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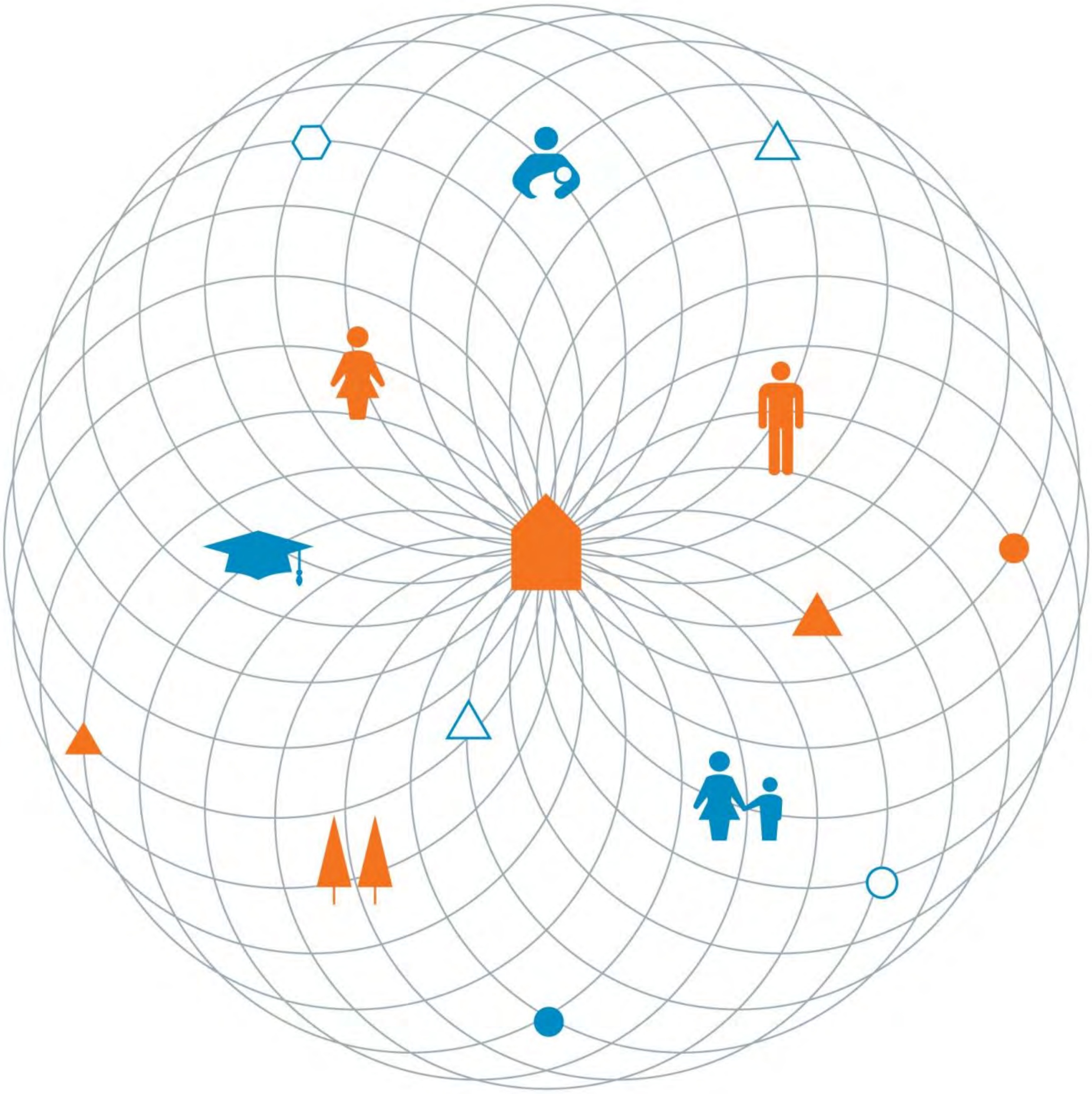
Baseline Report

Newton Fund Evaluation



PACEC
Public and Corporate
Economic Consultants

Baseline Report

Newton Fund Evaluation

August 2016

Department of Business Innovation and Skills (BIS)

Newton Fund Evaluation

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List of Partners

- PACEC

Coffey International Development Ltd

The Malthouse 1 Northfield Road Reading Berkshire RG1 8AH United Kingdom
T (+44) (0) 1189 566 066 F (+44) (0) 1189 576 066 www.coffey.com
Registered Office: 1 Northfield Road Reading Berkshire RG1 8AH United Kingdom
Registered in England No. 3799145 Vat Number: GB 724 5309 45

This document has been approved for submission by Coffey's Project Director, based on a review of satisfactory adherence to our policies on:

- Quality management
- HSSE and risk management
- Financial management and Value for Money (VfM)
- Personnel recruitment and management
- Performance Management and Monitoring and Evaluation (M&E)

Jamie Fotheringham, Project Director

Signature:

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Executive summary

In August 2015 Coffey International Development Ltd ('Coffey') in conjunction with Public and Corporate Economic Consultants (PACEC) were appointed by the Department of Business Innovation and Skills (BIS) to undertake a longitudinal evaluation of the Newton Fund, a 5-year programme to support research capacity building and collaboration for sustainable development in initially 15 but now 16 partner countries as part of the UK's Overseas Development Assistance.

Following the Inception Phase (September – October 2015), an Inception Report was produced by the evaluation team, which included the findings from a literature review on Newton Fund themes of interest, the draft Theory of Change for the Fund and some options for the evaluation approach. The Initial Analysis Phase (November – February 2015) consisted of a range of familiarisation and engagement activities, and culminated in the production of an Evaluation Strategy, a Monitoring Report and an Initial Analysis Report. The final part of the initial analysis phase involves provision of baseline reports on Newton partner countries and an overarching report, presented here.

Newton activities began in April 2014, more than a year prior to the commissioning of a programme-level evaluation, precluding the possibility of achieving a baseline from primary research. The approach taken here therefore employs the next best option, reconstructing a baseline position among the 15 diverse partner countries that were included from the launch onwards using secondary data from international organisations as well as relevant background literature. The data includes SJR bibliometric data from Elsevier on research output and collaboration, WIPO patent application data, UNESCO outbound mobility data, Global Competitiveness Index data on innovation capacity. The key criteria were availability of time series over long periods and data availability and comparability across groups/countries. Our indicators sought to capture the capacity for, and existing extent of, research, collaboration and translation across the **People**, **Research** and **Translation** pillars for the 15 partners. The data were combined with analysis of relevant policy and research literature to address four baseline themes: **existing extent of collaborations**, **science and innovation capacity**, **translation capacity** and **research funding structures and systems**.

International programmes working in a similar policy space have been mapped as part of the early-stage benchmarking research, with three broad comparator groups of programmes identified: USAID umbrella programmes; similar programmes led by national development agencies in Western Europe; and smaller initiatives undertaken by UK delivery partners which precede Newton such as research capacity building programmes.

The research investigates the research policy environment in partner countries and factors influencing and enabling international collaboration, capacity and skills.

1. Context, Purpose and Scope of Newton Fund Baseline

1.1. Purpose and scope

The baseline research in this report aims to capture the extent of science and innovation research capacity in Newton partner countries at the outset of the Newton Fund. It provides context on the existing capacity and capabilities of partner countries as well as a point of departure against which to measure programme outcomes and outputs. The assessment also helps provide a counterfactual against which to measure the additionality of Newton funding.

Baseline reporting is part of the second work phase (Initial Analysis Phase) for the evaluation programme. Our report is based on desk research as well as the familiarisation and consultation activities undertaken to date.

Approach

The Initial Analysis Phase (November 2015 – February 2016) of the research culminated in a revised Evaluation Strategy, incorporating more specific aspects of the evaluation and a justification for design and approach choices, a Monitoring Report, which identifies gaps provides recommendations to BIS on achieving consistent monitoring of outputs across partner countries, and an Initial Analysis Report summarising the Key Learning Points. The final part of this stage consists of fifteen country-level Baseline Reports and this over-arching Baseline Report which accompanies the country-level reports and summarises the baseline position for the Newton Fund as a whole.

As noted in the Monitoring Report, Newton countries employ distinctly different systems and practices in delivery of science funding, knowledge exchange, commercialisation and collaboration. These various systems do not utilise common evaluation and monitoring approaches for the purposes of evaluating Newton funding. **In measuring the baseline, a sufficiently generic approach has been employed to reflect the extremely wide range of systems and countries and the activities undertaken**. The three pillars which Newton funding is earmarked to develop – Research, People and Translation – cover a wide range of potential indicators and our framework is also designed to reflect this.

Our baseline approach is the product of an iterative and exploratory process, with the evaluation team working alongside programme management to develop appropriate measures and indicators to meet the unique aims and scope of the Newton programme.

The approach has therefore developed in two key stages:

1. We assessed research impact measurements from early Newton documentation supplied by DFID and BIS and reflecting standard UK evaluation guidance for international research programmes. These include measures such as Field Weighted Citation Impact[1].
2. We reviewed global aggregate indicators outlined in the Newton Inception Report, which followed high-level consultations and a review of in-house indicators from previous similar assignments. These are mostly generic global indicators identified by the World Bank as innovation benchmarks[2].

A baseline period from 2000 to the latest available year (constituting a baseline of more than 10 years) has been used for indicators of future potential and can be generated for other indicators. During this baseline period, there has been a difference in the trends by country and region over time.

The baseline indicators cover three main areas:

- **Indicators of present and future potential**: Bibliometric data (Elsevier's Scopus via SJR) on international collaboration, share of regional and global publications and research impact metrics.
- **Indicators of collaboration potential**: WIPO patent application data alongside measures Global Competitiveness Index indicators from the survey's 'Innovation Capacity' pillar.

[1] FWCI is part of Elsevier's SciVal suite and we expect to secure access to this data as part of the evaluation research.
[2] World Bank. (2010). *Innovation Policy: A Guide for Developing Countries*

- **Indicators of student and researcher mobility**: UNESCO Institute of Statistics (UIS) data on outbound mobility ratio and UK's rank as a destination for HE students.

These twelve baseline indicators for measuring success or impact in the Newton Fund were selected based on these inclusion criteria:

- Recent data available for all 15 Newton countries for an indicator (or 12 at a minimum) and coverage of at least 100 countries (i.e. majority of world countries).
- Time series data available (particularly for the indicators of potential and international collaboration) for most Newton countries for at least 5 years, but preferably 10 years or more to provide a long baseline period. Data sources included Scopus (SJR), the WIPO, UNESCO and well-established international studies such as the Global Competitiveness Index (GCI).

1.2. Baseline research questions

Our baseline research questions are focused on four broad themes, each containing a series of more specific questions. The four themes are designed to assess baseline performance of Newton countries over time across various stages of the research and translation cycle. The analysis includes considerable qualitative and descriptive assessments of the different aspects of countries' S&I systems, including extent of industry involvement, thematic and policy focus. It also compares and contrasts Newton with other international development initiatives operating in the research collaboration and capacity-building space.

Table 1. Map of baseline analysis to research question themes

Research question theme	Related baseline indicators or data analysis
Existing international collaborations and partnerships (Section 3) *To what extent are partner countries involved in existing international collaborations and partnerships?* *Which other programmes or funding initiatives, similar to the Newton Fund, are operating in the same space (thematic and geographical space) in partner countries?* *Which aspects of partner countries' S&I systems contribute to difficulties in establishing international collaborations and partnerships?*	• *Qualitative and comparative analysis* • International collaboration in publications • Indicators of student and researcher mobility
S&I capacity in partner countries (Section 4) *What are the main gaps in S&I capacity and skills in partner countries?* *What are the conditions in partner countries that seem to influence higher international collaboration, research outputs and citations?* *What is the capacity for innovation across the Fund?*	• Number of *research* publications • Research impact metrics • Capacity for *innovation* (GCI) • *Qualitative and comparative analysis*
Translation capacity (Section 5) *To what extent are partner countries facilitating university-industry and business-to-business collaborations?* *What are the conditions in partner countries that seem to influence higher numbers of patent applications?*	• University–*industry collaboration in R&D (GCI)* • *Patent applications: GCI and WIPO data* • *Company* spend on R&D (GCI) • *Qualitative and comparative analysis*
Funding structures (Section 6) *Which aspects of the research funding structures in partner countries appear to influence S&I capacity and skills?*	• *Qualitative and comparative analysis*

Existing international collaborations and partnerships

Our baseline assessment of international collaboration and partnership in Newton countries focused on the mobility of students and research personnel and on the tendency to collaborate on international publications. The assessment utilises SCIMago publication collaboration data (gross and as proportion of total national and regional output), as well as UNESCO UIS student mobility data. Within individual country reports we treat student flows to the UK as an indicator for potential to collaborate with UK researchers.

S&I capacity in partner countries

This section looks at research capacity in terms of skills, funding, policies and institutional factors, focusing on the gaps and conditions for innovation and collaboration as well as the existing baseline. Three sets of indicators are used:

- Number of research publications (Scopus via SCImago)
- Research impact metrics (Scopus)
- Capacity for innovation (Global Competitiveness Index)

The capacity for innovation across the fund is measured qualitatively through the GCI's global executive opinion survey.

The section refers to UNESCO's 'Expanding Out, Expanding Up' model for international research collaboration, which theorises that international collaboration and gross research output do not share a linear relationship, but fluctuate depending on capacity development.

Translation capacity

This section looks at the internal dynamics of science and innovation development within partner countries and the capacity to translate research findings and outputs into communicated policy outcomes, products, technologies and services.

GCI and WIPO patent data are used as an institutional measure of commercialisation capacity, with Global Competitiveness Index data on university-industry collaboration and company spend on R&D used to measure the extent and strength of relationships between research and commercial actors in the private and public sectors.

- University–industry collaboration in R&D (GCI)
- Patent applications: GCI and WIPO data
- Company spend on R&D (GCI)

Funding structures

Section 6 examines national funding systems, their contribution to innovation performance and compatibility with foreign collaborators. The different influences on R&D capacity and skills are then discussed, including sector origin of funding (international agencies, private sector, public research funding bodies) and the linkages between them, and differences in national innovation systems, structures and funding instruments.

1.3. Key baseline indicators

Twelve key baseline indicators are featured across individual country reports, summarised in Table 2 below[3]. A baseline period was constructed for the period 2000–2014 across the indicators of present potential (international collaboration; share in world publications).

Table 2. Baseline indicators

Indicator	Information on data
Number of publications with one or more foreign author (international collaboration)	Data sourced from SJR. Baseline period produced for 2000–2014, with 2014 taken as the year to represent current capability.
Share of world's total publications	Data sourced from SJR. Baseline period produced for 2000–2014, with 2014 taken as the year to represent current capability.
Field-weighted citation impact (FWCI)	Data sourced from Elsevier's Scopus via BIS, with the most recent year (2012) taken to be the indicator of 'present' potential. A four-year change (i.e. difference between 2008 and 2012) is calculated in order to measure the recent changes in research impact. • FWCI of 1.0 is equivalent to the world average for research impact across all research fields. The measure is based on the average number of citations for a country's research publications compared to the world average but adjusted for the differences in research area emphases. • The top 1% of world documents are the most-cited publications worldwide across all research fields.
Field-weighted citation impact (FWCI): change between 2008–2012	
Share of world's top 1% documents	
Share of world's top 1% documents: change between 2008–2012	
Patent applications	WEF GCI indicator 12.07 (2014–15) used as the main comparator for country profiles: PCT patent applications per million population.
Capacity for Innovation	Three WEF GCI indicators: • WEF GCI indicator 12.01 (2014–15) • WEF GCI indicator 12.03 (2014–15) • WEF GCI indicator 12.04 (2014–15) Each indicator is ranked on a scale from 1 to 7, based on the Executive Opinion Survey, with 7 indicating highest capability. See Table 6 in this report for more detail on the survey questions asked.
Company Spend on R&D	
University–industry collaboration in R&D	
Outbound mobility ratio	UIS 2012. Number of students from a given country studying abroad, expressed as a percentage of total tertiary enrolment in that country
UK's rank as a destination for country's HE students	UIS 2012. For the Newton countries, the UK is typically between #2 and #5 as a study destination.

Existing capacity and potential are distinct concepts, so they inform the categorisation of the baseline indicators into present/future potential and collaboration potential *respectively* (see Tables 5 to 7 in section 2). The **existing capacity** refers to the current performance of the national innovation system at a static period in time, whereas potential instead captures the underlying opportunity for capacity to change in future. The **potential** can be likened to the rate of change in recent performance, which is driven by the fundamentals of a country's competitiveness and innovation institutions.

[3] See Table A1 in the annex for an outline of each data source (e.g. SJR, UIS)

The collaboration potential baseline indicators cover the ability of countries to develop sustainable partnerships that could accelerate the growth in high-quality research output. The present/future potential indicators cover the research capacity over a long period of time (more than 10 years). The change over the baseline period is captured in those indicators, while the collaboration potential indicators account for the premise that past performance (in the baseline period) is not an indicator of future performance.

Countries that either have higher increases in research publications or relatively high competitiveness on the innovation pillar of the GCI indicate strong potential.

Tables 3a and 3b provide a summary of all the current baseline indicators for each Newton country. The baseline performance of countries also considered the time series from 2000 for countries on international collaboration and documents metrics, which are analysed and discussed in the individual baseline reports for countries.

Table 3a. Summary of baseline indicators of present and future potential, by country

Country	International collaboration (%)	Documents (rank)	Field-weighted citation impact (2012)	Field-weighted citation impact (4-year change)	Share of world top 1% documents (2012) (%)	Share of world top 1% documents (4-year change) (pp)
Brazil	28.99	13	0.770	-0.042	1.51	+0.46
Chile	59.01	44	1.101	+0.120	0.67	+0.38
China	17.59	2	0.764	+0.069	13.36	+7.29
Colombia	49.07	47	0.913	+0.103	0.40	+0.24
Egypt	51.24	37	0.748	-0.012	0.30	+0.20
India	16.36	6	0.724	-0.048	2.12	+0.94
Indonesia	44.19	52	0.859	-0.128	0.08	+0.02
Kazakhstan	37.80	67	0.551	+0.094	0.02	+0.01
Malaysia	35.73	23	0.958	+0.176	0.36	+0.21
Mexico	41.18	29	0.833	+0.018	0.74	+0.21
Philippines	59.93	70	1.313	+0.100	0.08	+0.01
South Africa	45.75	30	1.233	+0.096	0.89	+0.30
Thailand	39.34	40	0.965	-0.009	0.37	+0.16
Turkey	19.74	19	0.819	-0.005	1.08	+0.54
Vietnam	71.61	57	1.019	-0.028	0.10	+0.02
	-	*Of 229 countries*	*1 is world average*	-	*Data produced by Elsevier only for Newton countries, so ranking is not used*	-

Source: Coffey/PACEC; SJR; WEF; UNESCO.

Table 3b. Summary of baseline indicators of innovation collaboration potential and researcher mobility, by country

Country	PCT patent applications per million population (rank)	Capacity for innovation	Company spending on R&D	University-industry collaboration in R&D	Outbound mobility ratio (rank)	UK's rank as students' destination of study
Brazil	50	4.10	3.53	3.80	161	6+
Chile	43	3.71	3.06	4.20	155	4
China	34	4.24	4.29	4.40	121	4
Colombia	66	3.55	2.98	3.93	142	6+
Egypt	77	2.93	2.29	2.43	156	5
India	61	4.02	3.78	3.87	157	2
Indonesia	106	4.76	4.03	4.55	160	5
Kazakhstan	70	3.75	3.12	3.29	75	3
Malaysia	32	5.19	4.93	5.33	86	2
Mexico	58	3.72	3.09	3.97	153	5
Philippines	86	4.52	3.54	3.79	162	3
South Africa	45	4.33	3.41	4.49	159	2
Thailand	67	3.75	3.24	3.95	150	2
Turkey	42	3.70	2.95	3.69	143	4
Vietnam	93	3.48	3.15	3.27	118	5
	Of 124 countries	*1–7 Likert scale*	*1–7 Likert scale*	*1–7 Likert scale*	*Of 165 countries*	-

Source: Coffey/PACEC; SJR; WEF; UNESCO.

1.4. Programmes and stakeholders working in the same space

Given the geographical and sectoral scope of the Newton fund, the programme operates in a space alongside a variety of donors and other programmes. **The final evaluation employs contribution analysis, and it is therefore important to be aware of other donors and programmes and the extent of their contribution to the outcomes observed**. The existence of separate programmes with similar aims provides monitoring and evaluation outcomes data which can be used to compare effectiveness.

Newton in its entirety is an umbrella fund, and not directly comparable with individual programmes. The final contribution analysis will therefore include a comparison of individual Newton programmes with directly comparable counterparts (for example, Sweden's Researcher Links programme compared with Newton's programme). These will be completed during later stages of the evaluation as consistent and reliable monitoring data from individual Newton initiatives becomes available.

Three comparator groups have therefore been selected for the purposes of the baseline report. These are listed in Section 3, which details other capacity building, collaboration and translation programmes undertaken via international partnerships. The three comparator groups:

- USAID programmes, selected for their large scale, the interaction with high-calibre US researchers, and emphasis on the commercialisation process and commercial outcomes.
- Programmes led by national development agencies in Western Europe, such as SIDA, where there is a focus on building long-term linkages between countries and building capacity through development of people.
- Smaller programmes undertaken by UK delivery partners, such as the Royal Society and RCUK, which precede Newton. Many of these activities have been absorbed or expanded by Newton.

Our approach assumes baselines will change rapidly in partner countries as a result of other programmes operating in the same space (and multiple exogenous factors including rapid economic growth and improvements in education). The challenge is to define the extent of observed differences attributable to the Newton Fund – i.e. the total observed baseline changes minus those baseline changes which would have occurred in Newton's absence. The framework utilises contribution analysis, isolating individual causal mechanisms from the programme-level theory of change relating to each pillar.[4]

Larger programmes (such as USAID's) are important in that they have the potential to significantly impact the country's baseline. The value of smaller programmes (such as Royal Society capacity building) lies in their ability to provide performance benchmarks and possible monitoring and evaluation comparators.

[4] See Section 1.2.4 of the Evaluation Strategy for a detailed theory of change.

Table 4. Summary of programmes in the same space

Agency programmes	Capacity building	Research Collaboration	Translation
US (USAID)			
USAID Development Innovation Ventures			✓
USAID Global Development Partnerships			
USAID Higher education solutions network	✓	✓	
USAID International Research and Science Programs	✓	✓	✓
Germany (GIZ)			
Promoting innovation & technology in ASEAN countries		✓	✓
Sweden (SIDA)			
Innovations against poverty			✓
Japan			
Strategic International Research Cooperative Program	✓	✓	
Strategic International Collaborative Research Program			

2. Baseline Methodology

2.1. Baseline research questions

The process for selection of baseline research questions relates to the Evaluation Framework which guides the evaluation of the Newton Fund until the end of the programme.

Since evaluation questions are often phrased as summative research questions in relation to the programme (e.g. *have activities X and Y produced the expected effects?*), they do not make good candidates for the baseline research, at which point activities have not yet started or have just begun.

As a result, we have adapted the set of evaluation questions to the needs of the baseline and in doing so, we have identified the different areas which are of interest to understanding the context in which the Newton Fund is operating, in terms of existing collaborations, partnerships, funding structures and capacity.

The purpose of answering such baseline research questions is to produce non-biased, rigorous knowledge about the existing situation before the start of the Fund. It generates useful knowledge for Newton Fund stakeholders about the context they are working with, as well as providing a baseline for the evaluation of the Fund, at the end of the programme.

Table 5 outlines the research question themes of the Newton Fund evaluation and how the baseline data analysis maps to these.

Table 5. Map of baseline analysis to research question themes

Research question theme	Related baseline indicators or data analysis
Existing international collaborations and partnerships (Section 3) *To what extent are partner countries involved in existing international collaborations and partnerships?* *Which other programmes or funding initiatives, similar to the Newton Fund, are operating in the same space (thematic and geographical space) in partner countries?* *Which aspects of partner countries' S&I systems contribute to difficulties in establishing international collaborations and partnerships?*	• *Qualitative and comparative analysis* • International collaboration in publications • Indicators of student and researcher mobility
S&I capacity in partner countries (Section 4) *What are the main gaps in S&I capacity and skills in partner countries?* *What are the conditions in partner countries that seem to influence higher international collaboration, research outputs and citations?* *What is the capacity for innovation across the Fund?*	• Number of *research* publications • Research impact metrics • Capacity for *innovation* (GCI) • *Qualitative and comparative analysis*
Translation capacity (Section 5) *To what extent are partner countries facilitating university-industry and business-to-business collaborations?* *What are the conditions in partner countries that seem to influence higher numbers of patent applications?*	• University–*industry collaboration in R&D (GCI)* • *Patent applications: GCI and WIPO data* • *Company* spend on R&D (GCI) • *Qualitative and comparative analysis*
Funding structures (Section 6) *Which aspects of the research funding structures in partner countries appear to influence S&I capacity and skills?*	• *Qualitative and comparative analysis*

Source: Coffey/PACEC

2.2. Design and choice of indicators

The indicators utilised for measuring success or impact in the Newton Fund have been selected from existing research based on the following inclusion criteria:

1. Recent data available for all 15 Newton countries for an indicator (or 12 at a minimum) and coverage of at least 100 countries (i.e. majority of world countries).
2. Time series data available (particularly for the indicators of potential and international collaboration) for most Newton countries for at least 5 years, but preferably 10 years or more to provide a long baseline period.

The main data sources that fulfil those criteria[5] are from Scopus via SJR, the WIPO, the UNESCO Institute for Statistics and well-established international studies such as the Global Competitiveness Index (GCI). Due to the criteria used (long time series and data availability across groups/countries), the indicators typically form panel data, so there could be scope for advanced analysis such as econometric modelling. These datasets have been established for more than 10 years and are collected by large international organisations, so they should be available throughout the Newton Fund evaluation period.

The baseline methodology does not include primary research because the programme had already begun before the evaluation strategy was in place, and because there are limited infrastructure and available resources for primary data collection – these resources will mostly be focused on the mid-term and final stages of the evaluation. Baseline data has been established *a posteriori* from secondary data and Newton Fund partners' monitoring data from the first year. Tables 6 to 8 below outline the indicators that form the baseline analysis, with Tables A1 and A2 in the annex outlining the sources of data and the different regional classifications used in the datasets.

Table 6. Indicators of present and future potential

Indicator	Present potential: the latest data	Future potential: the 2000 onwards baseline
Number of publications with one or more foreign author (international collaboration)	Data sourced from SJR, with data for the most recent year (2014) taken to be the indicator of 'present' potential.	Data sourced from SJR, with 2000–2014 baseline used. Data are also available for 1996 onwards.
Share of world's total publications		
Field-weighted citation impact (FWCI)	Data sourced from Elsevier's Scopus via BIS, with the most recent year (2012) taken to be the indicator of 'present' potential.	Data sourced from Elsevier's Scopus via BIS. A four-year change (i.e. difference between 2008 and 2012) is calculated.
Share of world's top 1% documents		

World Economic Forum GCI indicators (for indicators of innovation collaboration potential) are directly comparable since the methodology has not been altered since 2006–07. Three of the indicators from the GCI are derived from questions in the Executive Opinion Survey, which has occurred annually since the WEF's first report on the competitiveness of European industry in 1979. In 2014 the Survey collected over 14,000 responses from business leaders across 148 countries.

Table 7. Indicators of innovation collaboration potential

Indicator	Information on data
Patent applications	WEF GCI indicator 12.07 (2014–15) used as the main comparator for country profiles: *Number of applications filed under the Patent Cooperation Treaty (PCT) per million population* Non-normalised data from WIPO were also used: *Total patent applications (direct and PCT national phase entries)*. This indicator had a baseline available for all

[5] See Annex 2 (Description of Sources)

Indicator	Information on data
	Newton countries at least for 2000–2013, so the data were analysed to compare growth rates in applications between countries. Some Newton countries became signatories of the PCT after 2000.
Capacity for Innovation	WEF GCI indicator 12.01 (2014–15): *In your country, to what extent do companies have the capacity to innovate? [1 = not at all; 7 = to a great extent] | weighted average*
Company Spend on R&D	WEF GCI indicator 12.03 (2014–15): *In your country, to what extent do companies spend on research and development (R&D)? [1 = do not spend on R&D; 7 = spend heavily on R&D] | weighted average*
University–industry collaboration in R&D	WEF GCI indicator 12.04 (2014–15): *In your country, to what extent do business and universities collaborate on research and development (R&D)? [1 = do not collaborate at all; 7 = collaborate extensively] | weighted average*

Table 8. Indicators of student and researcher mobility

Indicator	Information on data
Outbound mobility ratio	"Number of students from a given country studying abroad, expressed as a percentage of total tertiary enrolment in that country". Sourced from the UNESCO Institute of Statistics (UIS) for the most recent year, 2012, at the time of analysis. Data available since 1999.
UK's rank as a destination for country's HE students	Sourced from the UNESCO Institute of Statistics for the most recent year, 2012, with the top 5 destinations listed per country. For the Newton countries, the UK is typically between #2 and #5 as a study destination so the data were useful for Newton comparison. The UIS also has extensive data available on outflows and inflows of students to produce these statistics.

Many data sources were considered but did not fulfil the criteria. The INSEAD Global Innovation Index has a rich dataset for dozens of innovation input and output indicators, although there have only been three editions since 2012 that have easily accessible datasets and there is limited scope on analytical detail in individual countries. It may be of interest to programme managers to monitor the progress of Newton countries to examine whether some begin to develop strengths in certain areas. The GCI is more appropriate because it is selective through the use of seven headline innovation indicators, offering similar discussion on individual countries' progress on innovation. INSEAD's reports often have sections that give a detailed snapshot on certain countries: for instance China, India and Malaysia had chapters in the 2015 report. These reports could be consulted in later years to see if they include detailed analysis on Newton countries.

Other data from UNESCO UIS, such as gross domestic expenditure on R&D (GERD) and other R&D measures have incomplete data for Newton Fund countries so were not used. Datasets on indicators such as GERD either had incomplete data by country or across desired time periods, so there is limited scope to produce baselines for such indicators despite their prominence in literature on innovation.[6]

Qualitative research and policy literature is used as far back as 1999/2000, a benchmark year for key policy objectives such as the Millennium Development Goals which have driven many development-oriented research capacity building and collaboration programmes to date. Selected publications come from major research and policy organisations involved in co-ordinating and evaluating innovation and research activities around the world,

[6] Table 9 includes a 'Pre-Development' category for countries below the threshold for engaging in international collaborative research.

such as the Association of Commonwealth Universities, DFID, OECD, UNESCO and major data providers such as Elsevier. Theoretical literature on economic development referred to in the research is not confined by any time cut-off and is taken exclusively from well-known journals and academics.

2.3. Methods

The baseline period from 2000 to the latest available year (a baseline of more than 10 years) has been used for indicators of future potential and can be generated for other indicators. This covers a period following the Asian financial crisis of the late 1990s and includes the global financial crisis of the late 2000s. During this baseline period there have been major differences in trends between countries and regions.

Secondary data are derived from Scopus via SJR, the WIPO, the UNESCO Institute for Statistics and the World Economic Forum, described in greater detail in Annex 2. These sources are referenced frequently in policymaking literature, and are produced using a reliable methodology outlined in the inclusion criteria above.

Many of the World Economic Forum's GCI innovation indicators include quantitative scales (1–7 scale in the executive opinion surveys) that measure qualitative concepts, such as the perceived extent to which businesses and universities collaborate on R&D. These indicators are based on the answers to an executive opinion survey carried out in 144 countries. The executive opinion survey data have been used in other indices and have been used by the OECD, World Bank and IMF. The executive opinion survey is an appropriate comparator for these finer, qualitative concepts, with usage by the World Economic Forum since its first reports on economic competitiveness in 1979. One of the strengths of the survey is that it *"captures the opinions of business leaders around the world on a broad range of topics for which data sources are scarce or, frequently, nonexistent on a global scale"*[7].

Internationalisation is becoming an increasing part of universities' and policymakers' strategies for *"raising quality standards and global relevance, attracting the best students and staff, [and] generating revenue"*, among other significant objectives. Student mobility is a key measure of internationalisation and plays a role in innovation and skills development and capacity building. There has been a large increase in internationally mobile students over recent decades, from 800,000 in the mid-1970s to more than 3.5 million in 2009. However, during that time the numbers of tertiary students has increased by a similar amount, so there is a *"stable 'propensity' to study abroad"* of nearly 2%. The mobility rate of students abroad is viewed as critical to increase the *"future opportunities for TNE [transnational education] programmes'*[8]. UNESCO provides the main data for student and researcher flows and is being used by the British Council for its forecasting and policy analysis.

2.4. Baseline analysis

The GCI is one of the main sources of baseline data, with four of its seven innovation pillar indicators being potential indicators for innovation collaboration. The GCI aims to 'assess the level of total productivity of an economy' (since the Solow growth model academic literature has linked technical change and productivity growth as a determinant of long-term economic growth). The WEF has analysed the robustness of the GCI in estimating productivity in countries, finding strong correlations between the GCI and both GDP per capita and net-of-convergence growth rates[9].

Endogenous growth models, particularly since Romer and Lucas, have focused on the role of innovation (and the quality of human capital) in determining long-term economic growth. The Romer model theorises that economic growth is sustained in the long run by technological progress, particularly through R&D in labour-augmenting technology.[10] The GCI considers innovation under a wider 'ecosystem' that is conducive both to the generation of ideas and to the implementation of ideas in the marketplace, incorporating innovation beyond scientific R&D, which had been a focus of the literature and economic growth models[11]. There has not been extensive analysis on the robustness of the GCI's set of innovation indicators, as they form one part of competitiveness and draw upon findings from a diverse literature as part of the rationale for their inclusion.

