were not acquired by the comprehensive centres would either have to be self-financing or closed down
  - the comprehensive RCs would be reviewed on a quinquennial basis and excellence would be rewarded through further funding.

As noted in the SWOT analysis, the network of RCs and the wider R&D system is fragmented. This is an impediment to achieving a critical research mass and is likely to be one of the factors driving down research quality (as evidenced by the bibliometric analysis). We provide a short discussion paper on critical mass in research in Appendix C. Critical mass is important to achieve but difficult to define. It cannot be reduced to a single number and is best identified by peer review. In a fragmented system such as that in Greece, this judgement should not be left to individual institutes and RCs. Consideration should be given to consolidating the system of RCs, but key to this is finding a balance between the roles of researchers, government and other stakeholders.

One approach would be to take a bottom-up view that draws on the skills and experiences of multiple parties and stakeholders. The aim would be to allow the system to self-consolidate via a government decision to set up a process and create new incentives to encourage RCs and institutes to merge. That would be done on the basis of scientific merit and future strategic plans. The details of such a process would need to be carefully developed, but the GSRT could initiate a process whereby all RCs have to re-bid for funding every five to ten years. Two types of RC could be defined: those that are comprehensive and multidisciplinary and those have a clear disciplinary focus. The GSRT could consider funding X multidisciplinary centres and Y specialist
centres. The number of centres funded would be less than currently exist, thereby forcing centres either to merge or to be closed. Mergers (which need not be on a geographically closely located basis) would be encouraged but would not be directed – it would be up to the research community to determine the future structure of the system. Mergers could also occur at the level of institutes; an institute could move from one RC to another. Proposals would be invited for both multidisciplinary centres and specialist centres in two phases: the first pre-qualification, in which applicants set out an outline strategic plan for the next five years, stating their capacity and capability to deliver the strategy and the track record of the RC and makes strategic sense. The international panel would make decisions about which RCs should be funded and the level of funding. To ensure competition and merit-based funding as well as efficient channeling of limited resources, the number that were successful in the pre-qualification process would need to be fewer than the current number of RCs but greater than the number to be established in future. In the second phase, the shortlisted RCs would need to develop a detailed strategic plan. It would be allowable for those RCs to include institutes that were part of an unsuccessful pre-qualification application if they could demonstrate that their inclusion would add to the track record of the RC and makes strategic sense. The shortlisted RCs would present their strategy to the international panel at a series of site visits. Based on the site visits, the shortlisted RCs would present their strategy to the international peer-review panel. Based on the site visits, the international panel would make decisions about which RCs should be funded and the level of funding. To ensure that this competitive process continues to drive quality, it would be repeated every five or ten years, thereby allowing the system to be self-correcting on a regular basis.

The GTET would be self-correcting on a regular basis. This would be repeated every five or ten years, thereby allowing the international panel at a series of site visits. Based on the site visits, the shortlisted RCs would present their strategy to the international panel. The international panel would make decisions about which RCs should be funded and the level of funding. To ensure competition and merit-based funding as well as efficient channeling of limited resources, the number that were successful in the pre-qualification process would need to be fewer than the current number of RCs but greater than the number to be established in future. In the second phase, the shortlisted RCs would need to develop a detailed strategic plan. It would be allowable for those RCs to include institutes that were part of an unsuccessful pre-qualification application if they could demonstrate that their inclusion would add to the track record of the RC and makes strategic sense. The shortlisted RCs would present their strategy to the international panel at a series of site visits. Based on the site visits, the international panel would make decisions about which RCs should be funded and the level of funding. To ensure that this competitive process continues to drive quality, it would be repeated every five or ten years, thereby allowing the system to be self-correcting on a regular basis.


ναλαμβάνεται κάθε πέντε ή δέκα χρόνια, επιτρέποντας έτσι στο σύστημα να διορθώνεται μόνο του τακτικά.
Idea 3: Establish a Greek NRF

- The majority of OECD and European countries have independent NRFs, such as:
  - US National Science Foundation
  - French Agence Nationale de la Recherche
  - Swedish RC (Vetenskaprådet).

- A Greek NRF should aim to have the following characteristics:
  - fund excellence through competitive merit-based international peer review
  - be at arm’s length from government
  - provide a simple and transparent funding framework
  - guarantee a regular funding cycle
  - establish a level playing field between RCs, universities and other eligible bodies
  - be administratively light.

Consideration should be given to setting up a competitive national research foundation (NRF) that will provide project, programme and fellowship support to the RCs, universities and other research organisations. Greece is unusual in comparison to other European and OECD countries in not having such a body; examples from other countries include the US National Science Foundation, the French Agence National de la Recherche, the Research Council of Norway, and the Swedish Research Council (Vetenskaprådet). There have been indications that such a body has been considered in the past, but the idea was never taken forwards and therefore no action has been taken.

An NRF should focus on research excellence with the potential to establish for proposals around specific research priorities (as outlined in a national research strategy). The NRF should be at arm’s length from government. Funded research should be competitive with the NRF, facilitating the peer review on all incoming proposals, drawing on an international network of peer reviewers who can evaluate proposals.

At its inception, the NRF strategy should be kept simple and clear – for example, by specifying the appropriate

15 The report accompanying the Law 3653/08 which proposed the foundation of a national research organisation (the law is currently inactive until 31 December 2011) predicted about €12m per annum for operational costs.
division of funding between project, programme and fellowship grants. Clearly this mix would need further analysis and supporting evidence from other funders, but the aim is to avoid incremental complication of the funding framework.

Funding should operate in regular cycles, with a publicly available timetable that sets out the deadlines for submission of proposals, notification of outcomes of peer review, the start date of successful applications, and the schedule for payment. It would be imperative that the cycle of funding is adhered to as the research community needs to be able to anticipate and plan its research activities. Indeed, we were told a number of times in interviews that the regularity of funding is more important than the amount of funding made available.

All public R&D bodies should be eligible for funding from the NRF (and consideration could be given to funding private sector organisations). The aim would be to create a level playing field between the RCs and universities in competing for funds. In time this would ensure that funding followed excellence, driving up the quality and impact of Greek research.

The NRF should operate with as small a staff as possible, focusing resources on research and related support activities, with administrative costs being less than 5% of the total funding. It would be important that the NRF is not seen as (another) executive agency, but as an institution through which the scientific community could influence both its own development and its strategy.
Idea 4: Support the next generation of research leadership

• Over the next five years an estimated 20% of the senior leadership (Grade A) will retire from the RCs and universities.

• Combined with the current 1:5 (7) rule on recruitment, this is a major threat to the sustainability of the R&D system.

• The establishment of fellowships for the leading (c50) mid-career researchers in Greece should be considered; these would:
  - be awarded through an open competitive process based on research excellence, as judged by international peer review
  - provide generous and timely funding for salaries, research expenses, international conferencing, etc.
  - support and develop through an intensive programme of leadership training and mentorship
  - facilitate the establishment of a network to ensure a mutual learning environment.

As illustrated above, the Greek R&D system faces a major demographic challenge in terms of workforce ageing. Over the next five years an estimated 20% of Grade A researchers (the equivalent of full professors) will retire from RCs and universities. Compounded with current restrictions on recruitment,16 this creates a major threat to the sustainability of the R&D system. To anticipate and manage that threat a new fellowship scheme could be established with the aim of supporting and mentoring the next generation of research leadership. This would involve identifying, from an open merit-driven competitive process, a cohort of the best 30–50 mid-career researchers and providing them with generous five-year fellowships that cover salaries, research costs, and so on. Over the five years a programme of training and development in non-research areas such as financial management, leadership and communications could be provided so they are well equipped for future research leadership. It might also be beneficial to bring the group together at regular intervals so they develop a community spirit and to provide a mutual learning environment. This idea is, in part, informed by the ‘investigator’ programme funded by the US-based Howard Hughes Medical Institute. The programme is deliberately oriented towards high-risk

16 The 1:5 recruitment rule dictates that only one public-sector employee shall be hired for every five employees who retire/leave the public sector.
and uncertain research, with the view that the majority of projects will fail, but that those that are successful will be paradigm shifting. The fellowship scheme has recently been evaluated, and shown to have greater impact than the National Institute of Health Merit awards. Here we are proposing something that may be less risky than the Howard Hughes model, but that has an added component regarding leadership and management training, and is also aimed at a specific mid-career cohort of researchers.

Idea 5: Create government demand for research

• Government could act as an ‘intelligent customer’ for research, to inform its decision and policy making.
  – To facilitate this ‘demand’, each major policy-making department of government could have a chief scientist or researcher.
  – Reporting directly to the minister, the chief scientist would act as a broker between policy-makers and researchers. In this way s/he would:
    • know what the research priorities of the ministry were and be able to feed these back to the research community
    • ensure that the policy-making community was aware of the expertise and evidence available to inform its decision making.
  – This idea builds on the network of chief scientists developed by the UK government and discussed by the EC.
  – An interdepartmental committee of chief scientists could inform departments about future developments.
• There could also be short-term internships and placements for career scientists to spend short periods in ministries building capacity to understand and use research.

To help ensure that the government acts as an ‘intelligent customer’ for research in its (evidence-based) policy making, a network of chief scientific advisers (CSA) could be established in the major policy-making ministries. The role of a CSA would be to act as a knowledge broker between the policy and political system and the academic and research system. This would involve advising on the evidence underpinning policy proposals, and also feeding back the needs for evidence to the research community, thereby informing research priorities.

Government has the opportunity to align information about research and what it could do with incentives to act on this information, alongside the capacity to act effectively once incentivised to do so. For example, a new technology to deliver e-health has to be recognised and understood, the benefits explained, and the social and technological capacity developed to implement it successfully. Without this, potential mutual benefits may be lost.

Government chief scientists can provide an inexpensive way to ensure that departments and government are kept aware of scientific developments and their potential for use for the public benefit. A further mechanism is to hold (for example) annual horizon scanning activities involving the state, business and social interests in identifying potentially beneficial scientific and technological developments. However, researchers in innovation have shown that if new technologies and innovations are to be used optimally by...
government, public bodies need to develop their capacity to absorb the details\(^\text{18}\) – a department needs the ability to absorb information, to interpret what it implies for the delivery of departmental goals, to change the delivery process in order to use the new technology effectively, and to learn from the experience and adapt in the future. Chief scientists and seconded recruits from research organisations can help departments develop this (but they are unlikely to be sufficient).

This model is underpinned by a strong theoretical framework, originally applied in Canada (and termed ‘linkage and exchange’\(^\text{19}\)) but developed from the ‘co-production of knowledge’ literature.\(^\text{20}\) Linkage and exchange is similar to evidence-based policy making in as much as both strategies aim to link research (new knowledge) to action (decision making), thereby establishing the empirical base for that policy. Nevertheless, there is a key difference between them: evidence-based decision making is predominantly viewed by some scholars in the knowledge transfer literature as a technical exercise that links research to action by creating policy guidelines or performance indicators; by contrast, the linkage and exchange model of connecting research to action aims to include the decision-makers in the process of examining the evidence and focuses on interpersonal connections, making it a social as well as a technical exercise.\(^\text{21}\) In effect the chief scientist would act as the ‘linkage and exchange’ between the research and the policy-making communities.

ασχολείται (για παράδειγμα) με εργασίες ετήσιας διερεύνησης μελλοντικών δυνατοτήτων εμπλέκοντας κρατικά, επιχειρηματικά και κοινωνικά συμφέροντα στον προσδιορισμό δυνητικά ωφέλιμων επιστημονικών και τεχνολογικών εξελίξεων. Ωστόσο, οι ερευνητές στον τομέα της καινοτομίας έδειξαν ότι εάν οι νέες τεχνολογίες και οι καινοτομίες πρόκειται να χρησιμοποιηθούν με τον καλύτερο δυνατό τρόπο από το κράτος, ο δημόσιος τομέας θα χρειαστεί να αναπτύξει τις δυνατότητές του για να αφομοιώσει τις λεπτομέρειες\(^\text{18}\) – ένα τμήμα χρειάζεται την ικανότητα να αφομοιώνει πληροφορίες, να ερμηνεύει τι εννοούν για την επίτευξη των στόχων του τμήματος, να αλλάζει τη διαδικασία παράδοσης ώστε να χρησιμοποιεί αποτελεσματικά τη νέα τεχνολογία και να μαθαίνει από την εμπειρία και να προσαρμόζει στο μέλλον. Οι ανώτεροι επιστημονικοί σύμβουλοι και οι υπάλληλοι που θα έχουν μεταφερθεί από τους ερευνητικούς οργανισμούς μπορούν να βοηθήσουν τα τμήματα να αναπτύξουν τέτοιες δυνατότητες (αλλά είναι σχεδόν σίγουρο ότι δεν θα επαρκούν).

Το μοντέλο αυτό υποστηρίζεται από ένα ισχυρό θεωρητικό πλαίσιο, που αρχικά εφαρμόστηκε στον Καναδά (και ονομάζεται «διασύνδεση και ανταλλαγή»\(^\text{19}\)) αλλά αναπτύχθηκε από τη βιβλιογραφία της «συμπαραγωγή γνώσης».\(^\text{20}\) Το μοντέλο «διασύνδεση και ανταλλαγή» είναι παρόμοιο με τη χάραξη στοιχειοθετημένης πολιτικής καθώς και οι δύο στρατηγικές έχουν στόχο τη σύνδεση της έρευνας (νέα γνώση) με τη δράση (λήψη αποφάσεων), καθιερώνοντας με αυτόν τον τρόπο την εμπειρική βάση για την πολιτική αυτή. Ωστόσο, υπάρχει μια βασική διαφορά μεταξύ τους: η στοιχειοθετημένη λήψη αποφάσεων θεωρείται κυρίως από κάποιους μελετητές στη βιβλιογραφία της μεταβίβαση γνώσης σαν μια τεχνική άσκηση που συνδέει την έρευνα με τη δράση δημιουργώντας κατευθυντήριες πολιτικές ή δείκτες επίδοσης. Αντίθετα, το μοντέλο «διασύνδεση και ανταλλαγή» για τη σύνδεση της έρευνας με τη δράση, έχει σαν στόχο να συμπεριλάβει αυτούς που παίρνουν αποφάσεις στη διαδικασία εξέτασης των στοιχείων και επικοινωνείται στις διαπροσωπικές συνδέσεις, κάνοντας το μια κοινωνική καθώς και τεχνική άσκηση. \(^\text{21}\) Ουσιαστικά, ο ανώτερος επιστημονικός σύμβουλος θα ενεργεί σαν μέσο «διασύνδεση και ανταλλαγή» ανάμεσα στην ερευνητική κοινότητα και την κοινότητα χάραξης πολιτικών.


Idea 6: Create industry demand for research through procurement

- Procurement refers to the purchasing of a service or product; public procurement occurs when the state is the purchaser.
- Innovation procurement exploits the purchasing power of the state to stimulate demand for services or products that do not yet exist, but could be developed within a reasonable period.
- The Greek state spends a significant amount of money a year on purchasing goods and services; a proportion of this could be used to create lead markets for new technologies that would remove some of the innovation risk for the Greek private sector.
- The EC has made a number of recommendations in this area, including a call to member states ‘to use public procurement to drive demand for innovative goods, while at the same time improving the level of public services’ (Aho Report, 2006).

Conventional approaches to science and innovation policy emphasise supply side instruments such as NRFs and R&D tax credits. Procurement refers to the buying or purchasing of a product. Innovative procurement occurs when a desired product does not yet exist, but could probably be developed within a reasonable period of time, as illustrated in the two case studies shown above. A number of recent reports emphasise the use of public procurement to stimulate research and innovation, suggesting that it offers a large and substantially underexploited means of promoting innovation.22

The documented potential of public procurement in stimulating innovations is primarily owing to the provision of ‘early users’ for innovative firms. This provides them with the initial revenue and customer feedback they need (but often cannot find) for the further development of products and services. Other aspects underlying the acknowledged potential include the creation of incentives and the

Source: EC (2005)

**A case study: Eco-innovation in Sweden**

NUTEK, a Swedish agency which conducts procurement exercises on behalf of end-users, conducted a contest for firms to submit bids to supply refrigerators that used fewer chlorofluorocarbons as coolants and consumed less energy than the best available technology. The prize, an order for at least five hundred items, was won by Electrolux.

