

Trinity College Dublin

Response to the Consultation on Ireland's Strategy for Science, Technology and Innovation (SSTI 2)

Trinity College Dublin's ambition is to be a University of global consequence, delivering a distinctive educational opportunity for our students and undertaking multidisciplinary research that has global impact. We believe that a clear articulation of a **long-term vision** for Irish research - its role in enhancing Ireland's international reputation, and in underpinning the economic and social development of Ireland and its third-level education sector to 2025 and beyond - is required to contextualise SSTI 2 and to provide a focus for the selection of priorities. This vision should be rooted in strong **ambition and confidence** that Ireland, even as a small country, can tackle big questions. Addressing global challenges with international scope and deep and lasting impact from multi-disciplinary perspectives should therefore be fundamental to Ireland's research and innovation policy, as should an understanding of the societal benefits of research, including the development of a more inclusive society, a stronger sense of citizenship, and higher competence for intercultural engagement nationally and internationally.

In this context a suggested vision might be of:

A research and enterprise ecosystem that capitalises on our natural strengths and enables Ireland to excel in the development of talent - the creation of a generation of academics, researchers and graduates empowered to participate in the discovery of new knowledge as well as its translation to industry innovation. Such talent will support new foreign direct investment and indigenous company innovation, leading to increased job creation and high value exports as well as an international reputation for excellence in education, research and innovation, and a more sustainable society.

The development of a successful research and innovation ecosystem must be seen as a continuous work in progress. Investment decisions and strategies put in place now should not only sow the seeds for short- to medium-term benefits but will underpin our long-term capacity for success. Moreover, the published strategy will be an **internationally visible statement** of intent on behalf of Ireland that we have an education, research and innovation rich culture skilled at identifying and developing talent that is capable of delivering globally-connected innovation and change.

1. Background

Ireland is operating in a very different international economic environment to when SSTI 1 was developed. Specifically Ireland can now no longer differentiate itself on the basis of its tax regime. From a commercial perspective, this is a major change and it requires Ireland to develop a new focus. That focus is 'talent' as has been articulated by such representative groups as AmCham, the IDA, the Dublin Chamber of Commerce and the Irish Government.

"Our Chamber has a very clear mission - that Ireland remains the global location of choice for US FDI. In 2015, we will focus on a number of key factors that the Chamber believes are central to continued FDI success. Talent is at the top of this list."

Eamonn Sinnott, President of AmCham.

"We will focus on differentiating Ireland's offering in three key areas:

- *talent;*
- *connected world leading research; and*
- *place-making to provide attractive city regions to live, work and attract investment."*

DJEI Policy Statement of Foreign Direct Investment in Ireland 2014.

'Talent' is an all-encompassing phrase that captures the quality of education provided to our people, our innovation capability, our 'can do' approach, our creativity and problem-solving attitudes, our global outlook, and our self-confidence. These qualities are recognised internationally among our diaspora, however, a substantial long-term investment is required to ensure that Irish research is positioned appropriately on the international stage. In this context ***SSTI 2 must underpin a concerted effort to invest in 'talent' with the long-term goal of sustaining creativity, innovation and research excellence that can be harnessed to the overall benefit of the whole country. Doing so will ensure that Ireland is both internationally differentiated and prosperous into the future.***

Ireland currently competes for business at two levels. Manufacturing and service-orientated activity is vitally important to our economy, however, Ireland must also compete in the realm of innovation and research-linked activity where we must add value in order to retain, sustain and grow investment. For our SMEs competition is on the scale of a global environment that is increasingly connected through high-speed internet and big data. Creativity and innovation are vital to sustainable development of new indigenous industries.

Research-intensive Universities have a key role to play in this new global landscape not only as creators of knowledge but as developers and attractors of talented individuals: of academics and researchers who can create new and absorb emerging knowledge and deliver research-led education to our students and services to industry and public bodies; of PhD students who will play leadership roles in Irish-based companies and public bodies; and of graduates who will be future employees, innovators, entrepreneurs, artists, and policy makers.

In the last decade Ireland has achieved great progress in developing its research eco-system; however, we have not optimised the economic multiplier associated with long-term investment in science and technology. Ireland invests a substantially lower % of GDP in research compared to most of our peer countries. In addition many of these countries have substantially improved and developed their research capacity during the years of economic crisis in Ireland. As a consequence, Ireland is struggling to keep pace with peers and falling behind the leaders.

These concerns are evidenced by the following metrics, which might be regarded as early warning signs:

- Ireland's PhD student numbers are falling (Appendix I, *Figure 1*).
- For the first time in a decade, in 2011-2012 the increase in the number of documents published by Irish researchers stalled. A subsequent increase in 2012-2013 was proportionately lower than in previous years and has been followed by a sharp decrease in 2013-2014 (Appendix I, *Figure 2*).
- For the first time in over a decade, Ireland's percentage of world papers fell sharply between 2011 and 2012 and is still declining (Appendix I, *Figure 3*).
- In the same period, Ireland's overall impact relative to the world declined (Appendix I, *Figure 4*).
- Our Universities are continuing to fall down international rankings (Appendix I, *Figure 5*) and in particular falling behind in student:staff ratio (Appendix I, *Figure 6*).
- While Irish higher education institutions (HEIs) are (cumulatively) in the top 1% in the world in 19 of the 22 Essential Science Indicators, they are not in the top 1% in such foundational fields as mathematics.