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[7] See http://reports.weforum.org/global-competitiveness-report-2014-2015/introduction-2/
[8] British Council, "The shape of things to come: higher education global trends and emerging opportunities to 2020", *British Council*, 2012.
[9] See http://reports.weforum.org/global-competitiveness-report-2014-2015/view/gci-and-growth-empirical-analysis/
[10] P Romer, "Endogenous Technological Change", *Journal of Political Economy 98*, S71-S102, 1990.
[11] See http://reports.weforum.org/global-competitiveness-report-2015-2016/ideas-ecosystem/#view/fn-98

The bibliometric data for indicators of present and future potential by countries are widely used by governments and policymakers for comparative analysis between countries. For example, BIS has compared the performance of British research to that of other economies across a baseline period[12]. The European Commission has analysed and assessed the use of bibliometric indicators for developing the Horizon 2020 policy strategy.[13] The European Commission report analysed the research (or citation) impact of publications and found a 'pecking order' for how co-publication can influence research impact. In essence, the publications with higher average research impact had co-authorship in at least one EU country and one non-EU country, and those that had the lowest impact were domestic co-publications and single-author publications[14].

There are some issues with the data that required care: one major caveat concerns patent data from the WIPO, which include Patent Co-operation Treaty (PCT) patent applications, present a notable decline in years that follow a country's start of membership in the PCT standards, so trends on patents should account for this data nuance. Six Newton countries became members of the PCT since the start of the baseline period in 2000, including most recently Thailand and Chile in 2009 and Malaysia in 2006. Patent applications could fall by more than 50% within a year (or longer) of becoming a PCT member, due to a transition period towards international standards.

The data indicators are primarily quantitative, although the GCI indicators are scales that are based on qualitative assessments in the GCI's executive survey. Success of the Newton Fund in partner countries could be assessed over time through comparing their current ranks and metrics to scores in later stages of the evaluation. For the ranked indicators, a higher rank over time would indicate greater success and could be more meaningful (particularly for the GCI indicators that use a Likert-type scale of 1–7).

However, there is potential ambiguity in deriving conclusions from the most important indicator for the Newton Fund: international collaboration. There is no econometric modelling in the literature of the relationship between international collaboration and research capacity, which is a core relationship that underpins Newton activity. Newton is seeking to develop international research partnerships as a means to increase research capacity, although the relationship between international collaboration and research capacity appears non-linear over the course of a country's development cycle. Section 2.5 below elaborates on the nuances of the headline indicators. It is possible that countries could see a fall in international collaboration during Newton activity as they develop a more mature domestic research capacity, which accelerates the scale of research output.

2.5. Challenges and limitations of the baseline methodology

Field-weighted citation impact (FWCI) is a fairly abstract variable when compared to more tangible measures such as co-authorship and patent applications, so there are more difficulties in discussions of causality, particularly in comparison to international collaboration as an indicator. However FWCI is *"useful for benchmarking, since it smooths out, for the most part, differences in size, discipline, time, and publication type"*[15], which is not the case for many of the other baseline indicators. FWCI is a so-called 'snowball metric' (by Elsevier) which is agreed by universities themselves, but has variable utilisation from country to country[16]. The share of world top 1% documents is not normalised by level of output or population size, so as a metric it still captures research quantity despite its use as a measure of research quality. The four-year change metrics attempt to reduce this limitation.

There are challenges to the use of international collaboration (measured as the share of publications that are internationally co-authored) **as a baseline**. There do not appear to be time series trends in international collaboration by region or by countries that have large populations. More populous countries have larger networks of innovation that could stimulate high levels of domestic research due to population effects, as described by development economists such as Kremer in 1993. Kremer concluded that *"historically, among societies with no possibility for technological contact, those with larger initial populations have had faster technological change and population growth"*[17]. There is panel data for the baseline, for approximately 15 years and 15 Newton countries, so econometric modelling could be undertaken for a regression on the determinants of international collaboration. Such modelling could be extended to a wider international dataset to make it more robust, for instance including all

[12] Elsevier, "International Comparative Performance of the UK Research Base – 2013", *BIS*, 2013.
[13] European Commission, "Analysis of bibliometric indicators for European policies: 2000–2013", *Publications Office of the European Union*, 2015.
[14] *Ibid.*, pp. 14–15.
[15] R Dresbeck, "SciVal", *Journal of the Medical Library Association 103*(3), pp.164-166, 2014.
[16] R Dresbeck 2014.
[17] M Kremer, "Population growth and technological change: one million BC to 1990", *The Quarterly Journal of Economics 108*(3), pp. 681–716, 1993.

years from 1996 and hundreds of countries. Modelling can account for the group effects and time effects present in the data, although the robustness of the model would depend on the suitable assumptions that can be applied. There would be the scope to model an intervention utilising difference-in-differences analysis or the inclusion of variables related to interventions, such as levels of investment.

The relationship between international collaboration and research quality is unlikely to be linear (i.e. higher collaboration leads to higher quality research as the typical linear causation channel). As countries develop their indigenous capacity through greater openness, the conditions for collaboration improve and could lead to higher research impact. Once a country reaches an innovation capacity that creates an indigenous critical mass, the level of international collaboration could fall, with the increases in research impact accruing from the developed indigenous critical mass in research.

Many scholars highlight that the relationship between international collaboration and research capacity is non-linear but nevertheless important. Gaillard notes that *"although international collaboration is part of the strength of a national science system, there is a limit beyond which it can become a threat or at least a major weakness"*. He is highlighting the case of Senegal, which has increased its international co-authorship since the 1990s, but has seen research output become increasingly dependent on a single foreign institution, the French Research Institute for Development (IRD). Gaillard raises a number of questions about the sustainability of the indigenous research capacity in Senegal, the extent to which its national science might be disappearing amidst international research and whether the internationalisation of science is making national systems become irrelevant.[18] An attempt has been made by Elsevier to capture the relationship between indigenous capacity and international collaboration as part of a four-stage bibliometric model, with international co-authorship *"[discriminating] between the various phases in the development"*, (see Table 9 and Figure 1[19]). This model is explored in greater detail in Section 4.2 as part of a discussion of international collaboration trends.

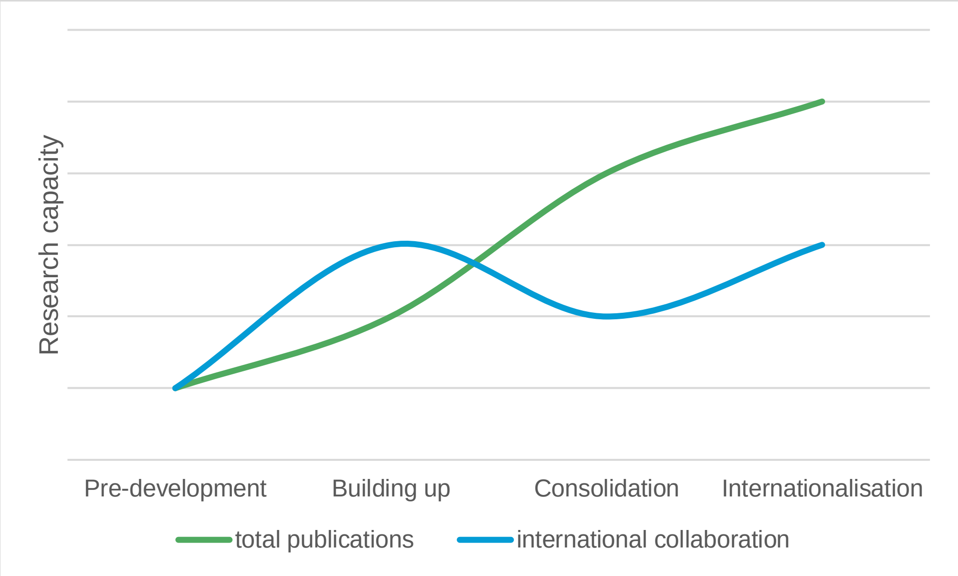
Table 9. UNESCO-Elsevier research development stages and bibliometric indicators

Development stage	Information on data	Trend in publications total	Trend in international collaboration
Pre-development	Limited research capacity and unclear research policy, with indicators prone to large annual fluctuations.	(.) *Low or limited*	(.) *Low or limited*
Building up	Foreign research teams begin collaboration on particular fields, with domestic researchers in secondary role.	(+) *Increase*	(++) *Large increase*
Consolidation and expansion	There is more domestic funding for research, with research increasingly carried out by domestic institutions only.	(++) *Large increase*	(-) *Decline*
Internationalisation	Research institutions take lead in international partnerships and domestic researchers influence global agenda.	(+) *Increase*	(+) *Increase*

Source: Adapted from Moed and Halevi (2014), as part of UNESCO (2014)

[18] J Gaillard, "Measuring Research and Development in Developing Countries: Main Characteristics and Implications for the Frascati Manual", *Science, Technology & Society 15*(1), pp. 77–111, 2010.
[19] H Moed & G Halevi, "Tracking scientific development and collaborations – The case of 25 Asian countries", *Research Trends 38*, 2014. Extracted from UNESCO 'Expanding Out, Expanding Up' (2014). See Section 4.2.

Figure 1. UNESCO-Elsevier research development stages



Source: Adapted from Moed and Halevi (2014), as part of UNESCO (2014)

3. Existing international collaborations and funding initiatives

Globalisation in science and technology research has led to rapid growth in partnerships and international collaboration in recent years. Researchers and policymakers alike have sought to access a larger range of skills, facilities and resources as international opportunities become available. Bibliometric data used in this report shows that Newton partner countries have enjoyed increases in the global research market share since 2000, as well as gross increases in the number of internationally co-authored documents.

As the global market share in research outputs for Newton partner countries has grown, the proportion of publication outputs involving international collaboration (measured as publications with authors from more than one country) has remained steady and in some cases has fallen over time. Maintaining the share of international publications at the same rate requires a considerable gross increase each year, implying considerable growth in the capacity to collaborate on international research. A decline in the proportion of international research collaborations may be indicative of growth in indigenous research capacity, in that foreign expertise and capabilities are no longer needed to produce high quality outputs and local resources can be used instead.

There is considerable variation in the extent of international collaboration and partnership between different Newton partner countries. Some countries have deep and well-financed institutional relationships with foreign companies and research organisations stretching back many decades. Initiatives typically span multiple stages of the innovation and commercialisation supply chain, including those captured by Newton's thematic focus areas (People, Research and Translation).

Some countries have only recently begun to engage with foreign partners, having so far only undertaken flagship activities or expressed interest in joint working (MoUs). A notable feature in these countries is the pace of change in the research landscape. A considerable proportion of initiatives have been developed over the last decade and many more are being planned.

The country baseline reports use SCImago bibliometric data on international publication collaboration alongside indicators on researcher and outbound student mobility (proxy indicators of internationalisation).

The research topics in this section will consider the following analysis and indicators:

- *Qualitative and comparative analysis*
- International collaboration in publications
- Indicators of student and researcher mobility

3.1. To what extent are partner countries involved in existing international collaborations and partnerships?

The partner countries are all engaged in existing international collaborations and partnerships, to different degrees.

All Newton partner countries had some extent of science and innovation research collaboration with the UK and other economies prior to the introduction of the fund.

Relationships between the UK and other research powers were extensive prior to Newton. Funding in countries with high research capacity or intermediate capacity with high immediate potential builds on a high starting baseline in which Newton funds will constitute a smaller proportion of overall collaborative research outputs. These countries enjoy extensive research relationships and have relatively internationalised research systems.

Considerable bibliometric data exists on the extent and volume of international co-publication. SCImago data illustrate the extent of international collaboration of partner countries prior to Newton inception.

China and India produce the most co-authored publications with the UK, and rank first and second in provision of international students and researchers to British universities. The two countries also have extensive existing relationships with UK delivery partners, with substantial co-investment by RCUK with counterpart research funders in China as of 2016[20] and joint investment with partners in India[21]. UK-China research collaborations doubled between the 1990s and 2005, and UK researchers have exclusive access to some Ministry of Science and Technology (MoST) collaborative funding streams[22]. The two countries also have extensive relationships with the EU through initiatives such as the EU-China Co-Funding Mechanisms for Research and Innovation, and large programmes with research ministries in Germany and France.

Student and researcher outbound mobility is a key measure of openness and internationalisation, so it is a good indicator of collaboration potential and international partnership. Within the country reports, we have used UNESCO student outbound mobility data as a proxy for collaborative and partnering potential. Countries attach a strong focus to doctoral students in their innovation system, due to their being at the forefront of domestic innovation activity in academia and industry. However, the datasets on doctoral student mobility only cover certain countries (e.g. the OECD Science, Technology and Industry Scoreboard), so only the higher-level indicator that covers tertiary students has been used in the baseline analysis due to the availability of data.

Many Newton countries have student mobility policies which form a crucial part of their national innovation strategies, including scholarships for international study, funding to 'repatriate' academics to positions in the country, and multilateral partnerships for fostering student exchange. The rationale of these policies is for countries to send their students abroad to universities of international excellence and to return to work in industry or academia after their studies, in order to bolster innovation activities. These are examples of policies described in the individual country reports:

- Colombia, Chile and Mexico (with Peru) are involved in the Pacific Alliance's reciprocal student exchange programme, which provides 100 scholarships per year for study abroad in each country (75 for undergraduates and 25 for doctoral & teaching candidates). It is described by the World Economic Forum as a *"benchmark of excellence for scholarship programmes in Latin America"*[23].
- Brazil's Science Without Borders scholarship programme enrolled 101,000 Brazilian students on sandwich courses in STEM and creative industries at international universities in its first phase (c. £900 million budget).
- Kazakhstan established its Bolashak scholarship programme in 1993, which funds the overseas study of Kazakh students (from undergraduate to PhD level) on condition that they return to the country for work within five years. Over 6,500 Bolashak scholars have studied at nearly 200 universities in 23 countries[24].
- South Africa's Research Chairs Initiative is a 'flagship programme' of the South African government and is now a key policy for the country's innovation strategy to 2030. The initiative provides funding for its expat researchers to return to work in the country, for up to 15 years and up to £110,000 in funding per annum. Over 150 Research Chairs have been funded since the start of the programme in 2007.

Table 10. Outbound Mobility Ratio among 165 countries (UNESCO)

Country	Outward mobility ratio (%)	Rank (of 165 countries)
Brazil	0.42	161
Chile	0.79	155
China	2.13	121
Colombia	1.21	142

[20] Research Councils UK: 'About RCUK China' – http://www.rcuk.ac.uk/international/offices/china/about-rcuk-china/
[21] Research Councils UK: information in December 2015 press release – http://www.rcuk.ac.uk/media/news/151221/ and non-Newton share confirmed by RCUK via email.
[22] Universities UK – International research collaboration: opportunities for the UK higher education sector. (2008)
[23] World Economic Forum, "Bridging the Skills and Innovation Gap to Boost Productivity in Latin America – The Competitiveness Lab: A World Economic Forum Initiative", p. 36, 2015.
[24] See http://inter.kstu.kz/category/international-programs/

Egypt	0.70	156
India	0.66	157
Indonesia	0.56	160
Kazakhstan	6.60	75
Malaysia	5.31	86
Mexico	0.85	153
Philippines	0.39	162
South Africa	N/A[25]	N/A
Thailand	1.01	150
Turkey	1.18	143
Vietnam	2.38	118

3.2. Which other programmes or funding initiatives, similar to the Newton Fund, are operating in the same space (thematic and geographical) in partner countries?

Newton is an umbrella fund that covers three pillars of funding, so it is not directly comparable to other programmes. However, there are a number of initiatives with similar research and development mechanisms and policy goals operating internationally, including USAID schemes and Sida's Innovations Against Poverty.

Newton is distinct among international development programmes. The fund supports a complex chain of research and translation mechanisms at multiple levels, designed to improve public policy and economic development indicators in a wide range of developing countries. Nevertheless, several recent or existing programmes share common research and development mechanisms and are motivated by similar policy goals. There are a number of initiatives designed to build research capacity in the developing world, though fewer involve the extent of collaboration, exchange and translation that characterise Newton, nor include a comparable diverse range of activities. The comparators listed below involve international development agencies of other countries, or programmes undertaken by UK-based delivery partners prior to the commencement of Newton funding.

- USAID funds a large number of programmes to build research capability and reduce poverty around the world. 'People' development activities include the Higher Education Solutions Network (HESN), which supports 8 development labs for researchers to catalyse and scale new science and tech-based solutions to the world's most challenging development problems. Partnerships to provide development solutions include the Partnerships in Enhanced Engagement in Research (PEER), programme, a $28m research grants program in which scientists from developing countries partner with U.S. government-supported researchers to build S&I capacity and address large, complex development issues.
- The European Union supports a variety of international research activities as part of its €80bn Horizon 2020 endowment.
- Individual European countries have also supported this type of initiative. Sweden's development agency SIDA is a well-known funder of research capacity development programmes, such as the Innovations Against Poverty Program, which allocates 83m SEK (£6.75m) to applicants working on translation projects, and the Researcher Links exchange and mobility programme. Germany's national development corporation (GIZ) promotes science and technology development in ASEAN countries, as well as large

[25] Incomplete data in the UNESCO dataset. However, the baseline report for South Africa has a note that the World Bank (in a different dataset) estimates the outward mobility ratio is 0.6%.

industry-academia programmes through the German Education and Research Ministry (BMBF) and German Research Foundation (DFG).

- Newton funding builds on existing partner activities. Research Councils UK (RCUK) and the Royal Society jointly run a £15m research project, the Africa Capacity Building Initiative, which supports African research consortia working with UK laboratories to address development challenges. The project is linked to DFID's research translation project, the Development Research Uptake in Sub Saharan Africa (DRUSSA), which aims to transform local knowledge into policy. BEIS also run flagship programmes such as UKIERI in India.

3.3. Which aspects of partner countries' S&I systems contribute to difficulties in establishing international collaborations and partnerships?

The predominant factor contributing to partner countries' difficulties in establishing international collaborations and partnerships is funding. Research funding systems are complex and not conducive to joint research programmes (e.g. the use of block grants, instead of competitive rounds of grant funding).

Funding: Access to research funding, research employment markets and infrastructure remain important issues in many partner countries. Funding systems in partner countries are complicated and the EU has set up the Access4 initiative to help European researchers access funding programmes in the BRIC countries, as well as South Africa. Many countries allocate science and technology funding through block grants, which help support institutional planning but are less suitable to international collaboration or policy-oriented research. The administration and management of research funding is considered a key strategic competence for exploiting emerging opportunities at the international level[26].

A key funding constraint on international collaboration in established S&I systems is the issue of 'double jeopardy', in which a joint project wins approval from one country but not another. Research Councils UK (RCUK) have identified this as a major inhibitor to the development of joint research, and have developed a number of flexible 'workaround' funding mechanisms to support the full range of engagements, from large collaborations to early-stage partnerships.

[26] A. Olsson, 'Funding instruments and modalities in Swedish Development Assistance to research' OECD IHERD report 2013

4. Science and innovation capacity in partner countries

The research topics in this section will consider the following analysis and indicators:

- Number of research publications
- Research impact metrics
- Capacity for innovation (GCI)
- *Qualitative and comparative analysis*

4.1. What are the main gaps in S&I capacity and skills in partner countries?

Capacity refers to the ability of countries to meet their various needs via the supply of skills, equipment, networks and funding. The two key ingredients in respect of science and innovation are human capital and institutional capacity. Newton partner countries differ in the extent of skills and capacity gaps in their science and innovation systems.

Research plays a fundamental role in enabling countries to define and understand their developmental needs. Some partner countries have few researchers per head of population. Others have attracted donor activity to one particular area, typically focused on primary education. Some partners attract large numbers of undergraduates but very few postgraduates and fewer still early career researchers. The Association of Commonwealth Universities (ACU), a key DFID partner on research development, has noted the complex challenges facing research career development: *"Early career researchers are emerging into a very different research environment to that into which their senior colleagues emerged in previous decades, where research is increasingly multidisciplinary, collaborative, mobile and data-intensive. They are also a vital dimension of any university's internationalisation strategy"*[27].

Further along the supply chain, research focus (often driven by donor focus) has typically been dedicated to knowledge generation at the expense of other stages in the cycle. The move to other stages, such as development of research agendas and the uptake and communication of findings, has been relatively more recent[28]. The result can lead to a failure to develop fundamental capacity among researchers within universities[29]. Institutional arrangements and linkages are therefore a key factor in capacity development, where many Newton countries are still in the process of transitioning from centrally-planned R&D funding systems to market-oriented ones.

Scientific and technological capacity to generate explicitly sustainable development is a more complicated matter still: **issues in sustainable development tend to be problem-driven (i.e., policy-driven), vertically integrated, interdisciplinary, and often highly complex**. Modern day researchers therefore need strong collaborative, communication and knowledge transfer skills, including the ability to interact with local policy stakeholders, engage commercial actors, communicate innovations to communities, and inform them of the benefits they can bring.

4.2. What are the conditions in partner countries that seem to influence higher international collaboration, research outputs and citations?

International collaboration and output in partner countries are affected by pre-existing research capacity, and institutional and policy conditions. The key institutional and policy dimensions are collaboration strategy and policy need.

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[27] Website of the Association of Commonwealth Universities (ACU) -- www.acu.ac.uk/focus-areas/early-careers/

[28] DFID/ODI. Research capacity strengthening in Africa: Trends, gaps and opportunities. N.Jones, M. Bailey and M. Lyytikäinen (2007) p.7

[29] The commercialisation of Chinese Universities and its effects on research capacity', 'The China and Transitional Economy Research Centre', Northampton University, Y Chen, R Sanders and J Wang, p.3

Policy

Some countries are more explicit than others in targeting science and technology research to meet specific policy and social goals. China's 2020 S&I policy agenda, for instance, targets increases in R&D investment, research citation and patent registration as part of the country's bid to drive economic growth through indigenous innovation[30].

Policy conditions are focused around collaboration strategy and policy needs, namely:

- **Collaboration strategy**: The existence of formal strategies for collaboration at country, institution and funding agency-level are key ingredients in determining output. There are known benefits from maximising research collaboration, and each institution and country will have priorities or restrictive criteria because of constraints on resources. Given that only highly internationalised universities tend to attract funding from a wide range of sources, universities and institutes must therefore have strategic mechanisms to support collaborative activities and build capacity, including travel abroad programmes, conferences, joint degrees, and support for joint research. A key measure of internationalisation is student outbound mobility and researcher flows.
- **Policy need**: Globe-spanning research challenges require international collaboration (e.g. disease control, climate change and sustainable energy). In these cases, public investment decisions are driven by policy need[31]. There are pockets of excellence in many countries, and science policy and resources are often directed towards local priorities; for instance, rice and grain research in the Philippines. Partner countries seek out international collaborative opportunities to help maintain their competitive advantage and attract expertise and funding. Collaboration then lends credibility to research and improves reach, visibility and citations.

Research capacity

International collaboration aims to build research capacity and improve the quality, scope and critical mass of research by linking funding, expertise and knowledge from one country to another[32]. The capacity to engage internationally, however, is determined by conditions of pre-existing capacity.

A notable feature of our country baseline reports is that many partner countries have experienced a decline in the proportion of internationally co-authored articles. A recent UNESCO science report suggests this is the result of a **four-stage education and research development model** in which collaboration (as measured by bibliometric data) has a non-linear relationship with research output[33]:

1. In the first stage, '**pre-development**', countries have severe constraints on research policy and publication output and lack the critical mass to engage in major initiatives. These countries are among the poorest in the world and no Newton partners fall into this category.
2. A second '**building up**' phase sees local researchers working with foreign collaborators on thematic research supported by foreign agencies, where internationally co-authored papers are a key output. Exchange programmes are promoted between developed countries with shrinking populations in need of fresh research talent and developing country researchers looking to develop skills and networks.
3. The third phase is '**consolidation and expansion**', focused on building science and innovation infrastructure locally. The number of internationally co-authored papers increases, but at a considerably slower rate than that of gross national output, with a resultant decline in the proportion of internationally co-authored publications. Our research finds most Newton partners located in this category.
4. The fourth phase, '**internationalisation**', countries become global research leaders and witness a fresh increase in the proportion of publications co-authored internationally.

Table 9 in Section 2 shows the trends in collaboration and output for each stage of development. Over the course of a country's development in the cycle, international collaboration over time has at least two inflexion points (i.e.

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[30] G Fabre, S. Grumbach 'The World Upside Down, China's R&D and innovation strategy.' FMSH (2012) p.9

[31] C Wagner, I Brahmakulam, B Jackson, A. Wong. T. Yoda, 'Science and Technology Collaboration: Building Capacity in Developing Countries?' RAND 2001

[32] P Boekholt, J Edler, P Cunningham, K Flanagan, Drivers of international collaboration in research (2009), European Commission, p.ii

[33] UNESCO, Higher Education in Asia, Expanding Out Expanding Up. (2014). See also Section 2.4 of this report on bibliometrics.

when the trend changes direction). In the third phase, which appears to be a suitable classification for most Newton countries, the trend in international collaboration is falling when research output is increasing at its fastest rate. A country could have success during Newton activity but experience a fall in international collaboration, yet this could indicate that the country is developing a strong indigenous research capacity with a positive impact on domestic researcher networks.

There is also a negative correlation in the baseline analysis between FWCI scores and the level of international collaboration, which indicates that international collaboration is likely to increase a country's research impact. Once countries develop their indigenous research capacity and as a consequence have a lower proportion of international co-authorship, their typical research output will have a lower FWCI.

4.3. What is the capacity for innovation across the Fund?

The capacity for innovation varies considerably between partner countries. Bibliometrics show most partner countries increasing their share of world research output since 2000.

Our Newton partner country baseline reports use Capacity for Innovation (from the Global Competitiveness Index) and the trends in research publications as the measures of innovation capacity across the Fund.

The baseline analysis of countries' shares in world research publications indicate that almost all Newton partner countries have increased their share in world research. Seven partner countries also had increases in the share of research publications in their regions. For example, China accounted for 22% of research in the Asiatic Region[34] in 2000 and 53% in 2014.

Overall, the baseline analysis indicates that countries selected for the Newton Fund on the whole have a good capacity for innovation.

[34] SCImago defined region.

5. Capacity to translate research and innovation

The research topics in this section will consider the following analysis and indicators:

- University–industry collaboration in R&D (GCI)
- Patent applications: GCI and WIPO data
- Company spend on R&D (GCI)
- *Qualitative and comparative analysis*

5.1. To what extent are partner countries facilitating university-industry and business-to-business collaborations?

Many partner countries score highly for collaboration between businesses and between businesses and universities. Policies have included attracting campuses of international universities; founding Centres of Excellence; setting up incubation centres; and developing clusters.

Malaysia, for example, has a strong focus on **university–industry collaboration through 'branch campuses'** of international universities based in key clusters in the engineering sector (an area of comparative advantage in the region). Australian universities were the first to establish branch campuses in Malaysia in 1998, beginning with Monash University, the rationale being building greater business–academia links in an international context. SEA-EU-Net in a report on innovation in Southeast Asia notes that the industry cluster collaboration with universities strengthened international technology transfer and commercialisation[35]. The University of Nottingham established a campus in Semenyih with 'Research Priority Centres' producing research to 'reflect priorities unique to Malaysia and Southeast Asia', including tropical environmental studies and palm oil research.

The focus, in countries like China, has been on **cluster development** through the creation of enterprise and cluster zones providing incentives, modelled on the success of Silicon Valley. The latest focus in China has been on 'research alliances', which are sector-specific partnerships between multiple enterprises, universities and research institutes (in a three-actor model). The first four Alliances in 2007 were in the sectors of steel, coal, chemistry and agricultural equipment. The Chinese government has established High-technology Zones, such as Beijing's Zhing Guan Cun Science Park – a base for over 4,500 enterprises including Lenovo, Google and Intel – which provide tax relief on investment for foreign enterprises. There were 105 of these Zones in 2012 and they account for the majority of incubator activity in the country.

'Centres of Excellence' such as those in Chile and Egypt support the applied research capacity of institutions through targeted funding. This scheme is similar to the 'Centres of Competencies' (COCs) initiative in South Africa, and features partnerships between industry, universities and research institutes to support commercialisation of R&D over a 10-year period. The CoCs are modelled on the Competence Centres in the European Union and 28 have been established in South Africa since 2010, with a programme review indicating in 2015 that there will be an extension of the programme in future. The Hydrogen South Africa (HySA) centre is one of the major CoCs; it contributes to value-added manufacturing and aims to supply 25% of the global hydrogen and fuel cells market by 2020. So far, there has been collaboration between organisations such as the University of Cape Town, Anglo American and Impala Platinum on minerals research.

Policies to incentivise incubation were also one of the factors that led to the development of collaboration activity in Brazil, with over 400 incubators in operation since the launch of a national programme in 1999. There are a few notable incubator parks that are technologically intensive, such as the Technological Park of Rio (dubbed a Brazilian Silicon Valley, home to Petrobas, Siemens and other large foreign enterprises) and the biomedical cluster at Supera. The São Paulo Research Foundation (FAPESP) is a major state institution that is an example of best practice in Brazil, having contributed significantly to the development of innovation clusters in the State of São Paulo. In 2012, FAPESP funded nearly four dozen university–industry collaborative research projects, which are funded for as long as 10 years.

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[35] Degelsegger, Gruber, Remøe. Trienes, 2014: "Spotlight on: Stimulating Innovation in Southeast Asia", *Centre for Social Innovation (ZSI)*

5.2. What are the conditions in partner countries that seem to influence higher numbers of patent applications?

There seems to be no correlation across the partner countries between the rate of patent applications per million population and the trend.

In the sample of Newton countries, **there is no correlation between the current patent applications per million people and the baseline (i.e. long-term prior) growth rate in patent applications**. There do not appear to be any recent studies on the determinants of patent application trends; rather, there appear to be more studies on the impacts of patent growth on other variables, including economic growth. The *"evolutions in innovation processes, the economy and patent regimes"* were described by the OECD as leading to the increase in patenting activity between 1992 and 2002 in OECD countries[36]. However, an Elsevier study in 1999 concluded that the increase in patenting in the USA was due to the *"increase in US innovation spurred by changes in the management of research"*, rather than the *"conventional wisdom"* of institutional change being behind the trend[37]. In a similar vein, it is plausible that the long-term variation in patenting activity between Newton countries is due to higher rates of change in innovation, with other factors such as macroeconomic conditions able to have some influence.

[36] OECD, 2004, "Patents and Innovation: Trends and Policy Challenges", *OECD Publications*.
[37] S Kortum & J Lerner, 1999, "What is behind the recent surge in patenting?", *Research Policy 28*(1), pp. 1–22.

6. Research funding structures

The research topics in this section will consider the following analysis and indicators:

- *Qualitative and comparative analysis*

6.1. Which aspects of the research funding structures in partner countries appear to influence S&I capacity and skills?

Enterprise has an important role in funding and performing research, in order for countries to have a sustainable research base and for innovation to maintain a direct interface between academia and industry. The GCI's 'Company spending on R&D' measure has been used in the baseline analysis to account for the importance of enterprise in funding innovation, rather than indicators such as business expenditure on R&D (BERD) which have incomplete data for the Newton countries.

The main source of R&D funding for OECD countries is industry, with some cross-country differences in R&D but a clear aggregate trend, as well as industry being the main performer of R&D activity: Industry's share as a source of research financing increased to 63% in 2001, compared to 50% in 1981[38]. OECD countries have moved away from a fairly equal split between government and industry financing towards funding structures that have industry as the main source of research financing. With this trend there has also been an increase in the proportion of university and public research institution financing from industry, although this has greater variation than the source of R&D funding.[39]

Countries such as South Africa have funded schemes to bring back or retain researchers in the country, such as the South African Research Chairs Initiative, as well as more general research diaspora schemes. Diaspora schemes are present in many countries, particularly in the form of developing databases of expatriate researchers and then reconnecting them with research bases in the countries.

The national innovation systems that have a more distributed setup of responsibilities, with government agencies having their own remits focused on certain innovation activities, are more effective in delivering suitable research strategies. For example, a Fraunhofer report for the World Bank indicates that *"there is evidence of strong issues within 'mega-institutions' that try to address too many objectives in parallel"*[40]. The Fraunhofer report reveals that there have been good results from organisations such as NAFOSTED and the Chinese Innofund being bestowed more flexibility in adapting their organisational missions in reaction to the demand for the funding measures.

While it remains important to have policies distributed across multiple agencies (e.g. industry activity, education activity, science-based activity), it is also crucial for national innovation systems to strike a balance where the distribution of innovation policy among organisations is not fragmented. This is an issue faced by the development of subordinate units in a certain ministry. For example, Fraunhofer offers an example of *"placing [an] organization under the Ministry of Education may lead to an undue focus on universities and neglect of other important players in the innovation system"*[41].

Funding and support instruments also face similar issues around focus and breadth that require a fine balance akin to that faced by governments' structuring of national innovation system organisations. For a national innovation system to be effective in its objectives, the Fraunhofer report notes that support offerings, including funding, *"should have a clear and recognizable character and not mix too many different objectives or types of support"*. The support offering could become "unattractive" to beneficiaries if the supports are too spread out; this is also detrimental to the fraction of supports that are the most successful but have low levels of funding[42]. In essence, an effective innovation system has clearly-defined, distinct supports which have sufficient funding and are reviewed regularly in order that they meet the needs of industry and researchers.

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[38] G Maass, "Funding of Public Research and Development: Trends and Changes", *OECD Journal on Budgeting 3*(4), p. 47, 2003
[39] *Ibid.*, pp. 42–43.
[40] H Kroll & T Stahlecker, "Global Review of Competitive R&D Funding", *Fraunhofer Institute for Systems*, 2012.
[41] *Ibid.*
[42] *Ibid.*

7. Newton Fund design in light of baseline findings: Opportunities and challenges

Table 11 tracks the allocation of funds to date (December 2015). Newton tracker data suggest a well-balanced blend of activities across Newton's three pillars.