Source: EC (2007)

**A case study: Variable message signs in England**

The English Highway Agency tendered for new variable message signs for motorways in 2001. Their purpose was to provide information to drivers on advisable speed, lane availability, etc. The agency used an output specification that allowed industry to apply new technology in their proposed solutions. The result was a sign of a type not previously seen, capable of generating graphics as well as text. As a result the agency acquired a good and innovative product. The company concerned went on to sell to new markets in The Netherlands and Russia.


reduction of market risk for suppliers, the ability of public procurement to create new markets for innovations, and the signals to private users sent out by public demand for innovative products. Yet, as Granstrand and Sigurddsson note: although there are several indications that private and public technology procurement is an efficient means of generating economically viable innovations, it does not follow that government policies to stimulate public and/or private technology procurement are easily implemented. In their report for the EC cited above, Edler et al. (2005) set out a number of requirements which make the procurement of an innovative technology more likely to be successful:

- **Reconcile expectations, needs and limitations.** This helps to define the needs that are to be addressed by the supplier, and to facilitate the application of the procured technology later on.
- **Use market intelligence.** This serves to understand what the market can deliver now and in the future. Moreover, it enables the procurer to obtain early feedback on the feasibility of the project.
- **Clearly specify the tender.** The challenge is to strike a balance between a functional specification that is sufficiently detailed to provide clear guidance to suppliers, and a specification that is general to allow for the consideration of alternative solutions.
- **Carefully select an awarding committee.** The committee needs competencies in evaluating the technical, operational and economic requirements defined in the contract award criteria. It is clear, however, that selection will be satisfactory only if the requirements are well defined and the procurement targets are very clear.
- **Manage contract delivery.** This provides opportunities for gathering information and conducting evaluative analyses to draw lessons for future projects. It is important to engage in an ongoing interaction between suppliers and procurers and to treat the project as an ongoing process, rather than a one-off.


Idea 7: Establish a performance monitoring and evaluation framework and cycle

- Focused and proportionate evaluation will support both learning and accountability. This would be helped by a clear and shared monitoring and evaluation (M&E) framework, as illustrated in the example opposite, developed for the English National Institute of Health Research (NIHR).

- A successful M&E framework requires organisations and projects to capture key data along the causal pathway connecting inputs, processes, outputs and outcomes.

- Data collection should focus on what stakeholders and funders are entitled to know and what evidence is needed in order to improve.

- Based on the data, organisations and projects would need to clearly identify their contribution to the whole R&D system, including research absorption and social benefit. Currently, responsibility for this system and its evaluation is fragmented and unclear.

- In time it would be possible to link funding outcomes to research excellence, as captured by the M&E framework.


A rapid review of the Greek research and development system

ducing a small, balanced set of indicators to support strategic decision making has given rise to the idea of ‘dashboards’.27 The graphic in the slide above illustrates a dashboard developed for the English National Institute of Health Research (NIHR).28 In developing such a dashboard, it is essential, in our view, for this to be a collective bottom-up exercise working with the research community and research managers in clarifying the aims and objectives of the R&D strategy, linking this to more concrete deliverables, identifying the aims of those deliverables, how they will be measured, what success will look like and so on.


This annex describes a bibliometric analysis of the Greek R&D system. It is intended to support the SWOT analysis presented in this report and to illustrate the potential use of bibliometrics to inform strategic decision making. Bibliometrics is the quantitative analysis of scientific publication and their citations, typically focusing on journal papers in the peer-review literature. It is one of a set of evaluation methodologies – including case study analysis, peer review, economic rate-of-return analyses and surveys – that may be used to help to assess research systems. The work presented here builds on the recent publication by the National Documentation Centre (NDC) of the National Hellenic Research Foundation (NHRF). The NDC report uses data from the National Science Indicators and National Citation Report Greece databases of Thomson-Reuters for the period 1993–2008 (here we focus on papers published between 2000 and 2004, as described below).


The bibliometric analysis was conducted in collaboration with the NDC at the NHRF. The NDC maintains a database of Greek publications in international journals between the years 1993 and 2008,31 which has been constructed using the Thomson-Reuters / Web of Science NSI databases and NCR-Greece.32 The database contains information about research articles, research notes and literature reviews; and excludes editorials, letters (e.g., to the editors, comments on published articles, etc.), correction notes and abstracts. The NDC kindly provided us with bespoke (sub) datasets and analyses that allowed us to identify the relative research strengths – by RC and research field – of the Greek R&D system and patterns of collaboration.

31 At the time that this study was undertaken 2009 and 2010 data were unavailable. NDC have now purchased the bibliometric data and work is under way to complete the update of the 1993–2008 database with the new data by the end of 2011.
We requested from the NDC the following bibliometric indicators for papers published between 2000 and 2004, by organisation and field of research:
- total number of scientific publications
- number of highly cited papers (HCPs) defined; the top 20% shows the share of publications attributed to a research unit that belong to the 20% most cited publications in the world for the same subject area and during the same time period
- relative citation index (RCI), which corresponds to the relative number of citations to publications from a specific research organisation compared to the world average of citations to publications in the same time period and for the same subject area.

For the RCI we used four impact categories based on those used by the Centre for Science and Technology Studies (CWTS) at the University of Leiden, Netherlands, and others:
- RCI < 0.8 was below world average
- RCI ≥ 0.8 or < 1.2 was world average
- RCI ≥ 1.2 was above world average
- RCI ≥ 2.0 was exceptional.

Publications to research organisations were attributed on a whole counting method.

We used the Thomson-Reuters’ 251 Journal Subject Classification to define research fields.
A rapid review of the Greek research and development system

the world average for its research area; when it is below 1, those publications are not cited as often as the world average for the research area. To differentiate further the citation impact of different groups of papers we use four impact categories developed by the Centre for Science and Technology Studies (CWTS) at the University of Leiden, Netherlands, and described in the slide above. In addition, we examined patterns of co-publications as a proxy indicator of collaboration. The analysis focused on both co-publications between Greek institutions (intra-Greek collaboration) and between Greek and European institutions. It included all Greek universities, RCs and other research organisations. Intra-Greek collaboration was identified when a publication had two or more Greek addresses and Greek–European collaboration was identified when a publication included two or more European addresses.

αριθμός των αναφορών που λαμβάνονται από κάθε άρθρο κανονικοποιείται με το μέσο αριθμό αναφορών που λαμβάνεται από όλα τα άρθρα του ίδιου έτους δημοσίευσης και της ίδιας θεματικής περιοχής, λαμβάνοντας έτσι υπόψη το γεγονός ότι οι πρακτικές αναφορών είναι διαφορετικές για κάθε ερευνητική περιοχή. Όταν ο δείκτης RCI είναι μεγαλύτερος από 1, αυτό σημαίνει ότι ένα άρθρο ή μια ομάδα άρθρων έχει μεγαλύτερη απήχηση από τον παγκόσμιο μέσο όρο για την ερευνητική περιοχή του. Όταν είναι κάτω από 1, οι δημοσιεύσεις αυτές δεν λαμβάνουν αναφορές τόσο συχνά όσο ο παγκόσμιος μέσος όρος για αυτή την ερευνητική περιοχή. Για να διαφοροποιηθεί ακόμη περισσότερο ο δείκτης απήχησης των διαφορετικών ομάδων άρθρων, χρησιμοποιούμε τέσσερις κατηγορίες απήχησης που αναπτύχθηκαν από το Κέντρο Επιστημονικών και Τεχνολογικών Σπουδών (Centre for Science and Technology Studies – CWTS) στο Πανεπιστήμιο του Λάιντεν, στην Ολλανδία, όπως περιγράφονται στην παραπάνω διαφάνεια.

Επιπλέον, εξετάσαμε μορφές συνδημοσιεύσεων ως αντιπροσωπευτικό δείκτη συνεργασίας. Η ανάλυση επικεντρώθηκε τόσο σε συνδημοσιεύσεις μεταξύ ελληνικών ιδρυμάτων (ενδο-ελληνική συνεργασία) και μεταξύ ελληνικών και ευρωπαϊκών ιδρυμάτων. Συμπεριλάμβαναν όλα τα ελληνικά πανεπιστήμια, τα ΕΚ και άλλες ερευνητικές οργανώσεις. Η ενδο-ελληνική συνεργασία προσδιορίστηκε όταν μια δημοσίευση είχε δύο ή περισσότερες ελληνικές διευθύνσεις και η ελληνο-ευρωπαϊκή συνεργασία προσδιορίστηκε όταν μια δημοσίευση περιλάμβανε δύο ή περισσότερες ευρωπαϊκές διευθύνσεις.
Data limitations and caveats

- There are a number of well-known limitations to bibliometric analysis:
  - bibliometric analysis is dependent on the quality and coverage of the bibliographic data indexed on the source databases, in this case the Web of Science
  - citation analysis is only one proxy indicator of ‘quality’
  - there is no underlying theory that explains citation behaviour
  - there are important differences in publication and citation behaviours between fields
  - there is a known language bias in journal coverage that is more pronounced in the humanities, arts and social sciences.
- Bibliometric indicators are reliable for the natural sciences and engineering, but significantly less so for the humanities, arts and social sciences.
- It should also be noted that the data we used are restricted to 2000 to 2004 publications, which means there is a bias against CERTH (established in 2000), ATHENA (established in 2001) and CERETETH (established in 2006).

Although there is a clear correlation between performance assessments carried out on the basis of citation analysis and the results of peer-review processes,33 there are limitations to bibliometric analyses.34 As a result, a number of important qualifications must be borne in mind when assessing the validity of bibliometrics. Citation analysis measures the impact of peer-reviewed publications on other researchers in a given field (and/or outside it), which reflects only one dimension of research impact as a proxy for ‘quality’. A robust definition of quality in research assessment has been elusive, but there is a growing consensus that any judgement of quality will need to be based on a combination of qualitative and quantitative analyses – in other words, bibliometrics should be viewed as one element of a wider process of review.

Citation analysis is predicated on the notion that the reference practices of researchers may reveal high-performing scientists, papers and institutions, as well as popular and influential areas of research. Unfortunately, there is no theory evident to explain why authors cite in the way that they do.35

35 S. Hanney et al. (2005). ‘Using categorisations of citations when assessing the outcomes from health research.’ Scientometrics 65:357-379
Differences between research fields exert important influences over the kind of analysis that can be performed. In certain fields – for example, the applied engineering sciences, social science and arts and humanities – peer-reviewed journal publications are not the primary means for disseminating research findings and it is therefore very difficult to apply bibliometrics to this kind of research, owing to issues of low coverage in bibliometric databases. There are known linguistic biases in the coverage of non-English-language journals in the underlying bibliographic databases, a bias that is more pronounced in the social sciences and humanities. Finally, by definition bibliometric analysis is dated – there is a time lag between the period when the research takes place and the date of publication, and another between publication and citation. To ensure that there is time for enough citations to accrue it is necessary to, in this analysis, focus on publications between 2000 and 2004. Despite these limitations, citation analysis, when used in combination with other methods, can be a very effective tool for strategic planning and informing funding decisions.

καθώς και δημοφιλείς και σημαντικές περιοχές έρευνας. Οι διαφορές ανάμεσα στους ερευνητικούς τομείς ασκούν σημαντικές επιρροές στο είδος της ανάλυσης που μπορεί να γίνει. Σε κάποιες περιοχές – για παράδειγμα, στις επιστήμες εφαρμοσμένης μηχανικής, στις κοινωνικές επιστήμες και τις τέχνες και στις ανθρωπιστικές επιστήμες – οι έγκριτες δημοσιεύσεις σε επιστημονικά περιοδικά δεν είναι το πρωτεύον μέσο για τη διάδοση των ερευνητικών ευρημάτων και είναι επομένως πολύ δύσκολο να εφαρμοστεί η βιβλιομετρική σε αυτού του είδους την έρευνα, λόγω ζητημάτων χαμηλής κάλυψης σε βιβλιομετρικές βάσεις δεδομένων. Υπάρχουν γνωστές γλωσσολογικές διαστρεβλώσεις στην κάλυψη επιστημονικών περιοδικών περιοδικών που δεν είναι στην αγγλική γλώσσα στις υποκείμενες βιβλιογραφικές βάσεις δεδομένων, μια διαστρέβλωση που είναι πιο έντονη στις κοινωνικές και τις ανθρωπιστικές επιστήμες. Τέλος, εξ ορισμού βιβλιομετρική ανάλυση είναι χρονολογημένη – υπάρχει μια χρονική καθυστέρηση ανάμεσα στην περίοδο που γίνεται η έρευνα και την ημερομηνία της δημοσίευσης, και μια ακόμη ανάμεσα στη δημοσίευση και την αναφορά. Παρά αυτού του περιορισμού, η ανάλυση των αναφορών, όταν χρησιμοποιείται σε συνδυασμό με άλλες μεθόδους, μπορεί να είναι ένα πολύ αποτελεσματικό εργαλείο για στρατηγικό σχεδιασμό και ενημέρωση των αποφάσεων χρηματοδότησης.

34 S.Hanney et al. (2005). ‘Using categorisations of citations when assessing the outcomes from health research.’ *Scientometrics* 65: 357-379
36 Note that although the main reason for using publications in this time frame is the need for citations to accrue, the NDC database currently includes publications up to 2008 only.
Bibliometric analysis

- In the following slides we present data on:
  - number of publications by research organisation
  - number of publications by research field
  - number of HCPs by research organisation
  - number of HCPs by research field
  - ‘map’ of HCPs by field and research organisation
  - top 25 centres of excellence as measured by HCPs
  - RCI for all organisations and fields
  - RCI for GSRT RCs and fields
  - GSRT RCs with an RCI ≥ 2.0
  - GSRT RCs with an RCI ≥ 1.2 and < 2.0
  - GSRT RCs with an RCI ≥ 0.8 or < 1.2
  - GSRT RCs with an RCI < 0.8
  - networks of Greek institutions with 50+ collaborative papers
  - networks of European institutions with 100-150, 150-200, 200-250, 250+ collaborative papers
- Please note that to reduce small number issues we present outputs only from organisations with 25 or more papers (i.e. 5 a year).

The following slides present the results of the bibliometric analysis. The first set of slides describes the volume of papers and HCPs by research organisation and fields across the whole of the Greek R&D system. The second set identifies centres of excellence as measured by HCPs or the RCI, focusing on the GSRT RCs. The final slides illustrate collaborative activity through social network diagrams.
The slide above shows the volume of publications published between 2000 and 2004 by research organisations. We have presented information for organisations that have on average more than five papers a year. We have highlighted (in red) the GSRT RCs that formed the focus of our rapid review of the Greek R&D system. The leading ten institutions, in terms of number of papers, are the following:

- National and Kapodistrian University of Athens
- Aristotle University of Thessaloniki
- National Technical University of Athens
- University of Patras
- University of Crete
- University of Ioannina
- Demokritos
- FORTH
- University of Thessaly
- Demokritos University of Thrace.

In total these organisations account for around 23% of research output in Greece.
This slide shows the volume of publications produced between 2000 and 2004 by research field. We have presented information for fields with more than five hundred papers a year. The distribution of fields is less skewed than the preceding slide, with the top ten accounting for around 7% of papers. The ten fields with the highest number of papers are (in order): oncology, electrical and electronic engineering, mathematics, environmental sciences, multidisciplinary materials science, biochemistry and molecular biology, physical chemistry, applied physics, theory and methods in computer science, and surgery.

* Fields with 500 or more publications between 2000-2004 only shown.
The slide above focuses on the number of HCPs – that is, papers that are in the top 20% of citations for their field worldwide – and gives an indicator of their scientific impact as a proxy for quality. In total, we identified 24,278 HCPs published between 2000 and 2004. It is worth noting that the 24,278 HCPs are out of total 252,366 papers from Greece, which is about 10% – half the expected 20% – and indicates the relatively low citation impact of Greek research, as also noted and commented on in the NDC report. The top ten organisations account for 28% of HCPs in Greece. By comparison a recent analysis of HCPs in the UK showed the dominance of four institutions which together account for 45% of university HCPs.\(^38\) FORTH and Demokritos are the only two GSRT RCs that appear in the top ten.


The ten fields with the highest number of HCPs are (in order): chemical engineering, oncology, theory and methods in computer science, electrical and electronic engineering, surgery, polymer science, pharmacology and pharmacy, food science and technology, multidisciplinary physics, and environmental sciences. In is interesting to note the overlap with the volume of papers (Page 53); five fields – oncology, theory and methods in computer science, electrical and electronic engineering, surgery, and environmental sciences – appear in the first ten in both lists, indicating the critical mass is being achieved and at internationally competitive level, whilst the remaining five fields with the highest number of HCPs are niche areas of excellence that could be developed for the future.

Οι δέκα τομείς με το μεγαλύτερο αριθμό HCP είναι (με σειρά): χημική μηχανική, ογκολογία, θεωρία και μεθοδολογία της πληροφορικής, ηλεκτρολόγου και ηλεκτρονικού μηχανικού, χειρουργική, επιστήμη πολυμερών, φαρμακολογία και φαρμακευτική, επιστήμη και τεχνολογία τροφίμων, διεπιστημονική φυσική και περιβαλλοντικές επιστήμες. Έχει ενδιαφέρον να σημειώσουμε την επικάλυψη με τον όγκο των άρθρων (Σελίδα 53); πέντε τομείς – ογκολογία, θεωρία και μεθοδολογία της πληροφορικής, ηλεκτρολόγου και ηλεκτρονικού μηχανικού, χειρουργική και περιβαλλοντικές επιστήμες – εμφανίζονται στα πρώτα δέκα και στις δύο λίστες, υποδεικνύοντας ότι η κρίσιμη μάζα επικαλυπτόται και σε διεθνή ανταγωνιστικό επίπεδο, ενώ οι υπόλοιπες πέντε περιοχές με τον υψηλότερο αριθμό HCP αποτελούν μέρη περιοχών αριστείας που θα μπορούσαν να αναπτυχθούν για το μέλλον.
By cross-tabulating the number of HCPs by organisation and field it is possible to identify centres of excellence within the Greek R&D system. This is illustrated in the slide above. So, for example, the cell that is magnified has 26 HCPs in it and is at the intersection of Biomedical research methods and the RC FORTH – in other words this shows that FORTH has 26 HCPs in the field of biomedical research methods. (An A3 version of the above slide is available from the authors on request for easier reading.) We have highlighted the GSRT RCs and – for illustrative purposive only – the top 25 cells in red in the matrix and the top 50 in pink. We have listed the top 25 in the next slide.