The consultation document points out that competitor Governments of countries similar in size to Ireland (such as Denmark and Finland) invested 1.02% and 1.01% respectively, of GNP in research and innovation (GBAORD) compared to 0.49% by Ireland in 2013. It is, therefore, not surprising that the volume of research (Appendix I, *Figure 7*) and impact relative to the rest of the world of Irish

research (Appendix I, *Figure 8*) lags behind both. It is also noteworthy that both countries have, for the first time in 2015, universities ranking in the elite THE Global University Reputation Ranking.

Ireland requires a research strategy that supports third-level education and invests in research and innovation at comparable levels to competitor countries. Without a cogent long-term strategy that addresses the development of talent and the metrics of research excellence, Irish research is destined to decline further, with increasing slippage of our major Universities in international rankings, and reduced appetite by external agents for investment in the full spectrum of research activity. The challenge of an investment of 3% of GDP as set out 15 years ago must be re-visited as a matter of urgency.

This investment must be considered as the most critical commitment by Ireland to defining and taking ownership over the structure of our future economy, over the jobs we provide to our population, over the type of enterprise investment we wish to see in Ireland, and the society in which we wish to live.

What would success look like?

- The ability to recruit and retain world-class talent in our universities, research centres and companies – attracted by a supportive and internationally recognised research environment.
- A critical mass of global companies carrying out mission critical research within Ireland.
- A strong commercialisation eco-system which is successfully translating research innovations into products and jobs.
- A growing number of Irish based companies investing >1.5% of revenues into research activities.
- A university consistently in the top 50 in the world rankings.
- The development of the natural resource of talent in Ireland to rank Ireland as leading internationally from undergraduate (UG) to PhD level.
- Leveraged infrastructure that supports integrated research initiatives across disciplines.
- A cohort of excellent researchers across all fields of research enabled to compete for and win international research funding such as Horizon 2020 awards as well as such prestigious grants as ERC awards, or Royal Society and Wellcome Trust Fellowships.
- World leadership in specific areas – e.g. capitalising on local strengths, such as our island status and our high level of connectedness.

2. The Research Funding Landscape

The strategic approach towards Irish research over the past five years has focused on building a stronger connection between our universities and industry. This has been catalysed by the successful establishment and development of research centres – both as SFI Centres and EI/IDA technology centres.

This development has resulted in the alignment of capability across our HEIs around topics of national and international importance, focussed on research challenges that are industry informed and, importantly, co-funded by industry.

The concentration of strategic funding in these research centres has resulted in the research centres being seen and used as a proxy for our entire research system. It has to an extent overlooked research excellence in other domains, and has placed at risk the highly innovative and cutting-edge research that is underway across the third-level sector. ***In particular, it fails to understand the true nature of where our research excellence lies and how this excellence can be harnessed for Ireland's benefit.***

In Trinity, which leads three SFI Centres, 70% of our research funding from industry comes to individual academics not operating in exchequer-funded centres. Moreover, across our faculty of 850 academics, approximately 85% are not linked with centres.

This community of academics not only generates research results that are of potential strategic, commercial and societal importance, it is also responsible for training the majority of our PhD students, creating new start-up companies, influencing public policy, winning ERC funding awards and H2020 grants, and building many valuable relationships with industry. Indeed, **enabling this broad community of researchers to compete at European level will be vital** to achieving the national target for drawdown from the Horizon 2020 programme, in which prior success in national funding programmes is often a prerequisite for establishing the credibility of an applicant.

Many of these academics excel internationally in areas that do not yet have the scale to form a centre. Notwithstanding, their research underpins our undergraduate and postgraduate educational programmes, and opens up new research avenues that will seed future centres and industry collaborations. In many cases these researchers are recognised as excellent and leaders by the international community both in academia and industry. As such they are contributing significantly to Ireland's reputation – our immunologists, for example, have contributed to Ireland being ranked first in terms of research impact in that increasingly important field, while our English and History Departments are among the most highly rated in the world.

Our new research strategy, while it must protect and grow the research centres as activities of scale that are internationally visible and competitive, **must also give a high priority to supporting the entirety of the research community and find mechanisms to support and recognise very clearly the value this community brings to Ireland.** Innovation by definition cannot be predicted. Failure to support research outside of a priori specified areas will inevitably stifle innovative research.

A sustained programme of PhD funding across a broad research base - from the arts and humanities, to biomedical science and healthcare to engineering and technology - is imperative. This will ensure Ireland has the capability to respond to new enterprise opportunities and educational and skill needs. It will also contribute to improving the global ranking of Ireland's universities; to increasing our competitiveness in attracting the best researchers to Ireland; and to developing the reputation of Ireland as an innovation leader. A commitment to growing our PhD funding across the spectrum of research is a necessary part of our research investment strategy to deliver on the vision for Ireland in 2025.

3. Developing Talent

A strategy that is focused on talent development serves a multitude of societal and economic needs. Such a strategy puts a focus not solely on the subject domains (or priority areas) in which we invest but the purpose of the funding e.g. we should fund across the spectrum to develop PhDs; to support early stage researcher development in order to ensure we maintain our brightest talents; and to build an ecosystem which attracts the best international talent.

At undergraduate level, access to research-led teaching is critical to the formation of graduates who are attractive to employers that are increasingly engaged in knowledge-intensive innovation and export-focused activities (as per the consultation document 68% of jobs are now in companies that are engaged in research and development). It is equally crucial to **ensuring that students in Ireland continue to have access to an education that is equivalent to that available anywhere in the world and therefore to the attractiveness of Ireland as a location for inward investment.** Increasing student:staff ratios and a narrow base of competitive research funding mitigate against the delivery of genuinely world-class third level education programmes and detract from Ireland's international reputation for talent development.