- China's largest Newton activities have multi-million funds for research including the £12 million AgriTech project through the Science & Technology Facilities Council. Projects with high funding have a focus on issues of agriculture, climate and environment. The People activities recognise the need to harness the emerging pool of doctoral students in China, through initiatives such as PhD partnering and Newton fellowships.
- In Malaysia activities seem appropriately apportioned, with investments focused on building longer-term institutional linkages of benefit to both countries as well as highly-specialised activities (e.g. industry-academia partnerships, commercialisation of dengue research, Policy Dialogue for STEM).
- Newton activities in South Africa have more of a focus on People activities than other countries, which present an opportunity. Activities include upskilling researchers, advanced fellowships, travel grants, PhD partnerships and a major research project on issues of access to higher education in Africa.
- Brazil's baseline profile indicates strong research and translation capacity in high-performance clusters in Sao Paolo, with a need to develop innovation capability through industry-academia linkages elsewhere. Newton tracker data indicate that large funding packages for business-research partnerships in collaboration with Innovate UK have been earmarked to begin in 2016. Thematic research is well-focused around energy, sustainability and urban development research.
- Chile has a relatively high proportion of activities on the Translation pillar, which represent an opportunity to develop a stronger interface between academia and industry. The baseline country report indicates that the OECD has recommended greater co-operation between industry and academia. Newton activities include multiple research calls with FONDEF and CONICYT to support centres of excellence in Chile, exchange of expertise between the countries and translate research into new products.
- India has the highest proportion of activities dedicated to the Research pillar, which reflects the importance attached to technologies and social development in the country. Research programmes funded through Newton are on topics such as agriculture, energy and the environment, and health.
- Mexico has the majority of its Newton funding allocated to People pillar activities. This appears to reflect the ambition of the UK and Mexico governments to forge deeper ties in education, evident by the large series of fellowships and travel grants for researchers (across all levels of researcher careers).
- Thailand's allocation of Newton activity funding by pillar is similar to the average for all Newton activity. The focus of People activities is towards PhD and advanced researchers, which is recognised as important in facilitating cross-border research collaboration. Thematic research projects are on issues such as health and food security.
- Newton funding in Indonesia and the Philippines is tilted towards Research pillar activities. Funding is presently focused on large research initiatives in niche areas such as rice research and infectious diseases, which are issues that have relevance throughout countries in Southeast Asia.
- Research capacity in Turkey is strong, with very high gross research output. The high allocation toward People activity reflects Turkey's proximity to the UK and European Research Area and EUREKA as well as historical linkages. Collaborative R&D activities between the two countries co-ordinated with EUREKA and Innovate UK are scheduled to begin in mid-2016. A large budget is proposed to deliver grants to businesses-researcher consortia on a competitive basis.
- Funding for Egypt and Kazakhstan is strongly focused on fundamental capacity building activities within the People pillar. Vietnam has a large weight on the Research pillar, largely as a result of three £2 million medical research projects in niche research topics relevant to Southeast Asia.

Table 11. Allocation of Newton funds by pillar to December 2015 (£ millions)

Country	Type	People	Research	Translation	Total	P%	R%	T%
Malaysia	1	2.288	4.700	4.530	11.518	20%	41%	39%
South Africa	1	7.573	11.248	3.512	22.333	34%	50%	16%
China	1	22.215	49.779	30.010	102.004	22%	49%	29%
Chile	2	1.434	4.312	3.786	9.533	15%	45%	40%
Thailand	2	4.107	6.000	2.414	12.521	33%	48%	19%
Mexico	2	6.837	3.000	2.014	11.852	58%	25%	17%
India	2	8.489	34.191	4.215	46.895	18%	73%	9%
Brazil	2	13.215	21.909	11.171	46.295	29%	47%	24%
Colombia	3	4.063	5.352	3.821	13.236	31%	40%	29%
Turkey	3	5.838	4.000	6.069	15.907	37%	25%	38%
Philippines	3	1.038	6.000	2.461	9.499	11%	63%	26%
Indonesia	3	1.032	7.000	2.608	10.639	10%	66%	25%
Vietnam	4	1.290	6.000	2.276	9.566	13%	63%	24%
Kazakhstan	4	4.786	0	3.351	8.136	59%	0%	41%
Egypt	4	6.213	0.350	4.452	11.015	56%	3%	40%
Total		**90.418**	**163.840**	**86.691**	**340.949**	**27%**	**48%**	**25%**

*** PACEC, Newton Tracker. Budgeted funds only as of December 2015. Excludes allocations for discontinued or cancelled programs.*

8. Conclusions

The key purpose of this baseline report has been to **establish a starting point for Newton partners** using consistent and comparable data across a lengthy time series. The indicators selected provide benchmarks for anticipated future progress in different countries. Our baseline research yields several important findings, synthesised here.

Heterogeneity

Our composite index of indicators used in the baseline research finds the **variation between countries within the fund to be very great**. For instance, some countries supersede UK capability on a number of innovation capability metrics, whilst others are closer to 'pre-engagement' status. We have summarised these differences and possible implications for future programming.

Determinants of international collaboration

Bibliometric data on scientific journal publications shows the extent of international research collaboration among partner countries and suggests possible reasons for changes in the amount of collaboration over time using an empirically-informed framework developed by Elsevier. The research suggests that **development of research capacity and the extent of collaboration are not linearly related**. The variability in international collaboration among Newton partners is not correlated to research performance.

Specificity of the fund

Newton funding is considered alongside similar international development programmes involved in research capacity building and collaborative research, and it is too early to draw conclusions on this element yet. Future evaluation research is expected to take a more granular approach once detailed programme-level data is available, comparing individual Newton programmes with highly equivalent programmes elsewhere as part of a more scientific approach involving contribution analysis.

Variety of capacity and skills gaps

S&I capacity in partner countries is addressed by describing **capacity and skills gaps** (the saturation of researchers, policy challenges and global incentive structures), enabling conditions for capacity development (international researcher mobility is used as a proxy measure of internationalisation, also a key strategic ingredient) and overall innovation capacity, as measured by the Global Competitiveness Index. Our review of secondary literature suggests that **partners face similar challenges in terms of training and retaining early career researchers**.

Relative importance of university-industry clusters and patent registrations

The translation capacity of partner countries is strongly affected by **university–industry clusters and patent registrations**. Some countries perform well on cluster development and patent registrations and score strongly on other indicators. Our research did not find a convincing causal explanation for why countries' patent applications change over time (our research did not detect a correlation), though historically macroeconomic conditions seem to play a major role.

Influence of research funding structures

Influences on capacity and skills development are found in certain aspects of **research funding systems**: the extent and locus of industry input and public funding incentives, and the connection between distributed responsibilities, flexibility and translation outcomes. Countries with flexible, well-distributed strategies were found to have strong translation outcomes.

9. Annexes

Description of sources

Table A1. Details on baseline indicator data sources

Data source	Description of data used for baseline indicators
SCI Mago Journal & Country Rank (SJR)	*Data sourced from http://www.scimagojr.com/countryrank.php* The SJR is a portal that is publicly accessible and utilises data produced in the Scopus database by Elsevier. The data cover indicators for journals and countries' scientific indicators since the year 1996. The data include breakdowns by year, by country and by subject area for the country rank set of data.
Scopus	Elsevier produce the Scopus database of scientific indicators: the most comprehensive and largest source of citation data in the world.
World Economic Forum (WEF)	*Data sourced from http://reports.weforum.org/global-competitiveness-report-2014-2015/* *Technical notes on indicators at http://reports.weforum.org/global-competitiveness-report-2014-2015/technical-notes-and-sources/* The WEF produce the annual Global Competitiveness Report with a Global Competitiveness Index (GCI). The GCI's 12th pillar is a set of seven indicators that measure innovation capacity in countries.
World Intellectual Property Organization (WIPO)	*Data sourced from http://www.wipo.int/ipstats/en/statistics/patents/* The WIPO produce statistics on global patent applications (as well as patents granted and other indicators), with data available for many countries from 1980 onwards. The WIPO data are used by organisations such as the World Bank.
UNESCO Institute for Statistics	*Data sourced from http://www.uis.unesco.org/datacentre/pages/default.aspx* *Context and visualisations also available at http://www.uis.unesco.org/Education/Pages/international-student-flow-viz.aspx* The UNESCO Institute for Statistics (UIS) collects data on the inflows and outflows of higher education students across the world. The statistics produced such as the gross outbound enrolment ratio and outbound mobility ratio measure the mobility of students internationally.

Table A2. Regional classifications by data source

<table>
<tr><th>Data source</th><th>Region groupings</th></tr>
<tr><td>SCI Mago Journal & Country Rank (SJR)</td><td>Regional classifications as defined at http://www.scimagojr.com/countrysearch.php
Western Europe
Eastern Europe
Africa
Northern America
Latin America
Middle East
Asiatic Region
Pacific Region
e.g. Asiatic Region includes: Afghanistan, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Hong Kong, India, Indonesia, Japan, Kazakhstan, Kyrgyzstan, Laos, Macao, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Northern Mariana Islands, North Korea, Pakistan, Philippines, Singapore, South Korea, Sri Lanka, Taiwan, Tajikistan, Thailand, Timor-Leste, Turkmenistan, Uzbekistan, Vietnam</td></tr>
<tr><td>World Economic Forum (WEF)</td><td>Regional classifications as defined in the GCI dataset:
Latin America and the Caribbean
Emerging and Developing Asia
Middle East, North Africa, and Pakistan
Sub-Saharan Africa
Commonwealth of Independent States
Emerging and Developing Europe
Advanced economies</td></tr>
<tr><td>UNESCO Institute for Statistics</td><td>Regional classifications as defined at http://www.uis.unesco.org/DataCentre/Pages/regions.aspx
Arab States
Central and Eastern Europe
Central Asia
East Asia and the Pacific
Latin America and the Caribbean
North America and Western Europe
South and West Asia
Sub-Saharan Africa</td></tr>
</table>

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10 Country Baseline Reports

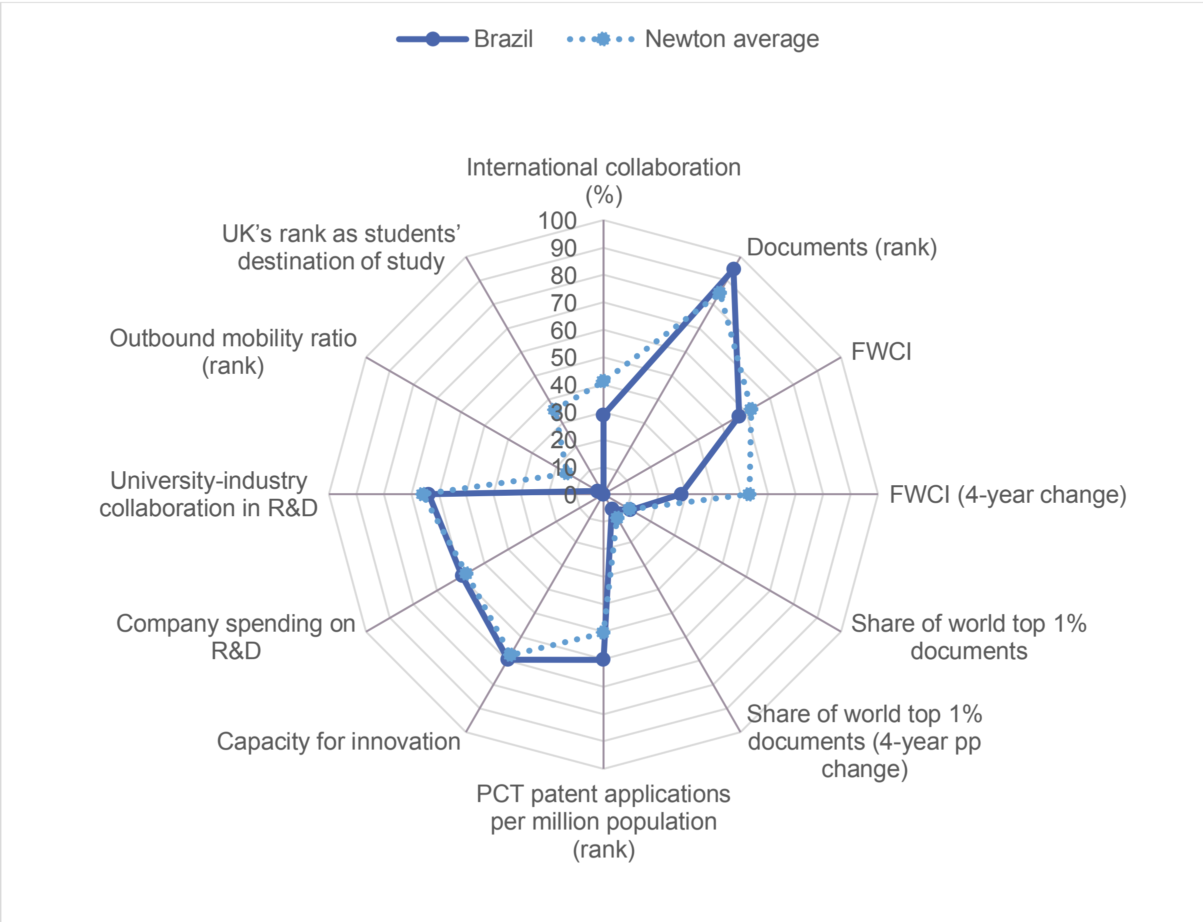
Brazil

Summary of baseline research capacity

Brazil has high levels of science capacity and relatively advanced innovation systems. Newton maintains a strong focus on innovation and research collaboration, managed in-line with UK Research Councils peer review systems. In particular, initial activities identified are PhD partnering, Newton Fellowships and Innovation Fellowships. The main council for state funding agencies, CONFAP, has committed to some level of co-funding for the programme.

In 2014/2015 and 2015/2016 Newton Fund activities in Brazil received **£9 million per annum** for UK–Brazil collaboration. For this period the Newton Fund prioritised the following areas in Brazil: health, with a focus on neglected diseases; sustainable agriculture; renewable energy; education; biodiversity and ecosystem; environmental technologies; climate change; the food, energy, water, environment nexus; and urban transformation. In 2014, the proposed balance of activities by Newton Pillar was as follows: 30% People; 30% Programmes; 40% Translation.

Figure 1. Country Profile



Brazil's performance on baseline indicators is strong, particularly on the indicators of future potential. The UK is not among the top 5 destinations for Brazilian students.

Table 1. Present and Future Potential indicators

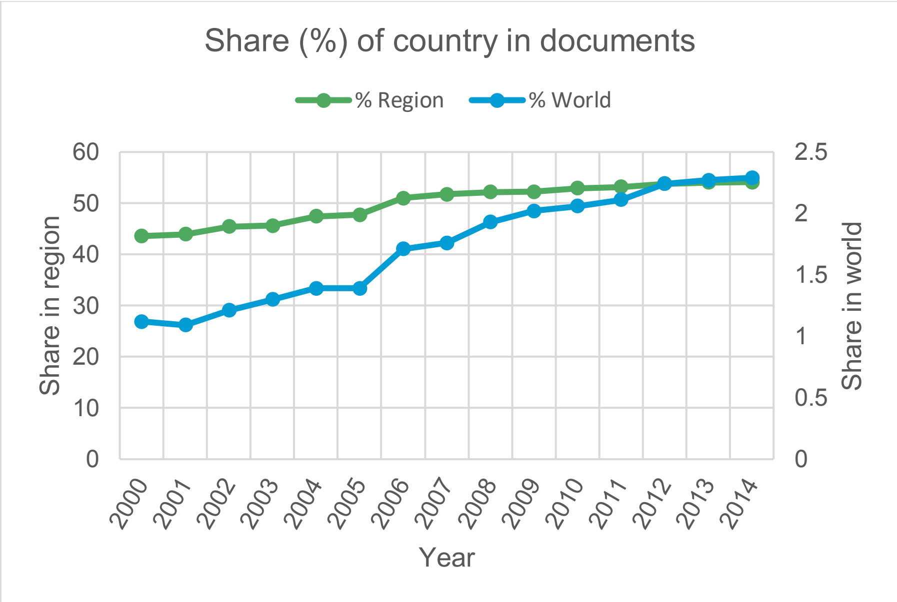
International Collaboration (%)	Documents	FWCI	FWCI (4-year change)	Share of world top 1% documents	Share of world top 1% documents (4-year change)
28.99	13/229	0.770	-0.042	1.51	0.46

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Indicators of Present and Future Potential

Brazil is emerging as a world leader in quantity of research output. The country ranks 13th in the world out of 229 countries for the production of published research documents. It produces 2.29% of documents in the world and 54.13% of documents in the Latin America region[1] (see Figure 2).

Figure 2. Production of documents



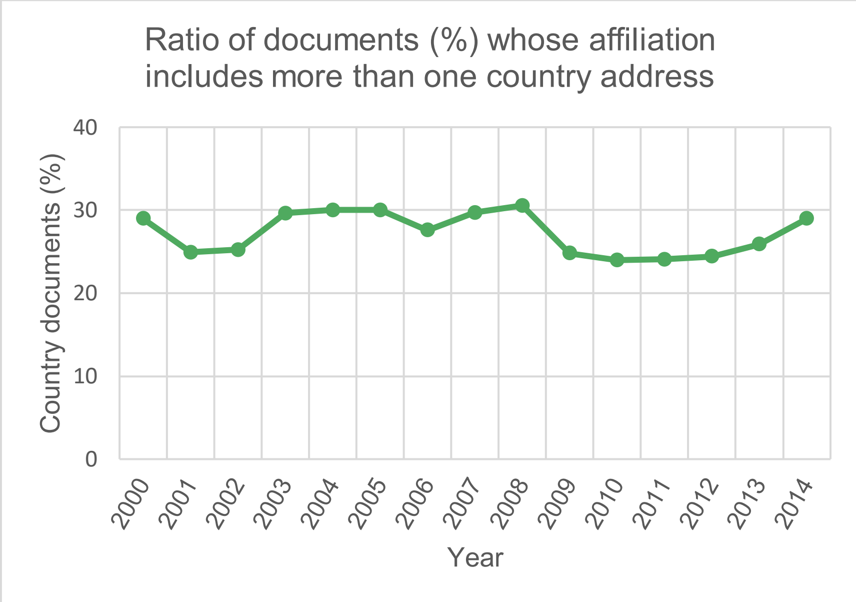
Source: SCImago Journal & Rank; PACEC

The Institute for Defence Analyses in 2013 identified Brazil as the leading country for research in South America, stating that the country has "*established global leadership in select sectors that leverage its natural resources*".[2] Its four sectors of global science and technology leadership are agriculture, oil and gas, aircraft manufacturing, and space and remote sensing. The country's subject area focus has changed significantly since 2000, in line with the country's sectoral comparative advantages. Medicine remains Brazil's leading subject area for publication output (constituting 17.1% of its publications), with Agricultural and Biological Sciences in second place, having increased to 12.7% from 8.2% in 2000. Brazil ranks fourth in the world for publications in Agricultural and Biological Sciences. Other emerging subject areas whose shares have increased by more than one percentage point since 2000 include Computer Science, Environmental Science and Social Sciences.

Brazil has a relatively low proportion of publications with more than one country affiliation, at 29%. This has increased in the last four years (see Figure 3).

[1] SCImago defined region: see Table A2 in the main baseline report appendix for information on countries and their regions.
[2] Gupta *et al* 2013, p. 11.

Figure 3. International Collaborations



Source: SCImago Journal & Rank; PACEC

Changes may be accounted for by a considerable shift in discipline emphasis in recent years, with a rapid relative contraction in Mathematics research and large increases in Health & Medical Sciences.[3]

Table 2. Profile Indicators (collaboration and mobility)

PCT patent a per million population	Capacity for Innovation	Company spending on R&D	University-industry collaboration in R&D	Outbound mobility ratio	UK's rank as students' destination of study
50/124	4.10	3.53	3.80	161/165	6+

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Indicators of Innovation Collaboration Potential

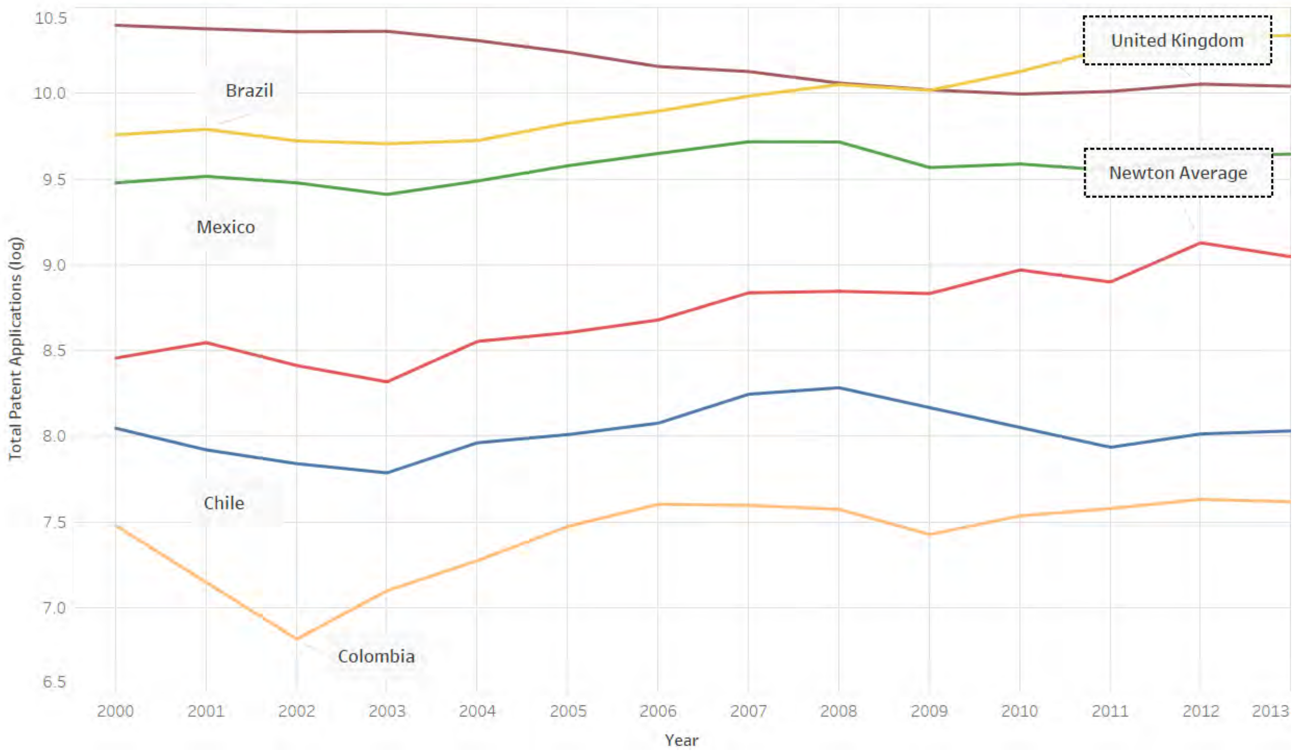
Brazil PCT patent applications amount to 3.23 per million, higher than the regional average for Latin America and the Caribbean (2.54). Patent applications in Brazil have enjoyed a steady increase in the last 10 years. Brazil has not experienced any significant dips in applications, with the total number of applications recently overtaking the United Kingdom. (see Figure 4).

The Global Competitiveness Index's (GCI) Capacity for Innovation indicator ranks Brazil 44th of 144 economies, with a country score of 4.10. In the 2014-15 GCI report, Brazil is described as having a variety of strengths, including "*pockets of innovation excellence in many research-driven, high-value-added activities*".[4]

Brazil achieved a score of 3.53 on the GCI's 'company spending on R&D' indicator which is its best performing indicator among those in the GCI innovation index. For university-industry collaboration in R&D, the score amounts to 3.80.

Figure 4. Patent Applications

[3] See BIS, 'International Comparative Performance of the UK Research Base' (2013). Brazil's *Activity Index* performance shows a radical change in research orientation by discipline.
[4] Schwab 2014, p. 33.



Source: WIPO; PACEC. Total patent applications (direct and PCT national phase entries). Log scale.

Indicators of student and research mobility

Brazil's mobility ratio was 0.42% in 2012, and it is one of only two countries not to include the UK among the top five international destinations for study. For Brazilian students, the top five destinations are the United States, Portugal, France, Germany and Spain.

Overview of research funding structure

Research funding in Brazil can come from many sources, which can be directly or indirectly linked to Brazilian ministries. Institutional funding typically comes from the National Scientific and Technological Development Fund (FNDCT), operated by the Ministry of Science, Technology & Innovation (MCTI). There are many science and technology (S&T) funds within FNDCT. In 2014, the approved budget of FNDCT was BRL 3.6 billion (£800 million), much of which was committed to sectoral funds. There are S&T funds for aeronautics, agribusiness, ship transportation, biotechnology, energy, space, hydro, IT, infrastructure, minerals, petroleum industry, health, transport. The Verde Amarelo Fund and the funds for infrastructure and the petroleum industry account for most of the committed funding by FNDCT in 2014[5].

Brazil is a federal country, meaning research funding is also allocated at state and municipal levels by regional institutions. Many states now have their own public institutions that fund R&D activity and have constitutional guarantees of states' tax incomes; the most notable and successful institution is FAPESP (the São Paulo Research Foundation), which is one of 27 state Research Support Foundations (FAPs). The State of São Paulo is Brazil's hub of scientific research, as it is responsible for 52% of Brazil's scientific output in international publications, despite having only 22% of the country's population and 30% of the country's scientists. State institutions such as FAPESP have established co-operation agreements with many other governments' research funding agencies, including Research Councils UK, France's National Research Agency (ANR) and Germany's Research Foundation.

These are the major agencies at a national level which are sources of funding for research:[6]

[5] A general fund that specifically aims to encourage collaborative research between universities and industry.
[6] Mazzucato & Penna 2016, pp. 99–100.

- Brazilian Development Bank (BNDES): the state-owned development bank is described as the *"most important funding agency for long-term [research] projects in Brazil"*. Its support for innovation funding became a strategic priority in 2003 and it has designed innovation support programmes such as Innovative Capital and the FUNTEC technological fund.
- Council for Scientific and Technological Development (CNPq): affiliated to the MCTI. More direct financing of research projects than the other agencies and has more focus on facilitating international collaboration. It provides grants both to individuals (students/researchers) and to specific research projects.
- Brazilian Studies and Projects Finance Organization (FINEP): affiliated to the MCTI. Typical finance through FINEP is through loans and grants for research institutions, although BNDES has more resources. It provides funds primarily through reimbursable loans and non-reimbursable grants.
- Federal Agency for Support and Evaluation of Higher Education (CAPES): affiliated to the Ministry of Education (MEC). It co-ordinates higher education support activities and funds scholarships for postgraduate students in Brazil and abroad.

Agencies such as the National Service for Industrial Training (SENAI) are also important within the innovation system, in providing training for professionals in the industrial sector (e.g. vocational training and technological assistance). SENAI has nearly 2,000 courses and has a student enrolment of over 2 million each year[7].

Funding initiatives similar to Newton

The **Global Innovation Initiative led by the UK and US governments** was launched in October 2013, with the aim of strengthening multilateral research collaboration between the two countries and others in the world, particularly on STEM-related issues of global significance. This initiative includes Brazil as one of four designated countries, along with China, India and Indonesia. The initiative assigned 23 and 14 awards in its first and second round, respectively, with grants of at least £100,000 or $100,000. One of the goals of the initiative is to "*forge university and business linkages that support international mobility in innovation and discovery activities*."[8] The awards for partnerships in Brazil include research on increasing energy efficiency through rapid Smart Grids, salt intrusion into estuaries related to global climate change, the GB3-Net (Global Bioenergy, Biofuels and Biorefining network), and the community ecology of Amazonian vector-borne diseases.

The São Paulo Research Foundation (FAPESP) has a **SPRINT initiative** (São Paulo Researchers in International Collaboration) with the goal of engaging researchers in the State of São Paulo with research partners abroad. There have been four rounds of funding per year since 2014, and partnerships have so far been established with researchers from universities in the UK, US, Australia, Canada, Germany, France and the Netherlands. The projects are in the field of science and are expected to generate capacities that can leverage further research funding in future. Some of the projects that have received funding include research on the characterisation of Potyviruses infecting vegetable crops in Brazil and on building metabolomics capacity in livestock research.

[7] See http://www.alliance4universities.eu/a4u/en/news/%EF%BB%BFsenai-brazil-visits-4u-universities
[8] See http://global-innovation-initiative.org/about-the-initiative/

Table 3. Summary of major funding initiatives similar to Newton

Funding initiative	Description of activity
Global Innovation Initiative	An initiative led by the UK and US governments since 2013 with aim to "*forge university and business linkages that support international mobility in innovation and discovery activities*" in four countries: Brazil, China, India and Indonesia. The activities focus on STEM issues in particular, with projects funded in Brazil including Smart Grids.
SPRINT Initiative	The regional research funding agency in São Paulo, FAPESP, runs the São Paulo Researchers in International Collaboration (SPRINT) programme, which seeks to engage researchers from the state with researchers abroad. There have been found rounds of funding each year since 2014 and projects have led to partnerships with universities in the UK, US, Germany and the Netherlands.
Denmark's Innovation Fund	There are many bilateral partnerships between Brazil and other European countries, such as the Danish government's Innovation Fund on strategic research collaboration on food science with FAPESP in São Paulo. The Fund launched an application round in 2015 with a budget of £1 million for research in eight food science topics.
Science Without Borders	Brazilian government funded international scholarship programme, which has enrolled over 101,000 Brazilian students on sandwich courses at international institutions in science and creative industries since its inception. The US received over 25,000 students in the programme's first phase. Highlighted by the World Economic Forum as a successful programme that could be adapted on a wider scale in Latin America.

The **Science Without Borders** (*Ciência sem Fronteiras*) is a scholarship programme run by the Brazilian Government, specifically MCTI and the Ministry of Education (MEC) through their funding agencies, CNPq and Capes. In its first phase, with a budget of $1.36 billion (approx. £900 million), it successfully enrolled 101,000 Brazilian students on sandwich courses (from undergraduate level to PhD) in STEM and creative industries at the world's best universities. The programme has received support from the UK Government, which aimed to take up to 10,000 Brazilian students for four years from 2012. This was described by *Ciência sem Fronteiras UK* as "*the first large scale student mobility programme operated in the UK*".[9] The United States received 26,300 students in the first phase of the scheme. The Brazil programme also offers inbound fellowships to 1,250 international researchers (or Special Visiting Researchers), as well as a Young Talent scholarships for at least 100 young researchers per year in 17 priority areas identified by the programme, such as aerospace and nanotechnology.

Science Without Borders was highlighted by the World Economic Forum in 2015 as a leading example of a programme to boost student and researcher mobility in Latin America. The World Economic Forum (WEF) believes mobility is a key issue for the region and has recommended other countries to develop similar programmes to increase indigenous innovation capacity. In the latest phase of the scheme there is an interest in targeting Asian countries such as China and Japan, which would facilitate a large increase in mobility.

M&E Measures

The Brazilian government publishes a well-established biennial national innovation survey of firms, PINTEC, which first appeared in 2000, with the national statistics agency IBGE responsible for its administration. Fieldwork for the 2014 PINTEC report, which covers the 2012-14 period, began in June 2015. The survey's methodology is in in line with the OECD's Oslo Manual guidelines on innovation statistics[10] and has been modelled on the EU's Community Innovation Survey, which means the survey results are comparable with other international studies. It includes an analysis of activities according to region and other strata of interest. It includes 'main indicators' (for instance, number of businesses that graduated from incubators) and a set of 'secondary indicators'. The OECD has recently

[9] Ciência sem Fronteiras UK n.d. – *About - Science Without Borders*.
[10] OECD 2013, p. 10.

utilised PINTEC data in an STI Scoreboard that compared countries such as Brazil, EU countries and South Africa on innovation metrics, including indicators of open innovation.

Overview of Business-Academia collaborations

According to the Institute for Defence Analyses, "*public funding typically goes to short-term partnerships instead of producing long-term collaborations, although there are indications that this may be changing*".[11] The report did however state that the Embrapa state enterprise and its national research centres have made a significant contribution to establishing Brazil as a global leader in the agriculture and biotechnology sectors since the 1970s. Additionally it highlighted improved public policy for research clusters, such as FAPESP, as an indication of recent change.

FAPESP can issue a joint call for research proposals with companies in the private sector, which explains the increasing role of many multinational companies in funding research with Brazilian institutions. In 2012 there were nearly four dozen university–industry collaborative research projects funded by FAPESP, which is more than three times the amount there were in 2008. Horizons for collaboration are also becoming longer, now reaching up to 10 years. For example, in October 2012 BP signed an agreement with the Brazilian Bioethanol Science and Technology Laboratory (CTBE) to develop a sugarcane juice fermentation process that can increase alcohol content before the distillation process. BP and FAPESP agreed to $50 million in bioenergy research projects in 2012 across a period of ten years. Other companies that have issued joint calls with FAPESP include AstraZeneca, Telefonica, Boeing, GSK and Peugeot-Citroen.

In recent years there has been an acceleration in incubation in Brazil, with over 400 incubators currently in operation, some of which are the result of an ambitious national programme that was launched in 1999. There are over 2,500 enterprises that have graduated from incubators, although many of them are not technologically intensive, with less than a dozen incubator parks notable for technological innovation by the World Bank's infoDev. These include:[12]

- **Technological Park of Rio:** based near the Federal University of Rio de Janeiro and composed of companies in the oil and gas sectors, such as Petrobas, Siemens, GE, Halliburton. It is often described as a Brazilian 'Silicon Valley' due to its prominence as an innovation cluster.
- **Campinas:** hub for telecommunications and biofuels based near the University of Campinas and the CPqD (former Telebras institute).
- **Supera:** biomedical and health innovation cluster at the University of São Paulo campus. It provides infrastructure and consultancy services in those industries.
- **CESAR Incubator:** based in Recife's Porto Digital tech cluster, it was founded by academics from the Federal University of Pernambuco. It is now a base for over 200 companies that are R&D clients for Motorola, Samsung and Sony Mobile.
- **São José dos Campos:** aeronautical cluster that is the base for research institutes such as the Aeronautical Technology Institute and the headquarters for Embraer.

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[11] Gupta *et al* 2013, pp. 45–46.
[12] *Ibid.*, pp. 46–47.