By cross-tabulating the number of HCPs by organisation and field it is possible to identify centres of excellence within the Greek R&D system. This is illustrated in the slide above. So, for example, the cell that is magnified has 26 HCPs in it and is at the intersection of Biomedical research methods and the RC FORTH – in other words this shows that FORTH has 26 HCPs in the field of biomedical research methods. (An A3 version of the above slide is available from the authors on request for easier reading.) We have highlighted the GSRT RCs and – for illustrative purposive only – the top 25 cells in red in the matrix and the top 50 in pink. We have listed the top 25 in the next slide.
Top 25 centres of excellence as measured by HCPs

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Field</th>
<th>HCPs</th>
<th>Total papers</th>
<th>% HCPs /Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>National &amp; Kapodistrian University of Athens</td>
<td>oncology</td>
<td>91</td>
<td>868</td>
<td>10</td>
</tr>
<tr>
<td>Aristotle University of Thessaloniki</td>
<td>engineering, chemical</td>
<td>72</td>
<td>286</td>
<td>25</td>
</tr>
<tr>
<td>National &amp; Kapodistrian University of Athens</td>
<td>cardiology &amp; cardiovascular systems</td>
<td>65</td>
<td>400</td>
<td>16</td>
</tr>
<tr>
<td>National &amp; Kapodistrian University of Athens</td>
<td>pharmacology &amp; pharmacy</td>
<td>59</td>
<td>511</td>
<td>12</td>
</tr>
<tr>
<td>National Technical University of Athens</td>
<td>engineering, electrical &amp; electronic</td>
<td>50</td>
<td>498</td>
<td>10</td>
</tr>
<tr>
<td>National &amp; Kapodistrian University of Athens</td>
<td>obstetrics &amp; gynecology</td>
<td>48</td>
<td>351</td>
<td>14</td>
</tr>
<tr>
<td>Aristotle University of Thessaloniki</td>
<td>chemistry, analytical</td>
<td>47</td>
<td>281</td>
<td>17</td>
</tr>
<tr>
<td>National &amp; Kapodistrian University of Athens</td>
<td>surgery</td>
<td>47</td>
<td>490</td>
<td>10</td>
</tr>
<tr>
<td>Aristotle University of Thessaloniki</td>
<td>environmental sciences</td>
<td>44</td>
<td>411</td>
<td>11</td>
</tr>
<tr>
<td>National &amp; Kapodistrian University of Athens</td>
<td>public, environmental &amp; occupational health</td>
<td>44</td>
<td>202</td>
<td>22</td>
</tr>
<tr>
<td>Aristotle University of Thessaloniki</td>
<td>food science &amp; technology</td>
<td>43</td>
<td>284</td>
<td>15</td>
</tr>
<tr>
<td>National &amp; Kapodistrian University of Athens</td>
<td>endocrinology &amp; metabolism</td>
<td>43</td>
<td>367</td>
<td>12</td>
</tr>
<tr>
<td>National &amp; Kapodistrian University of Athens</td>
<td>dentistry, oral surgery &amp; medicine</td>
<td>42</td>
<td>240</td>
<td>18</td>
</tr>
<tr>
<td>Agricultural University of Athens</td>
<td>food science &amp; technology</td>
<td>39</td>
<td>222</td>
<td>18</td>
</tr>
<tr>
<td>FORTH</td>
<td>polymer science</td>
<td>39</td>
<td>129</td>
<td>30</td>
</tr>
<tr>
<td>National Technical University of Athens</td>
<td>engineering, mechanical</td>
<td>39</td>
<td>177</td>
<td>22</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>engineering, electrical &amp; electronic</td>
<td>39</td>
<td>167</td>
<td>23</td>
</tr>
<tr>
<td>National &amp; Kapodistrian University of Athens</td>
<td>physics, multidisciplinary</td>
<td>38</td>
<td>182</td>
<td>21</td>
</tr>
<tr>
<td>University of Patras</td>
<td>polymer science</td>
<td>38</td>
<td>146</td>
<td>26</td>
</tr>
<tr>
<td>National &amp; Kapodistrian University of Athens</td>
<td>polymer science</td>
<td>36</td>
<td>105</td>
<td>34</td>
</tr>
<tr>
<td>University of Patras</td>
<td>engineering, chemical</td>
<td>36</td>
<td>95</td>
<td>38</td>
</tr>
<tr>
<td>Aristotle University of Thessaloniki</td>
<td>computer science, theory &amp; methods</td>
<td>35</td>
<td>165</td>
<td>21</td>
</tr>
<tr>
<td>FORTH</td>
<td>optics</td>
<td>35</td>
<td>115</td>
<td>30</td>
</tr>
<tr>
<td>National Technical University of Athens</td>
<td>physics, particles &amp; fields</td>
<td>35</td>
<td>182</td>
<td>19</td>
</tr>
<tr>
<td>National Technical University of Athens</td>
<td>telecommunications</td>
<td>34</td>
<td>200</td>
<td>17</td>
</tr>
</tbody>
</table>

This slide shows the top 25 cells, as measured by the number of HCPs, highlighted in the preceding ‘map’ of the Greek R&D system. The first column lists the research organisation, the second the research field, the third the number of HCPs, followed by the total volume of papers and the percentage of HCPs to total papers. In essence this illustrates the centres of excellence within the Greek R&D system as measured through bibliometrics. Three GSRT RCs are listed within the top 25. They are FORTH/polymer science, Demokritos/electrical and electronic engineering, and FORTH/optics.

Η διαφάνεια αυτή παρουσιάζει τα πρώτα 25 κέλια, όπως μετρήθηκαν από τον αριθμό των HCP, τον ισομερές στο ‘χάρτη’ του ελληνικού συστήματος Ε&Α που προηγήθηκε. Η πρώτη στήλη αναφέρει τον ερευνητικό οργανισμό, η δεύτερη τον ερευνητικό τομέα, η τρίτη τον αριθμό των HCP, ακολουθούμενα από τον συνολικό αριθμό άρθρων και το ποσοστό των HCP στο σύνολο των άρθρων. Ουσιαστικά αυτής η πίνακας απεικονίζει τα κέντρα αριστείας εντός του ελληνικού συστήματος Ε&Α όπως μετρήθηκαν μέσω της βιβλιομετρικής. Στη συνέχεια η ΓΕΤ αναφέρεται μέσα τα πρώτα 25. Αυτά είναι: ΙΤΕ/επιστήμη πολυμερών, Δημόκριτος/ηλεκτρολόγου και ηλεκτρονικού μηχανικού και ΙΤΕ/οπτική.
Using HCPs to evaluate research output is a widely accepted and credible way of identifying strongly performing research organisations. However, it does not reflect research performance across the full range of publication outputs as there may be many papers with very low impact. The RCI provides an alternative metric that focuses on the total output of a research organisation. In the slide above we have plotted the RCI for 853 organisation/field combinations where the vertical axis is the RCI and the horizontal axis the total number of papers. So, for example, the data point on the farthest right of the plot is for oncology research at the National and Kapodistrian University of Athens, which produces 868 papers with an RCI of 0.76. The colour bands align with the CWTS impact categories, where the pale red pink shading indicates an RCI below 0.80 (which can be considered as being relatively weak), the yellow an RCI between 0.81 and 1.20 (which can be considered as being within the average range), the green an RCI between 1.21 and 2.0 (which can be considered as being relatively strong) and the space above the green, with an RCI greater than 2.0, indicates areas of exceptional strength competing internationally. In total there are 384 (45%) points in the pale red band, 289 (34%) in the yellow, 148 (17%) in the green, and 32 (4%) classified as being exceptionally strong.

Η χρήση των HCP για την αξιολόγηση της ερευνητικής παραγωγής είναι ένας ευρέως αποδεκτός και αξιόπιστος τρόπος αναγνώρισης ερευνητικών οργανισμών με ισχυρές επιδόσεις. Ωστόσο, δεν αντανακλά τις επιδόσεις της έρευνας στο πλήρες εύρος των δημοσιεύσεων, καθώς μπορεί να υπάρχουν άρθρα με πολύ χαμηλή απήχηση. Ο δείκτης RCI παρέχει έναν εναλλακτικό τρόπο μέτρησης που εστιάζει στη συνολική παραγωγή του ερευνητικού οργανισμού. Στην παραπάνω διαφάνεια, παρουσιάζουμε τον RCI για 853 συνδυασμούς οργανισμού/τομέα, όπου ο κάθετος άξονας είναι ο δείκτης RCI και ο οριζόντιος άξονας είναι ο συνολικός αριθμός των άρθρων. Ετσι, για παράδειγμα, το σημείο δεδομένων στη δεξιά άκρη του γράφημα αφορά την έρευνα στην περιοχή της ογκολογίας στο Εθνικό και Καποδιστριακό Πανεπιστήμιο Αθηνών, το οποίο παράγει 868 άρθρα με RCI 0.76. Οι χρωματιστές λωρίδες ευθυγραμμίζονται με τις κατηγορίες απήχησης του CWTS, όπου ο χρώμα τα χρώμα αντιστοιχεί σε δείκτη RCI κάτω από 0.80 (που μπορεί να θεωρηθεί σχετικά αδύναμο), το κίτρινο χρώμα αντιστοιχεί σε δείκτη RCI ανάμεσα σε 0.81 και 1,20 (που μπορεί να θεωρηθεί ότι είναι εντός του μέσου εύρους), το πράσινο χρώμα αντιστοιχεί σε RCI ανάμεσα σε 1,21 και 2,0 (που μπορεί να θεωρηθεί ότι είναι σχετικά ισχυρό) και ο χώρος πάνω από το πράσινο, με RCI πάνω από 2.0, υποδεικνύει περιοχές εξαιρετικής ισχύος που ανταγωνίζονται διεθνώς. Συνολικά, υπάρχουν 384 (45%) σημεία στην ροζ λωρίδα, 289 (34%) στην κίτρινη, 148 (17%) στην πράσινη και 32 (4%) έχουν κατηγορη- ριστηθεί ως εξαιρετικά εξαιρετικά ισχυρά.
This slide is identical to the preceding one except that it displays only the data for the GSRT RCs. In this slide there are 106 data points and RC/field combinations, with 26 (24%) within the pale red band, 47 (44%) within the yellow band, 25 (24%) within the green band, and 8 (7%) above the green band. There follow four slides listing the RCs and fields for each of these bands. It is interesting to note that proportionately there are fewer data points with a RCI below 0.8 than for all research organisations (i.e. 24% versus 45%), and more with a RCI greater then 1.2 (31% versus 21%). This indicates that, on average, the RCs are outperforming the other research and academic institution within the Greek R&D system using the RCI metric.

Η διαφάνεια αυτή είναι ίδια με την προηγούμενη με μία εξαίρεση, ότι απεικονίζει μόνο τα δεδομένα για τα ΕΚ της ΓΓΕΤ. Στη διαφάνεια αυτή υπάρχουν 106 σημεία δεδομένων και συν-δυναμικά ΕΚ/επιστημονικής περιοχής, με 26 (24%) εντός της ροζ λωρίδας, 47 (44%) εντός της κίτρινης λωρίδας, 25 (24%) εντός της πράσινης λωρίδας και 8 (7%) πάνω από την πράσινη λωρίδα. Στη συνέχεια, ακολουθούν τέσσερις διαφάνειες που αναφέρουν τα ΕΚ και οι τομείς για καθεμία από τις λωρίδες αυτές. Έχει ενδιαφέρον να σημειώσουμε ότι αναλογικά υπάρχουν λιγότερα σημεία δεδομένων με RCI κάτω από 0,8 από ότι για όλους τους ερευνητικούς οργανισμούς (δηλ. 24% έναντι 45%) και περισσότερα με RCI πάνω από 1,2 (31% έναντι 21%). Αυτό υποδεικνύει ότι, κατά μέσο όρο, τα ΕΚ ξεπερνούν τα άλλα ερευνητικά και ακαδημαϊκά ιδρύματα εντός του ελληνικού συστήματος Ε&Α χρησιμοποιώντας το δείκτη μέτρησης RCI.
### GSRT RCs with an RCI ≥ 2.0

<table>
<thead>
<tr>
<th>Centre</th>
<th>Field</th>
<th>RCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>FORTH</td>
<td>genetics &amp; heredity</td>
<td>3.01</td>
</tr>
<tr>
<td>FORTH</td>
<td>optics</td>
<td>2.94</td>
</tr>
<tr>
<td>NOA</td>
<td>telecommunications</td>
<td>2.70</td>
</tr>
<tr>
<td>NCSR Demokritos</td>
<td>crystallography</td>
<td>2.42</td>
</tr>
<tr>
<td>FORTH</td>
<td>physics, multidisciplinary</td>
<td>2.42</td>
</tr>
<tr>
<td>NCSR Demokritos</td>
<td>engineering, multidisciplinary</td>
<td>2.27</td>
</tr>
<tr>
<td>FORTH</td>
<td>physics, mathematical</td>
<td>2.12</td>
</tr>
<tr>
<td>FORTH</td>
<td>mathematics</td>
<td>2.09</td>
</tr>
</tbody>
</table>

There are eight data points with a RCI greater than 2.0 (i.e., those plotted above the green panel in Page 58). These RC/field combinations may be considered areas of exceptional strength. It is noticeable that five of the eight come from FORTH, two from Demokritos and the final one from the NOA.

Υπάρχουν οκτώ σημεία δεδομένων με RCI πάνω από 2.0 (δηλ. αυτά που έχουν χαραχτεί πάνω από το πράσινο πλαίσιο στην Σελίδα 58). Αυτοί οι συνδυασμοί ΕΚ/τομέα μπορεί να αφορούν περιοχές εξαιρετικής ισχύος. Αξίζει να σημειωθεί ότι πέντε από τα οκτώ προέρχονται από το FORTH, δύο από το Δημόκριτο και το τελευταίο από το ΕΑΑ.
### GSRT RCs with an RCI ≥ 1.2 and < 2.0

<table>
<thead>
<tr>
<th>Centre</th>
<th>Field</th>
<th>RCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOA</td>
<td>engineering, electrical &amp; electronic</td>
<td>1.94</td>
</tr>
<tr>
<td>FORTH</td>
<td>engineering, chemical</td>
<td>1.94</td>
</tr>
<tr>
<td>FORTH</td>
<td>engineering, environmental</td>
<td>1.86</td>
</tr>
<tr>
<td>FORTH</td>
<td>biotechnology &amp; applied microbiology</td>
<td>1.85</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>telecommunications</td>
<td>1.85</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>engineering, electrical &amp; electronic</td>
<td>1.66</td>
</tr>
<tr>
<td>NHRF</td>
<td>polymer science</td>
<td>1.65</td>
</tr>
<tr>
<td>FORTH</td>
<td>mechanics</td>
<td>1.64</td>
</tr>
<tr>
<td>GAEC</td>
<td>nuclear science &amp; technology</td>
<td>1.61</td>
</tr>
<tr>
<td>FORTH</td>
<td>polymer science</td>
<td>1.56</td>
</tr>
<tr>
<td>NHRF</td>
<td>chemistry, medicinal</td>
<td>1.53</td>
</tr>
<tr>
<td>FORTH</td>
<td>cell biology</td>
<td>1.50</td>
</tr>
<tr>
<td>FORTH</td>
<td>computer science, interdisciplinary</td>
<td>1.46</td>
</tr>
<tr>
<td>FORTH</td>
<td>mathematics, applied</td>
<td>1.44</td>
</tr>
<tr>
<td>HCMR</td>
<td>fisheries</td>
<td>1.38</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>chemistry, inorganic &amp; nuclear</td>
<td>1.37</td>
</tr>
<tr>
<td>CERTH</td>
<td>engineering, chemical</td>
<td>1.33</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>engineering, chemical</td>
<td>1.29</td>
</tr>
<tr>
<td>FORTH</td>
<td>computer science, information systems</td>
<td>1.28</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>chemistry, medicinal</td>
<td>1.28</td>
</tr>
<tr>
<td>CERTH</td>
<td>energy &amp; fuels</td>
<td>1.27</td>
</tr>
<tr>
<td>CERTH</td>
<td>environmental sciences</td>
<td>1.26</td>
</tr>
<tr>
<td>FORTH</td>
<td>biochemistry &amp; molecular biology</td>
<td>1.26</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>oncology</td>
<td>1.21</td>
</tr>
<tr>
<td>FORTH</td>
<td>engineering, electrical &amp; electronic</td>
<td>1.21</td>
</tr>
<tr>
<td>CERTH</td>
<td>chemistry, applied</td>
<td>1.20</td>
</tr>
<tr>
<td>FORTH</td>
<td>environmental sciences</td>
<td>1.20</td>
</tr>
</tbody>
</table>