Trinity has recently committed to a renewed educational approach that both ensures excellence in disciplinary skills and that encourages, from an early stage, the mind-set of the innovator and entrepreneur. The programme enables experimentation, and the practice and refinement of ideas, products and services within the curriculum; and aims to develop a broad range of skills in leadership, ideation, management and organisation, design thinking, critical and analytical thinking, independent judgment, active citizenship, and the confidence to confront perceived wisdoms among others. Trinity aims to provide all undergraduate students with an opportunity to undertake a research/innovation project in their final year. This process, however, is predicated on the availability of academics who are engaged in internationally competitive research and requires a sustainable funding stream.

We also need to produce talented PhDs who can work in leadership and strategic roles in industry, enterprise, public service, and civil society to protect existing and to win future investment. It is essential to recognise that investment in research does not always provide a directly proportional or linear return. Many PhD graduates will occupy roles such as quality control, project management etc. Notwithstanding, the renewed education approach, with exposure to cutting-edge research, provides an intellectual rigor and clarity of mind that underpins all future activities, and that can be effectively harnessed in non-research endeavours.

To maintain and enhance Ireland's stated aspiration to develop a 'knowledge-based economy'; the research and innovation pipeline must be developed and sustained. Investment in future generations of world class academics who can advance the frontiers of knowledge as well as participate in and lead major research programmes is required. These research leaders can train future generations of leaders, researchers, teachers, entrepreneurs and academics as well as train PhD students and undergraduates. Such research excellence is also one of the most important attractors of young talent - the brightest students are attracted by big and challenging questions, which also drive public engagement with research. **Critical to the development of such talent is the broad availability of competitive research funding even at low levels but with a long horizon that will allow our academics to develop their expertise and become competitive for international funding opportunities as well as future larger scale grants.** Access to such project funding is also crucial to the development of PhD programmes which are often not well supported by programmes that have a shorter term delivery horizon or are more applied in focus. These funding programmes, coupled with the renewal of structured PhD programmes, are crucial to the development of the PhD talent pool.

4. Enhancing and Complementing Research Prioritisation

The NRPE has been a landmark in how Ireland has structured its research investment and communicated, both internally and internationally, our areas of strength and economic focus.

It is essential to continue to capitalise on our research investments to date, while recognising the necessity for flexibility in responding to research opportunities and rapid technological advances. Ireland needs to couple its research prioritisation with the availability of funds that can be invested at multiple points along the research pipeline.

An example of a complementary approach would be identifying specific 'National Challenges' that bring Government, MNEs, SMEs, and the full range of multi-disciplinary expertise within the HEIs together to develop societally sustainable solutions for needs that have national benefit. Many of these 'National Challenges' will also be 'Global Challenges', and the solutions we create will give Ireland the opportunity to influence international thinking and generate new export-oriented businesses. Such challenges could fund across an educational and research spectrum, from

supporting PhD programmes to providing a pipeline of talent that can be deployed to solve problems at multiple levels.

These programmes could be used to harness the breadth of multi-disciplinary (non-centre) research excellence within universities and indeed could engage with a process of public procurement to deliver prototypes, test beds and actual deployments.

For example, the emergence of an increasingly elderly population is seen as a challenge internationally and will be a challenge for Ireland in the future. An 'ageing' challenge would span a wide spectrum of fundamental research, from the underlying biomedical mechanisms of ageing and brain health to the engineering interventions designed to support independent living, from economic and policy interventions to the understanding of the social and cultural consequences of an increasingly elderly society resulting from renegotiation of the intergenerational contract. As such this challenge cross-cuts the spectrum of research and innovation activity from fundamental to applied, including social innovation, several of the existing NRPE areas, and the full spectrum of disciplines from the humanities to science, recognising that frontier research feeds the research pipeline for downstream success. A similar challenge within the biomedical sector could include the emerging field of 'personalised medicine', which includes aspects of big data, genomics, systems biology and drug development and capitalises on local strengths, such as our island status and our high-level of connectedness. Further challenges whose solutions will inevitably result in economic as well as social benefit include sustainability, urbanisation and the urban/rural divide, or the reimagining of the cultural and creative industries in the digital age - these build on Ireland's tradition of the cultural and creative industries creating growth and jobs, driving innovation, cross-fertilising between cultural actors, industry and academia. All of these areas represent opportunities for Ireland if diverse expertise from all disciplines can be harnessed and they also provide opportunities for embedding research in the arts, humanities and social sciences in the same way as is promoted in the Horizon 2020 programme.

Indeed it is critical that sustained investment is provided to support existing and future opportunities. For example Ireland does not currently prioritise drug discovery as a viable indigenous industry opportunity. Notwithstanding, eight of the top ten bio-pharma companies have invested in Ireland and a recent Trinity study with LinkedIn has shown that PhDs in the biomedical area are the most employable in Ireland in a wide variety of roles, including management as well as research and development.

In summary, as a small country it is necessary to prioritise our research. Notwithstanding we must ensure a more nuanced approach that enables a flexible approach as new opportunities arise. Research impacts are not linearly connected with inputs and the most interesting economic opportunities cannot always be planned. A portfolio of approaches is needed which are complementary and ensure a system which is nimble and proactive; a system which can pivot quickly to respond to national opportunities and exploits the full range of research expertise across our HEIs.

5. Linkages Between the Research Base and industry

One of the goals of SSTI 2 should be to position ***Ireland as the most connected country for research interactions between academic and industry*** across the whole TRL spectrum including fundamental research. Recent data, however, has shown that 300 firms account for 70% of research expenditure; and 67% of industry research is from FDI firms.¹

¹ Annual Business Survey of Economic Impact 2012 (ABSEI), FORFÁS, 2012.