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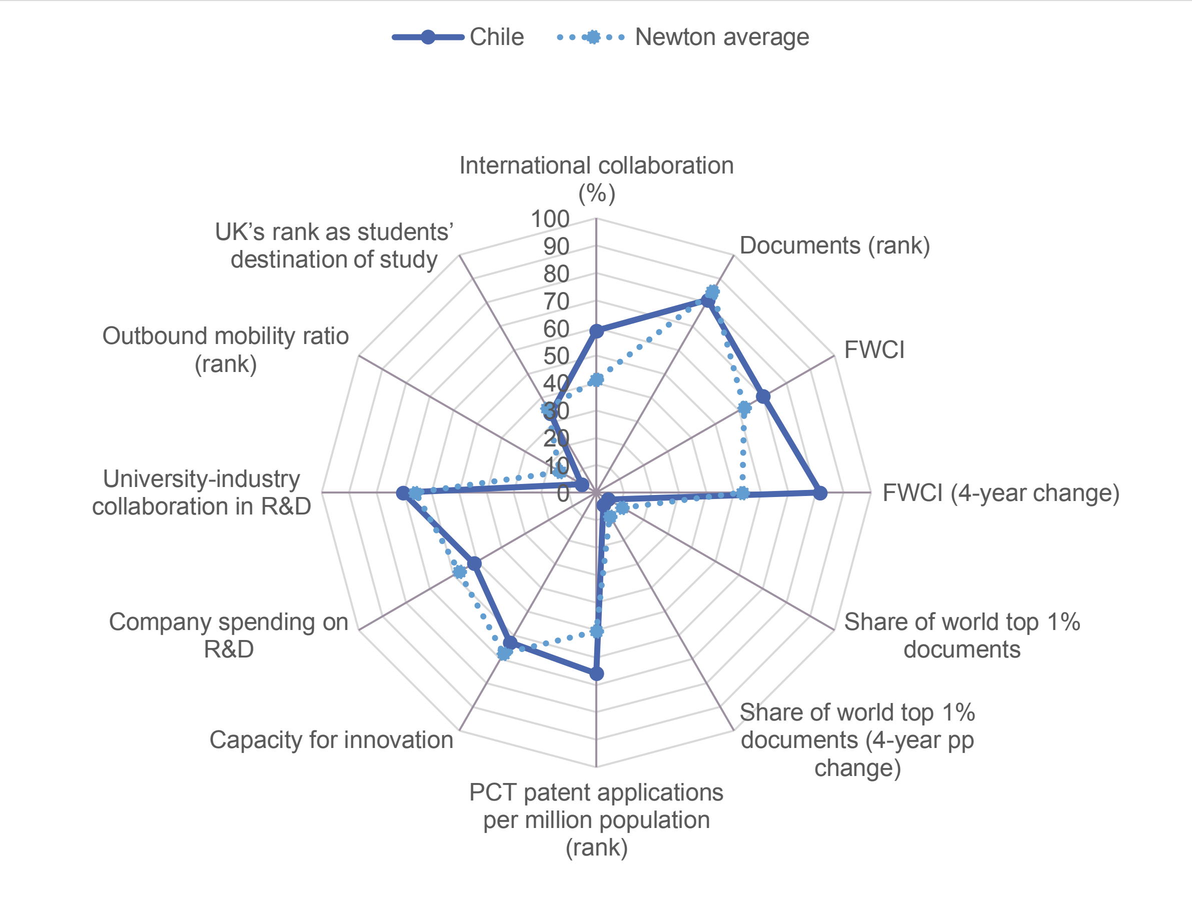
Chile

Summary of baseline research capacity

Chile has some high-level innovation and aspirations to develop, with Newton Fund interventions that are focused on achieving a stronger mix of research and innovation, as well as the development of stronger relationships for long-term collaboration with the UK. **A total of £4 million per year has been allocated to UK-Chile research collaboration in 2014/2015 and 2015/2016 through the Newton Fund,** with an additional £2.5 million in joint funding and matched funding from the National Commission for Scientific and Technological Research (CONCIYT). The Chilean government has experience with such intergovernmental collaboration and innovation policy.

The Newton Fund covers the following areas for priority activity in the aforementioned period: mining; agriculture; water; energy; health/functional foods; industrial research and development; aquaculture; climate change; medical sciences and biotech; education; and inequality. In 2014, the proposed balance of activities by Newton Pillar was as follows: 35% People; 40% Programmes; 25% Translation. Internal documents on Newton in Chile indicate that there is great willingness for the Chilean government to collaborate further with the UK on science and innovation, with a large amount of activity to be targeted at addressing research links between the countries.

Figure 1. Country Profile



Chile has a mixed baseline profile, with strengths in areas such as international collaboration. Chile has particular strengths in patent applications and university–industry collaboration. Its student and researcher mobility is strong in the regional context.

Indicators of Present and Future Potential

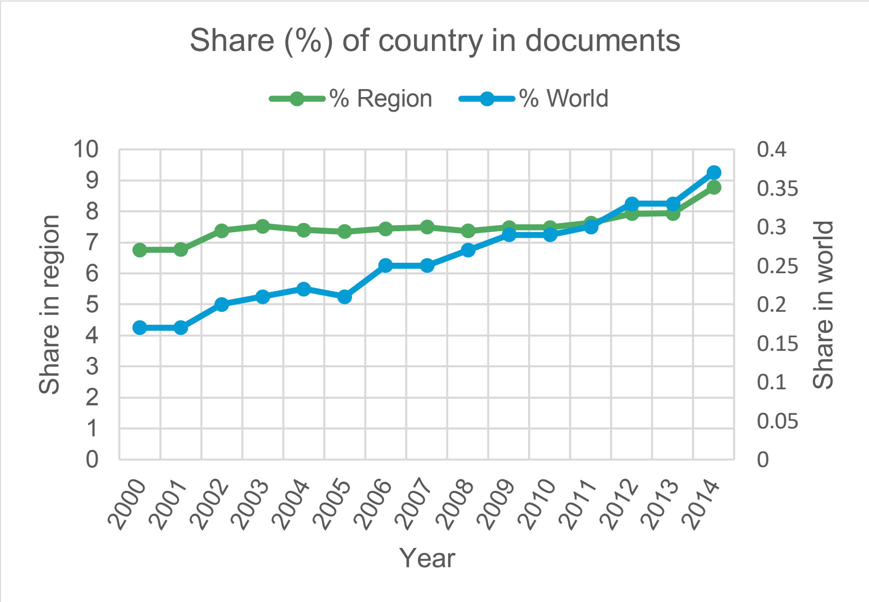
Table 1. Profile Indicators (present and future potential)

International Collaboration (%)	Documents	FWCI	FWCI (4-year change)	Share of world top 1% documents	Share of world top 1% documents (4-year change)
59.01	44/229	1.101	0.120	0.67	0.38

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Chile produces 0.37% of documents in the world and 8.77% of documents in the Latin America[1] region (see Figure 2).

Figure 2. Production of documents



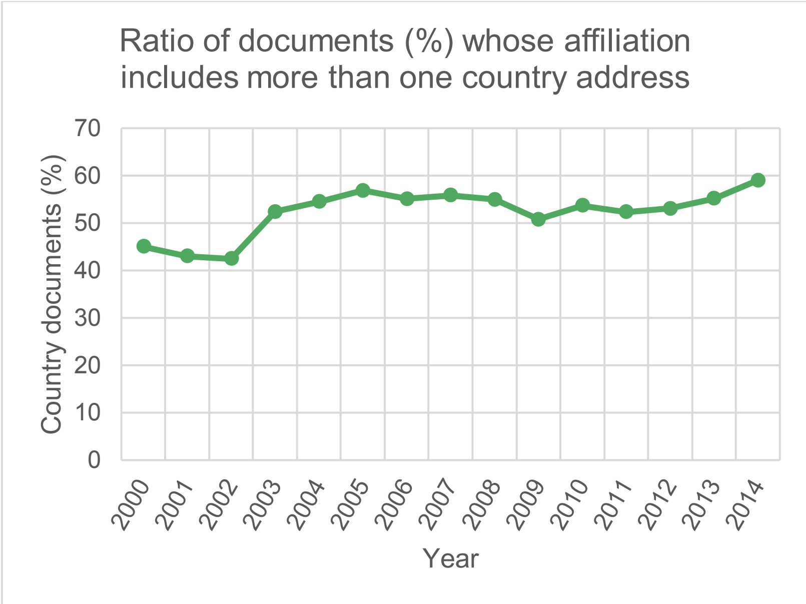
Source: SCImago Journal & Rank; PACEC

Chile has a field-weighted citation impact of 1.101, ranking strongly. Chile produces 0.67% of the world's top 1% of documents measured by citations.

Chile has a relatively high proportion of publications with more than one country affiliation, at 59%. This is the country's highest rate in Chile from 2000 onwards, with at least 50% achieved each year since 2003 (see Figure 3).

[1] SCImago defined region: see Table A2 in the main baseline report appendix for information on countries and their regions.

Figure 3. International Collaborations



Source: SCImago Journal & Rank; PACEC

Indicators of Innovation Collaboration Potential

Chile has 6.69 PCT patent applications per million, which is higher than the average of 2.54 for the Latin America and the Caribbean region. The country experienced a fall in patent applications in 2009 and 2010, which is partly attributed to Chile's entry into the PCT (Patent Cooperation Treaty) in June 2009 so these two years are omitted when discussing the trend.

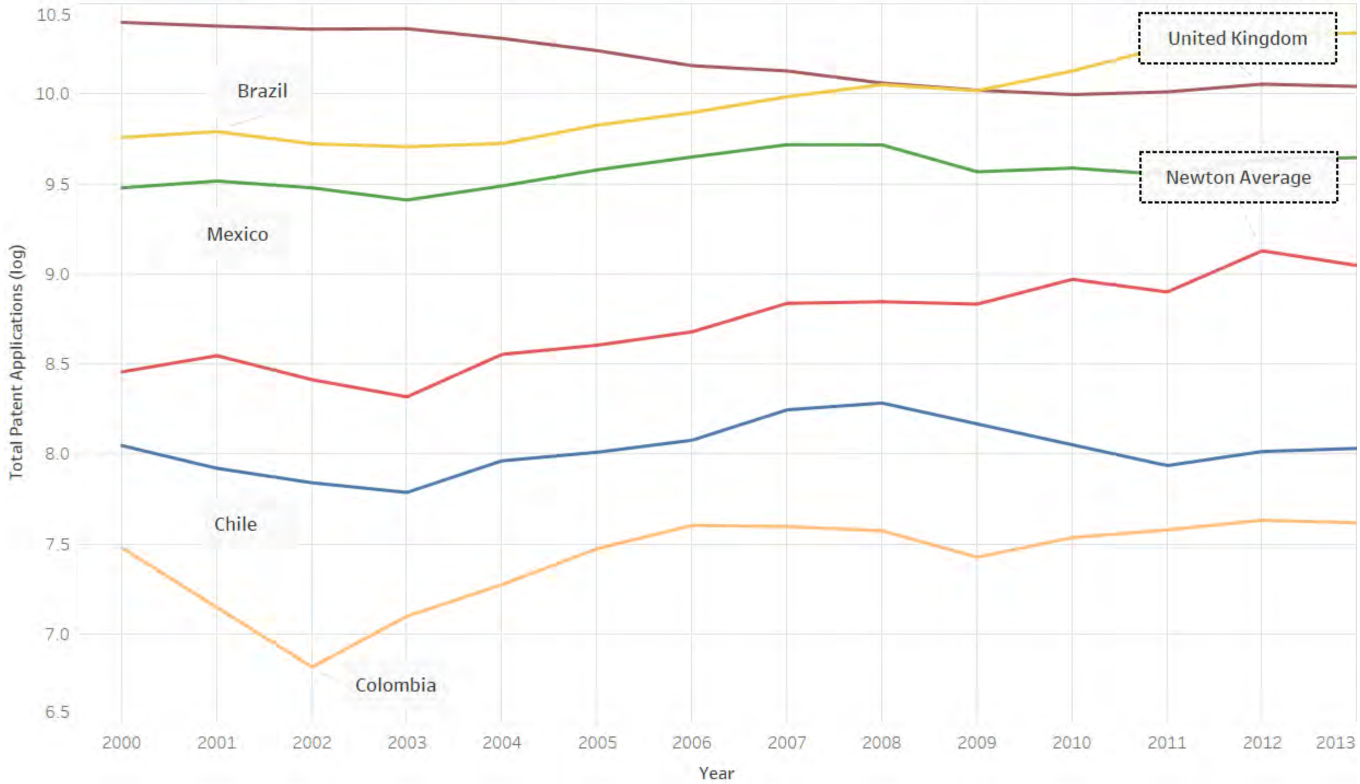
Chile scores 3.71 on the Capacity for Innovation indicator used in the Global Competitiveness Index (GCI). For the company spending on R&D indicator, Chile scores 3.06. For university–industry collaboration in R&D, the score is 4.20. The 2014-15 GCI report overall describes Chile as "*the most competitive economy in Latin America*".

Table 2. Profile Indicators (collaboration and mobility)

PCT patent applications per million population	Capacity for Innovation	Company spending on R&D	University-industry collaboration in R&D	Outbound mobility ratio	UK's rank as students' destination of study
43/124	3.71	3.06	4.20	155/165	4

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Figure 4. Patent Applications



Source: WIPO; PACEC. Total patent applications (direct and PCT national phase entries). Log scale.

Indicators of student and research mobility

The UK is the 4th most popular destination for Chileans who study abroad, behind the United States, Spain and France.

Overview of research funding structure

The Ministry of Education in Chile (MINEDUC) is responsible for stimulating scientific and technological research. The leading research agency is CONICYT (the National Commission for Scientific and Technological Research), which was initially an advisory body on scientific development for the Chilean President. CONICYT has executive responsibility on the national innovation system (NIS), with its two main objectives now focused on developing human capital and strengthening the country's scientific base. The latter is done through its support for research centres of excellence and partnerships between researchers and industry.

In 1998, the Chilean Government undertook the Mecesup programme (Higher Education Quality Improvement Program), which received funding from the World Bank. The programme aimed to increase the effectiveness of the higher education system and to enable the transition to a more knowledge-based economy.

The creation of a competitive fund for state-awarded research activities was one of the two key mechanisms of Mecesup: the Academic Innovation Fund (FIAC). The other mechanism introduced is a Performance Agreement (PBA) system to deliver quality assurance. Between 1999 and 2008, the FIAC funded 769 projects, with an average project size of $590,000 across nine rounds of competitive funding.

An evaluation of AIF outcomes as part of Mecesup's second phase (or Mecesup2) found that accountability for the process is strong and the R&D capacity in the country has increased since the phase began. After the evaluation of the second phase, Mecesup3 was launched, with further World Bank support. Enhancements have been made to the Academic Innovation Fund (termed FIAC2), with initial resources of $80 million for 2012 and 2013.

CONICYT now has a wide range of national research funds, namely:

- FONDECYT (National Fund for Scientific and Technological Development);

- FONDEF (Fund for the Promotion of Scientific and Technological Development);
- FONDAP (Fund for Advanced Research in Priority Areas for Centres of Excellence);
- National Fund for Research and Development in Health;
- Regional Fund for Scientific and Technological Development;
- Explore Program.

FONDEF is one of the country's major research funds, divided into the following programmes.

Table 3. FONDEF programmes

Regular programmes	Thematic programmes
IDeA programme; Annual R&D programme; Exploitation of Research at University (VIU) programme; Regional FONDEF programme.	HUAM programme on aquaculture; ICT for Effective Education (TIC-EDU); Red Tide programme; R&D in Bioenergy programme; Functional Food programme. FONDEF also manages two programmes in partnership with Corfo's InnovaChile initiative: • Biotechnological Tools for Genetic Improvement in Fruit-growing programme; • PDACH programme on aquaculture.

Source: http://www.conicyt.cl/fondef/

Funding initiatives similar to Newton

In March 2013, the American Government's National Science Foundation (NSF) and CONICYT formed a research partnership through the **Graduate Research Opportunities Worldwide (GROW) programme**, which at that time involved 10 countries. It is NSF's flagship initiative for coordinating research between countries internationally.

In 2015 the World Economic Forum recommended the creation of either a Latin American student exchange programme or a research mobility programme. Chile is a participant in the region's government-led **Pacific Alliance student and researcher mobility programme**, launched in 2012 and described by the World Economic Forum as a "*benchmark of excellence for scholarship programmes in Latin America*".[2] The other participants are Colombia, Mexico and Peru, with a 100 scholarships per year for each country (75 for undergraduates and 25 for doctoral & teaching candidates). In the first two years, the programme awarded 658 scholarships to students, including 186 granted by the Chilean government. Over 30 higher education institutions in Chile participated in the programme, including the flagship University of Chile.

M&E Measures

Chile's National Statistics Institute (INE) conducts a bi-annual innovation survey and a regular industrial survey (ENIA). INE is responsible for data collection and data processing, while the innovation division at the Ministry of Economy is responsible for survey design and estimation procedures. The surveys have been designed in line with the OECD's Oslo Manual guidelines on national innovation surveys.

[2] World Economic Forum 2015, p. 36.

Overview of Business-Academia collaborations

The National Innovation Policy for 2014-18 seeks to increase the collaboration between industry and academia through Strategic Programmes, which are initiatives that focus on developing public-private clusters in sectors that have the potential for high growth. The OECD indicates that the programmes will follow "the most effective approach" to develop a framework for dialogue between key actors – such as government, private firms and stakeholders – although it requires additional follow-through and will have more potential for success in industries which have comparative advantage in Chile (such as mining, fish farming, and solar power).[3]

The government has expanded business-academia activities through the Centres of Excellence programme implemented by InnovaChile-Corfo. This was first developed by the World Bank's Millennium Science Initiative (MSI) in the late 1990s, and, in its first phase, funded research projects at 10 centres of excellence, with further support from the Chilean government. As of 2012, 6 institutes and 25 science nuclei were established. The current programme can offer co-financing to institutions for a period of up to 8 years, with a programme budget estimated at $7 million per annum. The scheme aims to encourage the involvement of international organisations and businesses. The programme has been evaluated regularly, with a focus on outputs and some discussion of impacts based on qualitative assessments. The programme has seen the level of participation in research networks increase by 245% in 2008 when compared to the baseline period (before 2005). Additional assessments also indicated that "*the research centres programme has reduced the risk of brain drain from Chile*" as there has been an increase in opportunities for young researchers.[4]

In 2013, the Centres of Excellence programme supported the installation of the following centres that are relevant to Newton priority areas in Chile:

- GDF Suez (renewables);
- Emerson (mining) and Pfizer (genomics and bioinformatics);
- Sustainable Mining Institute of the University of Queensland, Australia (mining);
- University of California at Davis, USA (agriculture);
- Fraunhofer–ISE, Germany (solar).

[3] OECD 2013b, p. 37.
[4] Guimón 2013, p. 10.

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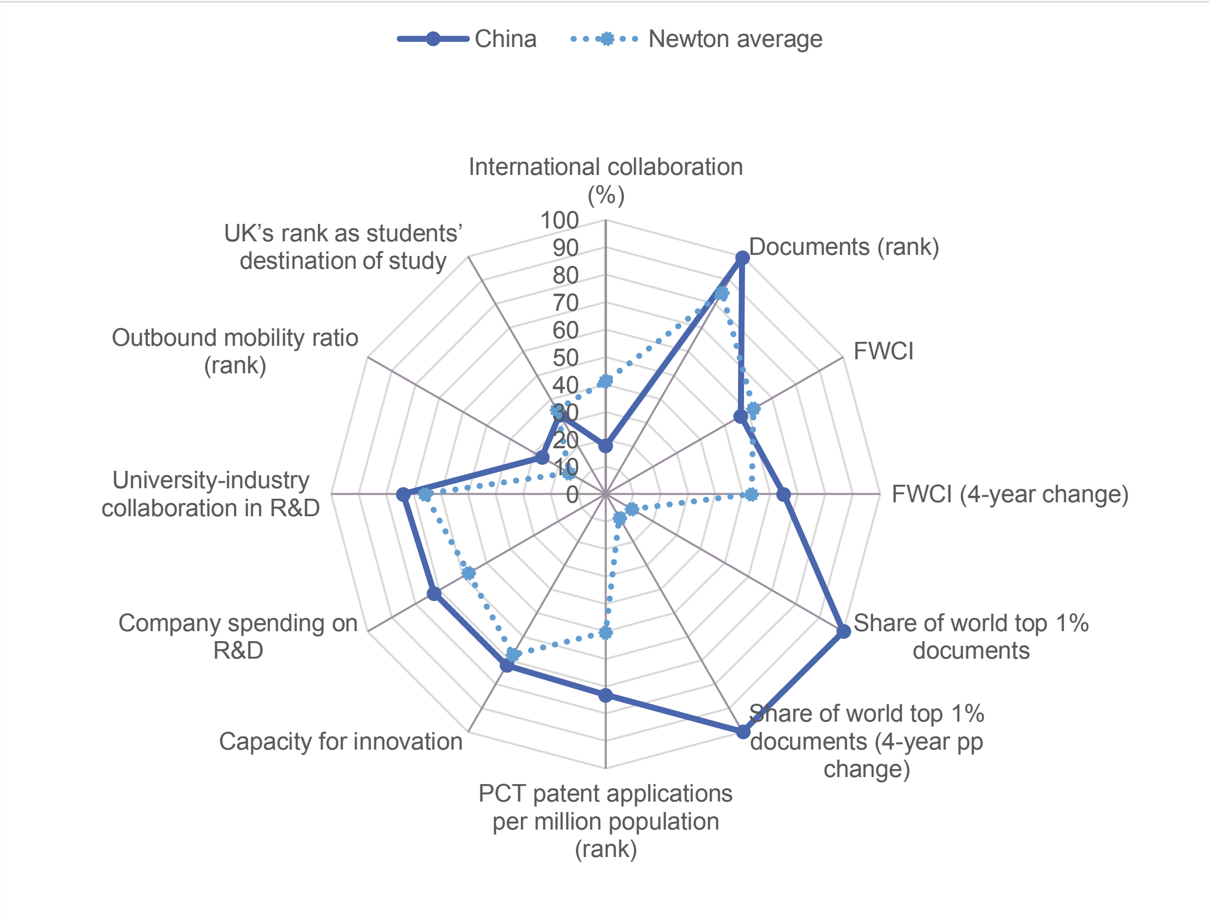
China

Summary of baseline research capacity

China has high levels of science capacity and advanced innovation systems. There is a strong focus on innovation and research collaboration managed in-line with UK Research Councils peer review systems. The Newton Fund is referred to as the UK-China Research and Innovation Partnership Fund in the People's Republic of China. This fund was allocated **£20 million per annum for UK–China collaboration in 2014/2015 and 2015/2016**.

Newton Fund activities in China are focused on the following priorities: the creative economy; education; energy; environmental technologies; food and water security; health; and urbanisation. In 2014, the proposed balance of activities by Newton Pillar was as follows: 35% People; 40% Programmes; 25% Translation. Internal documents on Newton in China indicate that there are long-term goals to develop the expertise of UK and China in the identified research areas, with collaboration as the main means to build the research base in the country. **China's baseline capacity has expanded rapidly in recent years, with real gross R&D expenditures (GERD) increases of 428% between 2000 and 2010., compared to the UK's 18%.**

Figure 1. Country Profile



China's baseline profile is strong. Its student mobility as measured by the outbound mobility ratio is also relatively strong.

Indicators of Present and Future Potential

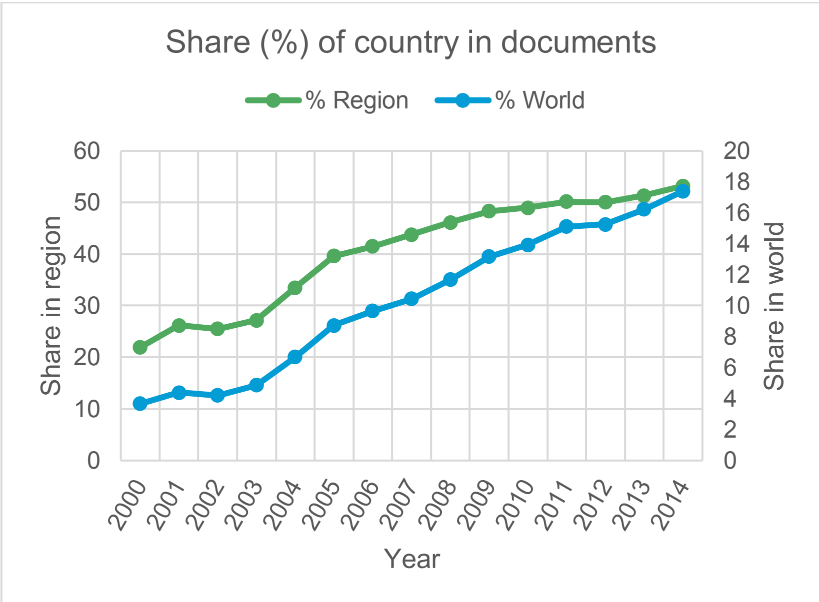
Table 1. Profile Indicators

International Collaboration (%)	Documents	FWCI	FWCI (4-year change)	Share of world top 1% documents	Share of world top 1% documents (4-year pp change)
17.59%	2/229	0.764	0.069	13.36	7.29

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

China ranks 2nd out of 229 countries worldwide for the production of published research documents, only behind the United States. It produces 17.40% of documents in the world and 53.19% of documents in the Asiatic region[1] (see Figure 2). China's share of world publications has grown rapidly since 2000, when it amounted to 3.66%, ranking 6th in that year, behind France and at half the level of Japan's output.

Figure 2. Production of documents



Source: SCImago Journal & Rank; PACEC

China has a reputation for scientific research in areas such as Engineering and Physics, although there has been a notable move to applied science research. According to Martin Tanke of Elsevier, "*there is an enormous emphasis on applied science rather than pure science, as research is expected to deliver tangible benefits to society such as highways, dams, hybrid crops, satellite systems and vaccines*".[2] Therefore, other subject areas such as Health and Engineering have become more prominent for research output in recent years. In 2013 *"China produced a significant share of the worldwide total of engineering articles, larger than the share of the United States and the EU"*.[3]

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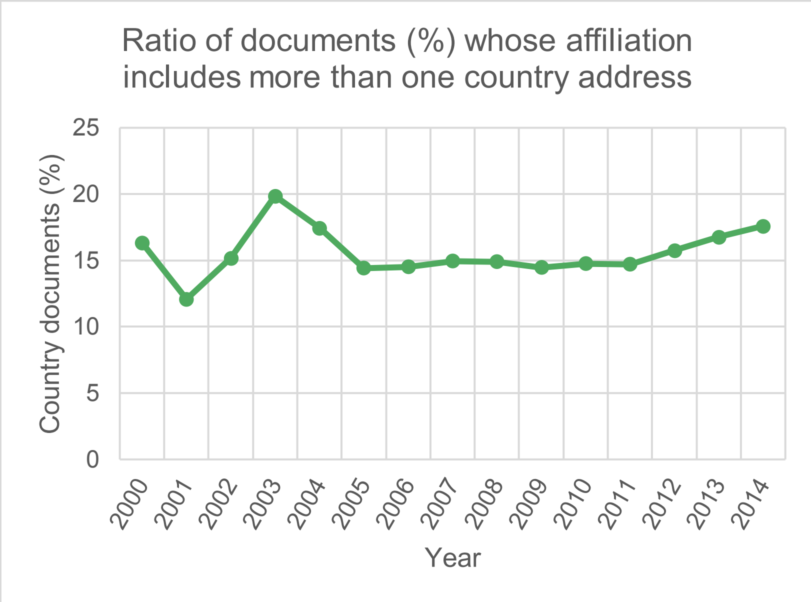
[1] SCImago defined region: see Table A2 in the main baseline report appendix for information on countries and their regions.
[2] Elsevier 2008.
[3] National Science Board 2016, p. O-21.

Industries of particular innovation strength include consumer electronics and textiles (each is 28% of world exports in 2013).[4] McKinsey has recommendations for improving the impact of Chinese innovation, including the introduction of impact- and output-based evaluation schemes and more rigorous peer review processes.[5]

China's proportion of publications with more than one country affiliation is 18%, which is likely to reflect a large indigenous capacity for innovation, particularly for a country of China's size.

Figure 3. International Collaborations



Source: SCImago Journal & Rank; PACEC

A study by Zhou and Glänzel found that international collaboration on research in China is strong in fields such as neuroscience, medicine, biosciences and agriculture.[6] The study also investigated the impact of international collaboration (e.g. through relative citation rate, or RCR) and found that China's research impact is higher through international collaboration[7], with other studies on certain Chinese industries also finding similar results.[8]

China performs very strongly in leading research publications, producing 13.36% of top 1% of global publications. This suggests high levels of research excellence.

Indicators of Innovation Collaboration Potential

China has 11.66 PCT patent applications per million people, which is much higher than the average of 1.73 for the region (as defined in the GCI). Patent applications in China have been on a persistent upward trend since 2000, presenting a high annual change.

The country scores 4.24 on the Capacity for Innovation indicator used in the Global Competitiveness Index (GCI). Company spending on R&D is China's strongest indicator, with a score of 4.29. University–industry collaboration in R&D has a score of 4.40.

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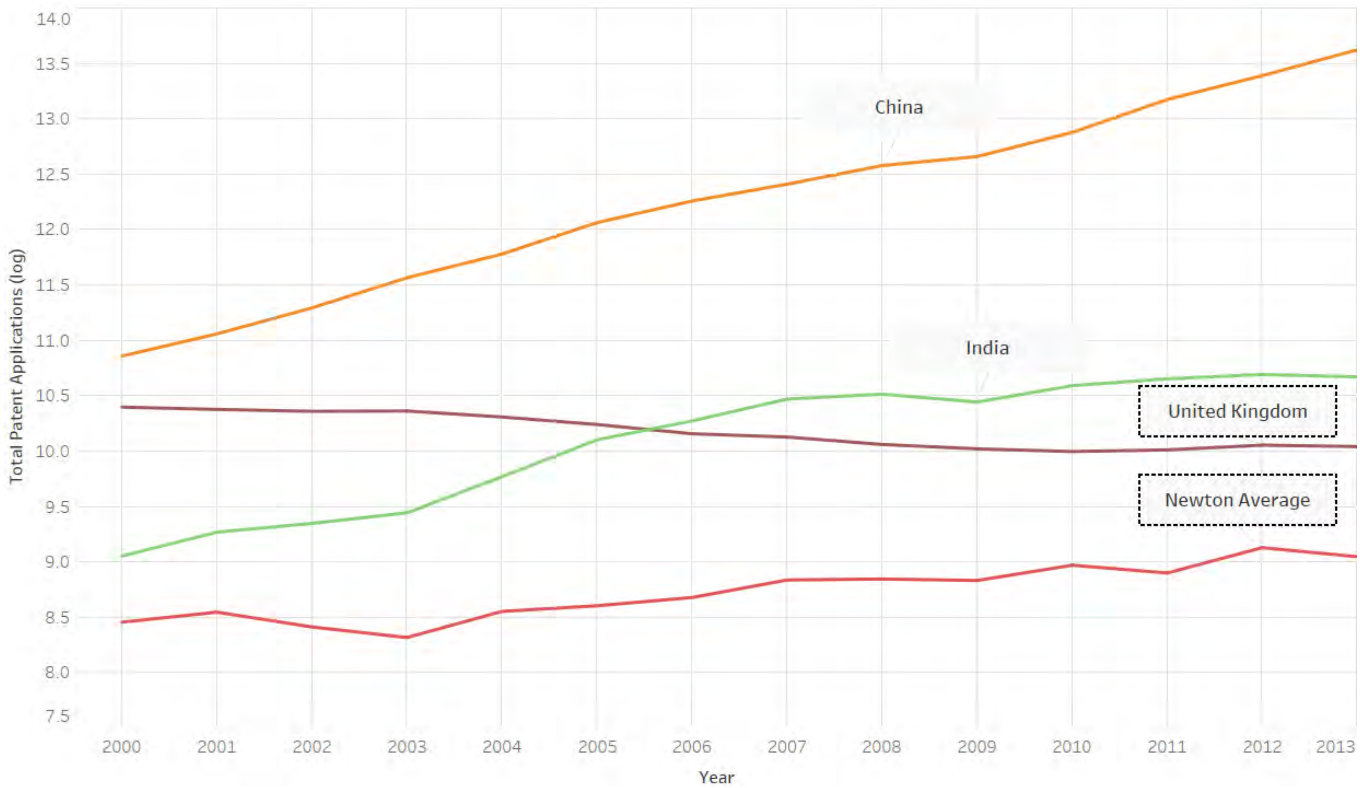
[4] *Ibid.*, pp. 33–35.
[5] *Ibid.*, p. 114.
[6] Zhou & Glänzel 2010
[7] *Ibid.*
[8] e.g. Tang & Shapira 2012 in the Chinese nanotechnology sector

Figure 4. Patent Applications



Source: WIPO; PACEC. Total patent applications (direct and PCT national phase entries). Log scale.

Table 2. Profile Indicators (collaboration and mobility)

PCT patent applications per million population	Capacity for Innovation	Company spending on R&D	University-industry collaboration in R&D	Outbound mobility ratio	UK's rank as students' destination of study
2/124	4.24	4.29	4.40	121/165	4

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Indicators of student and research mobility

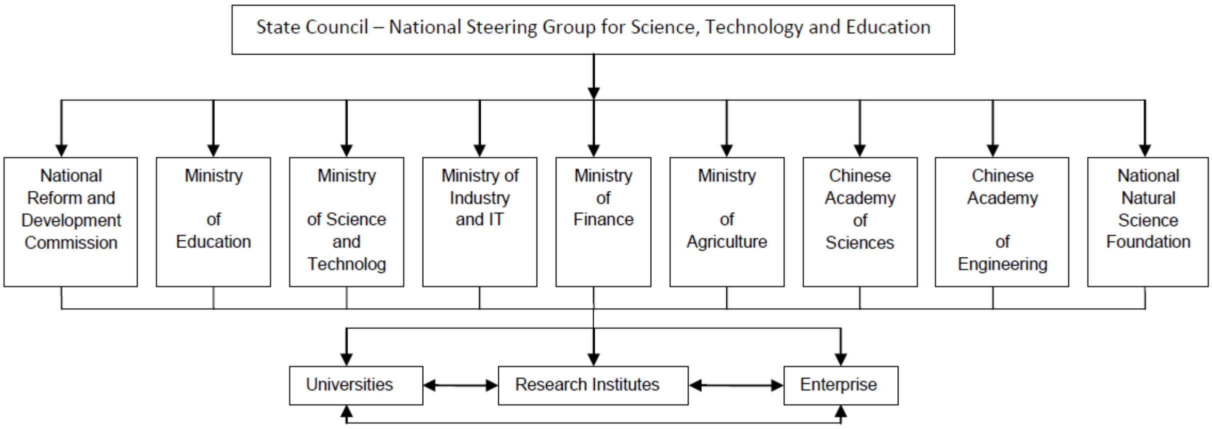
China had an outbound mobility ratio of 2.13% in 2012, which is in line with the East Asia and the Pacific[9] regional average of 1.95%. The UK is the 4th main destination for study for Chinese students, with the top three countries being the United States, Japan and Australia. South Korea is the 5th destination, although outflows to there are little over half of those reaching the UK.