The 27 RC/field combinations that have a research impact that is significantly greater than average are listed above (i.e., those plotted in the green panel in Page 59). As with the preceding slide these are areas of research strength that need to be preserved and/or developed. The majority come from either FORTH (12 out of 27) or Demokritos (6 out of 27).
<table>
<thead>
<tr>
<th>Centre</th>
<th>Field</th>
<th>RCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>physics, particles &amp; fields</td>
<td>1.18</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>physics, nuclear</td>
<td>1.18</td>
</tr>
<tr>
<td>FORTH</td>
<td>physics, condensed matter</td>
<td>1.17</td>
</tr>
<tr>
<td>FORTH</td>
<td>materials science, coatings &amp; films</td>
<td>1.17</td>
</tr>
<tr>
<td>HPI</td>
<td>immunology</td>
<td>1.17</td>
</tr>
<tr>
<td>FORTH</td>
<td>physics, atomic, molecular &amp; chemical</td>
<td>1.16</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>materials science, coatings &amp; films</td>
<td>1.16</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>physics, applied</td>
<td>1.15</td>
</tr>
<tr>
<td>FORTH</td>
<td>astronomy &amp; astrophysics</td>
<td>1.14</td>
</tr>
<tr>
<td>FORTH</td>
<td>chemistry, analytical</td>
<td>1.14</td>
</tr>
<tr>
<td>FLEMING</td>
<td>biochemistry &amp; molecular biology</td>
<td>1.13</td>
</tr>
<tr>
<td>FORTH</td>
<td>biophysics</td>
<td>1.13</td>
</tr>
<tr>
<td>FORTH</td>
<td>chemistry, physical</td>
<td>1.12</td>
</tr>
<tr>
<td>FORTH</td>
<td>physics, applied</td>
<td>1.09</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>engineering, environmental</td>
<td>1.07</td>
</tr>
<tr>
<td>HCMR</td>
<td>marine &amp; freshwater biology</td>
<td>1.07</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>polymer science</td>
<td>1.06</td>
</tr>
<tr>
<td>FORTH</td>
<td>materials science, multidisciplinary</td>
<td>1.04</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>physics, multidisciplinary</td>
<td>1.03</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>physics, mathematical</td>
<td>1.02</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>nuclear science &amp; technology</td>
<td>1.01</td>
</tr>
<tr>
<td>NOA</td>
<td>meteorology &amp; atmospheric sciences</td>
<td>1.01</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>materials science, multidisciplinary</td>
<td>0.99</td>
</tr>
</tbody>
</table>

The 44 RC/field combinations that may be considered as having average performance compared to the rest of the world are listed above (i.e. those plotted in the yellow panel in page 59).
### GSRT RC with an RCI < 0.8

<table>
<thead>
<tr>
<th>Centre</th>
<th>Field</th>
<th>RCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>CERTH</td>
<td>engineering, electrical &amp; electronic</td>
<td>0.79</td>
</tr>
<tr>
<td>CERTH</td>
<td>materials science, multidisciplinary</td>
<td>0.78</td>
</tr>
<tr>
<td>FORTH</td>
<td>meteorology &amp; atmospheric sciences</td>
<td>0.77</td>
</tr>
<tr>
<td>FORTH</td>
<td>nanoscience &amp; nanotechnology</td>
<td>0.76</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>nanoscience &amp; nanotechnology</td>
<td>0.75</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>biochemistry &amp; molecular biology</td>
<td>0.75</td>
</tr>
<tr>
<td>NOA</td>
<td>geochemistry &amp; geophysics</td>
<td>0.73</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>computer science, theory &amp; methods</td>
<td>0.73</td>
</tr>
<tr>
<td>CRES</td>
<td>energy &amp; fuels</td>
<td>0.71</td>
</tr>
<tr>
<td>NHRF</td>
<td>physics, condensed matter</td>
<td>0.71</td>
</tr>
<tr>
<td>FORTH</td>
<td>biochemical research methods</td>
<td>0.70</td>
</tr>
<tr>
<td>HCMR</td>
<td>geosciences, multidisciplinary</td>
<td>0.70</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>environmental sciences</td>
<td>0.70</td>
</tr>
<tr>
<td>NHRF</td>
<td>chemistry, physical</td>
<td>0.69</td>
</tr>
<tr>
<td>NHRF</td>
<td>physics, atomic, molecular &amp; chemical</td>
<td>0.69</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>chemistry, organic</td>
<td>0.69</td>
</tr>
<tr>
<td>NHRF</td>
<td>optics</td>
<td>0.67</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>spectroscopy</td>
<td>0.66</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>physics, atomic, molecular &amp; chemical</td>
<td>0.66</td>
</tr>
<tr>
<td>FORTH</td>
<td>instruments &amp; instrumentation</td>
<td>0.61</td>
</tr>
<tr>
<td>NOA</td>
<td>astronomy &amp; astrophysics</td>
<td>0.61</td>
</tr>
<tr>
<td>NHRF</td>
<td>biochemistry &amp; molecular biology</td>
<td>0.59</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>meteorology &amp; atmospheric sciences</td>
<td>0.58</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>chemistry, applied</td>
<td>0.57</td>
</tr>
<tr>
<td>NCSR DEMOKRITOS</td>
<td>chemistry, analytical</td>
<td>0.43</td>
</tr>
</tbody>
</table>

The 25 RC/field combinations with a RCI less than 0.8 are listed above (i.e. those plotted in the pale red panel in Page 59). These are areas of research weakness that may need restructuring.
To supplement the bibliometric analysis, we examined the level of intra-Greek and Greek–European collaboration using social network analysis. The analysis was based on two extracts from the 2000–2004 Greek publications database provided by the NDC. The first dataset included Greek publications with two or more Greek addresses – that is, two or more authors who were affiliated with Greek institutions – and the second dataset included publications with one or more Greek authors and two or more European (including non-EU27) authors. The social network analysis of these data helped us to investigate the level of collaboration among Greek researchers, and among Greek and European researchers.

The slide above illustrates the relationships between Greek research organisations that have published more than fifty collaborative papers. We have used the 50-paper filter as the network diagram would be too dense if we plotted all possible collaborations. The level of collaboration between the 167 research organisations in Greece is shown in Table 2 below; the figure depicts relationships between research institutions using data from the last three rows of the table. As may be seen in the slide and the table, the level of collaboration is low (and this was confirmed in the NDC report, as noted earlier). As you would expect, the multidisciplinary RCs (such as FORTH, Demokritos) and the universities with the highest number of publications and collaborations are located in the centre. These institutions
are the ‘central actors’ in the research system in Greece. On the other hand, the more specialised centres – such as HCMR and the Hellenic Pasteur Institute (HPI) – are located at the outside.

Table 2: Collaboration intensity by institute pairs, Greek institutions

<table>
<thead>
<tr>
<th>Number of collaborative papers</th>
<th>Number of pairs of research organisations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>847</td>
</tr>
<tr>
<td>Between 2 and 10</td>
<td>1267</td>
</tr>
<tr>
<td>Between 11 and 49</td>
<td>444</td>
</tr>
<tr>
<td>Between 50 and 100</td>
<td>89</td>
</tr>
<tr>
<td>Between 101 and 1000</td>
<td>92</td>
</tr>
<tr>
<td>Over 1000</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Αριθμός άρθρων με συνεργασίες</th>
<th>Αριθμός ζευγών ερευνητικών οργανισμών</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>847</td>
</tr>
<tr>
<td>Μεταξύ 2 και 10</td>
<td>1267</td>
</tr>
<tr>
<td>Μεταξύ 11 και 49</td>
<td>444</td>
</tr>
<tr>
<td>Μεταξύ 50 και 100</td>
<td>89</td>
</tr>
<tr>
<td>Μεταξύ 101 και 1000</td>
<td>92</td>
</tr>
<tr>
<td>Ανω των 1000</td>
<td>3</td>
</tr>
</tbody>
</table>
The slide above illustrates the relationships between Greek research organisations that have published between 100 and 149 collaborative papers.

We had to use a higher filter of 250 papers as there were many more institutions (n = 10,574) and institution pairs (as shown in Table 3 below). The only two RCs that are shown to be collaborating intensely with other European institutions are Demokritos and FORTH.

Table 3: Collaboration intensity by institution pairs, European institutions

<table>
<thead>
<tr>
<th>Number of collaborative papers</th>
<th>Number of pairs of research organisations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between 1 and 99</td>
<td>157, 157</td>
</tr>
<tr>
<td>Between 100 and 149</td>
<td>598</td>
</tr>
<tr>
<td>Between 150 and 199</td>
<td>386</td>
</tr>
<tr>
<td>Between 200 and 249</td>
<td>370</td>
</tr>
<tr>
<td>Over 250</td>
<td>389</td>
</tr>
</tbody>
</table>
The slide above illustrates the relationships between Greek research organisations that have published between 150 and 199 collaborative papers.
The slide above illustrates the relationships between Greek research organisations that have published between 200 and 249 collaborative papers.

Η παραπάνω διαφάνεια απεικονίζει τις σχέσεις ανάμεσα στους ελληνικούς ερευνητικούς οργανισμούς που έχουν δημοσιεύσει από 200 έως 249 άρθρα με συνεργασίες.
The slide above illustrates the relationships between Greek research organisations and other European research organisations that have more than 100 collaborative papers.

Η παραπάνω διαφάνεια απεικονίζει τις σχέσεις ανάμεσα στους ελληνικούς ερευνητικούς οργανισμούς και άλλους ευρωπαϊκούς ερευνητικούς οργανισμούς που έχουν περισσότερα από 250 άρθρα με συνεργασίες.
Appendix A – Technical Specification:
A review of the Greek research system in view of the new institutional framework for Research and Technology in Greece

1. This paper presents a proposal from RAND Europe to undertake a rapid review of the Greek research system, in response to the invitation to submit an offer dated 14th March 2011 (refer 2977). The review will inform the prospective restructuring of the research and higher education sectors with the aim of improving their effectiveness and management.

2. Key to longer term development of the Greek economy will be the establishment of a vibrant knowledge based economy in Greece, supported by a strong research system that not only depends on the strength of its individual actors – firms, government, research centres, universities etc. – but also on the links between them.

3. In the current context this means developing a strategy that will ensure government expenditure on research and development is focused on areas of strength that can be protected and enhanced to stimulate future growth. The challenge is to identify which parts of the research system are currently or potentially critical for the future.

4. We propose to undertake two complimentary analyses as part of the rapid review. The first will be a SWOT analysis based on key informant interviews, document and data review and our extensive experience of research systems. The second will be a bibliometric analysis of peer reviewed research publications in the serial literature. The two analyses will be synthesised in a final restricted distribution documented briefing.

SWOT analysis

5. A SWOT analysis is a simple planning tool that can identify internal and external factors that need to be considered in formulating a new policy objective, plan or strategy. We propose to use it to assess the Research Centres supervised by GSRT and other centres were data may be available. This analysis will inform the rapid review by identifying strengths and weaknesses internal to the research system and the opportunities and threats presented by the external environment.

6. We will complete the SWOT analysis by undertaking desk research, key informant interviews, and bibliometric analysis described below. We will use a number of evaluation criteria in the SWOT analysis including:
   - Knowledge production ie scientific outputs as captured via bibliometric indicators, other non-journal reports, etc
   - Research targeting and capacity building ie external following on funding for research project, development of career paths include PhDs, post-docs etc.
   - Informing policy and product development i.e. number of patents, licences and products (where reported), as well as non-commercial impacts such as informing policy guidelines, standards etc

7. We will where possible examine the strategic viability of future plans for Centres and Institutes, and more importantly the coherence of the plan to one-another. Where possible we will look at financial indicators, but note that given the timescales this is likely to be a very high level analysis.

8. The desk research will involve reading and assessing key documents and analysis of relevant data (such as R&D expenditure, Reports on Innovations etc). We will use key documents and data provided to us, including previous and any current assessments of the Research Centres and Institutes supervised by GSRT and other relevant material. We will complete the majority of the desk research prior to the key informant interviews. In this way we will have developed our knowledge of the Greek research system as well as identifying areas to focus on, explore and investigate in the interviews. The output of the desk research will be a memorandum for the project team.

9. For the key informant interviews we would like to speak to a diverse range of people. We suggest spending a week in Athens to meet: key individuals at the Ministry, GSRT, Research Centres, Universities, R&D intensive companies and other essential actors in the research system. Our preference would be to hold these meetings on the week commencing 28th March. We will rely on the Ministry in arranging these interviews and agenda for that week. We would anticipate undertaking a total of round 20-30 interviews.

10. In addition to the interviews with key actors we would like to speak to members of the National Research Council. By necessity the majority of these interviews will need to be telephone based. We would be happy to arrange these interviews but it would be helpful if an email/letter of introduction was sent by the Minister/Ministry.

11. We will synthesise our analysis of the desk research and interviews in a SWOT analysis. Our intention would be to focus on the key strengths, weaknesses, opportunities, and threats facing the Greek research system and to provide a commentary and analysis of each factor. For example, one of our emergent observations from our preliminary work undertaken in preparing this proposal is that the Centre/Institute structure is organisationally fragmented which is potentially preventing critical mass being achieved and thus is driving down the quality of research output (as measured by normalised citation indicators). Clearly this observation needs testing but if proven it could lead to a number of actionable policy recommendations arising from the analysis.
Bibliometric analysis

12 Bibliometrics is the quantitative analysis of scientific publication and their citation, typically focusing on journal papers in the peer review literature. It is one of a set of evaluation methodologies – including case study analysis, peer review, economic rate-of-return analyses and surveys – that may be used to help assess research systems.

13 We propose to work with the National Document Centre (NDC) to integrate further the dataset they complied for their recent report summarised in the Box. We will need to work with the NDC to develop (a) research profiles of each Centre/Institute which capture the number and impact of papers by the 250 subject fields defined in the Web of Science (WoS); (b) compare these profiles with the University sector; and (c) identify areas of collaboration between Centre/Institutions and with other sectors (i.e. Greek Universities and internationally). Specifically and initially we will need the NDC to compute (a) the field normalised citation score for each of the Research Centres/Institutes by the 250 journal subject categories published by Thomson Reuters and compare this against various benchmarks; (b) identify the number of highly cited papers (ie is paper that fall within the top-20 percentile of publications with the highest normalised by citations rate by journal subject categories; (c) generate social network maps/matrixes of intra-Centre/Institute collaboration. From reading the report it appears that the NDC has National Science Indicators database for Greece, and also use Essential Science Indicators published by Thomson Reuters. If that is the case it should be possible to compute these disaggregated field level statistics.

14 RAND has significant expertise in using bibliometrics to support research funders. Working collaboratively with the Centre for Science and Technology (CWTS) in the Netherlands, we delivered a series of regular bibliometric assessments on the English health research system that have supported the allocation of over £1bn of research funds into centres of excellence and faculty. We look forward to working collaboratively with the NDA, both to assist them in their bibliometric capability and capacity and to inform our own development.

15 We would also like to stress that there are a number of well-known limitations to bibliometric analysis and that the results will need to be used within that context, and for that reason the analysis is intend to inform (not substitute) decision making of the Ministry.

Box 1. Summary of main findings from the study: ‘Greek scientific publications 1993-2008: Bibliometric analysis of Greek publications in international scientific journals’ (in Greek)

- The number of publications in international journals has been increasing. In the period 1993-2008, Greece demonstrated the highest growth rate in journal publications amongst the EU27 and OECD countries; Greece was ranked 5th amongst all OECD countries,
- The number of citations and the citation impact of these publications also increased in the period 1993-2008. However, the citation impact of Greek journal publications remained lower (3.82 between 2004 and 2008) than the average citation impact of EU27 (5.03) and OECD (5.20) countries,
- The focus of Greek researchers was on Natural Sciences (51.4% of all publications) with decreasing trends in recent years,
- ‘Medical & Health Sciences’ has significantly increased. Between 2003 and 2008, the articles published in this area accounted for 37.5% of all international journal publications. In particular, the sub-area of ‘Health Sciences’ has exhibited a remarkably increasing trends,
- ‘Engineering & Technology’ publications account for 23.7% of all publication in international journals. Emerging areas are those of ‘Nano-technology’ whereas increasing trends were observed in the areas of ‘Civil Engineering’, ‘Environmental Engineering’, ‘Industrial Biotechnology’ and ‘Materials Engineering’,
- Social sciences’ publications accounted for only 5% of all journal articles published in the period 1993-2008; Agricultural sciences and Humanities account for 3.6% and 1% of all journal publications in the period 1993-2008, respectively.

Note: The bibliometric analysis used the ‘whole counting’ method, hence the percentages of publications across fields do not add up to 100%.

Reporting

16 We will synthesize our analysis into a restricted distribution documented briefing for the Minister and her officials. In a documented briefing the key message of the report can be found in slides at the top of each page with the text providing further details underneath. This layout will highlight the major observations of the review but also allow the reader the option to delve deeper into the detail of the review as circumstances permit.