The new research strategy must address this goal. It should incentivise bigger companies to invest in research in proportion to their activity and Irish companies should become more research active.

At present we have a similar set of schemes for all companies – independent of size, growth potential, revenue etc. Ireland must through this strategy consider specifically how research investment can support the different challenges in our industry profile and how universities with their research base – both human and physical – can play a role in helping Irish-based industry transition to a new mode of operation.

This kind of transformation has been tackled previously through the Technology Transfer Strengthening Initiative which focused on intellectual property and licensing. A similar approach, which requires HEIs to develop a strategy for industry engagement and which would be supported through the enterprise agencies, would be an innovative approach to this challenge.

In addition, there are mechanisms which can be put in place to support and harness the academic community not operating in centres. In the US there is an organisation called the University Industry Demonstration Partnership (UIDP) (<http://sites.nationalacademies.org/pqa/uidp/index.htm>) - an organization of universities and companies seeking to enhance the value of collaborative partnerships between these parties. UIDP provides a unique forum for university and industry representatives to meet and discuss operational and strategic issues such as contracting, intellectual property, and compliance matters. Trinity is well positioned to promote the establishment of such a partnership in Ireland to focus on connecting our non-centre researchers with industry. Such an initiative would require Government support to harness the currently under-utilised talent that is available outside of the prioritised research centres.

Entrepreneurship is a critical characteristic needed to capitalise on research investment. A clear strategy as to how to engage our HEIs in developing an entrepreneurship strategy to couple to its research and innovation strategy is critical. It is this approach which will optimise the opportunity to commercialise the returns from research.

Intellectual Property management. There is a need to review how we support patent strategies and the associated costs. Three immediate opportunities would include:

- Support increased patent applications. This will be required as the type of research funded and delivered within the universities becomes increasingly commercially relevant.
- Increase the maturity of our patent portfolios allowing increased de-risking of technology and increased commercial interest from industry.
- Increase the number of patents granted – a current weakness in Ireland’s innovation scorecard – resulting in improved international rankings for Ireland in relation to innovation.

6. Infrastructure

Any strategy that focuses on talent must also recognise that continuous investment in supporting infrastructure, both hard and soft, will be needed to underpin investment. Increasing numbers of undergraduate and postgraduate students will need to be accommodated over the next 10 years. Notwithstanding the potential benefits of using new technologies to support blended learning approaches, expected growth in information and communications technologies, engineering and science subjects will require new facilities including test beds and laboratories. Likewise, the growth of centre-level activities will need to be accommodated close to students to facilitate teaching as well as greater on-campus industry engagement.

In addition to physical, soft infrastructure - including the provision of a flexible HR environment to attract the best international researchers to Ireland - is crucial.

Conclusions

During SSTI1, Ireland made significant progress in terms of developing its research ecosystem and its international reputation for research. However, the global landscape for research is changing and becoming more competitive, as countries view research as a key measure of future economic competitiveness and prosperity. This sense of international competition is notably acute for Ireland as we evolve to a less differentiated corporate tax regime.

In this context of the increased importance of research, Ireland is also seeing some indicators of our research competitiveness falling. SSTI2 must set out a strong vision and commitment to research to demonstrate both nationally and internationally that Ireland remains committed to research and the development of an economic model built on innovation and *talent*.

SSTI2 also must develop programmes which ensure Ireland can fully leverage all of its research investment and which ensures we fund research programmes and PhDs across a broad research base – developing our nation’s best resource: our people. In addition we need to enhance and complement research prioritisation by establishing sister activities which harness the broad research base to deliver greater benefit and impact for Ireland; and develop improved connections between academia and enterprise, and within enterprise itself.

Successful implementation of such a strategy will not only serve to enhance Ireland’s reputation as a centre of learning and an active contributor to the global research endeavour. A policy that asserts Ireland’s ambition and belief that it can contribute to research questions of international significance and that it has confidence in the excellence of its researchers to deliver solutions will not only enhance that reputation but in doing so will enhance economic development and Ireland’s long-term attractiveness for foreign direct investment.