[9] UNESCO Institute of Statistics defined region

Overview of research funding structure

China's top-down research funding structure is highly centralised, in order to cope with the vast growth in quantity of research outputs in recent years. At present, around 100 competitive grant schemes are overseen by 30 government departments. Around 60% of Chinese government funding is allocated on a competitive basis[10].

Figure 5. Research funding structure



Source: European Commission ERAWATCH – China

There are three main agencies for collaborative funding on STEM projects:

- National Natural Science Foundation of China (NSFC);
- Chinese Academy of Sciences (CAS);
- Ministry of Science and Technology (MoST).

Smaller agencies also involved in funding programmes include:

- China Association for Science and Technology;
- Chinese Academy of Engineering;
- Chinese Academy of Social Sciences;
- Bureau of International Cooperation.

Funding initiatives similar to Newton

The **Global Innovation Initiative** led by the UK and US governments was launched in October 2013, with the aim of strengthening multilateral research collaboration on STEM-related issues of global significance between the two countries and other global players. This initiative includes China as one of four designated countries alongside Brazil, India and Indonesia. The initiative assigned respectively 23 and 14 awards in its first and second rounds, with the size of these grants being at least £100,000 or $100,000. One of the goals of the initiatives is to "*forge university and business linkages that support international mobility in innovation and discovery activities*."[11] The awards for partnerships in China include research on the impacts of outdoor air pollution in China, the development of an international 'electricity highway' system and reducing flood risk.

China has many bilateral and multilateral agreements with European countries such as Germany, France and the UK. The Sino-German Centre for Research Promotion for example receives joint funding by the National Natural Science Foundation of China and the German Research Foundation. The Fraunhofer Society, the largest applied research organisation in Europe, has important co-operation programmes through its China office in areas such as production technology, environmental technologies, microelectronics and energy technologies. The EU has an

[10] The Scientist, 'China Shakes Up Research Funding' (October 27 2014)
[11] See http://global-innovation-initiative.org/about-the-initiative/

extensive innovation programme, **Dragon Star**, which aims to support Chinese participation in Horizon2020 and increase collaboration between EU countries and China in research.

The **German Academic Exchange Service (DAAD)** has a well-established programme in China for the exchange of students and fellows between the countries. The number of Chinese students receiving stipends to study in Germany has risen from 1,100 in 2006 to 1,711 in 2014. The China Daily noted that "*cooperation with Germany has resulted in more projects than with any other European country*".[12] Several scholarships are available, particularly for STEM courses at German research centres such as at the Max Planck Institutes. Those eligible usually attend the elite Chinese universities in the Project 211 group, which represent approximately 5% of all students but account for the majority of the country's doctoral researchers. Other relevant German programmes are the Research Grants exchange programme with China and general initiatives such as the Graduate School Scholarship Programme. [13][14] Of particular interest here are DAAD's 'Lighthouse projects', which have funded research at Chinese universities, including the prestigious Tongji University in Shanghai. There DAAD supports courses in electrical, mechanical and automotive engineering and other applied sciences, with the best students also having the opportunity to extend their studies in Germany.

The Chinese government has supported its higher education institutions since 1998 with the **Yangtze River Scholars Programme**, which appoints foreign professors each year (particularly in STEM) to encourage international collaboration. The programme is jointly run and funded by the Li Kang Shing Foundation and the Ministry of Education (MOE). Professors receive a subsidy of CNY 100,000 (approx. £10,000) each year and universities can provide them with research funding of at least CNY 2 million (approx. £200,000) for S&T research projects. There are also funds or subsidies of a smaller level for short-term lecturer contracts and awards for outstanding achievements from Chinese scholars.

Additionally, Chinese organisations are also organising research exchanges and fostering cooperation with international institutions. These include:

- **Natural National Science Foundation of China (NSFC)**: Activities[15] from its budget of ¥22.2bn (£2.3bn) in 2015 include international joint research projects with Research Councils in the UK and since 1988 the Research Fund for International Young Scientists.
- **Chinese Academy of Sciences (CAS)**: joint statement between CAS and the Royal Society in 2013 on working together. This has resulted in the President's International Fellowship Initiative (PIFI), which will be imlemented in 2016 and is targeted at post-doctoral and international PhD students.

Table 3. Summary of major funding initiatives similar to Newton

Funding initiative	Description of activity
Dragon Star – Horizon 2020 programme	The EU–China programme for the EU's Horizon 2020 programme. In 2016 there is €28 million (£21 million) in funding for research activities to support collaboration in innovation. The latest aims of Dragon Star are to provide a cooperation platform for policymakers and to have a platform like ERA-NET for funding agencies to exchange best practices.
Global Innovation Initiative	A joint US-UK initiative launched in 2013 that aims to "*forge university and business linkages that support international mobility in innovation and discovery activities*" in four countries: Brazil, China, India and Indonesia. The activities focus on STEM issues in particular, with projects funded in China including research on hydrogen power and global farm platforms.
DAAD student exchange and researcher mobility programme	Long-established scheme by the German Academic Exchange Service (DAAD) for promoting the mobility of students and researchers between Germany and China.

[12] The China Daily 2007.
[13] *Projektbezogener Personenaustausch*
[14] *Leuchtturmprojekte*
[15] NSFC presentation in Brussels, (28 May 2015) – information on UK-NSFC research collaboration activities and spend

	DAAD funded the studies of 1,711 Chinese students in Germany in 2014. There is a particular focus on STEM courses, with scholarships available at institutions such as the Max Planck Institute. There is also financial support for studying in China and supplemental funds to extend the stay of students already in Germany.
Yangtze River Scholars programme	A Chinese government initiative since 1998 that appoints foreign professors to Chinese research institutions specifically with the aim of encouraging international collaboration on research, particularly in science fields. It is jointly funded by the Ministry of Education and the Li Kang Shing Foundation.
Major bilateral co-operation initiatives	A list of significant bilateral co-operation initiatives between European governments and China: • Sino–German Centre for Research Promotion (SGC) • China–France Joint Research Centre in Computer Science, Automation and Applied Mathematics • The UK–China collaboration initiative on sustainable energy

M&E Measures

China's National Bureau of Statistics conducts a regular Innovation Survey of Industrial Enterprises, which is modelled on the EU's Community Innovation Survey (CIS): the Innovation Survey of Industrial Enterprises. The CIS is based on the OECD's Oslo Manual guidelines on innovation surveys. The Ministry of Science and Technology is involved in the survey design and data analysis of the innovation survey. According to an OECD overview of innovation survey metadata, China presented some differences from Oslo Manual guidelines as recently as 2006, since *"firm size is defined by number of employment, revenue and net assets in China"*.[16]

Overview of Business-Academia collaborations

Industry-university collaborations are a major area of opportunity for China according to the OECD. International business-academia collaboration programmes in existence include Innovation China-UK.

China has an established policy of Industry-Research Strategic Alliances since 2007, with the purpose of enhancing technology capabilities through partnerships between industry, universities and research institutes (a three-actor model) based on market principles. MOST is the ministry that is responsible for governance on these Alliances. The Alliances "*take priority in terms of funding*" in the country's allocation of innovation policy funds and are an integral part of the country's Medium- to Long-term Strategic Plan (2006-20) for S&T Development.[17] The first four Alliances were established in 2007 in the areas of steel, coal, chemistry and agricultural equipment. These involve 26 enterprises, 18 universities and 9 research institutes.

A recent example in 2015 – the Alltech Research Alliance – highlights the scale of collaboration between businesses and researchers from across the world on the issue of innovation in agribusiness. It was established in 2004 and has created collaborative research curricula with 12 universities and 7 global agribusinesses, with involvement from countries such as Japan, Norway, India and the UK.[18]

The Chinese government has recently introduced other policies to facilitate further activity in international R&D centres, including duty-free importation of certain equipment for R&D centres. These R&D alliances have also provided a crucial source of R&D financing within rather constrained public budgets. According to Ji, "*IBM, Intel, Microsoft, and many other foreign firms now cooperate substantially with Chinese URIs [university and research institutes], and hire highly skilled Chinese researchers to work in China*". Ji in particular found that R&D collaborations are likely to be high when foreign investors have prior experience in China and when alliances were conceived for research purposes rather than development purposes.[19]

[16] OECD 2014, p. 14.
[17] *Ibid.*, p. 73.
[18] Alltech 2015.
[19] Ji 2010.

Several High-technology Zones and incubators have been established on the model of Silicon Valley in the United States, with 105 Zones in 2012 that account for the majority of the country's technology incubators, up from 83 in 2010. One of the most notable High-technology Zones is Beijing's Zhong Guan Cun Science Park (ZGC), established in 1988 to facilitate the commercialisation of public research. The ZGC now hosts over 4,500 high-tech enterprises – such as Lenovo which was set up there, as well as Google, Intel and other multinational companies – as well as the Chinese Academy of Sciences (CAS) and 39 universities. There are many benefits for High-technology Zones in order to encourage investment from abroad, such as lower tax rates for foreign enterprises and tax exemptions available subject to approval from the Chinese government. There are similar zoning policy initiatives such as Special Economic Zones (SEZs) and Economic and Technological Development Zones (ETDZs), in place since the 1980s, which are focused moreso on attracting FDI and adopting foreign technology.

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Colombia

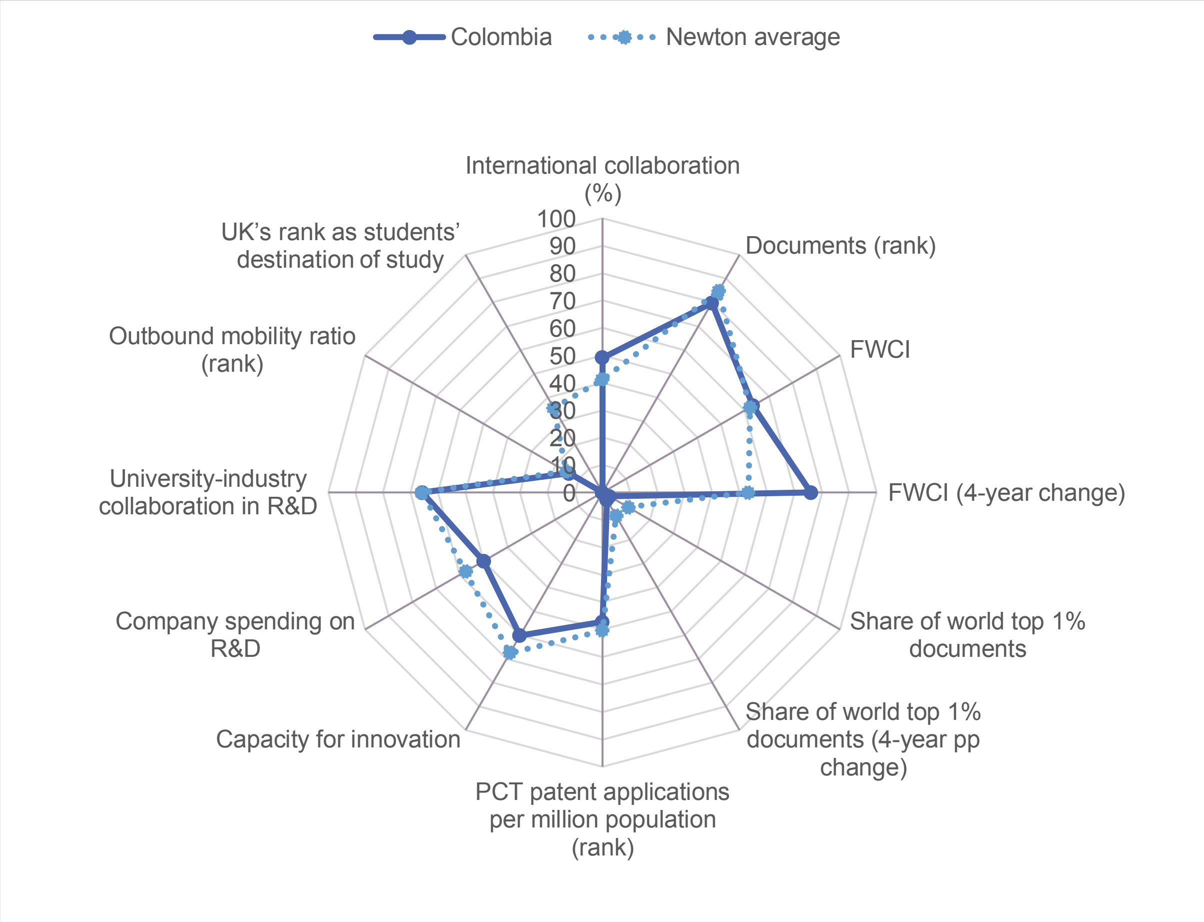
Summary of baseline research capacity

Colombia has an appetite for engagement, with Newton interventions focused on partnership and capacity building, with a view to foster long-term collaboration with the UK in the future. Hence the **Newton Fund was allocated £4 million per annum in 2014/2015 and 2015/2016 for UK-Colombia collaboration**.

Newton Fund activities in Colombia have a focus on the following areas: rural and urban development; agriculture competitiveness; stimulation of entrepreneurship; climate change planning mitigation; health; and wider institutional capacity building in government. In 2014, the proposed balance of activities by Newton Pillar was as follows: 40% People; 45% Programmes; 15% Translation.

Internal documents on Newton in Colombia indicate that the country has a "high priority for science and innovation" in public policy. A large amount of Newton activity will aim to increase personal links in collaboration networks, through developing capacity and links with the UK.

Figure 1. Country Profile[1]



[1] See Table 1 for the statistics and section 2 of the baseline report for a list of the indicators.

Indicators of Present and Future Potential

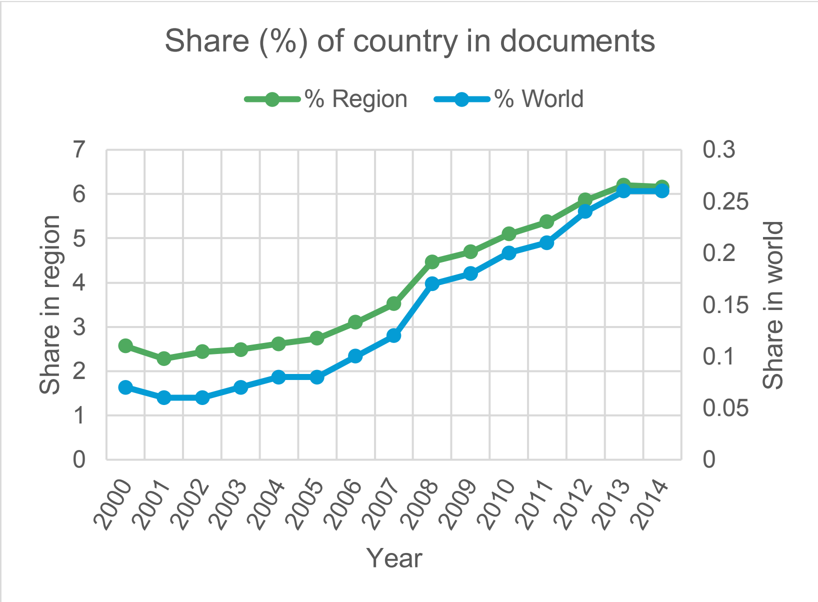
Table 1. Profile Indicators (present and future potential)

International Collaboration (%)	Documents	FWCI	FWCI (4-year change)	Share of world top 1% documents	Share of world top 1% documents (4-year pp change)
49.07	47/229	0.913	0.103	0.40	0.24

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Colombia ranks 47th in the world for the production of published research documents. As shown in Figure 2, the country produces 0.26% of all documents published in the world and 6.16% of publications in the region[2].

Figure 2. Production of documents



Source: SCImago Journal & Rank; PACEC

The focus of Newton Fund priority areas for Colombia has kept pace with local developments. While Physics and Astronomy was the second main subject area for publications in 2000 (behind Medicine), its share in the country's research halved by 2014. At the same time, Engineering doubled in share to over 11% and is now the second subject area. The Health Professions area, which aligns closely with Newton Fund activities in health, constituted 0.1% of research in 2000 but surpassed 1% in 2013. Agricultural and Biological Sciences is one of the major subject areas in Colombia and has consistently accounted for almost one in ten publications since 2000. The Computer Science subject area accounted for 2.1% of Colombian publications in 2000, but increased to 7.4% by 2014. This should not surprise when taking into consideration the increasing start-up activity in Bogota and Medellin, which have provided Colombia with one of the fastest growing technology industries in the world.[3]

Colombia has a score of 0.913 for citation impact adjusted by field, having grown strongly in recent years. Colombia also has a share of publications ranked in the global top 1%, at 0.4% of the total.

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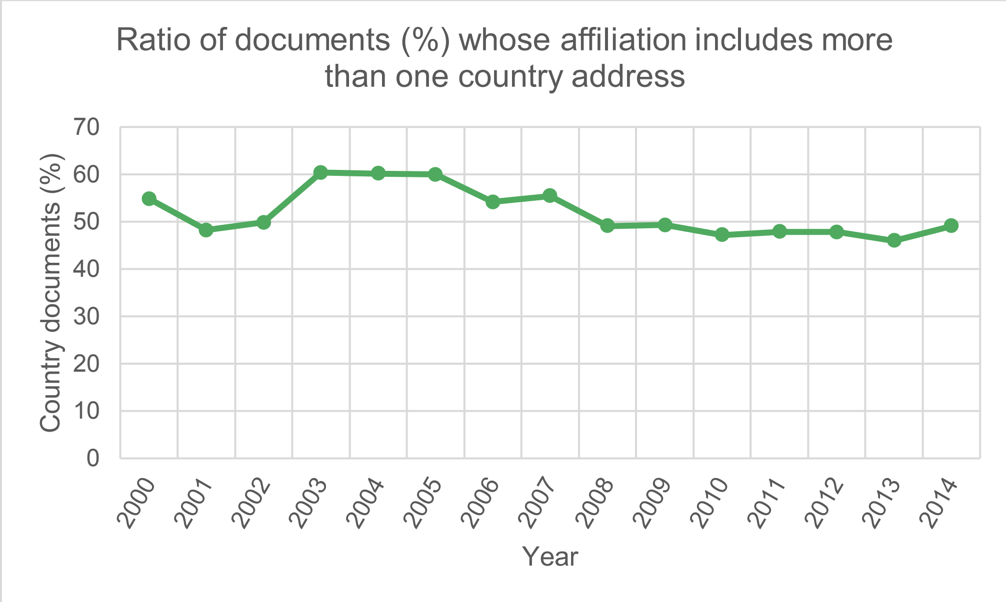
[2] SCImago defined region: see Table A2 in the main baseline report appendix for information on countries and their regions.
[3] Egusa 2014.

Figure 3. International Collaborations



Source: SCImago Journal & Rank; PACEC

The level of international collaboration for publications is 49.07% (see Figure 3), which is higher than average.

Indicators of Innovation Collaboration Potential

Table 2 Profile Indicators (collaboration and mobility)

PCT patent applications per million population	Capacity for Innovation	Company spending on R&D	University-industry collaboration in R&D	Outbound mobility ratio	UK's rank as students' destination of study
66/124	3.55	2.98	3.93	142/165	6+

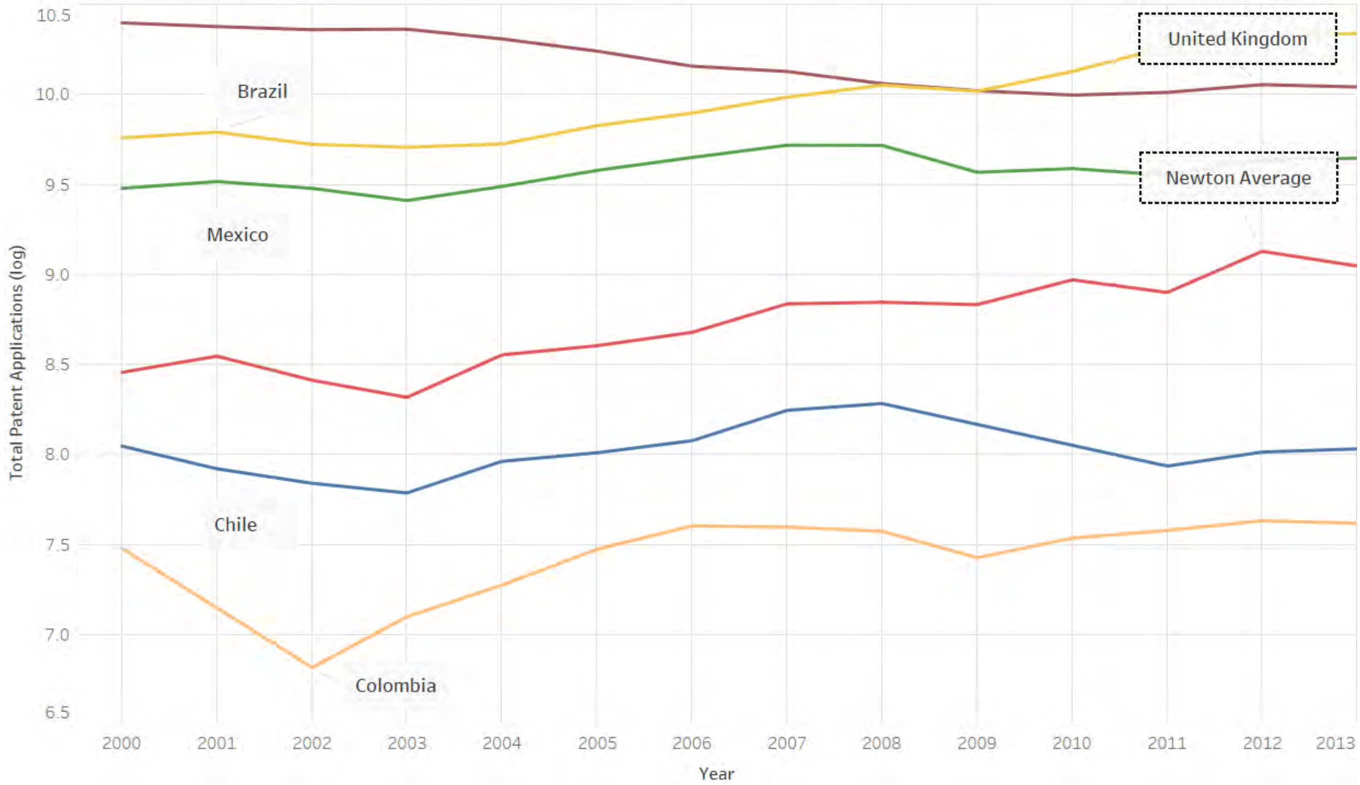
Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

In the Global Competitiveness Index (GCI) 2014–15 report, Colombia is noted to have a stable competitiveness profile.

Colombia's Capacity for Innovation score is 3.55. The scores for company spending on R&D and university–industry collaboration in R&D are 2.98 and 3.93. This is Colombia's best performance in the GCI's innovation pillars.

There are 1.24 patent applications per million people in Colombia.

Figure 4. Patent Applications



Source: WIPO; PACEC. Total patent applications (direct and PCT national phase entries). Log scale.

Indicators of student and research mobility

1.21% of Colombian students study abroad, which is a relatively high proportion for the region.

The top 5 destinations for Colombian students in 2012 were the United States, Spain, France, Australia and Germany according to UNESCO Institute for Statistics (UIS) data.

The Colombian government has many 'internationalisation' policies in place. These include scholarships for PhD students in order to increase student presence at universities abroad and develop co-operation mechanisms. The OECD notes that "*outward mobility of Colombians has been quite high, especially at the PhD stage, and this helps build external networks*".[4]

Overview of research funding structure

Colciencias is the government body that acts as Ministry of Science, research council, and innovation funding agency. The consolidation of these manifold responsibilities in one agency is the result of the 2009 innovation policy review. The budget for Colciencias has varied in the past two decades, as it was often increased via transfers from the SENA (National Service of Learning) government agency. Since 2011, a high proportion of the budget for Colciencias has been funded by a World Bank loan. In 2011, Colciencias allocated COP 46,056 million (approx. £10 million) to funds for research and innovation projects. Universities in Colombia do not directly receive institutional funding from Colciencias.

In 2014 the OECD noted that Colombia's national innovation system has a *"compartmentalisation of STI activities"*, spread across public research institutions and government-led public funding.

In 2011, Colciencias accounted for 70% of the funding for research projects at the Universidad Nacional (National University), with companies and agricultural associations accounting for 21%.

[4] OECD 2014, p. 232.

35% of the Colciencias budget in 2011 (COP 118,000 million, or approx. £25 million) was allocated to **supporting PhD students**. Increasing the human capital of Colombians, particularly through greater funding for advanced degrees and international doctorates, has been a high priority in the Colombian government's innovation policy. A consortium of British Universities is participating in Colciencias scholarships for Colombian students, including universities such as Edinburgh, Southampton, Bath and Brunel. The Colombian government also supports the COLFUTURO non-profit foundation, which has disbursed over $130 million since 1991 to fund postgraduate education for almost 6,000 Colombian students at global universities.

The Innpulsa government agency was established in 2012 to support business growth through better innovation practice and receives funding from the Ministry of Commerce, Industry and Tourism. In 2012, COP44 billion was allocated to projects for 41 firms, while additional funding was given to Colombia's regions to develop local innovation roadmaps, with the aim of augmenting their capacity for innovation.

Funding initiatives similar to Newton

The European Union (EU) is funding several projects and a regional innovation framework in order to develop the research capacity of countries such as Colombia. Through **Horizon 2020 and FP7 funds**, it allocated more than €100 million (£75 million) to research activities in the Community of Latin American and Caribbean States (CELAC) region between 2007 and 2013. Moreover, the **EU-CELAC Knowledge Area** was created to organise research in priority areas identified as mutually beneficial for European and Latin American countries. Here, Colombia is a co-chair, together with France, of the working group on biodiversity and climate change.[5] The **Network of the European Union, Latin America and the Caribbean Countries on Joint Innovation and Research Activities** (ERANet-LAC) is a partnership that seeks to strengthen innovation programmes and research coordination between EU member states and Latin American countries, including Colombia. The programme's rationale as part of the Joint Initiative for Research and Innovation (JIRI) was endorsed by the Madrid Plan. The first call of the programme included €10 million committed funds. At the end of 2015, the initiative launched its second joint call, to which Colciencias has contributed approximately €100,000 (approx. £75,000) for research calls in Colombia. The second call featured a research theme on biorefinery, in particular for developing high-value bio-products on the fractionation and valorisation of residual biomass, and lignocellulosic biorefinery platform. Research will be funded up to a maximum of €25,000 (approx. £19,000).

In 2015, the World Economic Forum recommended the creation of either a Latin America student exchange programme or a research mobility programme. Colombia is a participant in the region's government-led Pacific Alliance student and researcher mobility programme, launched in 2012 and described by the World Economic Forum as a "*benchmark of excellence for scholarship programmes in Latin America*".[6] The other participants are Chile, Mexico and Peru. In the first two years, the programme awarded 658 scholarships for students, including 157 by the Colombian government. The main destinations for scholars to Colombia are Saint Thomas Aquinas University (*Universidad Santo Tomas*), which is the oldest in the country, the UAN in Cali and the EAN University in Bogota. Environmental Sciences and Climate Change are some of the priority areas for the courses undertaken by scholars in the mobility programme.

[5] European Commission 2015.
[6] World Economic Forum 2015, p. 36.

Table 3. Summary of major funding initiatives similar to Newton

Funding initiative	Description of activity
EU–CELAC Horizon 2020 programme	€100 million (£75 million) in activities for research in priority areas in CELAC countries between 2007 and 2013 as part of EU aims in strengthening international science & technology co-operation, with grants for 720 CELAC participants. Activities focus in particular on these areas: the environment; food, agriculture & biotechnology; ICT; health.
ERANet-LAC	The Network of the European Union, Latin America and the Caribbean Countries on Joint Innovation and Research Activities (ERANet-LAC) is a partnership between EU member states and Latin American countries, which aims to strengthen research coordination between Europe and Latin America. The first call of the programme had €10 million (£7.5 million) in committed funds.
Pacific Alliance student exchange & researcher mobility programme	Student exchange and researcher mobility programme launched in 2012 by the four Pacific Alliance countries (Chile, Colombia, Mexico and Peru). It is a reciprocal programme that provides 100 scholarships per year for each country (75 for undergraduates and 25 for doctoral & teaching candidates). The World Economic Forum has described the programme as a "*benchmark of excellence for scholarship programmes in Latin America*".

M&E Measures

The Observatory of Science and Technology (OCyT) was created in 1999 and is the main producer of statistical indicators for benchmarking innovation in Colombia. OCyT receives 80% of its funding from Colciencias. Furthermore, the National Administrative Department of Statistics (DANE) undertakes national innovation surveys, whose datasets are analysed by the OCyT and used in international studies, for instance in those conducted by the Inter-American Development Bank). OCyT acts with some subsidiarity to the Colciencias agency; therefore, it is in line with international practice for benchmarking purposes.

In order to further develop the country's strategic intelligence on innovation, the OECD recommends that the OCyT and DANE extend the levels of data collection and analysis to sectors beyond manufacturing.

Overview of Business-Academia collaborations

In the University of Los Andes, business organisations have accounted for approximately 5-10% of research income between 2004 and 2011.[7] Of the 20 main external funders of the university, four are companies, including Industria Militar and Ecopetrol. Ecopetrol has 28 cooperation agreements with Universities and appears to be the company with the strongest links with academia at the country level.

There is evidence that initiatives in universities, such as mentorship schemes for industrial engineering, have led to greater links with industry and that universities have *"gained confidence and momentum in approaching new companies for their involvement"*.[8]

[7] *Ibid.*, p. 96.
[8] Anaya Salazar & Cabrera-Rios 2011

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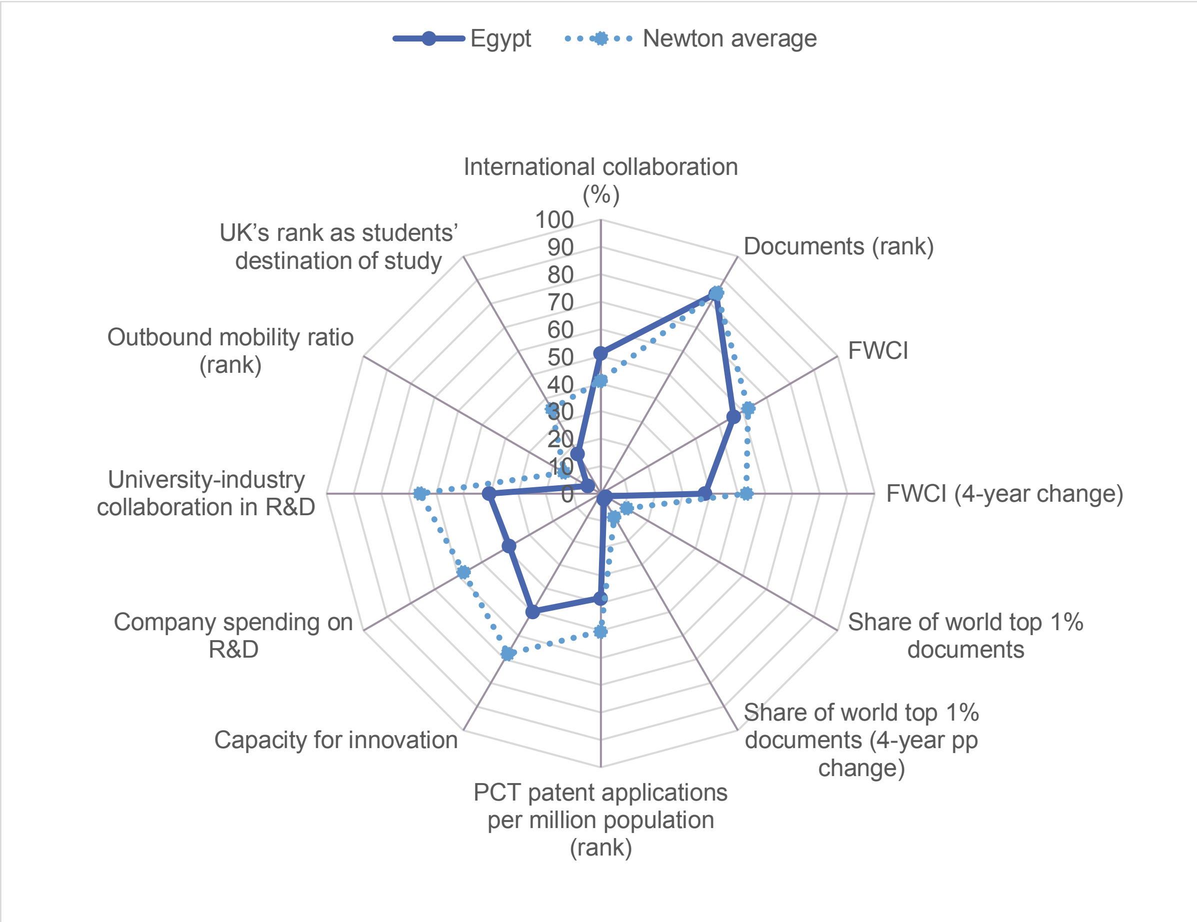
Egypt

Summary of baseline research capacity

Egypt has an appetite for engagement, with Newton interventions focused on partnership- and capacity-building, with a view to long-term collaboration with the UK in the future. In 2014, the proposed Newton activities were focused entirely on capacity-building (people and equipment), although there was no breakdown of budget per Newton Pillar. **Newton activities in Egypt receive £2 million per annum for UK-Egypt collaboration**.