1 http://www.ekt.gr/metrics/
A rapid review of the Greek research and development system

RAND Europe’s experience

RAND Europe is an independent not-for-profit research institute whose mission is to help improve policy and decision-making through research and analysis. We realise our mission by undertaking objective, balanced, and relevant research and analysis; communicating our findings to a wide audience, often through publications, many of which are available on our website; working in partnership with our clients; and working collaboratively with others. RAND Europe’s work lies on the continuum between that of universities and consultancies, combining the academic rigour of universities and the professional, task oriented approach of consultancies.

We are delighted to offer this proposal and believe that RAND Europe is uniquely qualified for this work given our broad experience in research policy, strategy and evaluation having worked for a wide range of government and charitable funders, as illustrated by the list of selected projects in the Annex.

Project team

RAND Europe is committed to professional and collaborative working with clients. We will provide regular email updates about the progress of the work, as well as involving the Ministry at key points to ensure common understanding of the tasks at hand. The RAND Europe team for this project combines substantial and relevant experience in research policy, strategy and evaluation:

- **Jonathan Grant, PhD**, would lead this review. Jonathan is President of RAND Europe, Cambridge, UK. Dr Grant obtained a degree in Population Studies followed by a doctorate investigating the demographic, genetic and epidemiological effects of consanguineous marriages. His main research interests are in research and development strategy, policy and evaluation, and the consequences of low fertility and population ageing in Europe and associated public policy responses. Dr Grant has published widely in a number of areas including on health R&D policy and research evaluation methodologies. He led the project team supporting the English Department of Health’s Research and Development formulation of Best Research for Best Health, and is Co-Director of the DH funded policy research unit that focuses on health R&D policy. Prior to joining RAND Europe in 2002, Jonathan was Head of Policy at the Wellcome Trust.

- **Prof Tom Ling**, is Director of Evaluation and Audit and member of the Executive team at RAND Europe. He has designed and led projects for The Health Foundation, the Department of Health, and the Wellcome Trust and led evaluations for LBRO, DG SANCO, the NAO, European Social Fund, and the UK British Ministry of Defence. Tom understands the potential risks and pitfalls involved in delivering evaluations. He has a detailed knowledge of both ex post and ex ante evaluation and strong project management skills with a reputation for bringing studies in on time and on budget. A particular focus of Tom’s work has been in the area of futures thinking and scenario planning. Tom has published on evaluation and accountability issues and is a member of both the European Evaluation Society and INTEVAL, the international group of researchers in evaluation. Through all of these he worked successfully and closely with policy makers, senior managers, service users and staff. He is also a Professor (Emeritus) of Public Policy at Anglia Ruskin University where he contributes to postgraduate teaching.

- **Dimitris Potolgou, PhD** is an Analyst at RAND Europe in Cambridge, UK. He has a Ph.D. in Urban Transportation Geography from McMaster University, Canada, with this thesis focusing on understanding and predicting demand for conventional and alternative fuelled vehicles. He has expertise in surveys, discrete choice modelling, stated preference techniques, geographic information systems and spatial data analysis. At RAND Europe he has worked on projects focusing on the use of stated preference methods to quantify willingness to pay for public goods and services, such as water services, social care, postal services and to quantify individuals’ trade-offs across privacy, liberty and security. He has also contributed to a comparative study across countries and sectors on the value of life for Roche.

- **Deirdre May Culley** joined RAND Europe as a Research Assistant in January 2010 after completing an MPhil in International Relations at the University of Cambridge, and an internship at the Institute of International and European Affairs (IIEA) in Dublin. Her work has included conducting targeted literature reviews, data analysis, key informant interviews and assisting in a project management capacity on a range of different projects.

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2 www.rand.org/randeurope
3 RAND Europe is ISO 9001 certified. ISO (International Organization for Standardisation) is the world’s largest developer of standards. ISO is primarily concerned with «quality management» through meeting customer and applicable regulatory requirements and continually improving performance in this regard. This certification means that all of the procedures within RAND Europe, from research process to administration are independently quality assured.
Annex: Selecting projects illustrating experience in research strategy, policy and evaluation

<table>
<thead>
<tr>
<th>Title</th>
<th>Client</th>
<th>Dates</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning from and Evaluation of the ‘Research Capacity Strengthening in African Institutions’ Initiative</td>
<td>Wellcome Trust</td>
<td>12/2009 – 01/2014</td>
<td>In 2009, the Wellcome Trust launched a research capacity strengthening programme known as the ‘African Institutions Initiative’ (AII). The AII is innovative in its methods and organisation. The Trust has funded networked consortia (7 consortia involving over 18 African countries, and Northern partners). RAND Europe has been commissioned to undertake a four year evaluation and learning project for the AII. The aims of the project are to (i) evaluate the performance of each consortium and ultimately the initiative as a whole, based on high quality evidence; (ii) to support intra, inter and extra consortium networking for learning and exchange; and (iii) to extract lessons learnt from the initiative and disseminate these to the Trust, other funders and relevant stakeholders in academic, policy and practice communities. Our study design and methods are concerned with ensuring that evaluation and learning is participative, objective, comprehensive and feasible.</td>
</tr>
<tr>
<td>Evaluation of the NIHR Collaborations for Leadership in Applied Health Research and Care (CLAHRCs)</td>
<td>SDO</td>
<td>06/2009 – 08/2011</td>
<td>RAND Europe is carrying out a longitudinal large scale three-year evaluation of the nine Collaborations for Leadership in Applied Health Research and Care (CLAHRCs) which were established in October 2008 by the National Institute for Health Research. Their aim is to encourage and strengthen collaborations between Universities and local NHS organisations that are focused on improving patient outcomes through the conduct of applied health research and the implementation of the research findings in practice. In an evaluative approach that develops as the CLAHRCs themselves establish their ways of working, we will explore the various methods and strategies being adopted by CLAHRCs to address the second translation gap and build both translational research and research adoption capacities, identifying common features, promising ideas, and the strengths and weaknesses of various models. We will look at the new processes and structures being established to improve local capacities to undertake and use research. Our evaluation approach is rooted in logic model and theory of change methodologies. We will also examine the impact of CLAHRCs on the processes of commissioning and undertaking local research. Our style of working will be collaborative with the distributed CLAHRC stakeholders and the commissioning body, and we hope to contribute to shared learning and improvement during the lives of the CLAHRCs as well as arriving at an evaluative judgement at the end of the evaluation process.</td>
</tr>
<tr>
<td>Title</td>
<td>Client</td>
<td>Dates</td>
<td>Description</td>
</tr>
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<tr>
<td>Retrosight – Measuring the Outputs and Impacts of Health Research</td>
<td>UK Department of Health and Health Economics Research Group (HERG), Brunel University</td>
<td>10/2005 – 02/2011</td>
<td>This study aims to improve our understanding of how basic and early clinical research develops into patient benefit, focusing on the case of cardiovascular research. The study focuses on cardiovascular disease because of its importance in terms of health, the clear health gains that have been made in the past 15-20 years and because it has often been examined by research on research studies, providing a solid base on which to build. The research is intended to provide suggestions for improving the effectiveness and efficiency of scientific research, as well as to contribute to the accountability of research funders. The study will use 29 case studies, examining the story of individual research grants awarded in the early 1990s and following their development up to the present day. To ensure we capture the full range of benefits developing from the research, we are using archival review, research publications, interviews with researchers and their collaborators, and bibliometric analysis. The DH support of this study is critical in providing the core support for the project and the UK case studies, and it was also pivotal in allowing us to build an international consortium of funders to support the international aspect of the work. For this study, we are collaborating with the Health Economics Research Group at Brunel University; CWTS in Leiden and Linda Butler (a respected Australian bibliometrician). This study adds an international dimension to our extensive work in research impacts.</td>
</tr>
<tr>
<td>Mental Health Retrosight</td>
<td>Science of Science for Mental Health Research Network</td>
<td>12/2009 – 07/2010</td>
<td>Mental Health Retrosight is a three-year, multi-country project to investigate the translation and payback from basic and early clinical mental health research into clinical application and community practice. It will look at research in mental health, with a particular focus on schizophrenia, over the past 20-25 years in Canada, the US and the UK. Building on methodology previously applied by RAND Europe and the Health Economics Research Group (HERG) at Brunel University in the fields of arthritis and cardiovascular research, case studies of research grants awarded in the late 1980s will explore how their findings, methods and ideas were built on and developed up to the present day. A complementary stream of work will look backwards in time from treatment advances made in the last five to ten years, identifying the research which contributed to their development. Driving this bi-directional Retrosight approach is the perception that mental health research has been disproportionately poor in translating from bench to bedside. To help us understand why this is the case, the study aims to: (i) identify the long term...</td>
</tr>
<tr>
<td>Title</td>
<td>Client</td>
<td>Dates</td>
<td>Description</td>
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</tr>
<tr>
<td>Mental Health Retrosight</td>
<td>University of Cambridge and the Arts and Humanities Research Council</td>
<td>06/2009 – 03/2010</td>
<td>payback from mental health research; (ii) identify factors that are associated with the successful translation of research; and (iii) provide actionable insights that will inform future funding policy.</td>
</tr>
<tr>
<td>Assessing the Impact of Arts and Humanities research</td>
<td>University of Cambridge and the Arts and Humanities Research Council</td>
<td>06/2009 – 03/2010</td>
<td>In 2009–2010, RAND Europe was jointly commissioned by the University of Cambridge and the Arts and Humanities Research Council (AHRC) to provide an assessment of the impact of arts and humanities research activities that would be suitable for dissemination to local and national stakeholders, including senior levels of Government. This study used four methods in combination to assess the impact of arts and humanities research activities at the University of Cambridge, in-depth interviews with senior academics, a survey of all arts and humanities researchers at the University, external interviews and detailed cases. Using the Payback Framework, a logic model designed to capture the entire research process from project specification to final impact, this study highlighted a broad range of impacts on, for example, policy, professional practice, education, quality of life, society, the economy, the Arts, and heritage.</td>
</tr>
<tr>
<td>Evaluation of DG SANCO’s Data Management Practices</td>
<td>DG SANCO, European Commission</td>
<td>01/07/2009 – 31/01/2010</td>
<td>Against a perceived increased need for data and “evidence” DG SANCO is currently developing a comprehensive data strategy for their policy making needs. As part of these efforts, Rand Europe already conducted an international benchmarking study to identify potentially good practice. In a second stage we have now been asked to evaluate their current internal data management practices and to develop recommendations how to further develop the system.</td>
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<td>An ex post Evaluation of the cTEN programme</td>
<td>cTEN Management Committee/ Competitiveness and Innovation Programme (CIP), European Commission</td>
<td>12/2006 – 01/2010</td>
<td>This study was an ex post Evaluation of the cTEN programme, which supported (and still supports) the deployment of trans-European electronic services. The evaluation synthesised and updated previous relevant assessments to provide a meta-evaluation of the cTEN Programme within a logical framework consistent with best practice evaluation standards. This included a critical appraisal of the chosen mechanisms of programme implementation. The final evaluation looked at the impact, efficiency, effectiveness, relevance and sustainability of cTEN, and derived lessons learned and recommendations which could inform implementation of the Policy Support Programme and of similar initiatives at Member State and/or EU level.</td>
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<td>Assessing the Impacts of Intellectual Property Rights in Developing Countries</td>
<td>UK Intellectual Property Office</td>
<td>11/2009-12/2009</td>
<td>RAND Europe was commissioned by the IPO to do a literature review on the impacts of intellectual property rights in developing countries. Significant attention was devoted to issues of IP in the health sector. Should intellectual property regimes in developing countries be strengthened and harmonised across the globe? An examination of literature and research concerning the role of intellectual property policies in the development of poor and industrialising countries considers economic and social development along five key dimensions: attracting foreign direct investment; encouraging export diversification; harnessing innovation, research and development; improving public health; and reaping the benefits of genetic resources and traditional knowledge. The study reveals that a country’s intellectual property regime is systematically related to its broader state of development, such that attempts to harmonise intellectual property regimes across the globe will present policymakers with some rewards, but also with a number of unintended consequences and intractable challenges.</td>
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<td>Mapping the Impact of Arthritis Research: RAND ARC Impact Scoring System (RAISS)</td>
<td>Arthritis Research Campaign</td>
<td>03/2009-08/2009</td>
<td>This built upon the project above, and developed an on-line survey tool to replace end of grant reporting for the Arthritis Research Campaign (ARC) – allowing them to map the impact of their entire research funding portfolio and, at the same time, reduce the administrative burden on researchers. The tool developed took the form of a simple, tick-box-based Web questionnaire that explores all the major areas of potential impact - knowledge production, research capacity building and training and affects on policy or product development. The questionnaire should also allow the impacts of research to be followed over time and permit the comparison of areas of research or types of funding. The RAND ARC Impact Scoring System (RAISS) is designed to capture the diversity of biomedical research impacts, while minimising the burden on researchers completing the tool. Implemented as a web questionnaire the tool has 187 Yes/No questions that explore what impacts a piece of research has contributed to. By using high level questions to determine which detail questions are asked and by asking exclusively Yes/No questions the average completion time of the questionnaire is just over half an hour, with 90% of questionnaires completed in less than an hour. However the questionnaire still collects information across a huge range of impacts including on career development; collaboration within and outside academia; research capacity building, research tool production, dissemination in academic and non-academic contexts, impacts on health policy through</td>
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Mapping the Impact of Arthritis Research: RAND ARC Impact Scoring System (RAISS) (continued)

A variety of routes; impacts on education and training of others and a wide variety of intervention, product development and public health advice outcomes.

The tool provides an overview of research impact and a basis for more detailed examination of particular research evaluation questions focussing on the ‘why and how’ of translation. The outputs of the tool can be represented as an impact array that gives an instant overview of the research portfolio and the ease of completion can allow tracking of impacts over time.

A Review of the Impacts of Biomedical Research Units

UK Department of Health 04/2009 – 06/2009

In May 2008, Department of Health commissioned RAND Europe to conduct a review of key stakeholders in Biomedical Research Units (BRUs) in England, to explore what impact the scheme is having on the translational research landscape. BRUs are smaller and more specialised than BRCs. Through BRUs, the NIHR aims to help NHS/University partnerships that are at the forefront of their field internationally to achieve critical mass and thus enable the partnerships to further strengthen research capacity so that they are capable of submitting a credible bid for BRC status in the future.

We conducted in-depth interviews with senior executives from BRUs, including Trust Chief Executives, Deans of the academic partner and BRU Directors. We explored the impacts of the BRU scheme on the health research system, and discussed opportunities and challenges going forward.

The information obtained through our study suggests that the BRU scheme is helping direct the health research system towards pursuing translational research and innovation, with the clear goal of realising patient benefit. The BRUs are already contributing to observable changes in institutional relationships between the NHS and academic partners. For example, Trusts and medical schools are collaborating more closely than in the past, have signed up to the same vision of translational research from bench to bedside, and are managing and governing targeted research resources more professionally and transparently than in the past.

There is also a stronger emphasis on engaging industry and more strategic thinking about strengthening regional and national collaboration with other hospital Trusts, PCTs, research organisations, networks and development agencies. In addition, the scheme is also transforming capacity building in the health research system.