Appendix I

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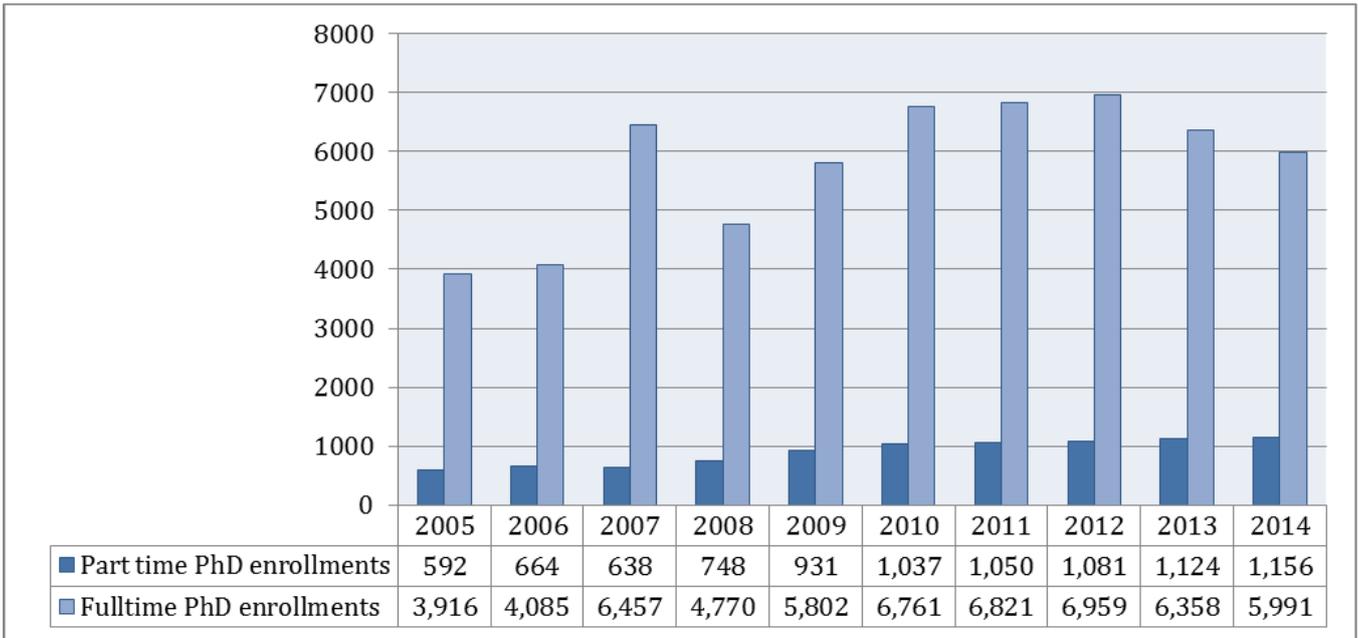


Figure 1 Irish University PhD Enrolments (2005-2014)¹

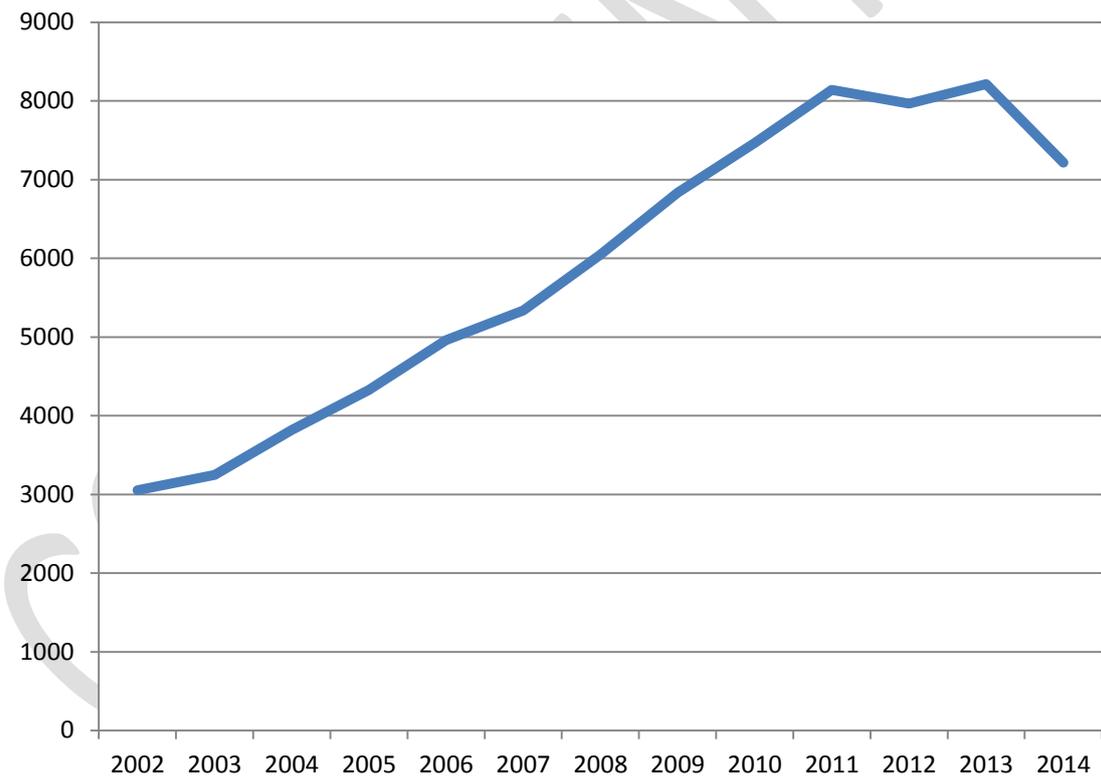


Figure 2 Ireland: Number of Web of Science Documents (2002-2014)²

¹ HEA System Performance First Report 2014-2016, p.11.

² Data courtesy of Thompson Reuters March 2015.