Egypt has been able to engage fully in the first year of the Newton programme. The initial focus has been on capacity-building (people and equipment) through the People Fund, to enable future research and innovation collaborations. Egypt's proposed research focus for the programme includes renewable energy, sustainable food production, sustainable water management, affordable and inclusive healthcare, and archaeology and cultural heritage. It is hoped that the archaeology focus will help revive tourism, attracting overseas visitors thanks to archaeological findings. There is also a desire for PhD funding, and career paths for trained academics.

Figure 1. Country Profile



Egypt has a high level of international collaboration (51%) on research and has a sizable level of publication output.

Indicators of Present and Future Potential

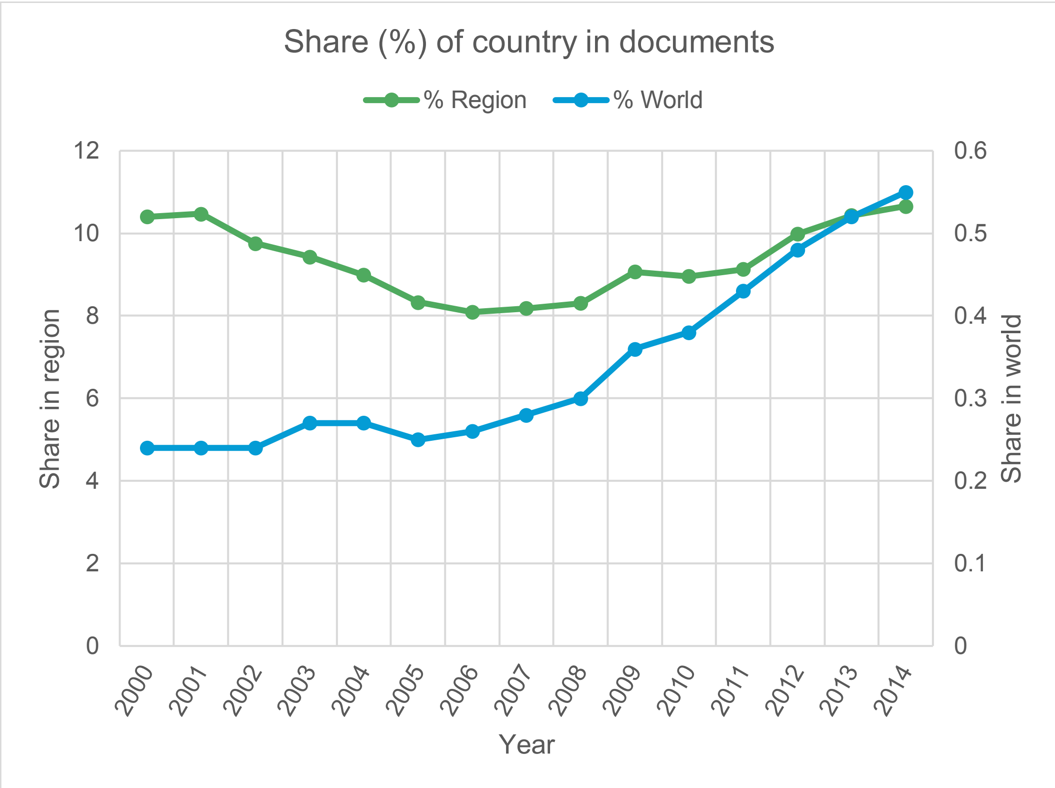
Table 1. Profile Indicators (present and future potential)

International Collaboration (%)	Documents	FWCI	FWCI (4-year change)	Share of world top 1% documents	Share of world top 1% documents (4-year pp change)
51.24	37/229	0.748	-0.012	0.30	0.20

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Egypt ranks 37th in the world for the production of published research documents. It produces 0.55% of documents in the world and 10.66% of documents in the Middle East region[1] (see Figure 2). Egypt's share of world publications has increased significantly since 2000.

Figure 2. Production of documents



Source: SCImago Journal & Rank; PACEC

There have been strong increases in the numbers of papers published in agriculture, engineering, computer science, medicine and biochemistry, genetics, and molecular biology (Bond, 2014).

Egypt's proportion of publications with more than one country affiliation is 51%, which is higher than average. This has been on an upward trend since 2000 (see Figure 3). The country's level of international collaborations has been increasing with its share in world documents, which could point to a greater utilisation of international research networks.

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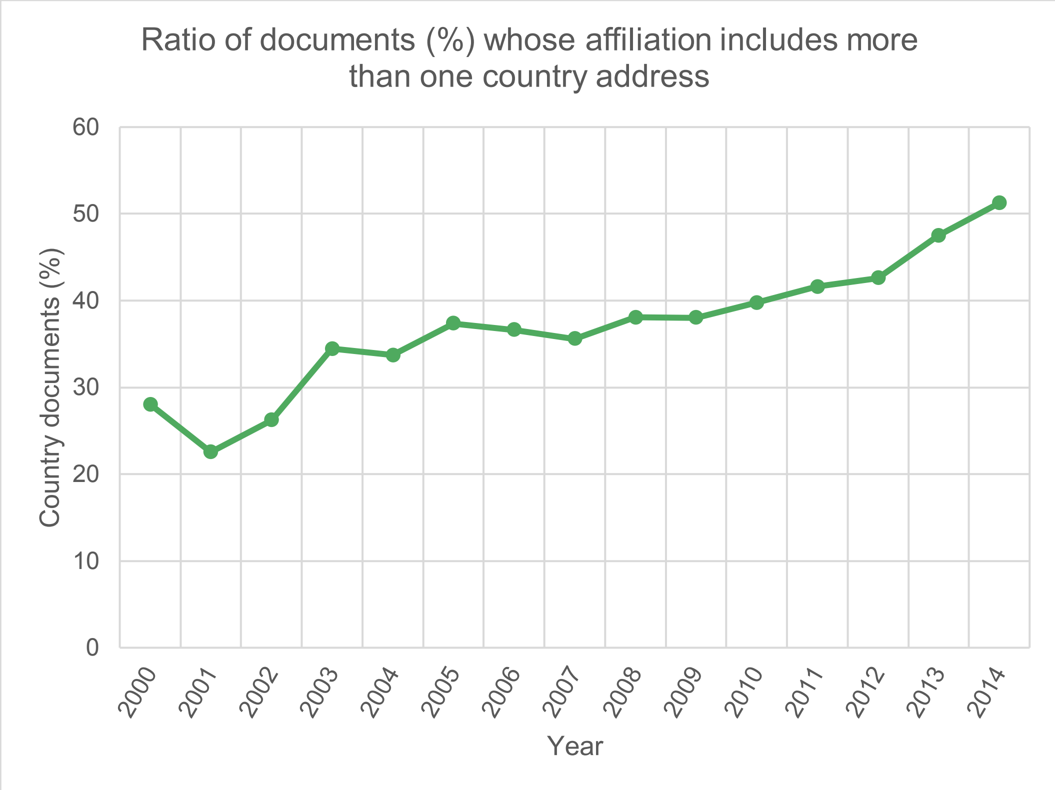
[1] SCImago defined region: see Table A2 in the main baseline report appendix for information on countries and their regions.

Figure 3. International Collaborations



Source: SCImago Journal & Rank; PACEC

Egypt has a field-weighted citation impact of 0.748. The FWCI for Egypt fell by 0.012 between 2008 and 2012. Egypt's share in the world's top 1% documents by citations is 0.3%, increasing relatively fast by 0.2pp between 2008 and 2012.

Indicators of Innovation Collaboration Potential

Table 2. Profile Indicators (collaboration and mobility)

PCT patent applications per million population	Capacity for Innovation	Company spending on R&D	University-industry collaboration in R&D	Outbound mobility ratio	UK's rank as students' destination of study
77/124	2.93	2.29	2.43	156/165	5

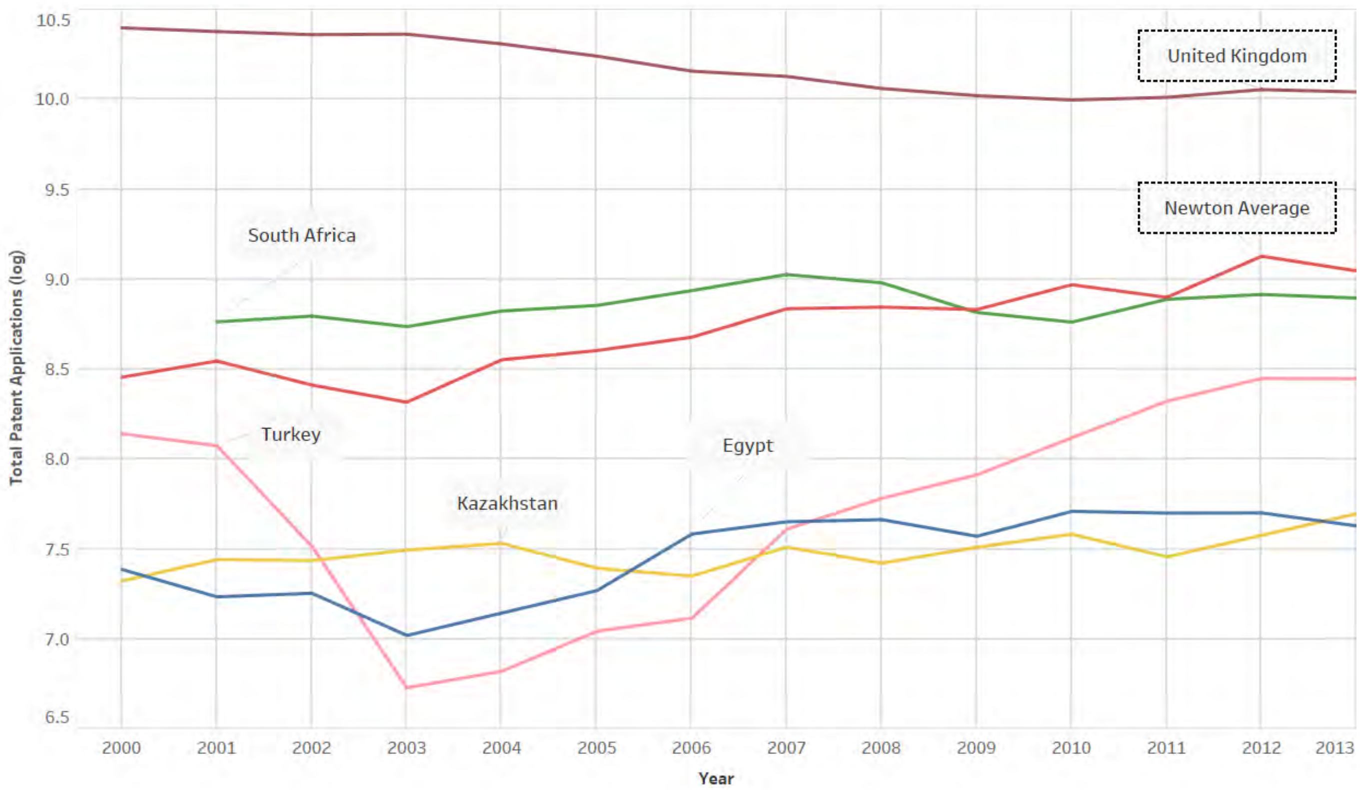
Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Egypt has 0.59 PCT patent applications per million people. Patent applications in Egypt had a small dip in 2004, coinciding with the country's entry into the PCT in September 2003.

According to the Global Competitiveness Index (GCI), three areas are of particular importance for the country are: the macroeconomic environment; domestic competition; and labour market policy.

For the indicator on company spending on R&D, Egypt scores 2.29. University–industry collaboration in R&D has a score of 2.43.

Figure 4. Patent Applications



Source: WIPO; PACEC. Total patent applications (direct and PCT national phase entries). Log scale.

Indicators of student and research mobility

The UK is the 5th main destination for study by Egyptian students, behind the United Arab Emirates, Saudi Arabia, the United States and France.

Overview of research funding structure

The Supreme Council of Science and Technology (HCST), chaired by the President, is composed of ministers and eminent scientists, and is responsible for defining the national funding priorities. These are renewable energy, water resources, health, food and agriculture, space technology, ICT, and socio-economic sciences and humanities. During the Decade for Science and Technology (2007-2016), the Developing Scientific Research Plan was devised for the same period. The Academy of Scientific Research and Technology (ASRT) no longer has a funding role, but advises on policy and coordinates research.

The Egyptian Ministry of Higher Education and Scientific Research (MOHE) runs the Research, Development and Innovation (RDI) programme, which was set up jointly with the European Union and is designed to encourage applied research that is useful to business. It also directs various funds including the Science and Technology Development Fund (STDF), which provides national peer-reviewed research grants; joint research grants with the USA, Germany, France, Italy, and Japan; targeted research calls in renewable energy, sustainable food production, water desalinisation, and hepatitis C; capacity building; and innovation grants. Affiliated research centres include the National Research Centre, and are organised within the MOSR under the Supreme Council of Scientific Research Centres and Institutes.

In addition to MOHE, other ministries promoting innovation and technological development include the Ministry of Trade and Industry and the Ministry of Communication and Information Technology. Other Ministries actively undertaking research include Agriculture and Land reclamation; Water Resources and Irrigation; Health; Energy and Electricity; and Petroleum. There are a number of Institutes affiliated to Ministries, such as the Industrial Modernisation Centre and the Information Technology Industry Development Agency.

Funding initiatives similar to Newton

Table 3. Summary of major funding initiatives similar to Newton

Funding initiative	Description of activity
EU–Egypt Innovation Fund	€11 million (approx. £8 million) in EU funding for research activities for collaborative research in priority areas identified by Egypt (e.g. energy, nanotechnology) with researchers in EU member states. 51 projects were funded in the first period of 2007–2011.
German–Egyptian Research Fund (GERF)	Major bilateral research programme run jointly by the International Office of the German education ministry and the Egyptian Science & Technology Development Fund. Grants of up to £150,000 for collaborative research projects that last for 2 years. It launched in 2008 and has research call cycles of two years.

The **EU–Egypt Innovation Fund** since 2007 is a research fund for collaborative research, from an agreement between the EU and Egypt in support of the country's Research Development & Innovation (RDI) programme. In the first phase between 2007 and 2011, the Fund supported 51 projects, on priority research areas identified by Egypt such as energy, ICT, materials and nanotechnology. There are two sets of grants: one scheme up to approx. £450,000, with objectives that are focused more on securing capital investment; the other grant scheme up to £75,000, which focuses on facilitating international research links.

There are several joint research funding strategies in place with the USA, Japan, France, Italy, and Germany.

The **German–Egyptian Research Fund (GERF)** launched in 2008 is a major bilateral research initiative with grants of up to €200,000 (approx. £150,000) for joint research projects of up to 2 years. Research is focused on priority areas such as material sciences, biosciences, health and medical research, and environmental research. Funding is open to all research institutions in Germany and Egypt but particularly open to industry participation. The GERF budget has equal co-funding between the Egyptian and German governments.

The flagship Egypt-Japan University of Science and Technology (E-JUST) at Alexandria prioritises links with Japanese science and industry.

M&E Measures

STDF carries out evaluations of internal performance, which provide detailed analysis of activities and programmes. For example, reintegration grants have been modified by raising their funding from 750,000 L.E to 1.5m L.E. (up to approx. £136,000). In other cases, laboratory establishment and follow-up procedures have been evaluated by experts from counterpart agencies, such as the German Research Agency, whose experts often visit STDF.

STDF is seeing a growing response from Egyptian researchers to calls for applications, particularly in selecting independent evaluators for the proposals. The shortage of local evaluators was addressed by nominating Egyptian experts in the initial proposal stage and establishing a committee including international experts in the second stage.

Overview of Business–Academia collaborations

It is estimated that 5% of R&D funding comes from the private sector[2]. There is a plan to raise GERD to 1% of GDP by 2015.

The STDF provides innovation grants for prototype development, overcoming technological risk, and supporting faculties which work with industry. There is an Innovation workgroup tasked with promoting the innovation cycle.

[2] As estimated by ASRT, quoted in Bond et al. (2012).

There is a Centres of Excellence Programme, funded by STDF, which funds teams of researchers led by experts from academia and industry to produce valuable innovative products and services. Around 500 Centres of Excellence have been funded.

Finally, the Information Technology Industry Development Agency provides loans to small and medium ICT businesses to help them expand.

References

Further to information about the Newton Fund from confidential internal documents, the external sources below have been consulted for the Egypt baseline report.

Bond, M., Maram, H., Soliman, A., & Khattab, R. (2012) *Science and Innovation in Egypt*. London: The Royal Society.

OECD (2012) Science, Technology and Industry Outlook 2012

Schwab, K. (2014) *The Global Competitiveness Report 2014–2015.* Geneva: World Economic Forum.

India

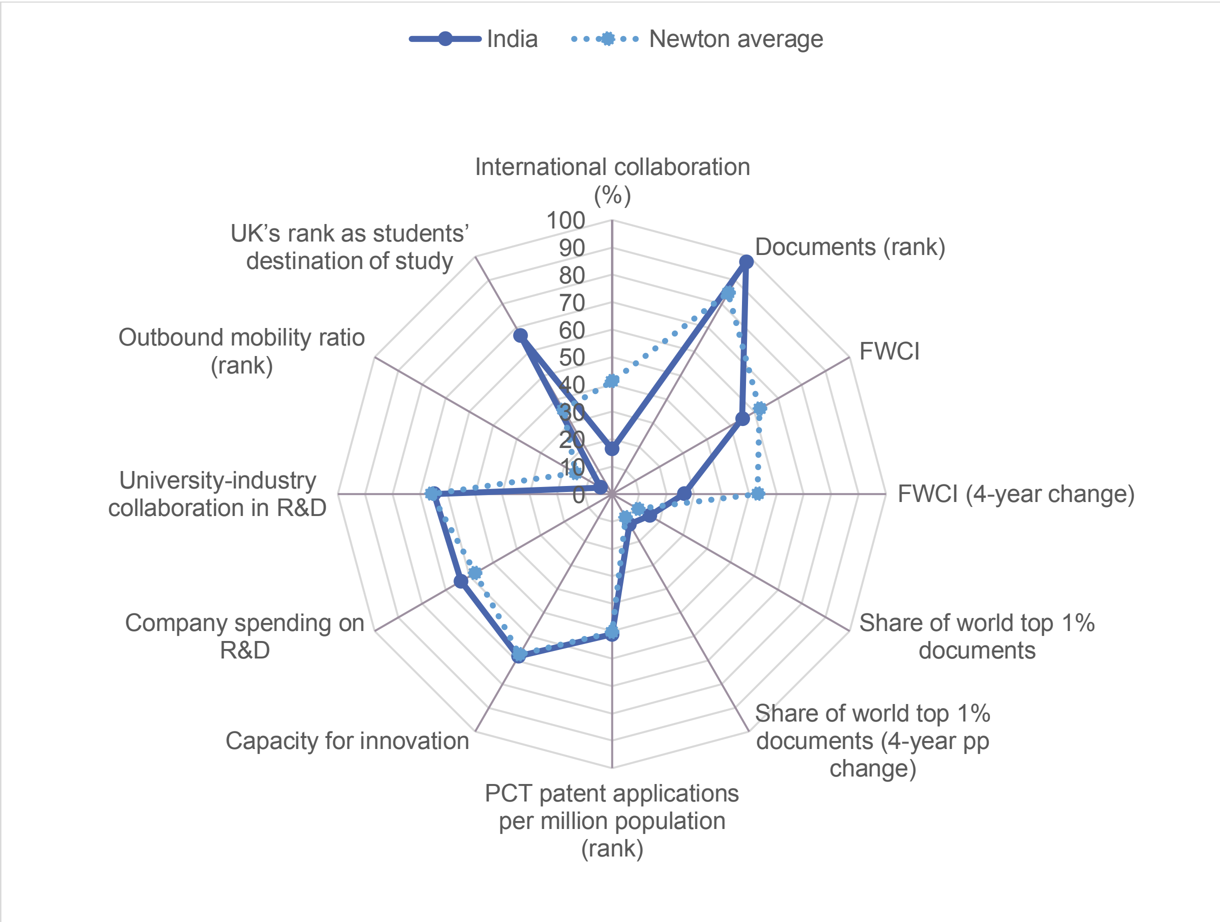
Summary of baseline research capacity

India has high levels of science capacity and advanced innovation systems. Newton has a strong focus on innovation and research collaboration, managed in line with UK Research Councils' peer review systems. **Newton Fund activities in India receive £10 million per annum for UK–India collaboration**.

India has a strong scientific tradition, with equalisation of science with and economic development being a central policy theme.

Newton Fund activities in India have a focus on the following areas: Sustainable Cities and Urbanisation; Public Health and Well Being; and the Energy-Water-Food Nexus. There are also two 'underpinning capabilities' of High Value Manufacturing and Big Data.

Figure 1. Country Profile



India's baseline profile is strong, indicating innovation collaboration potential, with particular strengths in company spending on R&D and capacity for innovation.

Indicators of Present and Future Potential

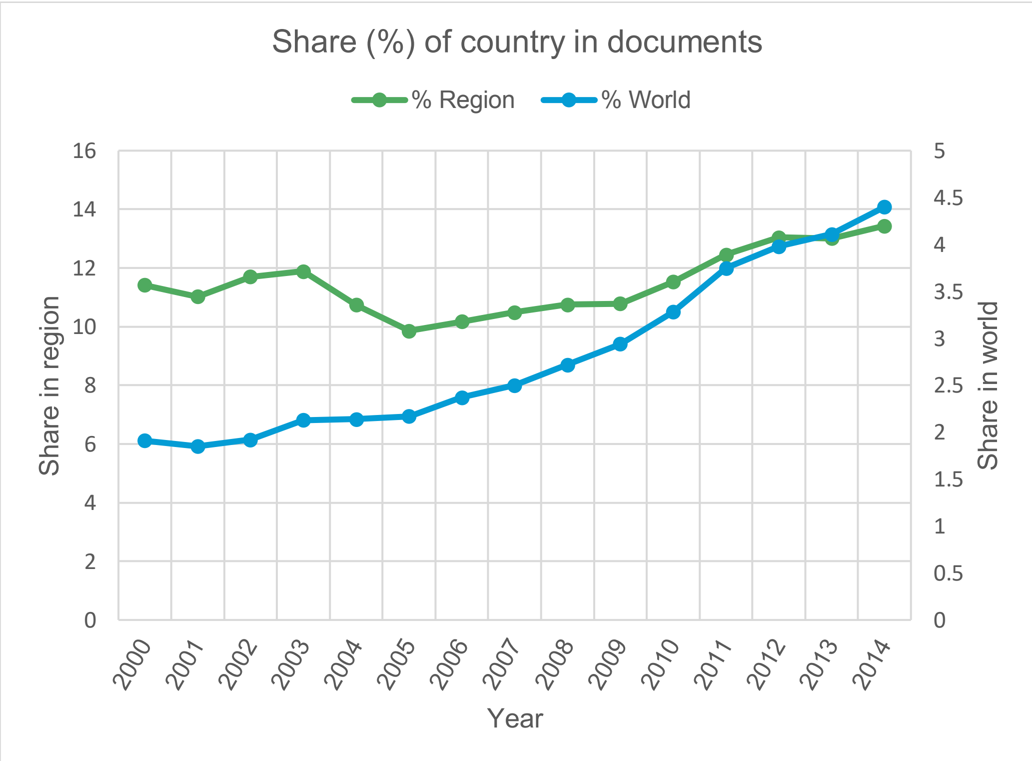
Table 1. Profile Indicators (present and future potential)

International Collaboration (%)	Documents	FWCI	FWCI (4-year change)	Share of world top 1% documents	Share of world top 1% documents (4-year pp change)
16.36	6/229	0.724	-0.048	2.12	0.94

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

India ranks 6th out of 229 countries for the production of published research documents. It produces 4.4% of global research publications and 13.44% of documents in the Asiatic region[1] (see Figure 2). India's share of world publications has steadily increased at a high rate since 2000.

Figure 2. Production of documents



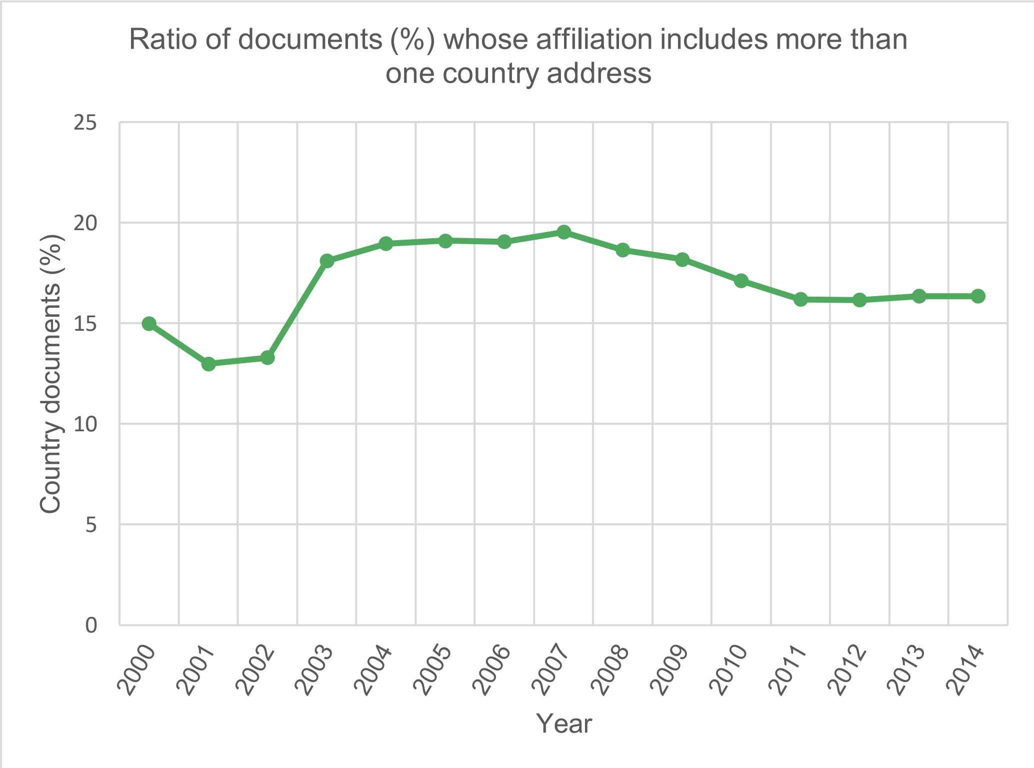
Source: SCImago Journal & Rank; PACEC

The research and innovation ecosystem in India is considered complex and difficult to measure. The country has had rapid growth in research output since 2000, enjoying pockets of excellence in a number of key sectors such as IT, biotechnology, pharmaceuticals, space and renewable energy, and automotive technology, with a large pool of highly skilled knowledge workers from its many universities and technology institutes. India has the world's fifth largest power generation portfolio and is the fifth largest wind energy producer. Foreign Direct Investment and private sector investment in innovation have grown substantially since the 1990s as the economy has become more focused on global markets.

[1] SCImago defined region: see Table A2 in the main baseline report appendix for information on countries and their regions.

India's proportion of publications with more than one country affiliation is 16%, a level it has maintained over the past 15 years. This reflects vast increases in overall research output, as well as India's strong indigenous capacity for innovation.

Figure 3. International Collaborations



Source: SCImago Journal & Rank; PACEC

India has a field-weighted citation impact of 0.724. India accounts for 2.12% of the world's top 1% documents by citations, increasing by 0.94pp between 2008 and 2012.

Indicators of Innovation Collaboration Potential

Table 2. Profile Indicators (collaboration and mobility)

PCT patent applications per million population	Capacity for Innovation	Company spending on R&D	University-industry collaboration in R&D	Outbound mobility ratio	UK's rank as students' destination of study
61/124	4.02	3.78	3.87	157/165	2

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

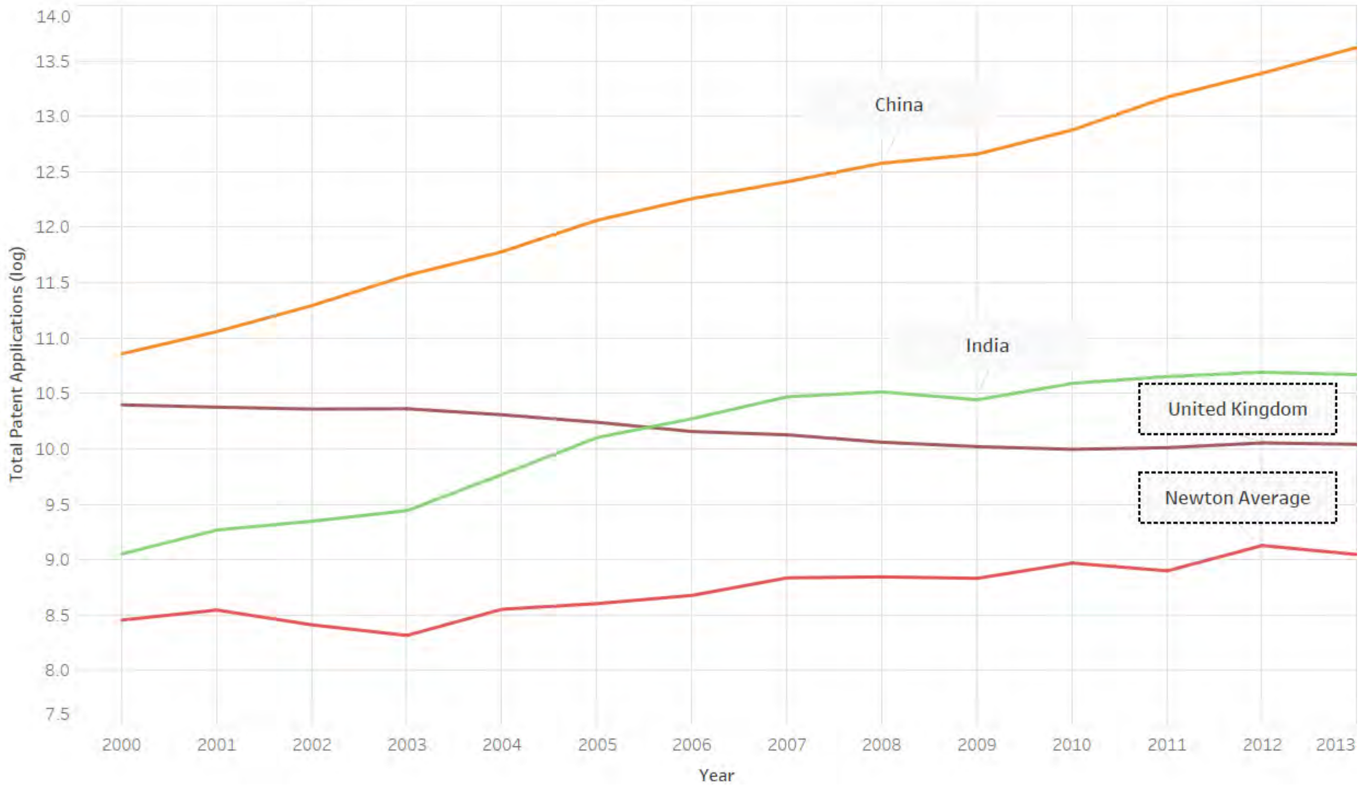
India's future research and innovation capacity is expected to benefit from strong institutional factors, with large increases in foreign investment and continued availability of qualified personnel. The complexity of the country's research and innovation systems may not be fully reflected in global indexes.

India has 1.54 PCT patent applications per million people. Patent applications in India enjoyed a persistent upward trend in the 2000s.

The country scores 4.02 on the Global Competitiveness Index's (GCI) Capacity for Innovation indicator. The 2014-15 GCI report noted that: "*overall, India does best in the more complex areas of the GCI: innovation (49th) and* *business sophistication (57th). In contrast, it obtains low marks in the more basic and more fundamental drivers of competitiveness [such as the quality of primary education and technological connectivity]".*[2]

India's score for company spending on R&D is 3.78 (ranked 30th globally), making it the country's strongest innovation indicator in the GCI. University–industry collaboration in R&D has a score of 3.87, ranking 50th worldwide.

Figure 4. Patent Applications



Source: WIPO; PACEC. Total patent applications (direct and PCT national phase entries). Log scale.

Indicators of student and research mobility

India had a **relatively low outbound mobility ratio**, ranked 157th of 165 countries in the world, which indicates a low international mobility of Indian students. Its outbound mobility ratio of 0.66% in 2012. **The UK is the 2nd main destination for study by Indian students after the United States**, with the next three countries being Australia, Canada and the United Arab Emirates. This score may be misleading given the vast size of the country: the gross number of students from the country is very high and Indians remain the second largest group of international students in the UK.

Overview of research funding structure

India has no central research funding body. Regulations and standards are overseen by the University Grants Commission (UGC), but the locus of research and funding is centred on India's large government science agencies[3]. Overall responsibility for science and technology policy is held by the Ministry of Science and Technology, with funds dispensed through its three constituent departments:

- Department of Scientific and Industrial Research (DSIR). The DSIR oversees the Council of Scientific and Industrial Research (CSIR), India's foremost research and development organisation;

[2] Schwab 2014, p. 29.

[3] V. Krishna, Case Study India: Centre of excellence as a tool for capacity building, OECD Programme on Innovation, Higher Education and Research for Development (IHERD).

- Department of Science & Technology (DST);
- Department of Biotechnology (DBT).

The DST and DBT generally utilise grants and subsidies to support research, whilst the laboratories and institutes (such as those supported by CSIR) support research through programmes and fellowship schemes[4]. Other major funding agencies include the Department for Atomic Energy (DAE) and the Indian Council of Medical Research (ICMR), both of whom have collaborated extensively with counterpart research councils in the UK.