A restricted distribution report was provided to the DH R&D Directorate. The report is being reviewed by those interviewed, and will be made publically available shortly. The results of this study were shared with Trust Chief Executives during a workshop.
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<td>Future networks: Informing the i2010 midterm review</td>
<td>DG INFSO, European Commission</td>
<td>04/2008 – 05/2009</td>
<td>This study developed market and technology scenarios for the future of the ubiquitous networked society; including drivers, bottlenecks and policy recommendations. RAND Europe built on the existing trend and technology foresight work and scientific knowledge, by translating it to effective policy and policy mechanisms and tools for the EU to be more competitive, sustainable and ultimately deliver higher welfare or quality of life for its citizens. The study thus defined the socio-economic policy context driven by connectivity and internet trends and assessed the state of i2010 and how well it is adapted to address the challenges for the short, medium and long term future; and finally, suggested new ways of dealing with these challenges.</td>
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| Mapping the impacts of arthritis research                            | Arthritis Research Campaign | 06/2006 – 02/2009 | One of the tensions in research evaluation is obtaining the necessary information for assessment without over-burdening the researchers who carried out the research. Often surveys over burden researchers and receive low response rates or only a small sample of researcher is case studied. Furthermore the burden of surveying means that research impact cannot be flowed as it develops over time. This project aimed to address this tension by developing a tool that would collect detailed information on impact but use the minimum amount of researcher time.  
This project developed an on-line survey tool to replace end of grant reporting for the Arthritis Research Campaign - allowing them to map the impact of their entire research funding portfolio and, at the same time, reduce the administrative burden on researchers. Nothing similar had been attempted by other major funding organisations and there was no freely available tool for the task.  
The development process involved extensive engagement of ARC researchers and the administrators to ensure it was easy to use and produced information that would be useful for strategic decision making. The final tool took the form of a simple, tick-box-based Web questionnaire that explores all the major areas of potential impact - knowledge production, research capacity building and training and affects on policy or product development. The final questionnaire that took most researchers less than an hour to complete - a substantial time saving on the 4-8 hours previously required for end of grant reports. The questionnaire should also allow the impacts of research to be followed over time and permit the comparison of areas of research or types of funding  
The tool has been integrated into the final reporting system for ARC – largely replacing the previous end of grant report. In terms of wider dissemination the work
| Title                                                                 | Client                     | Dates         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
### Innovation Procurement

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<td>Innovation Procurement</td>
<td>Department of Health (England)</td>
<td>6/2008-2/2009</td>
<td>In January 2006, Best Research for Best Health (BRfBH) set out a mission to create a health research system in which the NHS supports outstanding individuals, working in world-class facilities, conducting leading-edge research, focused on the needs of patients and public?. A number of initiatives have been set up as part of the BRfBH strategy, and RAND Europe was commissioned by the DoH to conduct a review of one such initiative i.e. the NIHR Biomedical Research Centres. The NIHR has created eleven Biomedical Research Centres within leading NHS and University partnerships, to drive progress on innovation and translational research in biomedicine. RAND will investigate whether the centres are achieving their goals, what the challenges and enablers have been, and what the major opportunities, needs and risks are looking forward. A particular interest is on how relationships between academia and the NHS have changed as a result of the centres, and what this has implied in the context of innovation and patient benefit. Under this framework contract with the Department of health, a report was produced (report number DB-580-DH, 2009) to discuss the possible role and limitations of innovation procurement as an innovation policy instrument. The report was funded by the Health Research Development Policy Research Unit of the English Department of Health. The motivation for the report is the increasing interest of policy makers in procurement as an innovation policy measure, while the gap between the policy and economics literature is becoming bigger and bigger. Whereas the policy literature tends to take a relatively broad and sympathetic stance, the economics literature is typically more detailed and less enthusiastic. The aim of the report is to narrow this gap by reviewing the two bodies of literature in the context of two very specific questions — aiming at the efficiency, effectiveness and value for money contributions of innovation procurement: can innovation procurement ensure that the pace and amount of innovation is maintained through optimal investment in R&amp;D? Can innovation procurement ensure that investment in innovation is distributed to where it will be most effective? We believe this is useful, because bringing together the two bodies of literature — policy and economics — challenges some of the current thinking on these issues on both sides and possibly contributes to a more nuanced view on innovation procurement and its potential.</td>
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<td>Options appraisal of a VfM study on knowledge transfer/Options appraisal of a VFM study on the supply of UK scientists</td>
<td>NAO</td>
<td>02/2008 - 05/2008</td>
<td>This project produced Options Papers for two subsequent NAO VfM projects: the supply of scientists in the UK and the returns from publicly-funded technology transfer. The Options Papers gave 3-4 suggested approaches for how these studies could be undertaken, with the idea being to give the NAO a selection of ways of assessing VfM.</td>
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<td>Assessing the economic impact of research funded by the Health Research Board of Ireland (HRB)</td>
<td>HRB</td>
<td>03/2007 - 05/2008</td>
<td>The mission of the Health Research Board (HRB), Ireland's leading funder of health-related research, is to improve health through research and information dissemination. This project involved assessing the economic impact of research funded by the HRB in a collaborative project between RAND Europe and the Health Economics Research Group (HERG) at Brunel University. The project used case studies of research funded by the HRB from 5 to 15 years ago, in order to assess the value and benefits to the Irish economy of HRB-funded research. The project used the payback framework as a method of investigation, taking into account both quantitative and qualitative measures of effect.</td>
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<td>Issues and Ideas on Innovation: Informing the NHS Next Stage Review</td>
<td>Department of Health</td>
<td>11/2007 - 2/2008</td>
<td>This project for the Department of Health looked at issues around innovation in the NHS. The main output of this project was a documented briefing (document number DB-554-DH, 2009), prepared for the Department of Health. It presents a ‘think piece’ on the key issues and ideas on innovation in the NHS. The objective of the work was to provide a challenge function for the Department of Health on its work around innovation for the NHS Next Stage Review. The issues and ideas are grounded in theory or empirical evidence and, where possible, supported by examples. This report does not purport to be a systematic review of innovation theory, but should be of interest to policymakers in the Department who are concerned with innovation, especially in the context of health systems.</td>
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<td>Study of the Impacts of IST-RTD on Key Strategic Objectives Related to Growth and Jobs</td>
<td>DG INFSO, European Commission</td>
<td>12/2006 - 02/2008</td>
<td>The project comprised a study of the links between the socio-economic impacts (particularly in respect of growth and jobs) of ICT research and development. In particular, it examined and tested the causal links among the IST-RTD (programme) policy objectives; key initiatives within the i2010 policy framework; and broader socio-economic objectives. It thus included an analysis of the scope and direction of mechanisms for making these links and the extent to which the specific mechanisms and measures of EU IST-RTD contribute to the development of an innovation-friendly market capable of making productive use of RTD outputs.</td>
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<td>Study of the Impacts of IST-RTD on Key Strategic Objectives Related to Growth and Jobs (continued)</td>
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<td>We have also considered new market-driven initiatives proposed in i2010 and made recommendations for the fine tuning of programmes to optimise their contribution to those final socio-economic benefits.</td>
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<td>Informing the National Audit Office’s strategy for VFM coverage of DIUS</td>
<td>NAO</td>
<td>11/2007 – 12/2007</td>
<td>This project supported the development of a strategy for the NAO’s Value for Money programme of the new Department for Innovation, Universities and Skills (DIUS). Created in June 2007, DIUS incorporates responsibilities for science and innovation from the former Department of Trade and Industry, and further and higher education from the former Department of Education and Skills. RAND Europe’s activities included mapping the DIUS landscape, generating and selecting topics for future study; and producing a ‘think piece’ to support the NAO’s strategy formulation by drawing together all existing material into a concise and coherent strategy paper.</td>
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<td>Comparing how some tax authorities tackle the hidden economy</td>
<td>NAO</td>
<td>08/2007 – 30/10/2007</td>
<td>The objectives of this international comparison were to gain an understanding of how tax authorities manage the risk to tax revenue from unregistered businesses, moonlighters, and ghosts in the hidden economy; how tax authorities encourage individuals and businesses to enter the formal economy; how tax authorities detect cases of unregistered businesses, moonlighters, and ghosts in the hidden economy, follow up on them, and use sanctions; and finally how tax authorities work with other agencies/private sector/ and departments to tackle the hidden economy. The purpose was to give an indication of HMRC’s performance and initiatives in this area in a comparative context. RAND Europe’s work formed part of the NAO’s wider VfM study examining whether HM Revenues and Customs (HMRC) could use its resources more effectively to reduce the tax lost from unregistered businesses, moonlighters, and ghosts in the hidden economy.</td>
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<td>Assessing the wider impacts of social science research</td>
<td>Economic and Social Research Council</td>
<td>01/2006 – 09/2007</td>
<td>This project evaluated the wider impact of the ESRC’s ‘Future of Work’ programme and explored the applicability of the Payback Framework to social science. The ESRC is the UK’s largest research funder and training agency addressing economic and social concerns. The ‘Future of Work’ programme aimed to investigate of the future prospects for paid and unpaid work. The first phase of the programme started in Oct 1998, followed by a second phase in January 2001. Using a survey and a series of case studies the project catalogued the impact of the ‘Future of Work’ programme on policy makers, professional practitioners and other groups outside academia.</td>
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<td>Assessing the wider impacts of social science research (continued)</td>
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<td>It demonstrated that the impacts of the programme had been extensive and diverse and identified a number of reasons why this was likely to have been the case including the involvement of a ‘media fellow’; the effective transfer of networks from the programme leader and steering group to other participating researchers and the timing of the programme. The project also demonstrated that, with subtle modification and generalisation of the impact categories, the Payback Framework was a suitable evaluation framework for investigating the impact of social sciences.</td>
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<tr>
<td>Evaluating progress in tackling benefit fraud</td>
<td>NAO</td>
<td>02/2007 – 06/2007</td>
<td>The NAO commissioned RAND Europe to evaluate the effectiveness of current efforts by the Department of Work and Pensions (DWP) to tackle benefit fraud and error, in terms of impact and value for money. The project looked at what is currently being done by the DWP, how the DWP arrives at decisions, and whether these decisions are cost effective.</td>
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| Department of Health Funding for a Designated R&D Policy Unit        | UK Department of Health       | 2006 – 2015  | RAND Europe hosts a Department of Health research unit: PRISM (Policy Research in Science and Medicine), which works on the science of science. PRISM aims to provide research, analysis and advice to support the effective implementation of the Department of Health's research strategy “Best Research for Best Health” and to improve research to support decision-making more widely in the health research sector. The unit has three main streams of work:  
1) **Supporting the National Institute for Health Research**, providing timely advice and analysis that supports the operational decisions of NIHR.  
2) **Science of Science**, carrying out high quality research that will develop the field and improve our understanding of how health research, and the translation of that research, occurs.  
3) **Dissemination**, ensuring that the results of our work are seen and used by those in positions to make use of them.  
Co-locating these activities provides considerable added value by ensuring the cross fertilisation of ideas and practice. By ensuring that advice is informed by theoretically sophisticated research and analysis, and that our research is sensitive to the shifting needs of the health research system.  
The unit was established in 2006 with funding of £300K pa, the unit was renewed for five years, and expanded to £500K pa, in 2010. The unit is co-directed by Dr Jonathan Grant and Dr Steven Wooding. |
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<td>A bibliometric assessment of Biomedical Research Centres and Units</td>
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<td>2006 and 2010</td>
<td>We undertook a bibliometric analysis to support the selection of candidate National Institute of Health Research Biomedical Research Centres and Biomedical Research Units. The analysis was intended to inform potential applicants in deciding whether to submit a prequalification questionnaire as part of the procurement process and to inform the deliberations of the selection panel for the Biomedical Research Centres and Units. The work was a collaboration between the Centre for Science and Technology studies in the Netherlands (CWTS), and RAND Europe.</td>
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<td>NIHR Senior Investigator Awards: A bibliometric analysis of Applicants (2007, 2008, 2009, 2010)</td>
<td>UK Department of Health</td>
<td>2006-2010</td>
<td>RAND Europe was asked to conduct a bibliometric analysis of publications from NIHR Senior Investigator applicants, for three rounds of awards, of which two have been made to date. This bibliometric analysis was requested to inform and support the decision-making of a selection committee consisting of a panel of experts convened by the Department of Health, for the specific purpose of identifying those applicants that combine research excellence with the ability to translate their research into benefits for patients and the health and well-being of the public. A tranche of NIHR Senior Investigators is selected annually. To date, four rounds of awards have been made. The work was a collaboration between the Centre for Science and Technology studies in the Netherlands (CWTS), and RAND Europe.</td>
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<td>Bibliometrics as a tool for supporting prospective R&amp;D decision-making in the health sciences: strengths, weaknesses and options for future development</td>
<td>UK Department of Health</td>
<td>2009</td>
<td>The aim of this project is to produce an accessible, “beginner’s guide” to bibliometric theory and application in the area of health R&amp;D decision-making. The report also aims to identify future directions and possible next steps in this area, based on RAND Europe’s work with the English Department of Health to date. It is targeted at a range of audiences, and will be of interest to health and biomedical researchers, as well as R&amp;D decision-makers in the UK and elsewhere.</td>
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Appendix B

Methods and approach

The methods used to undertake this rapid review included the following:

- Desk research: document and data review.
- Key informant interviews and workshops.

Bibliometric analysis

The bibliometric analysis was conducted in collaboration with the NDC at the NHRF. The NDC maintains a database of Greek publications in international journals between the years 1993 and 2008,39 which has been constructed using the Thomson-Reuters / Web of Science NCR-Greece and NSI databases.40 The database contains information about research articles, research notes and literature reviews, and excludes editorials, letters (e.g. to the editors, comments on published articles, etc.), correction notes and abstracts.

The key bibliometric indicators used in this review included the following:

- **Total number of scientific publications** produced by Greek universities and research centres and other research units during the period between 2000 and 2004. The publications were classified across 255 subject areas also known as JSC.
- **RCI** of papers published in the period 2000–2004. RCI was computed using a five-year rolling citation period so that all citations would have a five-year citation window, which was set as standard.41 This indicator reflects the relative number of citations to publications from a specific university, RC or other research unit compared to the world average of citations to publications in the same time-period and subject area. If the RCI indicator for a given research institution is greater than 1.00, that means that publications from this research institution are cited above the world average. For example, if the RCI for a given RC and subject area is 1.50, publications from this RC are cited 50% above average.

38 Όταν έγινε η μελέτη αυτή δεν υπήρχαν διαθέσιμα δεδομένα για το 2009 και το 2010. Το ΕΚΤ έχει καταγράψει για πρώτη φορά τα βιβλιομετρικά δεδομένα για την περίοδο αυτή το 2009.
41 For example, if a paper was published in 2000, RCI was computed by counting the 2000–2005 citations; whereas if a paper was published in 2004, RCI was computed by counting the 2004–2008 citations for the various institutions/JSC.

Парαρτήματα B

Методы и подход


Визуализация

Визуализация была проведена с участием NDC в NHRF. NDC поддерживает базу данных греческих публикаций в международных журналах, которая была построена с использованием Thomson-Reuters / Web of Science NCR-Greece и NSI. Данная база содержит информацию о научных статьях, научных заметках и ревью, и исключает редакционные статьи, письма (например, адреса редакции, комментарии к опубликованным статьям), исправления.

В качестве ключевых индикаторов библиометрии использовались следующие:

- **Общее количество научных публикаций** создано греческими университетами и исследовательскими центрами и другими исследовательскими единицами в период между 2000 и 2004 годами. Публикации были классифицированы по 255 тематическим областям, также известным как JSC.
- **RCI** публикаций, опубликованных в период 2000–2004. RCI рассчитывался с помощью пятилетнего окна цитирования, которое было установлено как стандарт. Этот индикатор отражает отношение количества цитирований к публикациям конкретного университета, RC или другой исследовательской единицы по сравнению с средним миром. Если индикатор RCI для данной исследовательской единицы превышает 1.00, это означает, что публикации этой единицы цитируются выше мирового уровня. Например, если RCI для данного RC и тематической области составляет 1.50, публикации из этой RC цитируются на 50% выше среднего.
• Number of top 20% papers in the period 2000–2004 by research unit and subject area. The top 20% shows the share of publications attributed to a research unit that belong to the 20% most cited publications in the world during the same time-period and same subject area. Other top values such as top 1%, top 5% and top 10% are also used and are computed in the same way as the top 20%.

The above indicators helped to identify combinations of subject areas and research units that produced above average world-class research and published papers that were within the top 20% most cited publications in a given subject area.

Furthermore, the analysis focused on co-publications, which were used as an indicator of collaboration. The analysis focused on both co-publications between Greek institutions (intra-Greek collaboration) and between Greek and European institutions. The analysis included all Greek universities, RCs and other research units. Intra-Greek collaboration was identified when a publication had two or more Greek addresses and Greek–European collaboration was identified when a publication included two or more European addresses.

The results of the analyses are shown on Pages 52–69.

Social network analysis

Further to the bibliometric analysis, we examined the level of intra-Greek and Greek–European collaboration using social network analysis. The analysis was based on two extracts from the 2000–2008 Greek publications database used in the bibliometric analysis. These data were also provided by the Greek NDC. The first dataset included Greek publications with two or more Greek addresses – that is, two or more authors who were affiliated with Greek institutions – and the second dataset included publications with one or more Greek authors and two or more European (including non-EU27) authors. The social network analysis of these data helped us to investigate the level of collaboration among Greek researchers, and the level of collaboration among Greek and European researchers.

Each record in the database represented one publication and included as many columns as the number of authors. Each cell in the dataset corresponded to the affiliation of the author in the corresponding column (first, second, third, etc.).

Prior to the social network analysis, we further processed the data in order to avoid double-counting and to make it compatible with the social network analysis software. Specifically, there were multiple-authored papers for which there was more than one author from the same institution. This effect was likely to generate double-counting. For example, a paper with 21 authors had only 16 unique institutions/addresses, and therefore it would be appropriate to count all possible pairs on the basis of those 16 unique addresses and not on 21 authors. Following this approach, the level of collaboration between a 21-author and a 2-author paper would be accounted in a consistent manner, the 2-authored paper would be accounted in a consistent manner.
The desk research involved reading and assessing key documents and data review (RJV) – called STEP to RJV – and contains detailed information on all collaborative cross-national research projects funded by the EC from FP1 to FP7. The database contains information on all collaborative cross-national research projects, including partial data on the FP7 programme up to the end of 2009. The laboratory maintains a databank of European research joint ventures – that is, address1–address2, address1–address3 and address2–address3.

In the dataset with two or more Greek addresses, the data included multiple-authored papers from the same institution. Out of 48,188 papers in the database, there were 20,308 (42%) with all authors coming from the same institution. As these publications did not provide any further information about collaboration, they were excluded from further analysis.