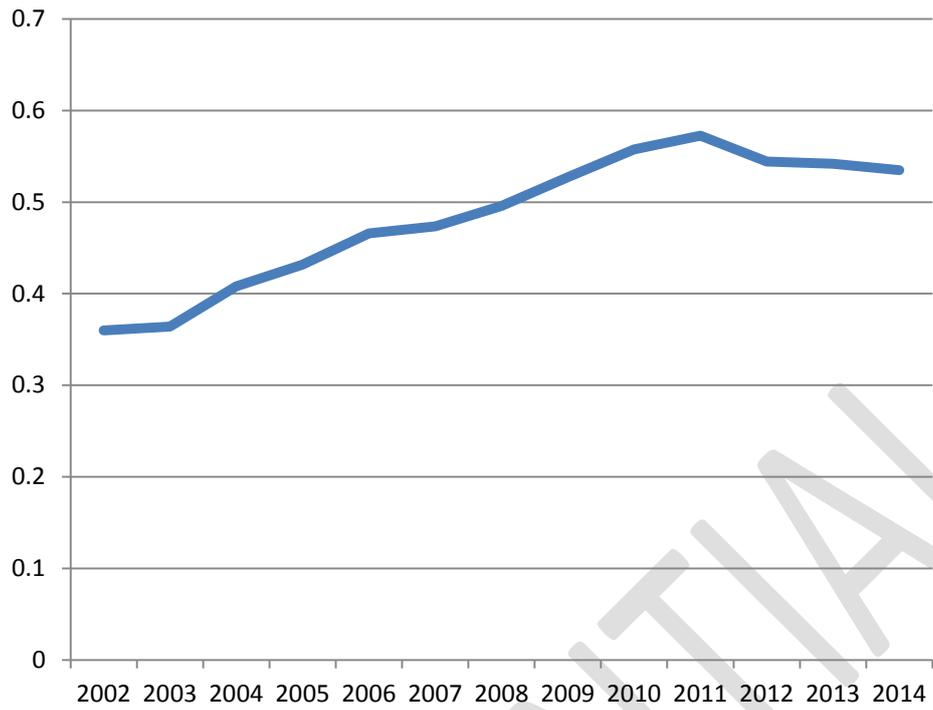


Figure 3 Ireland: Percentage of Documents in the World (2002-2014)²

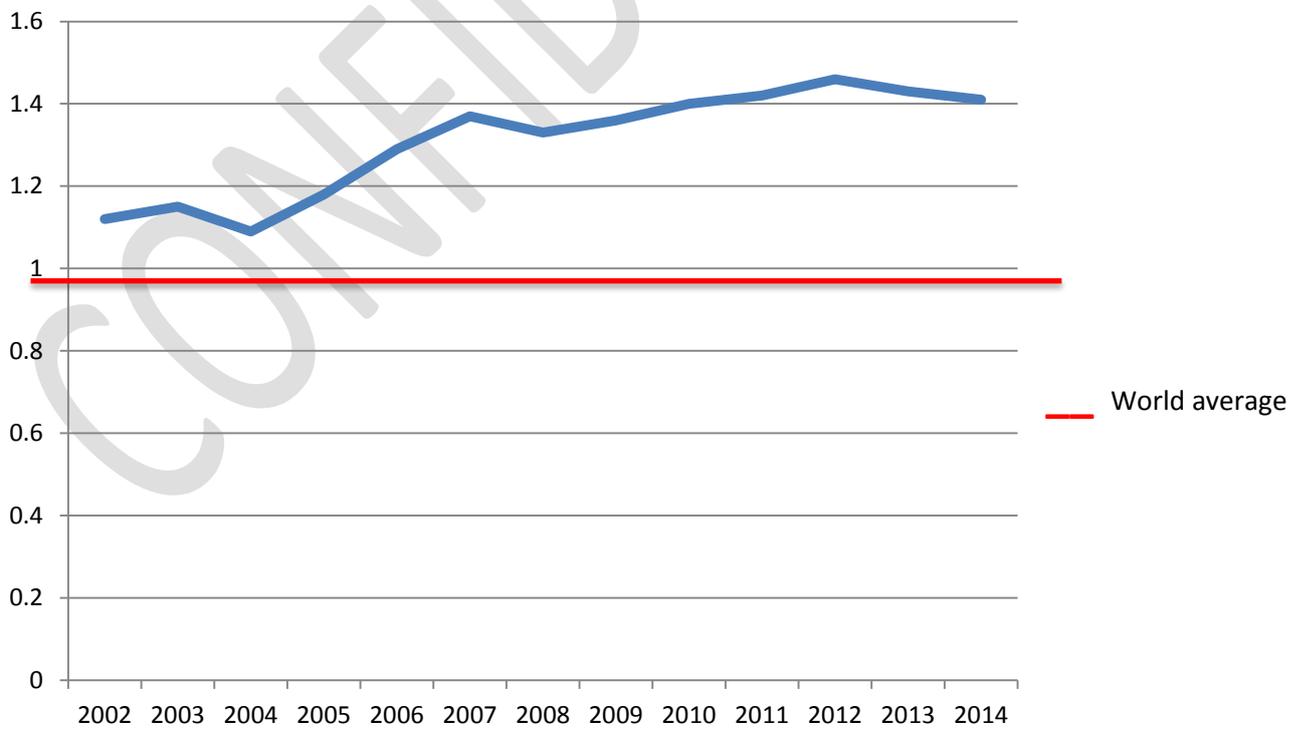


Figure 4 Ireland: Impact relative to the world (2002-2014)²

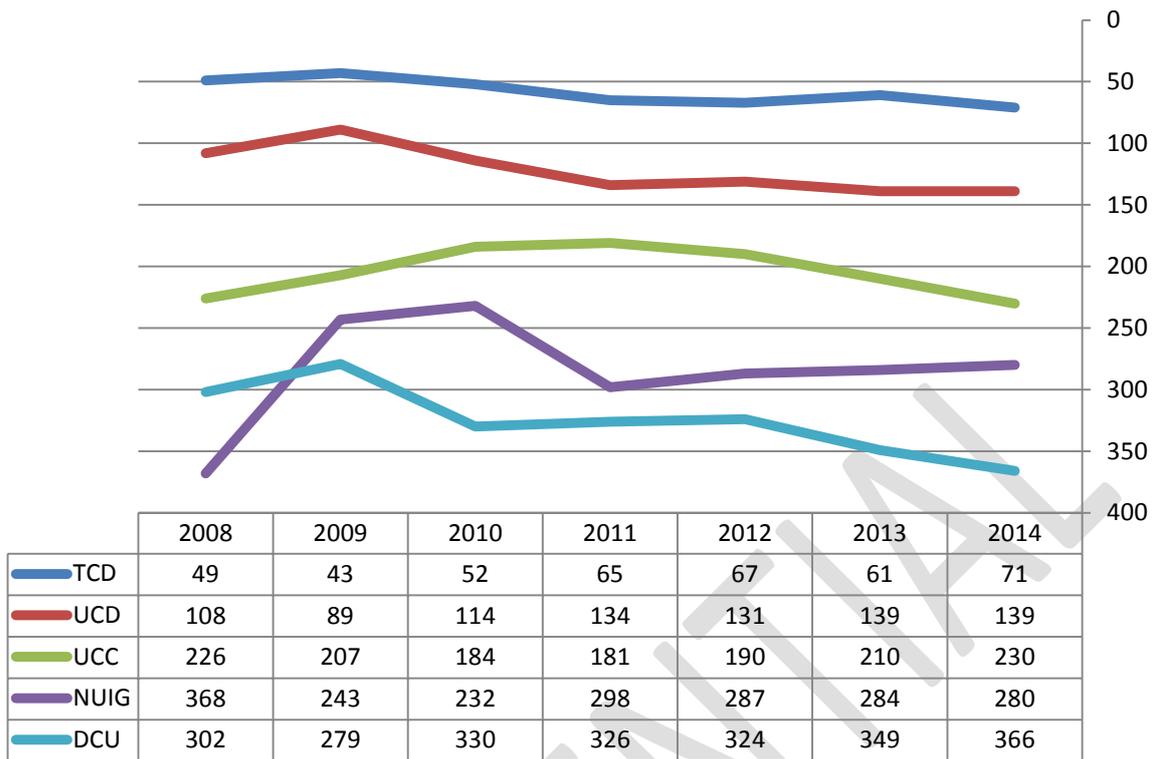