The Government's plans for building research and innovation capacity are ambitious. The National Knowledge Commission was set up in 2005, charged with setting priorities for India's knowledge economy. The government designated 2010-2020 as the 'Decade of Innovation', and established a new National Innovation Council which developed a road map. In 2015, the Indian government ordered research organisations and public laboratories to seek external research funding and also outlined plans to improve research commercialisation processes[5].

Private funding has grown very rapidly in recent years, with R&D business expenditure (BERD) growing from 13.8% of GERD in 1991 to over a third today[6]. Large multinationals play an increasingly important role in funding commercially-applicable science and technology research, sponsoring institutes and activities around the country. Major sponsors include Microsoft and IBM, as well as Indian multinationals such as Tata Group. Non-public funding is also provided by several hundred DSIR-recognised scientific and industrial research organisations (SIROs) whose activities are non-commercial and receive tax exemptions, and industry groups such as the Federation of Indian Chambers of Commerce and Industry (FICCI), India's largest business organisation.

Funding initiatives similar to Newton

Table 3. Summary of major funding initiatives similar to Newton

Funding initiative	Description of activity
Research Councils UK partnership	Research Councils UK has co-invested over £200 million with Indian partners since 2008 on research through its local presence in RCUK India This figure includes Newton Funds.
Wellcome Trust/DBT India Alliance	The Wellcome Trust/DBT India Alliance is an £160 million initiative funded equally by The Wellcome Trust, UK and Department of Biotechnology, India. The broad aim of the India Alliance is to build excellence in the Indian biomedical scientific community by supporting future leaders in the field. The India Alliance offers four Fellowship schemes to basic biomedical scientists, clinicians, public health researchers and veterinarians who wish to pursue academic research in India. The basic aim of all the schemes is to provide flexible and generous funding to enable the researchers in different stages of their careers, to perform internationally competitive scientific research.
Global Innovation Initiative	An initiative led by the UK and US governments since 2013 with aim to "*forge university and business linkages that support international mobility in innovation and discovery activities*" in four countries: Brazil, China, India and Indonesia. The activities focus on STEM issues in particular, with projects funded in India including research on use of mobile technology to monitor water safety.
UK-India Education and Research Initiative (UKIERI)	UK government bilateral partnership with India since 2006 on education and has facilitated more than 200 research partnerships between institutions. Phase 2 in

[4] Shaping the National Innovation System: The Indian Perspective', Global Innovation Index 2012, chapter 7.
[5] Dehradun Declaration, June 2015
[6] Krishna, Case Study India, p.6

	2011–2016 focused on priorities identified by both countries (e.g. innovation partnerships and mobility).
Innovation in Science Pursuit for Inspired Research (INSPIRE)	National initiative by the Indian government that aims to build the human capital of researchers in innovation activity. Components such as Assured Opportunity for Research Careers offer five-year fellowships for post-doctoral researchers.

UK-India research linkages in science and technology are considerable. **Research Councils UK** (RCUK) has a strong local presence under the RCUK India brand. The UK government has also promoted bilateral linkages in education through the **UK-India Education and Research Initiative** (UKIERI) since 2006, designed to foster links and develop synergies between institutions in both countries. UKIERI will be in Phase 3 for 2016–2021 and has completed Phase 2, which focused on priorities identified by both countries (including innovation partnerships, skills development and enhancing mobility). More than 200 research partnerships between institutions have been facilitated by UKIERI since the initiative began.

The **Global Innovation Initiative** led by the UK and US governments was launched in October 2013, with the aim of strengthening multilateral research collaboration between the two countries and others in the world, particularly on STEM-related issues of global significance. This initiative includes India as one of four designated countries, along with Brazil, China and Indonesia. The initiative assigned 23 and 14 awards in its first and second round, respectively, with grants of at least £100,000 or $100,000. One of the goals of the initiative is to "*forge university and business linkages that support international mobility in innovation and discovery activities*."[7] The awards for partnerships in India include research on use of mobile technology to monitor drinking water safety and satellite-based Smart Grids.

Bilateral India-EU co-operation in science and technology has existed since 2002, fostering institutional linkages and funding support. The EU sponsors a number of enterprise and skills development initiatives, such as the India-EU Software Education and Development Centre in Bangalore.

The Indian government has launched initiatives in recent years which share some parallels with Newton Fund programmes. The Council for Scientific and Industrial Research (CSIR) has launched a researcher mobility scheme, designed to attract talent to its laboratories from universities and the private sector. At the national level, the **Innovation in Science Pursuit for Inspired Research** (INSPIRE) scheme is designed to raise science and innovation awareness, and includes the Assured Opportunity for Research Careers (AORC), a component aimed at early career researchers[8].

M&E Measures

The Department of Science and Technology (DST) collects and develops a range of indicators on science, innovation and knowledge creation activities through the Indian National Innovation Survey. These include overall expenditure data (by sector and subject area), human development metrics (doctoral degrees awarded, enrolment of women) and a range of intellectual property metrics. The data are utilised in international comparisons by the OECD and WIPO. The innovation survey incorporates the internationally recognised Oslo Manual guidelines in its methodology.

Overview of Business-Academia collaborations

Presently the majority of R&D collaboration between businesses and outside research organisations is conducted in partnership with non-HEI research agencies. However, the proportion of R&D expenditure occurring in both universities and the private sector is increasing.

- There are a number of schemes set up by public research bodies to promote innovation and collaboration with industry. The Department of Biotechnology (DBT) has a leading scheme for promoting innovation in industry, the Biotechnology Industry Partnership Programme.

[7] See http://global-innovation-initiative.org/about-the-initiative/

[8] Thomson Reuters, The New Geography of Science: Research & Collaboration in India (2009)

- **Atal Innovation Mission (AIM)** was announced by the Government of India in 2015 with an overarching purpose to promote a culture of entrepreneurship and innovation in India. One of its objectives is to develop new programmes and policies for fostering innovation in different sectors of economy.
- In order to increase private sector's investment in R&D, an innovative pilot project named **Global Innovation & Technology Alliance (GITA)** was initiated by CII (Confederation of Indian Industry) and the Department of Science & Technology (DST) in 2007-08. GITA is a unique institution in the country for providing demand-driven technology solutions through frontline global alliances for Indian Companies.
- **Biotechnology Industry Research Assistance Council (BIRAC)** set up by Department of Biotechnology (DBT) as an industry-academia interface agency to stimulate and enhance the strategic research and innovation capabilities of the Indian biotech industry, particularly start-ups and SMEs.
- A number of government science agencies, such as those responsible for biotechnology, defence, and telecommunications, have set up specialised Centres for Excellence which foster collaborative research and innovation. The Ministry of Communications and Information Technology, for example, oversees excellence centres run in collaboration with Microsoft and Vodafone. The Confederation of Indian Industry (CII) has set up nine Centres of Excellence (CoEs), usually with niche or industry associations, to work with India's many micro-, small and medium enterprises (MSMEs) to improve innovation in their respective sectors, and hundreds of incubators have been set up within India's many engineering and technology institutions. The CoEs have built institutional partnerships with over 300 counterpart organisations around the world.
- The Ministry for Micro, Small and Medium Enterprises (MSMEs) has promoted initiatives to support the development of clusters and to assist collaborative partnerships. Small and medium enterprises still provide more than half of employment in the country.
- There are extensive relationships between India's IT sector and academia in a number of clusters, most notably in Bangalore. The city hosts large multinationals, such as Intel and SAP labs, as well as leading Indian firms, with extensive collaboration between universities and technology institutes and industry, following a Silicon Valley model. Well known universities and institutes in the city include the Indian Institute of Science and the Jawaharlal Nehru Centre for Advanced Scientific Research. Debate persists as to the strength and depth of these linkages and the role played by external developments[9]. IBM, for example, has set up software centres of excellence in over 100 locations across the country.
- India's large public research institutions have extensive collaborative relationships with leading multinationals, and can draw on a large pool of highly skilled workers trained at leading institutions. Leading organisations for collaboration include the Centre for the Development of Advanced Computing, the Indian Space Research Organisation (ISRO), and the Defence Research and Development Organisation (DRDO)[10].

[9] A.P. D'Costa, Exports, University-Industry Linkages, and Innovation Challenges in Bangalore, India, (2006)
[10] Herstatt. C, Tiwari, R., Ernst, D., and S. Buse, 'India's National Innovation System: Key Elements and Corporate Perspectives', Technology and Innovation Management Working Paper no.51, January 2008

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NSTMIS. (2014) Understanding Innovation: Indian National Innovation Survey. New Delhi: National Science and Technology Management Information System (NSTMIS).

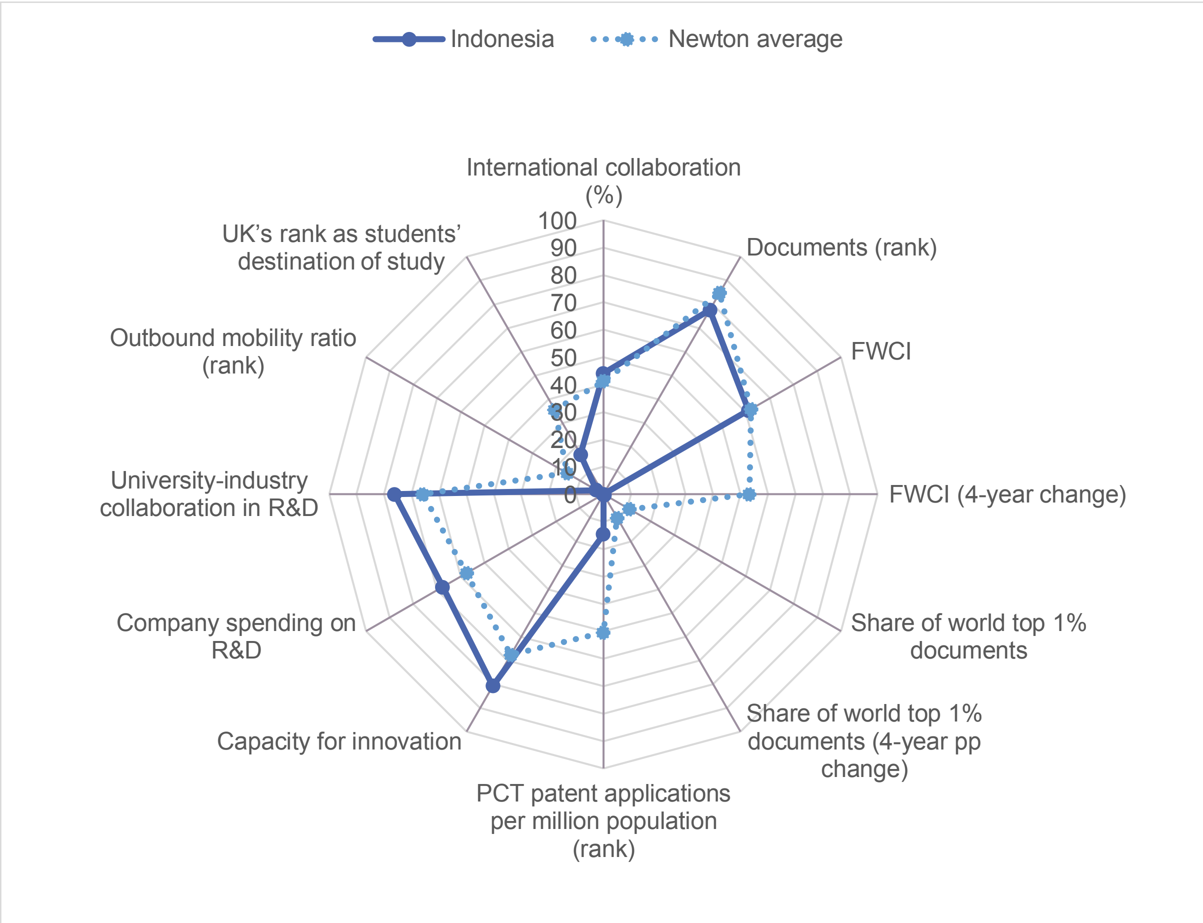
Indonesia

Summary of baseline research capacity

Indonesia has an appetite for engagement, with Newton interventions focused on partnership- and capacity-building with a view to fostering long-term collaboration with the UK in the future.

Activities in Indonesia have a focus on the following areas: Energy and Climate change; Health; Maritime; Urban Development (including sustainable living, transportation, infrastructure and urban design); Food Security; and Capacity-building in Science and Innovation. The proposed balance of activities between Newton Pillars was as follows: 40% People; 40% Programmes; 20% Translation.

Figure 1. Country Profile



Indonesia has a strong baseline performance on indicators of innovation collaboration potential, with high capacity for innovation and university–industry collaboration in R&D. It has the potential to increase research capacity significantly in the future as it has an institutional setup that is competitive.

Indonesia is the largest of the ASEAN countries, and has grown strongly since 2000, with a strong reliance on exports of natural resources[1].

[1] OECD, 2013.

Indicators of Present and Future Potential

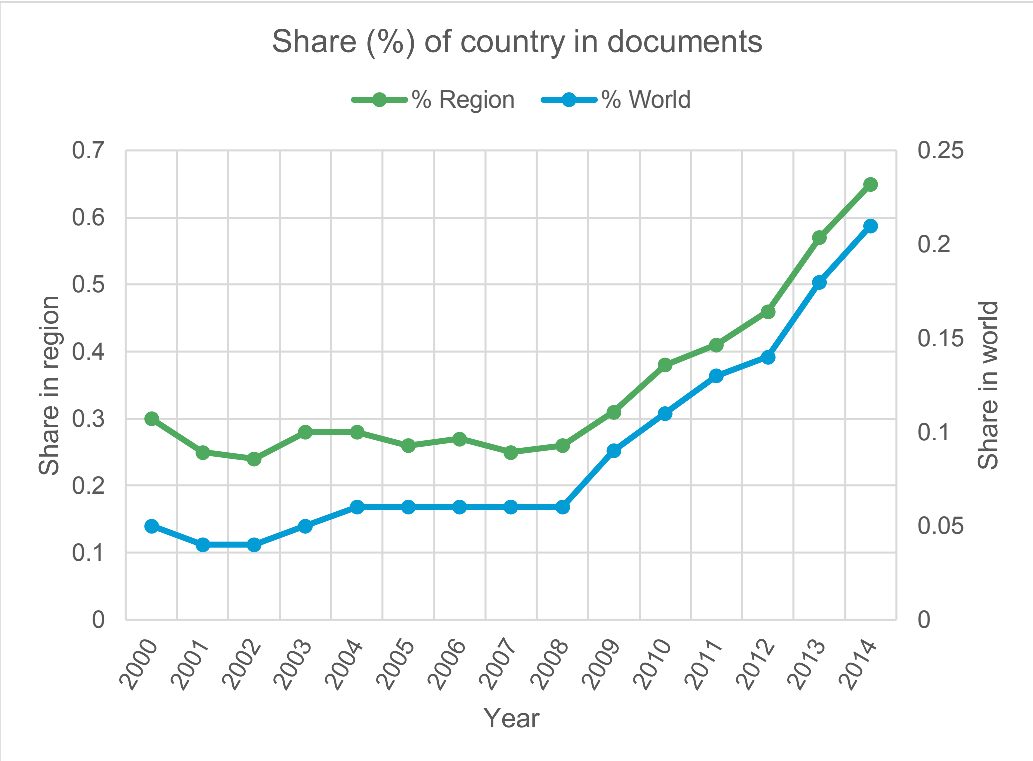
Table 1. Profile Indicators (present and future potential)

International Collaboration (%)	Documents	FWCI	FWCI (4-year change)	Share of world top 1% documents	Share of world top 1% documents (4-year pp change)
44.19	52/229	0.859	-0.128	0.08	0.02

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Indonesia ranks 52nd in the world out of 229 countries for the production of published research documents. It produces 0.21% of documents in the world and 0.65% of documents in the region[2] (see Figure 2). Since 2008 the share has increased significantly, from 0.06% to the current level.

Figure 2. Production of documents



Source: SCImago Journal & Rank; PACEC

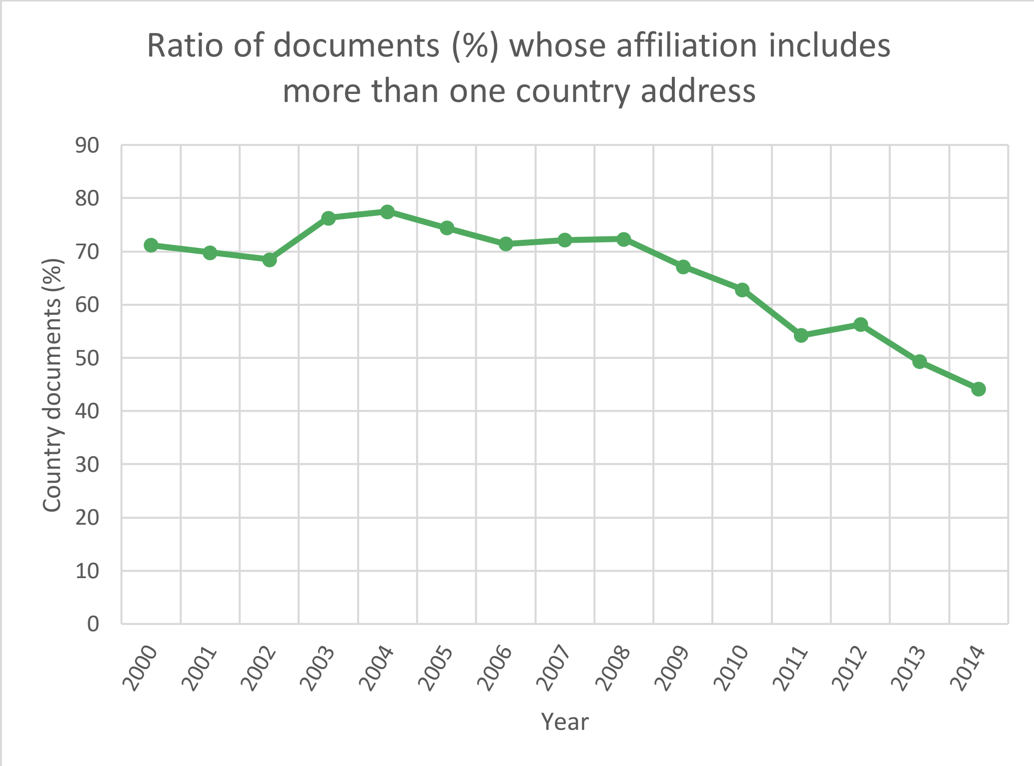
The highest numbers of publications in Indonesia are found in life sciences, ICT, enabling and strategic technologies, and physics and astronomy. In terms of citations, life sciences is the most important area, which includes earth and environmental sciences and agriculture, forestry, and fisheries. The highest impact papers are found in the areas of general science and technology and historical studies, although these account for a smaller proportion of the total[3].

Indonesia's proportion of publications with more than one country affiliation is 44%, which is higher than average. The top country for collaborative research with Indonesia is Japan. The level of international collaboration

[2] SCImago defined region: see Table A2 in the main baseline report appendix for information on countries and their regions.
[3] *Ibid.*

was mostly above 70% during the 2000s, although the decrease observed since 2008 coincides with the upward trend in publication shares (see Figure 3). Despite the headline trend, the literature indicates that large private companies in Indonesia collaborate on knowledge-intensive activity with international enterprises rather than domestic businesses in the life science industries[4].

Figure 3. International Collaborations



Source: SCImago Journal & Rank; PACEC

Indonesia has a field-weighted citation impact of 0.859. The country's share in the world's top 1% documents by citations is 0.08%, with an increase of 0.02pp between 2008 and 2012.

[4] Degelsegger *et al.* 2014, p. 27.

Indicators of Innovation Collaboration Potential

Table 2. Profile Indicators (collaboration and mobility)

PCT patent applications per million population	Capacity for Innovation	Company spending on R&D	University-industry collaboration in R&D	Outbound mobility ratio	UK's rank as students' destination of study
106/124	4.76	4.03	4.55	160/165	5

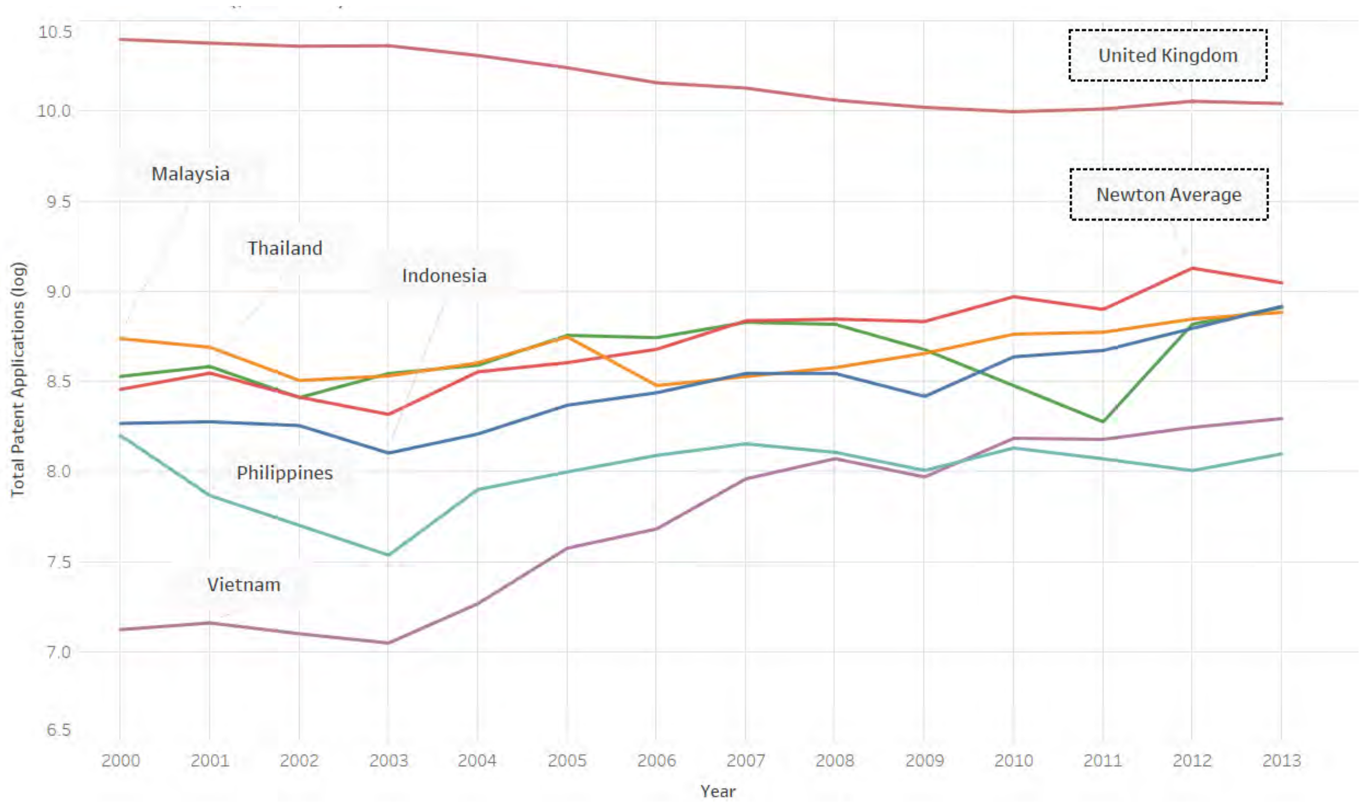
Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Indonesia has 0.07 PCT patent applications per million people. Patent applications in Indonesia have witnessed an upward trend since 2000. The country is ranked high for all other GCI innovation pillar indicators.

The country scores 4.76 on the Capacity for Innovation indicator used in the Global Competitiveness Index (GCI). In the 2014-15 GCI report, it was noted that Indonesia has made large improvements on areas such as government efficiency and quality of institutions. However, there was no specific discussion about the country's remarkable innovation performance.

For the company spending on R&D indicator, Indonesia scores 4.03. University-industry collaboration in R&D has a score of 4.55, ranking 30th in the world.

Figure 4. Patent Applications



Source: WIPO; PACEC. Total patent applications (direct and PCT national phase entries). Log scale.

Indicators of student and research mobility

Indonesia had an outbound mobility ratio of 0.56% in 2012. **The UK is the 5th main destination for study by Indonesian students, behind Australia, Malaysia, the United States and Japan**.

Overview of research funding structure

Research funding is awarded predominantly through institutions, rather than through competitive grants[5].

The Ministry of Research and Technology (RISTEK) has four main functions: policy making; coordination and synchronisation of policy; managing state assets; and supervising implementation. The Ministry is assisted by the National Research Committee. The Ministry coordinates a range of institutions: the Indonesian Institute of Sciences (LIPI), the National Institute of Aeronautics and Space (LAPAN), the Agency for the Assessment and Application of Technology (BPPT), the National Nuclear Energy Agency (BATAN), the Nuclear Energy Regulatory Agency (BAPETEN), the Agency for Geospatial Information (BIG), the National Standardization Agency (BSN), the Centre for Science and Technology Research (PUSPIPTEK) Serpong, the Eijkman Institute for Molecular Biology (LBME), the Centre for Science and Technology Exhibits (BIG), and the Agro Techno Park Palembang (ATP). The National Innovation Committee (KIN), founded in 2010, coordinates the complex innovation system.

The Agency for the Assessment and Application of Technology (BPPT) aims to produce innovation through assessment, intermediation, solutions, clearing house services, and technology audits, in the specific fields of agro-industry technology and biotechnology; information technology, energy, and materials; technology design and engineering; development of natural resources; and technology policy.

The Incentive for IPR Management programme funds individual IPR registrations and the establishment of IPR Centres.

Funding initiatives similar to Newton

Table 3. Summary of major funding initiatives similar to Newton

Funding initiative	Description of activity
Scientific Programme Indonesia Netherlands (SPIN)	Joint research projects between the Netherlands and Indonesian governments. Other support includes one-year research grants for Indonesian students to study in the Netherlands. An external evaluation of SPIN was published in 2015.

The Netherlands runs joint research projects as part of the Scientific Programme Indonesia-Netherlands (SPIN), and also offers one-year research grants and funding for PhD students to study in the Netherlands. SPIN has been in place for over 10 years and is an international research programme most similar to Newton.

The National Institute of Health Research and Development (NIHRD) has international partners in the Netherlands, Belgium, Japan, and Thailand, and provides training programmes sponsored by USAID.

Germany has worked closely with Indonesia on environmental issues, including tsunami warnings and coastal marine ecosystem protection.

The Wadhwani Foundation's National Entrepreneurship Network, based in India, is expanding into Indonesia with a capacity building programme to create a pipeline for entrepreneurship beginning in the Universities[6].

There are Memorandums of Understanding in place for co-operation on science and technology with Japan, the USA, Tunisia, Korea, Mozambique, Australia, and Austria.

M&E Measures

A regular national innovation survey is conducted by the Indonesian Institute of Sciences (LIPI) in Jakarta, known as PAPPIPTEK-LIPI. UNESCO reports that the Indonesian survey is produced in line with the internationally recognised Oslo Manual guidelines. The questionnaire is not modelled on established innovation surveys, such as the EU standard Community Innovation Survey (CIS).

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[5] Degelsegger, 2014.
[6] Wadhwani Foundation (n.d.).

Overview of Business-Academia collaborations

The National Innovation System Research Incentive (2014) funds consortiums consisting of representatives from government, industry, and Universities to undertake R&D projects and strengthen science and technology capabilities in industry.

There is an Entrepreneurship Programme for students, and a Co-operative Academic Education (Co-op) programme with SMEs, run by the Ministry of Education and Culture[7].

Some business innovation centres and science parks have been established, including the Centre of Science and Technology Research (PUSPIPTEK–Serpong), the Bandung Raya Innovation Valley (BRIV), Cibinong Science Centre (CSC-LIPI), Bogor Botanical Garden (LIPI), the North Gresik Innovation-based industrial zone, several Agro Techno Parks, and the Innovation in Tropical Disease Vaccines Centre of Excellence.

The National Long-Term Development Plan (RPJPN 2005–2025) aims to establish an economic structure based on the agricultural economy and mining, with manufacturing becoming the economic motor and the service sector providing resilience. The current Medium-Term Development Plan (RPJMN 2015–2019) prioritises science and technology, with an emphasis on the green economy and sustainable growth. Resilience against climate change and reductions in carbon emissions are explicit targets.

The Masterplan for Acceleration and Expansion of Indonesia's Economic Development (MP3EI) defines six geographical clusters, or corridors, of distinct economic and industrial concentrations. Universities within these development areas are expected to accelerate science and technological capability in the specific nominated sectors.

[7] Degelsegger 2014 p. 26.

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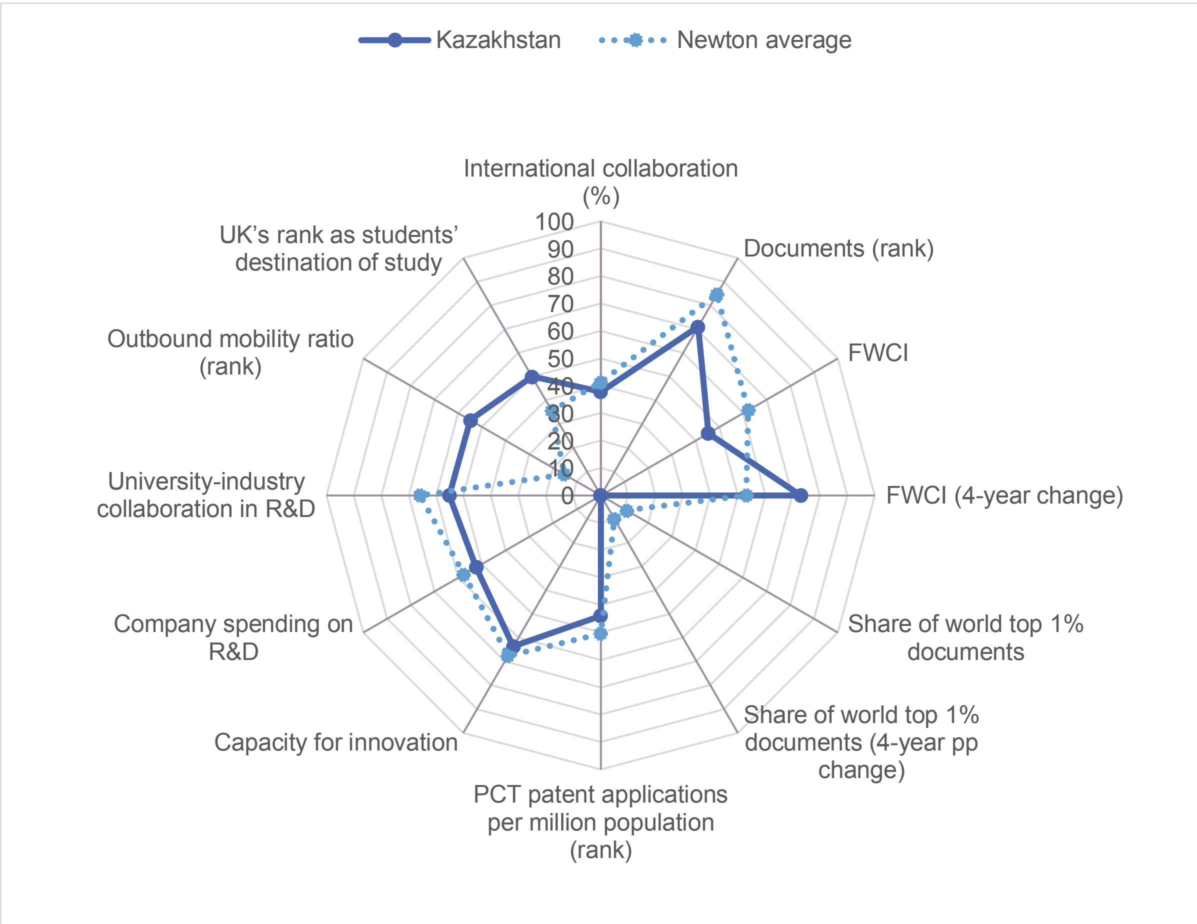
Kazakhstan

Summary of baseline research capacity

Kazakhstan has an appetite for engagement, with Newton interventions focused on partnership and capacity building, with a view to fostering long-term collaboration with the UK in the future. **Activities in Kazakhstan receive £2 million per annum for UK–Kazakhstan collaboration**.

Kazakhstan is on track to spend its Newton fund allocation of £2 million. The Newton priority areas are the following: energy; health and wellbeing; agricultural technologies; resilience and natural disasters; ecology and the environment; and food and water. The primary delivery partners is the British Council, though others such as the Royal Academy of Engineering are also engaged. **The partnership is considered high-profile by policymakers in both countries, and has been referenced in recent policy speeches**. The initial focus of Newton activities is on the People strand, to help develop capacity. In 2014, the Newton Fund spending was expected initially to be targeted entirely on the People strand, for capacity building (PhD scholarships, researcher mobility, direct training of researchers and policy-makers, links between research groups and institutions, and industry placements, etc), with Research and Translation funding expected to rise in future years.

Figure 1. Country Profile



Kazakhstan's highest performing indicator is the outbound mobility ratio, indicating a high mobility of students internationally.