The social network analysis was conducted using Node XL. Add-in for Microsoft Excel.

### Analysis of Greek participation in FPs in the period 1984–2009

The analysis of Greek participations in FPs was led by Professor Yiannis Caloghirou, Dr Aimilia Protogerou and Evangelos Siokas at the Laboratory of Industrial and Energy Economics in the School of Chemical Engineering at the National Technical University of Athens. The laboratory maintains a databank of European research joint ventures (RJV) – called STEP to RJV – and contains detailed information on all collaborative cross-national research projects funded by the EC from FP1 to FP7. The database contains information about 23,341 research projects and 54,514 different organisations, with a total of 177,244 participations covering a period of 25 years. The data drawn for the purposes of this study focus on how Greece’s participation and the amount of funding acquired during the period 1984–2009 compares with that of the other European countries.

### Desk research: document and data review

The desk research involved reading and assessing key documents and other relevant material, and analysing data which were provided by GSRT. The desk research was completed prior to the key informant interviews. Developing this knowledge base on the Greek research system enabled us to identify key areas of focus, to be further explored and investigated in the interviews.

The documents and data reviewed included the following:

- ERAWATCH country profile, 2009.
- Evaluation reports and quantitative data of GSRT RCs, 2005.
- Evaluation reports and quantitative data of GSRT RCs, 2005.

42 The database includes partial data on the FP7 programme up to the end of 2009. The database is being updated with the missing data and information as soon as they become available.
• Επιστημονικη και Τεχνολογικη Έρευνα στην Ελλαδα.

Key informant interviews and workshops
The key informant interviews and workshops were based on the interview protocol shown in Box 1. The primary objective of the protocol was to guide the discussion with RCs, institute directors and representative stakeholders of the R&D system in Greece. The interviews and workshops took place in Athens between 28 March and 1 April 2011 and enabled us to develop a qualitative understanding of the Greek research system. Box 2 shows the list of participants in the key informant interviews.

1984-2009 συγκρίνεται με εκείνη των άλλων ευρωπαϊκών χωρών.

Δευτερογενής έρευνα: ανασκόπηση εγγράφων και δεδομένων
Η δευτερογενής έρευνα περιέλαβε την ανάγνωση και αξιολόγηση βασικών εγγράφων και άλλου σχετικού υλικού και την ανάλυση δεδομένων τα οποία μας παρέδωσε η ΓΓΕΤ. Η βιβλιογραφική έρευνα ολοκληρώθηκε πριν από τη διεξαγωγή των συνεντεύξεων. Η ανάπτυξη αυτής της γνωσιακής βάσης για το ελληνικό ερευνητικό σύστημα, μας έδωσε τη δυνατότητα να εντοπίσουμε βασικούς τομείς ενδιαφέροντος, τους οποίους θα διερευνούσαμε επιπλέον και θα μελετούσαμε στις συνεντεύξεις.

Τα έγγραφα και τα δεδομένα που αξιολογήθηκαν περιλάμβαναν τα εξής:
• Προφίλ χώρας της ERAWATCH, 2009.
• Εκθέσεις αξιολόγησης και ποσοτικά δεδομένα των ΕΚ της ΓΓΕΤ, 2005.
• Δημόσιες δαπάνες για Ε&Α και προϋπολογισμό του Υπουργείου Παιδείας 2010.
• Σελίδα τρέχουσας κατάστασης – έρευνα τρέχουσας κατάστασης στην Ελλάδα, 2009.
• Αναφορά χώρας του Economist, Ιανουάριος 2011.
• Επιστημονική και Τεχνολογική Έρευνα στην Ελλάδα.
• OECD – WP 2009: Raising outcomes in Greece.
• OECD – Science Outlook, Greece, 2008.
• Economist country report, January 2011.
• Science and Technological Research in Greece.
• Νομικές διατάξεις για Ε&A και προϋπολογισμούς του Υπουργείου Παιδείας 2010.

Συνεντεύξεις και συζήτησεις
Οι συνεντεύξεις και οι συζήτησεις βασίστηκαν στο πρωτόκολλο συνεντεύξεων που παρουσιάζεται στο Πλαίσιο 1. Ο πρωτόκολλος στόχος του πρωτοκόλλου ήταν να καθοδηγήσει τη συζήτηση με τα ΕΚ, τους διευθυντές των ιδρυμάτων και τους αντιπροσώπους άλλων ενδιαφερόμενων μερών του συστήματος Ε&Α στην Ελλάδα. Οι συνεντεύξεις και οι συζήτησεις έγιναν στην Αθήνα από τις 28 Μαρτίου έως την 1 Απριλίου 2011 και μας έδωσαν τη δυνατότητα να αναπτύξουμε μία ποιοτική αντίληψη του ελληνικού ερευνητικού συστήματος. Το πλαίσιο 2 παρουσιάζει τη λίστα των συμμετεχόντων στις συνεντεύξεις.
Introduction
I hope you received the presentation outlining our organisation’s record working in the area of research systems. This covers a wide range of countries and disciplines. We are a European organisation with a diverse staff from across Europe and the bulk of our work is for European and international institutions. However, we are independent of any governmental or international institutions and our core values are the independence of our analysis and the rigour of our research.

Purpose and context of interview
This is part of the data collection for a piece of research for the Ministry of Education, Lifelong Learning and Religious Affairs. The study will identify the strengths, weaknesses, opportunities and threats for the Greek research system to inform the Ministry in its strategic deliberations. Other sources of information include bibliometric analysis, desk research and document review, and RAND Europe’s extensive body of research on research systems. The purpose of our interviews is to provide an additional context for the bibliometric and documentary analysis; to discuss your understanding of the strengths, weaknesses, opportunities and threats for the Greek research system; and to understand how your institution contributes to these strengths, weaknesses, opportunities and threats. Finally, we would like to understand your views on the best way forward for the Greek research system.

Our final report will be a restricted distribution briefing to the Ministry. In this we will list whom we have spoken to but we will not attribute views and opinions to any individuals unless we first confirm with those individuals that they are happy for us to do so.

We would like to record this interview but solely for us to check our notes after the meeting. We will not produce transcripts of these meetings and we will destroy the tapes within six months of completing the project.

Questions
1. Can we start by you telling us a little about your role in (the institution) and how long have you been in post? What do you find are the challenges of the job?
2. What are the contextual factors that help us to understand the performance of (your institution)?

Box 1. Interview protocol of key informant interviews

Πλαίσιο 1. Πρωτόκολλο διεξαγωγής συνεντεύξεων

Εισαγωγή
Ελπίζω ότι λάβατε την παρουσίαση που περιγράφει την ιστορία του οργανισμού μας για την εργασία του στον τομέα των ερευνητικών συστημάτων. Αυτό καλύπτει ένα μεγάλο εύρος χωρών και επιστημονικών περιοχών. Είμαστε ένας ευρωπαϊκός οργανισμός με προσωπικό από όλη την Ευρώπη και το μεγαλύτερο μέρος της δουλειάς μας αφορά ευρωπαϊκά και διεθνή ιδρύματα. Ωστόσο, είμαστε ανεξάρτητοι από κάθε κρατικό ή διεθνές ίδρυμα και οι βασικές αρχές μας είναι η αντικειμενικότητα των αναλύσεών μας και η αυστηρότητα της έρευνάς μας.

Σκοπός και περιεχόμενο της συνέντευξης
Η συνέντευξη αποτελεί ένα μέρος της συλλογής δεδομένων για μία έρευνα για το Υπουργείο Παιδείας, Δια Βίου Μάθησης και Θρησκευμάτων. Η μελέτη θα προσδιορίσει τα δυνατά σημεία, τις αδυναμίες, τις ευκαιρίες και τις απειλές για το ελληνικό ερευνητικό σύστημα ώστε να κατατοπίσουμε το Υπουργείο στις στρατηγικές του διαβουλεύσεις. Άλλες πηγές πληροφοριών περιλαμβάνουν βιβλιομετρική ανάλυση, δευτερογενή έρευνα και ανασκόπηση εγγράφων και την εκτεταμένη έρευνα της RAND Europe στα ερευνητικά συστήματα. Σκοπός των συνεντεύξεων είναι να μας παρέχουν επιπλέον στοιχεία για τη βιβλιομετρική ανάλυση και την ανάλυση εγγράφων, να συζητήσουμε το πώς αντιλαμβάνεστε εσείς τα δυνατά σημεία, τις αδυναμίες, τις ευκαιρίες και τις απειλές για το ελληνικό ερευνητικό σύστημα, και να καταλάβουμε πώς το δικό σας ίδρυμα συμβάλει σε αυτά τα δυνατά σημεία, τις αδυναμίες, τις ευκαιρίες και τις απειλές. Τέλος, θα θέλαμε να κατανοήσουμε τις απόψεις σας για τον καλύτερο τρόπο με τον οποίο μπορεί να εξελιχθεί το ελληνικό ερευνητικό σύστημα.

Η τελική μας έκθεση θα είναι μια ενημέρωση περιορισμένης διανομής προς το Υπουργείο. Σε αυτή θα αναφέρουμε με ποιους μιλήσαμε, αλλά δεν θα αποδώσουμε γνώμες και απόψεις σε κανένα από τα άτομα αυτά, αν δεν έχουμε επιβεβαιώσει πρώτα με τους ίδιους ότι επιθυμούν να κάνουμε κάτι τέτοιο.

Θα θέλαμε να καταγράψουμε τη συνέντευξη αυτή, αλλά μόνο για δική μας χρήση, ώστε να ελέγξουμε τις σημειώσεις μας μετά τη συνάντηση. Δεν θα υπάρξουν πρακτικά για τις συναντήσεις αυτές και θα καταστρέψουμε τις κάσετες εντός έξι μηνών από την ολοκλήρωση του έργου.

Ερωτήσεις
1. Μπορούμε να ξεκινήσουμε με λίγα λόγια σχετικά με τον ρόλο σας (στο ίδρυμα) και το πόσο καιρό είστε
• Prompts:
  – Labour market / supply of scientists
  – Governance and infrastructure
  – Organisation of research institution
  – Support of national/European/international research programmes

3. What would you say are the strengths of the Greek research system? How does your institution contribute to these strengths?

4. What would you say are the weaknesses of the Greek research system? How does your institution contribute to these weaknesses?

5. What would you say are the threats to the Greek research system? (may need to explain ‘threats’ as external)? How does your institution contribute to these weaknesses?

6. What would you say are the opportunities for the Greek research system? How does your institution contribute to these opportunities?

7. If it were up to you, what would you do to take the Greek research system forward in the current context?

3. Ποια θα λέγατε ότι είναι τα δυνατά σημεία του ελληνικού ερευνητικού συστήματος; Πώς συνεισφέρει το δικό σας ιδρυμα σε αυτά τα δυνατά σημεία;

4. Ποιες θα λέγατε ότι είναι οι αδυναμίες του ελληνικού ερευνητικού συστήματος; Πώς συνεισφέρει το δικό σας ιδρυμα σε αυτές τις αδυναμίες;

5. Ποιες θα λέγατε ότι είναι οι απειλές για το ελληνικό ερευνητικό σύστημα (ισχώς χρειαστεί να εξηγήσετε ότι εννοείτε εξωτερικές απειλές); Πώς συνεισφέρει το δικό σας ιδρυμα σε αυτές τις απειλές;

6. Ποιες θα λέγατε ότι είναι οι ευκαιρίες για το ελληνικό ερευνητικό σύστημα; Πώς συνεισφέρει το δικό σας ιδρυμα σε αυτές τις ευκαιρίες;

7. Εάν αποφασίσατε εσείς, τι θα κάνατε για να προωθήσετε το ελληνικό ερευνητικό σύστημα με τις τρέχουσες συνθήκες;
### Box 2. List of participants

Alexander Fleming Biomedical Science Research Centre  
- Prof. B. Savakis, Director of the Centre and Director of the Institutes

Centre for Research and Technology Hellas (CERTH)  
- Prof. G. Giannopoulos, Vice Chairman of Administrative Council; Director, Hellenic Institute of Transport  
- Prof. E. Kakaras, Director, Institute of Solid Fuels Technology and Application  
- Dr A. Konstantopoulos, Director, Chemical Process Engineering Research Institute  
- Prof. M. Petrou, Director, Informatics and Telematics Institute  
- Prof. A. Tsafaris, Institute of Agrobiotechnology

Centre for Research and Technology Thessaly (CERETETH)  
- Prof. E. Choustis, Centre Director and Chairman of Administrative Council  
- Prof. Y. Koutedakis, Director, Institute of Human Performance and Rehabilitation  
- Dr T. Bartzanas, Researcher, Institute of Technology and Management of Agricultural Ecosystems  
- Dr V. Gkretsi, Researcher, Institute of Biomedical Research and Technology

Hellenic Centre for Marine Research (HCMR)  
- Prof. K. Synolakis, Centre Director  
- Dr V. Papathanasiou, Director, Institute of Oceanography  
- Dr C. Papaconstantinou, Director, Institute of Marine Biological Resources  
- Dr A. Diapoulis, Institute of Inland Waters  
- Dr P. Divanach, Director, Institute of Fish Farming  
- Dr D. Sakelariou, Senior Researcher, Institute of Oceanography

Hellenic Pasteur Institute (HPI)  
- Prof. A. Antoniadis, President of the Executive Board  
- Prof. E. Mylonakis, Centre Director

National Centre for Social Research (NCSR)  
- Prof. T. Maloutas, Acting Centre Director, Director of the Administrative Board  
- Ms E. Abdelidhi, Researcher, Institute of Urban and Rural Sociology

### Πλαίσιο 2. Λίστα συμμετεχόντων

Ερευνητικό Κέντρο Βιοϊατρικών Επιστημών «Αλέξανδρος Φλέμινγκ»  
- Καθηγ. Πίτσι της Σαββάκης, Διευθυντής του Κέντρου και Διευθυντής των Ινστιτούτων

Εθνικό Κέντρο Έρευνας και Τεχνολογικής Ανάπτυξης (EKETA)  
- Καθηγ. Γ. Παναγιώτου, Αντιπρόεδρος του Διοικητικού Συμβουλίου, Διευθυντής του Ελληνικού Ινστιτούτου Μεταφορών  
- Καθηγ. Ε. Κακαράς, Ινστιτούτο Τεχνικής Χημικών Διεργασιών  
- Δρ. A. Κωνσταντόπουλος, Διευθυντής, Ινστιτούτο Μεταφορών  
- Καθηγ. Κ. Συνολάκης, Διευθυντής Κέντρου  
- Δρ. V. Papathanasiou, Διευθυντής, Ινστιτούτο Τεχνικής Χημικών Διεργασιών  
- Καθηγ. Κ. Παπακωνσταντίνου, Διευθυντής, Ινστιτούτο Θαλάσσιων Βιολογικών Πόρων  
- Δρ. Κ. Παπακωνσταντίνου, Διευθυντής, Ινστιτούτο Θαλάσσιων Βιολογικών Πόρων

Ελληνικό Κέντρο Θαλάσσιων Ερευνών (ΕΛΚΕΘ)  
- Καθηγ. Κ. Συνολάκης, Διευθυντής Κέντρου και Πρόεδρος του Διοικητικού Συμβουλίου  
- Καθηγ. E. Χούστης, Διευθυντής Κέντρου και Πρόεδρος του Διοικητικού Συμβουλίου  
- Δρ. Θ. Μπαρτζάνας, Ερευνητής, Ινστιτούτο Τεχνικής Χημικών Διεργασιών

Εθνικό Κέντρο Ψυχικής Υγείας (ΕΚΕΘ)  
- Καθηγ. Α. Αντωνιάδης, Πρόεδρος του Διοικητικού Συμβουλίου  
- Καθηγ. Ε. Μυλωνάκης, Διευθυντής Κέντρου  
- Καθηγ. Θ. Μαλούτας, Αντιπρόεδρος Κέντρου, Διευθυντής Διοικητικού Συμβουλίου  
- Κα. Ε. Αβδελίδη, Ερευνήτρια, Ινστιτούτο Αστικής και Αγροτικής Κοινωνιολογίας
National Hellenic Research Foundation (ENHRF)
- Dr. D. Barourdos, Acting Director, Institute of Social Policy
- Dr. D. Emmanouil, Researcher, Institute of Urban and Rural Sociology
- Dr. D. Karantinos, Researcher, Institute of Social Policy
- Ms C. Varouxi, Institute of Political Sociology

National Observatory of Athens (NOA)
- Dr. K. Tsiganos, Centre Director
- Dr. K. Makropoulos, Director, Institute of Geodynamics
- Dr. I. Daglis, Director, Institute for Space Applications
- Prof. C. Goudis, Director, Institute of Astronomy and Astrophysics
- Dr. M. Petrikis, Director, Institute of Environmental Research and Sustainable Development

NCSR Demokritos
- Dr. N. Kanellopoulos, Centre Director and Chairman of Administrative Council
- Dr. C. Spyropoulos, Vice President of the Board of Directors; Director, Institute of Informatics and Telecommunications
- Dr. I. Papazoglou, Director, Institute of Nuclear Technology – Radiation Protection
- Dr. G. Fanourakis, Director, Institute of Nuclear Physics
- Dr. G. Papavassiliou, Director, Institute of Materials Science
- Dr. D. Tsoukalas, Director, Institute of Microelectronics
- Dr. P. Falaras, Institute of Physical Chemistry
- Dr. E. Tsilibary, Institute of Biology