Figure 5 QS World University Rankings & Irish Universities³

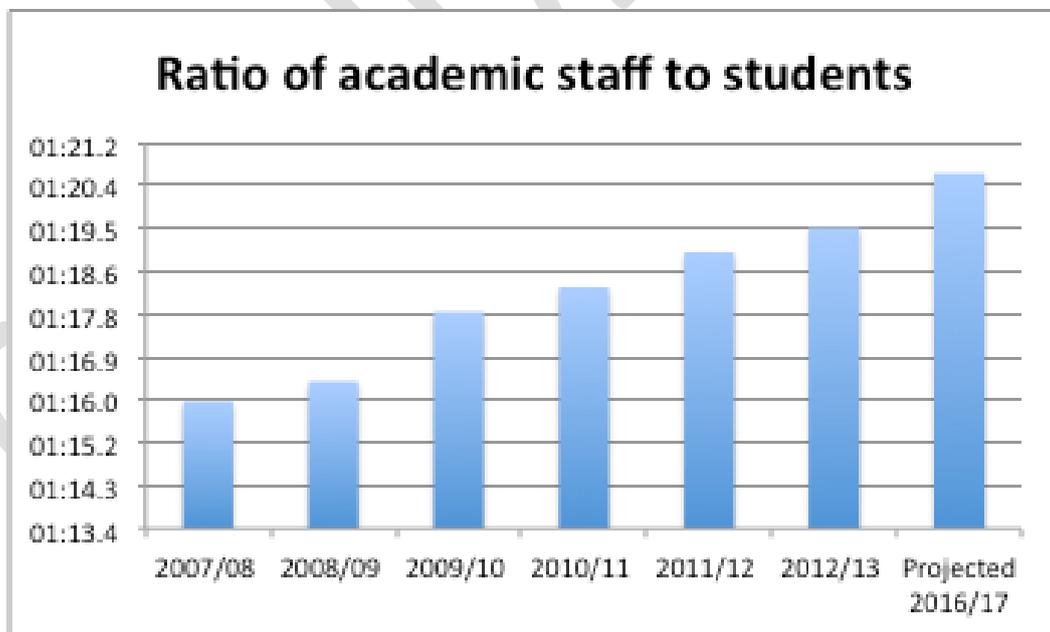


Figure 6 Ireland: Academic staff to student ratios^{4,5}

³ <http://www.topuniversities.com/university-rankings>

⁴ *ibid.*

⁵ HEA System Performance First Report 2014-2016 p.58.