National Hellenic Research Foundation (ENHRF)
- Dr. D. Barourdos, Acting Director, Institute of Social Policy
- Dr. D. Emmanouil, Researcher, Institute of Urban and Rural Sociology
- Dr. D. Karantinos, Researcher, Institute of Social Policy
- Ms C. Varouxi, Institute of Political Sociology

National Observatory of Athens (NOA)
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- Dr. G. Fanourakis, Director, Institute of Nuclear Physics
- Dr. G. Papavassiliou, Director, Institute of Materials Science
- Dr. D. Tsoukalas, Director, Institute of Microelectronics
- Dr. P. Falaras, Institute of Physical Chemistry
- Dr. E. Tsilibary, Institute of Biology

Eκδοσια Μνημείων Ερευνών (ΕΕΜΕ)
- Αρ. Ε. Μπουμπούκας, Διοικητής, Εθνικό Ίδρυμα Ερευνών (ΕΙΕ)
- Δρ. Δ. Μπαλούρδος, Διευθυντής, Ινστιτούτο Κοινωνικής Πολιτικής
- Δρ. Δ. Εμμανουήλ, Ερευνητής, Ινστιτούτο Αστικής και Αγροτικής Κοινωνιολογίας
- Δρ. Δ. Καραντινός, Ερευνητής, Ινστιτούτο Κοινωνικής Πολιτικής
- Κα. Χ. Βαρουξή, Ινστιτούτο Πολιτικής Κοινωνιολογίας

Εθνικό Αστεροσκοπείο Αθηνών (ΕΑΑ)
- Δρ. Κ. Τσίγκανος, Διευθυντής Κέντρου
- Δρ. Κ. Μακρόπουλος, Διευθυντής, Γεωδυναμικό Ινστιτούτο

ΕΚΕΦΕ Δημόκριτος
- Δρ. Ν. Κανελλόπουλος, Διευθυντής, Ινστιτούτο Πολιτικής Κοινωνιολογίας
- Δρ. Κ. Σπυρόπουλος, Αντιπρόεδρος του Διοικητικού Συμβουλίου, Διευθυντής, Ινστιτούτο Πληροφορικής και Τηλεπικοινωνιών
- Δρ. I. Papazoglou, Διευθυντής, Ινστιτούτο Πυρηνικής Τεχνολογίας – Ραδιοπροστασίας
- Δρ. G. Fanourakis, Διευθυντής, Ινστιτούτο Πυρηνικής Φυσικής
- Δρ. G. Papavassiliou, Διευθυντής, Ινστιτούτο Πυρηνικής Φυσικής
- Δρ. G. Papavassiliou, Διευθυντής, Ινστιτούτο Επιστήμης Υλικών
- Δρ. G. Papavassiliou, Διευθυντής, Ινστιτούτο Μικρογραφίας
- Δρ. Ι. Πιλάρας, Διευθυντής, Ινστιτούτο Φυσικοχημείας
• Δρ. Ε. Τσιλιμπάρη, Ινστιτούτο Βιολογίας
• Δρ. Γ. Παπαχρήστος, Ινστιτούτου Ραδιοϊσοτόπων και Ραδιοδιαγνωστικών Προϊόντων
• Δρ. Β. Κολικογλου, Χημικός

Ερευνητικό Κέντρο Κατανομής στις Τεχνολογίες της Πληροφορίας, των Επικοινωνιών και της Γνώσης (ΑΘΗΝΑ)
• Δρ. Ι. Ιωαννίδης, Γενικός Διευθυντής
• Σ. Πιπερίδης, Υπεύθυνος του Τμήματος Εφαρμογών Γλωσσικών Τεχνολογιών
• Γ. Βολτή, Γραμματέας Διεύθυνσης

ΆΛΛΟΙ ΟΡΓΑΝΟΙ:
• Δρ. Δ. Δενιόζος, Αρχή Διασφάλισης Ποιότητας στην Ανώτερη Εκπαίδευση, Υπουργείο Παιδείας
• Ν. Ιωαννίδης, Υποπρεπής, Τμήμα Content Delivery, Intracom Telecom / Sitronics Telecom Solutions
• Καθηγ. Ι. Καλογήρου, Εργαστήριο Βιομηχανικής και Ενεργειακής Οικονομίας, Σχολή Χημικών Μηχανικών, Εθνικό Μετσόβιο Πολυτεχνείο
• Π. Καρνιούρας, Δίκτυο Πράξη
• Καθηγ. Α. Λυκουργιώτης, Πρόεδρος του Εθνικού Συμβουλίου Παιδείας (ΕΣΥΠ)
• Δ. Λουκάς, Πρόεδρος, Ένωση Ελλήνων Ερευνητών
• Καθηγ. Β. Μακιός, Γενικός Διευθυντής, Corallia
• Δρ. Β. Παπαχρήστος, BiC S.A.
• Καθηγ. Β. Παπαζογλου, Ειδικός Γραμματέας, Διοικητικός Τομέας Ανώτατης Εκπαίδευσης, Υπουργείο Παιδείας, Δια Βίου Μάθησης και Θρησκευμάτων

National Agricultural Research Foundation
• Εθνικό Ίδρυμα Αγροτικής Έρευνας

Benaki Phytopathological Institute
• Εθνικό Ίδρυμα Αγροτικής Έρευνας

Other organisations
• Εθνικό Ίδρυμα Αγροτικής Έρευνας

ΑΛΛΟΙ ΟΡΓΑΝΟΙ:
• Δρ. Δ. Δενιόζος, Αρχή Διασφάλισης Ποιότητας στην Ανώτερη Εκπαίδευση, Υπουργείο Παιδείας
• Ν. Ιωαννίδης, Υποπρεπής, Τμήμα Content Delivery, Intracom Telecom / Sitronics Telecom Solutions
• Καθηγ. Ι. Καλογήρου, Εργαστήριο Βιομηχανικής και Ενεργειακής Οικονομίας, Σχολή Χημικών Μηχανικών, Εθνικό Μετσόβιο Πολυτεχνείο
• Π. Καρνιούρας, Δίκτυο Πράξη
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• Δ. Λουκάς, Πρόεδρος, Ένωση Ελλήνων Ερευνητών
• Καθηγ. Β. Μακιός, Γενικός Διευθυντής, Corallia
• Δρ. Β. Παπαχρήστος, BiC S.A.
• Καθηγ. Β. Παπαζογλου, Ειδικός Γραμματέας, Διοικητικός Τομέας Ανώτατης Εκπαίδευσης, Υπουργείο Παιδείας, Δια Βίου Μάθησης και Θρησκευμάτων
• Dr A. Protogerou, Department of Chemical Engineering, National Technical University of Athens
• T. Rongas, Greek Federation of Exporters of Northern Greece (SEVE)
• I. Stournaras, Foundation of Economic and Industrial Research (FEIR)
• Dr A. Tsakanikas, National Technical University of Athens and Foundation of Economic and Industrial Research (IOBE)

• Δρ. Α. Πρωτόγερου, Σχολή Χημικών Μηχανικών, Εθνικό Μετσόβιο Πολυτεχνείο
• Τ. Ρόγκας, Σύνδεσμος Εξαγωγέων Βορείου Ελλάδος (ΣΕΒΕ)
• Ι. Στουρνάρας, Ίδρυμα Οικονομικών και Βιομηχανικών Ερευνών (ΙΟΒΕ)
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Critical mass: unpacking the issues for research policy

Critical mass is a fuzzy, amorphous but nevertheless important concept. It is an important issue but it requires care if it is not to be an elusive target for policy-makers. This is because the notion combines multiple elements, processes and influences, such as the following:

- Stark differences in research processes across the disciplines (e.g. physics vs biology).
- More subtle differences between applied and basic research.
- Differences between assessing research at the institutional, group and individual levels.
- Varying degrees of potential for economies of scale in the use of instruments and equipment.
- Challenges of measuring inputs and outputs of research (e.g. What counts as research collaboration?).
- The highly skewed productivity distribution of research-ers (known as Lotka’s Law).
- The influence of economies of scope with non-research functions (such as teaching and administration).
- The theoretical development of critical mass literature.
- The notion of critical mass serves as an important entry point into a discussion that directs us towards effective policies. Actively creating critical mass has not tended to be an explicit goal of policy-makers, although it is often an important aim of policy-makers in many countries. Japan is an exception where it has had an explicit policy of concentration, but it is controversial and comes alongside a set of other research policies. Other countries such as France, Spain and Italy may not have explicit concentration policies but they do have a high proportion of their research concentrated in a few research institutions.

This appendix seeks to untangle the notion of critical mass in research by briefly exploring how the themes listed above relate to research. It considers whether or not a policy aiming to increase critical mass by a process of concentration is beneficial. Theory and evidence are presented, and conclusions and policy implications are offered.

Theory and evidence from the research policy literature

A key question in research policy is ‘Should funding be concentrated on a small number of research institutions or spread over a larger number of institutions?’

This question brings to the fore notions of optimising research outputs by achieving critical mass. However, size alone is not a good indicator of quality. There may be pockets of excellence within otherwise poorly performing institutions. For example, findings from the UK’s research assessment exercise (RAE) conducted during the 1990s and 2000s showed very clearly that there were often clusters of
excellent research housed within large, poor-quality institutions. Concentrating funding on a select few institutions would overlook these groups, and that suggests that a more fine-grained look at the research system is needed. So when considering critical mass, the unit of analysis needs further elaboration. In developing a policy towards critical mass we need to consider:

- the unit of analysis
- critical mass of what
- available empirical evidence.

We shall consider these in turn.

**Which unit of analysis?**

There is a common understanding that contemporary research has become a highly distributed group activity. This view was highlighted by Gibbons et al. (1994), who argue that there has been a shift in how research is conducted, from what has been termed 'mode 1', where research is conducted in single disciplines in single institutions, to what is known as 'mode 2', where research involves more individuals and teams who are likely to come from more disciplines and more organisations. While this argument remains controversial, it does raise the question of what unit of analysis policy should be the focus when thinking about the notion of critical mass in research.

Hospitals, non-profit research institutes, industry, government (Etzkowitz and Leydesdorff 2000) may all be involved in research, and indeed do contribute to publications (Hicks 1995). Vast networks may not necessarily be inherently superior as there may be a need for costly coordination and governance (Hicks 1995). Vast networks may not necessarily be inherently superior as there may be a need for costly coordination and governance (Hicks 1995). 

Studies in psychology confirm the idea that small groups often outperform even the most talented individuals on certain cognitive tasks and complex problem solving (Hill 1984; Rosenberg 1992; Baird 2004). There may be many ways other than co-location within one institution to create critical mass or to ensure the efficient use of large pieces of equipment. Involvement of partners in research may influence the extent to which one might look outside research institutions to the broader knowledge system or innovation system (Nelson 1993), before beginning to define critical mass.

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Critical mass of what? Economics of scale and scope both matter.

A further immediate question would be to ask ‘Critical mass of what?’ Researchers, full-time researchers, part-time researchers, visiting researchers, research students, lecturers, non-research staff and teaching staff are all capable of contributing to research outputs. Should they all be included when counting for critical mass? Are there benefits to having teaching and administration allied closely with research functions? And should the equipment they use be counted when making critical mass calculations (Price 1984; Rosenberg 1992; Baird 2004)?

Clearly there are substantial disciplinary differences both in the number of researchers in productive groups, and in the way in which those groups use and rely on equipment and instruments, teaching, training and administration. These differences are not only across subject matter (physics vs biology) but also across degrees of ‘appliedness’ and sectors of industry (Pavitt 1984). So the applied research teams are often larger than basic research teams. Theoretical papers tend to have fewer authors than more practice-oriented papers (Katz and Martin 1997). Clinical biomedical research (cardiology) generated larger teams and more co-authorship than more basic science (pharmacology) (Bordons and Zulueta 1997). Applied research tends to require increasingly diverse – yet specialised – bodies of knowledge, and so the need for larger teams with both deeper skills and broader intellectual reserves is congruent with the fundamental tenets of innovation theory (Pavitt 1999).

If critical mass does not straightforwardly refer to the number of staff, or the number of microscopes in a laboratory, might it have some resonance with the skills and knowledge base that is brought to bear on the research endeavour? After all, one can follow thinking along the lines that ten researchers may not represent critical mass, but three extremely talented and prolific researchers might do just that. Furthermore, it has long been recognised that there is a highly skewed Matthew effect in the distribution of funding, publications and citations to a very small minority of individuals (Lotka 1926; Price 1963; Cole and Cole 1972). The behaviour of superstar researchers, and their contribution to critical mass, have not yet been systematically studied (Zucker and Darby 1996; Azoulay et al. 2011). For example, are ‘stars’ attracted to large institutions that can boast rich resources or to smaller institutions where they may find greater autonomy?

At the level of departments, there may be trade-offs in size. Larger departments may have greater budgetary and intellectual resources, higher cross-fertilisation of ideas, and more opportunity to share and pool teaching and non-research related responsibilities. Small departments may offer greater creativity and individuality, and better one-to-one training, tighter co-operation and higher degrees of autonomy.
Previous findings are difficult to interpret
The UK’s Research Assessment Exercise (RAE) afforded two researchers an opportunity to explore how research quality relates to group size (Kenna and Berche 2010). Their findings suggested that there is a threshold above which quality does not appear to improve significantly. Kenna and Berche go so far as to suggest a numerical range in which the critical mass of researchers exists (Evidence to UK Parliament 201043). They seem to be broadly consistent with the argument that more theoretical and basic subjects have a smaller numbers.

However, it is likely that the Kenna and Berche (2010) finding is an artefact of the way in which research was assessed, rather than evidence of critical mass per se. This is because their assessment relies on two sets of assumptions: that the quantity and quality of research outputs have been accurately measured on the one hand, and that the scope and scale of the inputs into research have been accurately measured on the other hand.44 The authors themselves recognise that RAE may not have done this, so relating size to productivity increase is slower (Qurashi 1993) and in some cases it even drops in larger groups (Bonaccorsi and Daraio 2005). Some studies find no correlation between size and productivity (Cohen 1991). The relationship between size and research quality is problematic but, where numbers are identified, the optimum appears to be between 4 and 15, with some permanent core-funded staff, some soft-money researchers, some support staff and other non-research staff (Rey-Rocha et al. 2006). When teaching and training is the main focus, the number may be smaller but the support functions would have to become more numerous and expensive (Stephenson 1994).

Conclusions and implications: more fruitful targets for policy
The evidence is clear that the effects of critical mass may be masked or amplified by specific contextual factors. This makes the measurement of inputs very difficult. For example, some who have contributed nothing or little are included as ‘honorary’ co-authors (Katz and Martin 1997). Such issues make the measurement of outputs very difficult.

43 http://www.publications.parliament.uk/pa/cm201011/cmselect/cmsctech/writet/856/m27.htm
44 For example, on the outputs side consider two groups that produce research that is rated as being of international excellence; one group is small, the other is large. Say the large group produces research of international excellence that contributes much more to its field than the other group, which is also of international excellence. The inability to discriminate between the groups’ respective quality may lead one to conclude that the increase in size has no effect on quality because the improvement was not captured, and this may contribute to the appearance of a critical mass effect. On the inputs side, for example, not all collaborations between researchers result in co-authorship and contributors are often not acknowledged as authors. Conversely, some who have contributed nothing or little are included as ‘honorary’ co-authors (Katz and Martin 1997). Such issues make the measurement of inputs very difficult.
However, it implies that it should be addressed with care and with attention to how size relates to other drivers of quality, such as leadership, exchange of ideas, the role of research users and so on. At the macro-levels (institutions and departments) and the micro-levels (individuals and superstars), the evidence is certainly particularly hard for policy-makers to interpret. But there is some evidence and scope to formulate policy at the meso-level (research groups and teams). For example, there may be some advantages in pooling non-research resources or resources indirectly related to research, and there may be scale economies that come from the complementarities that arise from teaching and research being close together. Effective research group/team size tends to be quite small (around 5–9), but is highly dependent on the skills of individuals, discipline and 'appliedness', and the overall composition of the team – which may include some permanent researchers as well as non-research staff.

The key difficulty in building up an evidence base would be that critical mass appears to be a phenomenon that is embedded as a part of the research process itself and acquired through research training and undertaking research. Critical mass is something that R&D systems achieve rather than a number to be targeted. Understanding how to help researchers achieve this critical mass is the important question for policy-makers.

There may be more fruitful targets for critical mass policy than strict attention to size. As has been repeatedly found for private firms (Powell et al. 1996), it is not smallness that tends to be the main problem, but loneliness. The new mode-2 knowledge production characterised by Gibbons et al. (1994) and described above means that communication, linkages and collaboration are ever more important. The integration of research teams into international and elite networks (Pavitt 1999) and systems of innovation (Nelson 1993) appears to be paramount for performance.