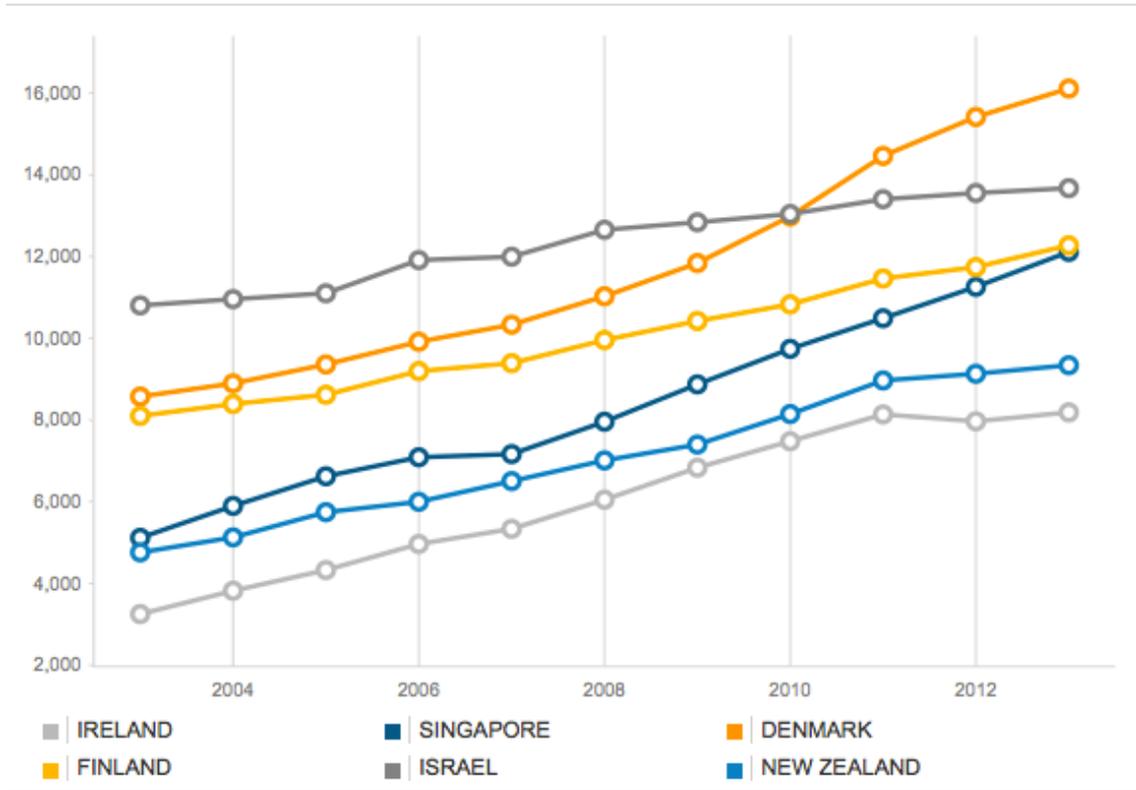


Figure 7 Small Nations Comparison: Number of papers⁶

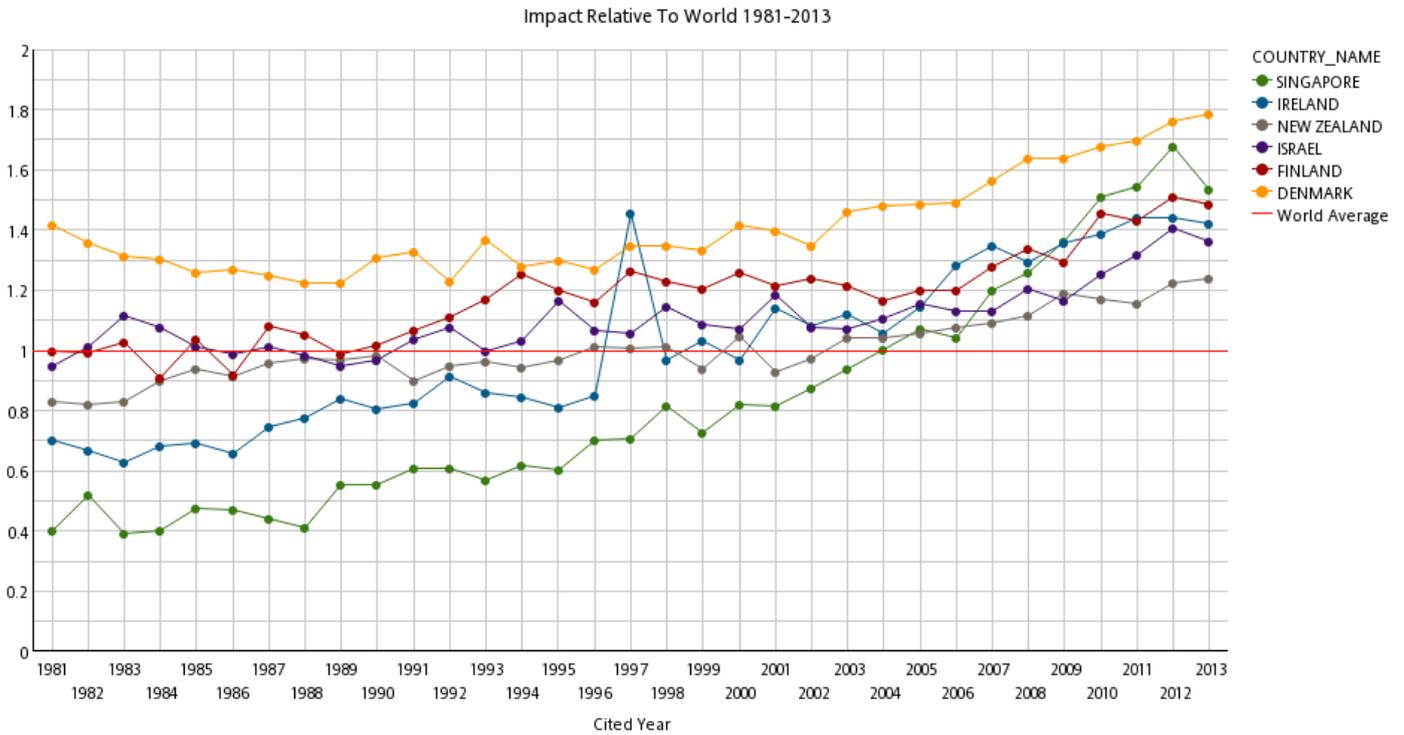


Figure 8 Small Nations: Impact relative to world⁶

⁶ Thompson Reuters InCites, March 2014.