Indicators of Present and Future Potential

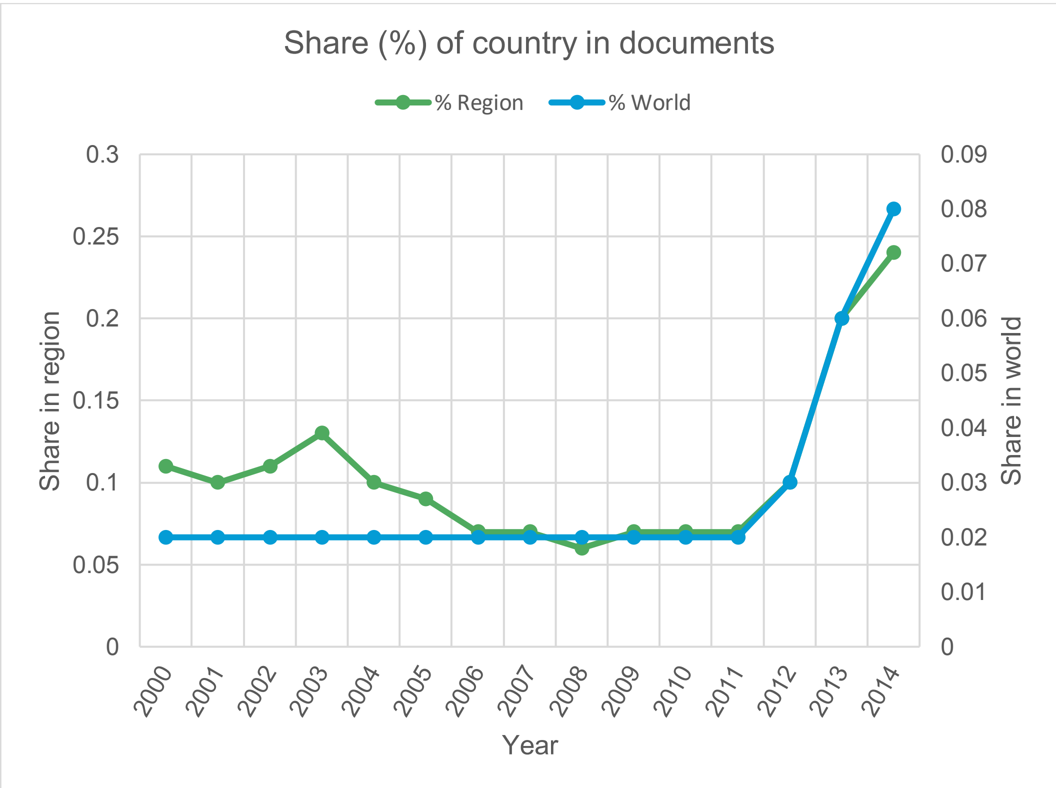
Table 1. Profile Indicators (present and future potential)

International Collaboration (%)	Documents	FWCI	FWCI (4-year change)	Share of world top 1% documents	Share of world top 1% documents (4-year pp change)
37.80%	67/229	0.551	0.094	0.02	0.01

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Kazakhstan ranks 67th in the world out of 229 countries for the production of published research documents. It produces 0.08% of documents in the world and 0.24% of documents in the Asiatic region[1] (Figure 2). Kazakhstan's share of world publications was constant between 2000 and 2011 at 0.02%, but it has increased significantly since 2012 to reach its current level. In the 2000s, the country's share of publications in the region was falling, while in recent years it has reached its highest level.

Figure 2. Production of documents



SCImago Journal & Rank; PACEC

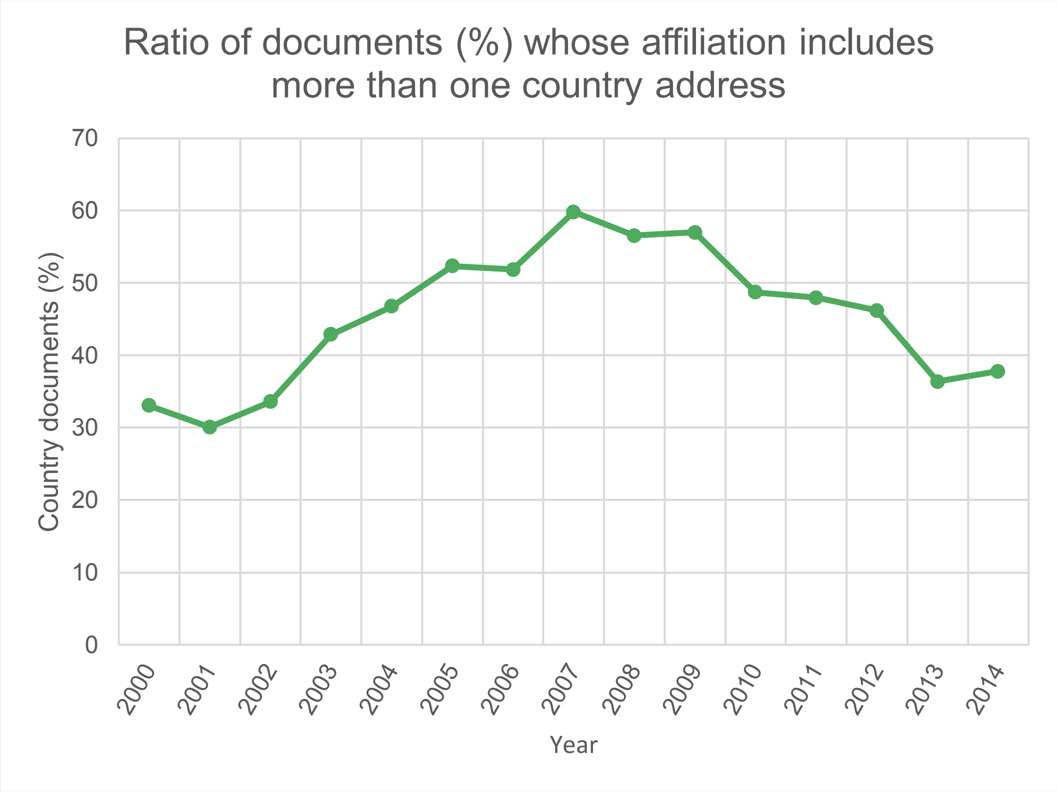
The majority of scientific papers published in international journals are in physics, astronomy, and chemistry. Most citations are achieved in physics, biology, space, and ecology. The most cited international collaborations are in **high energy physics**[2].

Kazakhstan's proportion of publications with more than one country affiliation is 38%.

[1] SCImago defined region: see Table A2 in the main baseline report appendix for information on countries and their regions.
[2] Çengel et al., 2013

Kazakhstan has a field-weighted citation impact of 0.551. The FWCI increased by 0.094 between 2008 and 2012, which means that there has been a fairly large increase in research impact over that period. Kazakhstan accounts for 0.02% of the world's top 1% documents by citations, although it is already developing its capacity considerably.

Figure 3. International Collaborations



Source: SCImago Journal & Rank; PACEC

Indicators of Innovation Collaboration Potential

Table 2. Profile Indicators (collaboration and mobility)

PCT patent applications per million population	Capacity for Innovation	Company spending on R&D	University-industry collaboration in R&D	Outbound mobility ratio	UK's rank as students' destination of study
70/124	3.75	3.12	3.29	75/165	3

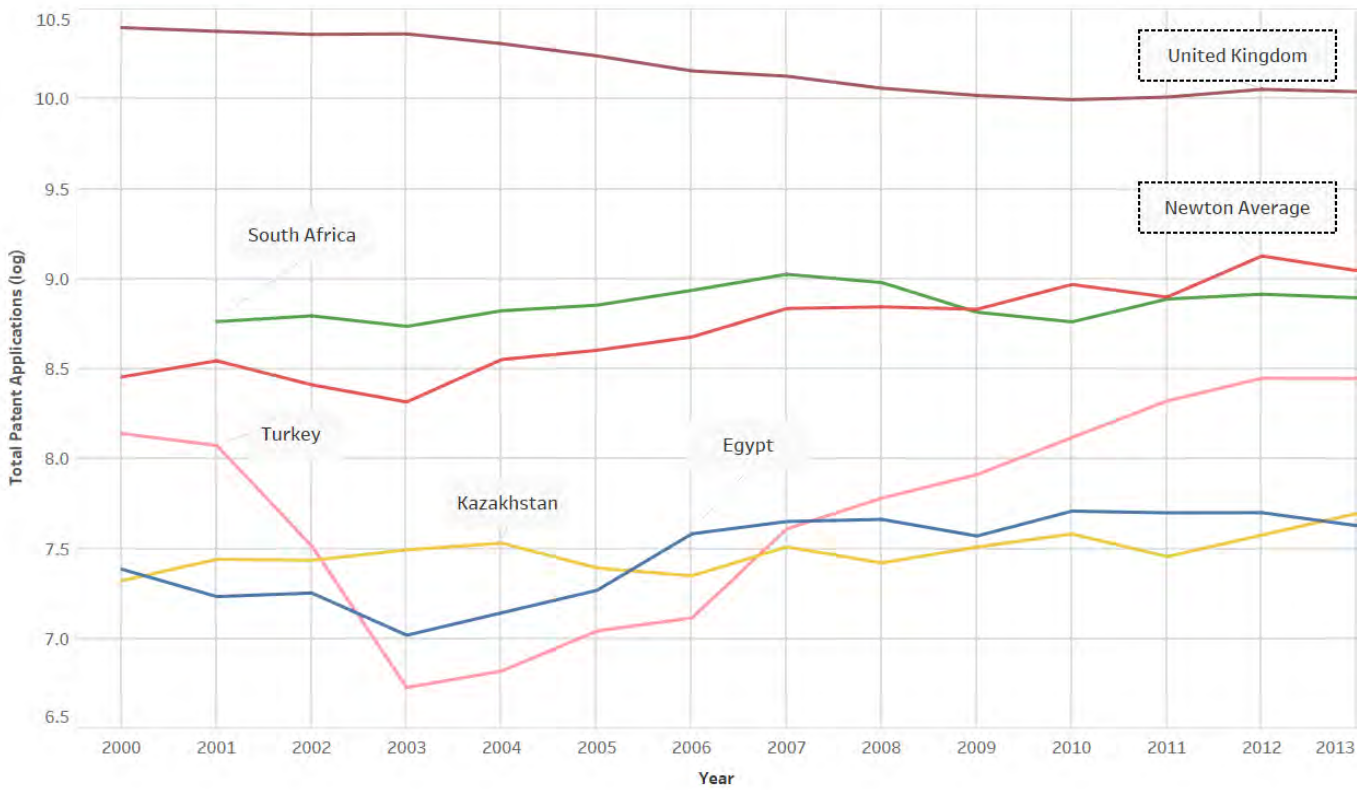
Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Kazakhstan has 1.05 PCT patent applications per million.

The country scores 3.75 on the Capacity for Innovation indicator used in the Global Competitiveness Index (GCI).

For the company spending on R&D indicator, Kazakhstan scores 3.12, making this Kazakhstan's strongest indicator under the GCI's innovation pillar. University–industry collaboration in R&D has a score of 3.29.

Figure 4. Patent Applications



Source: WIPO; PACEC. Total patent applications (direct and PCT national phase entries). Log scale.

Indicators of student and research mobility

Kazakhstan has a high outbound mobility ratio, which indicates a high international mobility of Kazakh students[3]. Its outbound mobility ratio was 6.60% in 2012. **The UK is the 3rd main destination for study by Kazakh students, behind Russia and Kyrgyzstan** and ahead of the United States and the Czech Republic. According to ICEF, there is substantial government support for study abroad through the Bolashak scholarship programme and the Academic Mobility Scholarship programme, as part of an internationalisation policy pursued by the government.

Overview of research funding structure

Kazakhstan has passed a Law of Science and drastically increased science expenditure since 2010. The law was developed by the Supreme Council for Science and Technology (SSTC), and specifies five priorities for the Ministry of Science and Education[4]: energy; materials and goods processing; IT technologies; life sciences; and fundamental research and humanities. The first four areas are directly aimed at supporting innovation. National Research Councils and funding streams have been established. There is also a legal requirement for oil companies to spend 1% of profits on science and innovation. Shell, together with KazMunayGas (KMG) and the Kazakh Institute of Oil and Gas, has developed a Roadmap for R&D into upstream oil and gas technology[5], which is being implemented with presidential support. It includes a centre of excellence on geochemical studies to be commissioned in Atyrau as an upgrade of the Caspimunaigaz laboratory complex.

A five-year Technology Commercialization Project was launched in 2010, in conjunction with the World Bank. It funds 20 high quality commercially-oriented R&D projects and invests in world class instrumentation and infrastructure in the International Materials Science Centre, which coordinates twenty modern laboratories. A

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[3] The number itself could indicate a weak capacity (e.g. reliance on Russia institutions), or that Kazakh students are part of internationalised HE. It's conjecture but the former is more likely, particularly when looking at the Central Asia average which covers more comparable countries, whereas the other Newton countries are very different.

[4] Sharman (2012).

[5] Upstream oil and gas is the exploration and production sector.

Technology Commercialization Centre has been set up to support research projects in technology marketing, intellectual property protection, technology licensing contracts, and launching start-up companies.

A further five-year project, **Fostering Productive Innovation**, was launched with the World Bank in November 2014. This has five component aims: development of the knowledge base for innovation; promotion of innovation consortia; consolidation of the technology commercialisation cycle; strengthening the national innovation system; and supporting project implementation. In June 2015, the Kazakh government signed a loan agreement with the World Bank in support of its research and commercialisation measures.

From 2010 to 2014 the State Program for Accelerated Industrial Innovative Development (SPAIID) has supported businesses and increased exports. The Kazakhstan 2050 strategy builds on this with three key aims: to define new markets; to create a favourable investment climate; and to develop an effective private sector and public-private partnerships. The strategy has two stages: modernisation of industry through to 2030, followed by sustainable development highlighting the knowledge economy.

Nazarbayev University is the flagship research University in Kazakhstan: its School of Engineering is partnered with UCL and the Graduate School of Education has two overseas strategic partners: Cambridge, and the University of Pennsylvania, USA. Other departments are partnered with Universities in the USA and Singapore.

Funding initiatives similar to Newton

Table 3. Summary of major funding initiatives similar to Newton

Funding initiative	Description of activity
Bolashak Scholarship	Scholarship programme by the Kazakh government since 1993 which funds the overseas study of Kazakh students (for Bachelor, Master or PhD study), on condition that they return to work in Kazakhstan after end of scholarship. The UK has been the main destination country for Bolashak scholars (39% of total).
UK Prosperity Fund	UK-funded programme supports innovation capacity in Kazakhstan through bilateral industry–academia activity.

The **Bolashak scholarship system** provides funds to a few hundred students annually to study abroad, on condition that they return to Kazakhstan and work for at least five years afterwards. This is available to students of Bachelor, Master and PhD degrees and to academics for visiting research abroad for up to a year. However, up until 2011, funding was also available for first degrees. Since its establishment in 1993, over 6,500 Bolashak scholars have studied at nearly 200 universities in 23 countries[6].

The scholarship scheme was expanded in 2008 due to its importance in the government's innovation strategy. In 2013 the British Council noted that the UK has been the main destination country, in taking 39% of Bolashak scholars since the scheme was launched[7]. Kazakhstan is expected to be among the top ten countries for outwardly mobile students in 2020; since the UK is a sought-after destination, it is the partner of choice for Bolashak.

[6] See http://inter.kstu.kz/category/international-programs/
[7] See https://www.britishcouncil.org/organisation/press/uk-kazakhstan-education-partnerships

M&E Measures

The World Bank has proposed a variety of metrics for evaluating the activities of its own programmes inside the country. The bank's Fostering Productive Innovation project uses a variety of project development indicators, including: international journal publications in peer-reviewed journals, share of enterprise sector finance for R&D, tech spin-outs arising from projects and their sales, beneficiary patent agreements, PhD holders and students trained abroad and projects with social impact completed.

Monitoring and Evaluation guidelines in the project's appraisal document note that the Kazakh Ministry of Education and Science is planning to launch an Innovation Observatory, "*a permanent framework to monitor innovation performance both in productive and public sector*"[8].

Overview of Business-Academia collaborations

Several of the abovementioned UK-sponsored research programmes focus directly on supporting business-academia collaborations. The UK government's Prosperity Fund is currently running projects to support R&D industry-academia collaboration.

UCL has an international partnership in Kazakhstan as a co-founder of Nazarbayev University, and the university is looking to develop its partnerships with existing institutions overseas, having signed a partnership agreement with the New University of Astana (NUA) in 2010.

The World Bank's suite of programmes in Kazakhstan aims to enhance the country's research institutes to work with industry, making them part of "*productive technology consortia in agriculture, extractive industries, [and] manufacturing*"[9].

[8] World Bank, 2014
[9] World Bank, 2015

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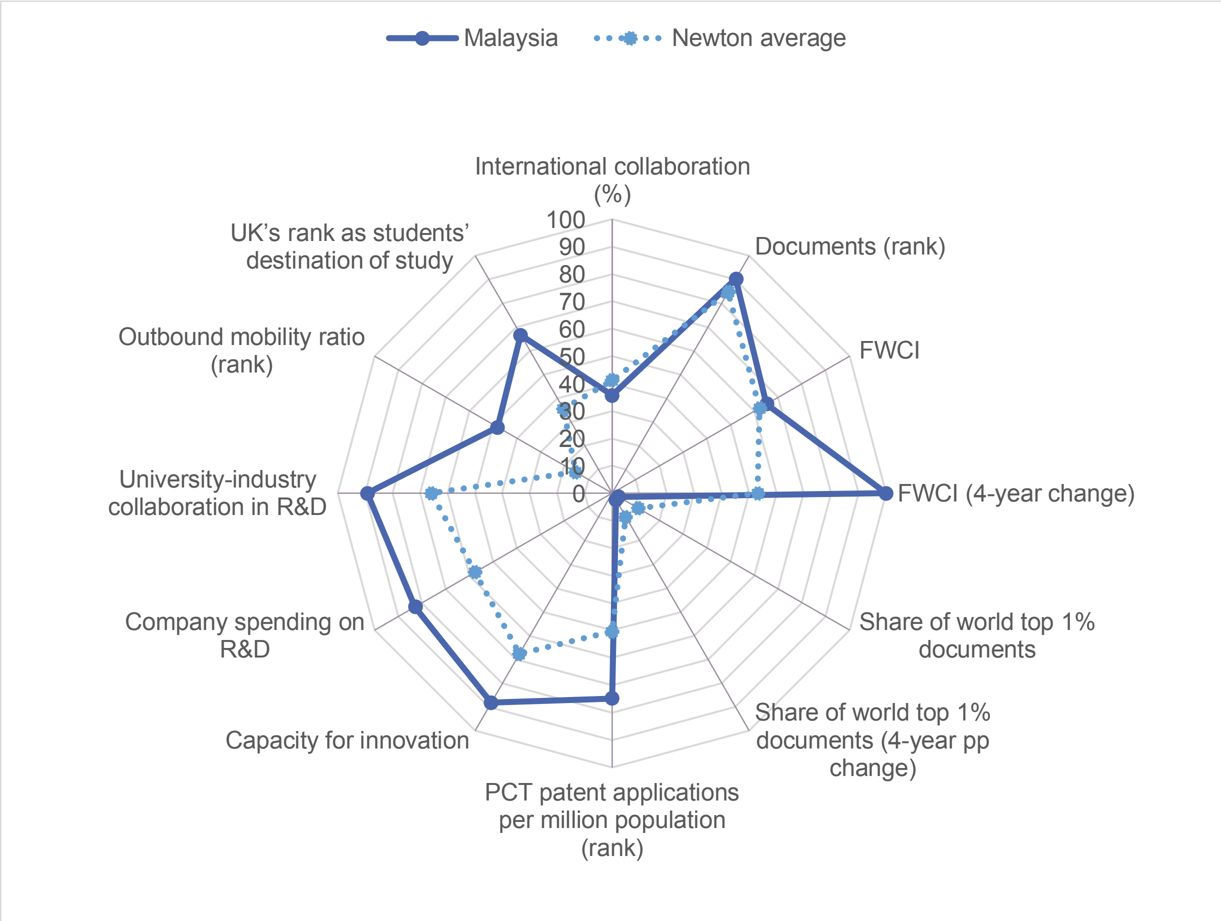
Malaysia

Summary of baseline research capacity

Malaysia is increasing its science capacity and moving towards a more knowledge-based economy. Newton maintains a strong focus on partnership building through upskilling academic researchers, strengthening industrial research ecosystem and developing compatible systems for research, innovation and governance.

Activities in Malaysia have a focus on the following priority areas: health and life sciences; environmental resilience and energy security; future cities; agri-technology; digital innovation and creativity. In 2014, the proposed balance of activities by Newton Pillar was as follows: 30% People; 40% Programmes; 30% Translation.

Figure 1. Country Profile



Malaysia outperforms averages on most indicators. In fact, it has one of the most balanced profiles on analysed indicators. Malaysia's research capacity is high, particularly on indicators for innovation collaboration.

Indicators of Present and Future Potential

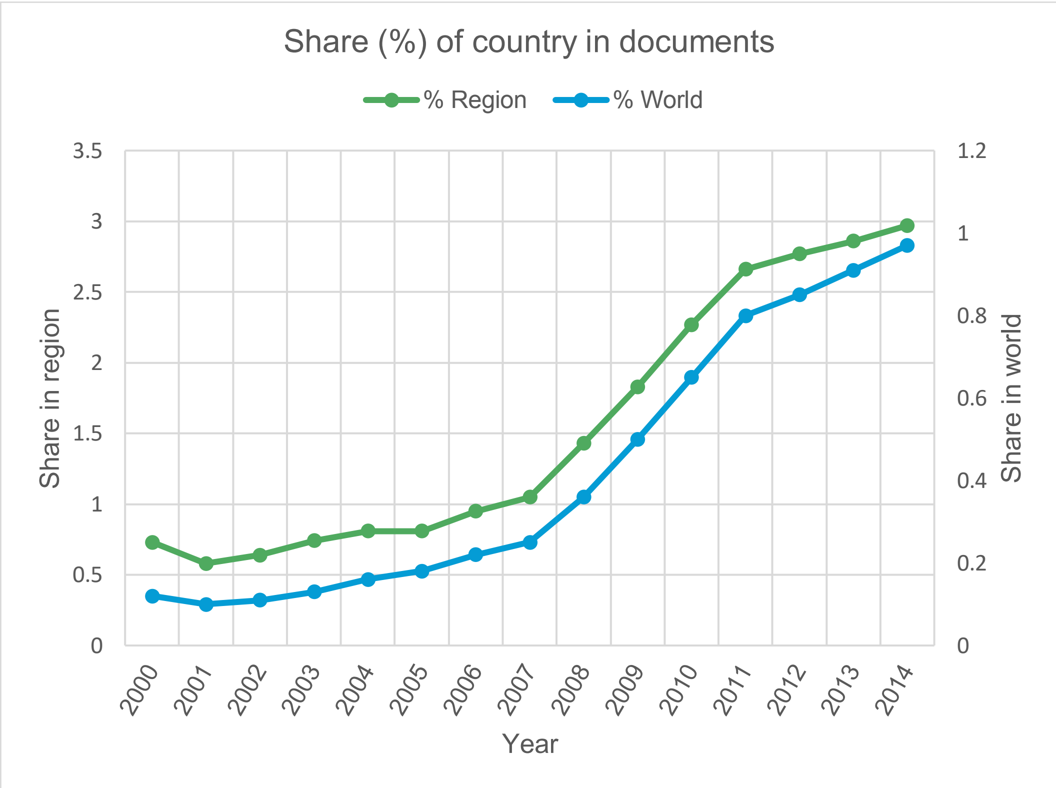
Table 1. Profile Indicators (present and future potential)

International Collaboration (%)	Documents	FWCI	FWCI (4-year change)	Share of world top 1% documents	Share of world top 1% documents (4-year pp change)
35.73	23/229	0.958	0.176	0.36	0.21

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Malaysia ranks 23rd out of 229 countries for the production of published documents. As shown in Figure 2, it produces 0.97% of all documents published in the world and 2.97% of publications in the region.[1] In particular, Malaysia is ranked 10th for Multidisciplinary publications and 15th for both Economics, Econometrics and Finance and Energy publications. According to STI benchmarking by the Malaysian government, **Malaysia had the highest growth rate of countries "in the world" in science & technology publications** (average annual growth rate of 52.3%).[2]

Figure 2. Production of documents



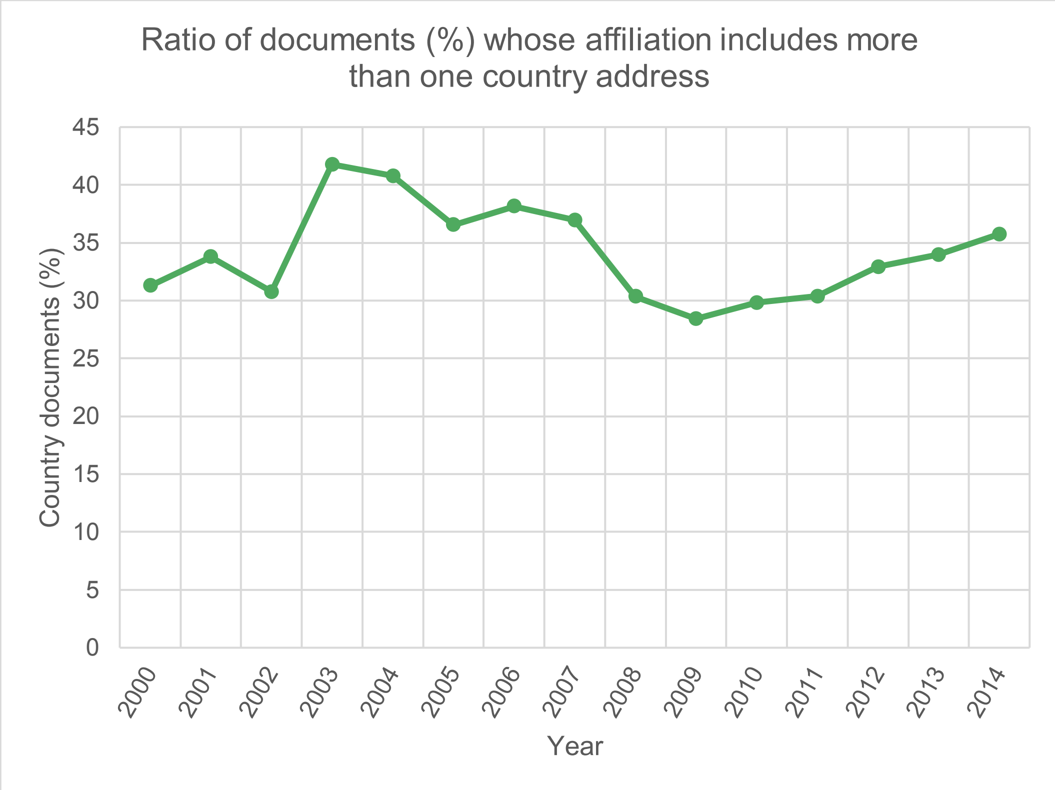
Source: SCImago Journal & Rank; PACEC

The share of Malaysian research dedicated to certain subject areas has changed substantially since 2000. The Medicine subject area accounted for 15% of Malaysian publications in 2000, declining to 7.4% by 2014, despite being the country's main subject for publications until 1999. During that time, Agriculture and Chemistry publications also experienced a similar fall in publication shares, decreasing by approximately one half. Engineering is now the main research field for publications, having increased to 21.3% in 2013 from 16.2% in 2000. Energy and Environmental Science now consist of 3.1% and 5.0% of Malaysian publications respectively. They have proven to be emerging fields during the past 15 years, as their share in Malaysian publications has almost doubled in that time. Both areas align with Newton activities on environmental resilience and energy security. Multidisciplinary studies have contributed to as much as 4% of Malaysian publications since 2010, despite being lower than 0.5% up to 2005, which is a strong indication of increasing research capacity across various fields.

The level of international collaboration for publications is 35.73% (see Figure 3), and there has been an increase every year since 2009.

[1] SCImago defined region: see Table A2 in the main baseline report appendix for information on countries and their regions.
[2] MASTIC 2012, in executive summary.

Figure 3. International Collaborations



Source: SCImago Journal & Rank; PACEC

Malaysia has a field-weighted citation impact of 0.958. However, Malaysia had a significant change in FWCI between 2008 and 2012 (+0.176), which shows a fast increase in research impact. Malaysia accounts for 0.36% of the world's top 1% documents by citations, although its share increased by 0.21pp between 2008 and 2012. The performance on research impact metrics point to Malaysia as being a country that is progressing fast in the development of its research capacity.

Indicators of Innovation Collaboration Potential

Table 2. Profile Indicators (collaboration and mobility)

PCT patent applications per million population	Capacity for Innovation	Company spending on R&D	University-industry collaboration in R&D	Outbound mobility ratio	UK's rank as students' destination of study
32/124	5.19	4.93	5.33	86/165	2

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Malaysia has a high ranking for each of the four indicators of future potential, as defined by the Global Competitiveness Index (GCI). In the GCI 2014-15 report, Malaysia was highlighted as a good performer across the twelve pillars of competitiveness (including the twelfth pillar: innovation). It was considered to be on-track in its aim "*to become a high-income, knowledge-based economy by the end of the decade*".[3]

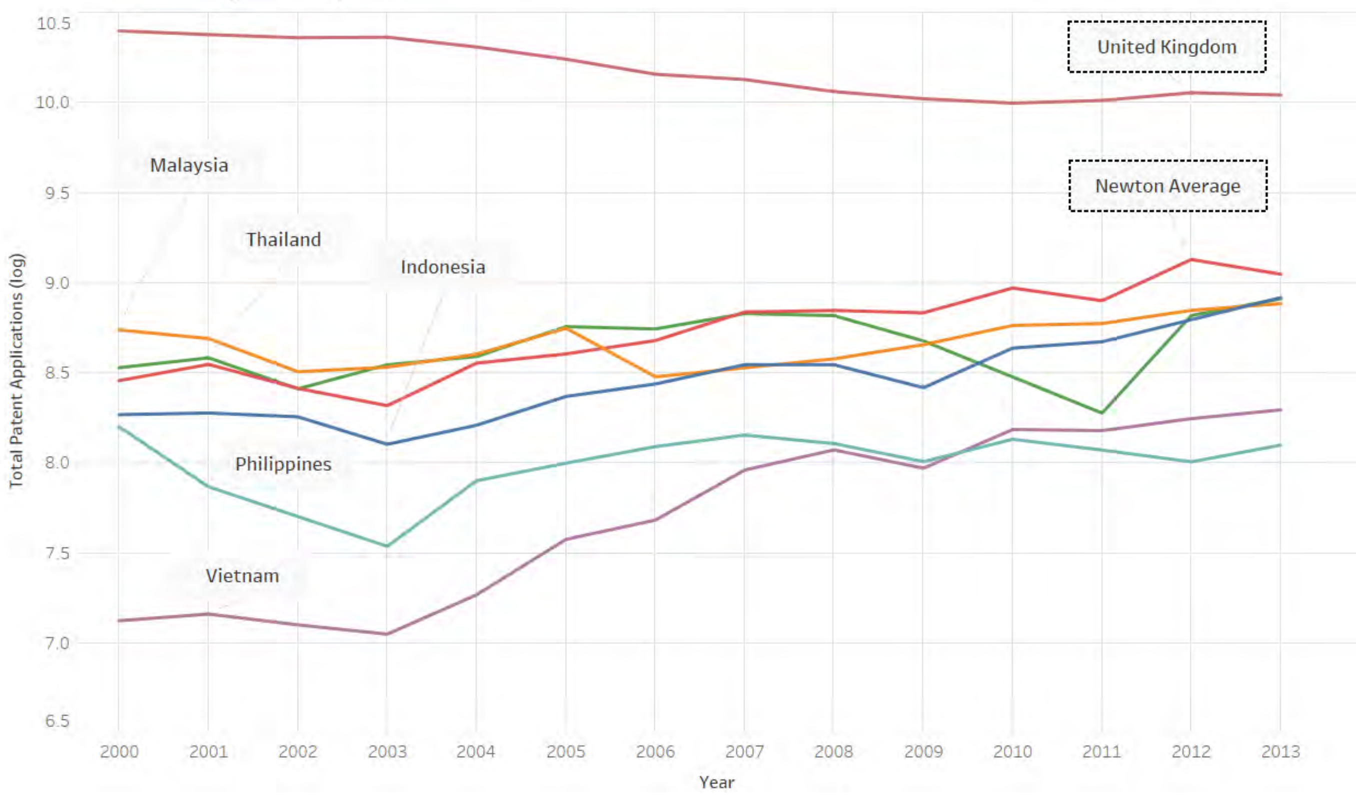
There are 12.62 patent applications per million people in Malaysia, which is much higher than the regional average of 1.73.

[3] Schwab 2014, p. 27.

A high proportion of patent applications in Malaysia are from non-residents, which is due to foreign direct investment, particularly in sectors such as electronics. The most frequently granted patents for residents in 2012 were in sectors such as medical technology, chemical engineering and computer technology. The largest patentee in Malaysia is MIMOS Berhad, which has one of the highest PCT filings in the world by a public research institute. Since a re-orientation by government in 2006, the institute has successfully increased its commercialisation of IP in the ICT industry.

The Capacity for Innovation score is 5.19, which ranks Malaysia 13th in the world. The scores for company spending on R&D and university–industry collaboration in R&D are 4.93 and 5.33, ranking 9th and 12th respectively.

Figure 4. Patent Applications



Source: WIPO; PACEC. Total patent applications (direct and PCT national phase entries). Log scale.

Indicators of student and research mobility

Malaysia has a high level of international student mobility, with 5.31% of its students studying abroad. In 2012, the top 5 destinations for Malaysian students were Australia, the United Kingdom, the United States, Russia and Indonesia. According to the UNESCO Institute of Statistics (UIS), there were 12,822 outbound Malaysian students in the UK, which is almost twice as high as the number of those studying in the US. In addition there is also a large number of Malaysian students who are undertaking their qualifications overseas (for instance, at UK branch campuses).

In 2015 the government launched the Education Blueprint 2015-25, which gives greater emphasis to the tertiary sector's role in developing the skills base.

Overview of research funding structure

In the 2013 federal budget, the Malaysian Government allocated RM600 million to financial support (e.g. grants) for research, or approx. £120 million at the time. The Ministry of Higher Education (MOHE) is responsible for funding research through its agencies. Other ministries such as the Ministry of Science, Technology and Innovation (MOSTI), in particular with its agency the Malaysian Science and Technology Information Centre (MASTIC), have aligned goals for innovation policy, and provide a link for researchers to information such as R&D grants for STI research and activities.

Bodies such as MOHE and MOSTI offer funding for researchers across many schemes, for different goals and scales of activity. MOHE has many research grant schemes that have identified research priorities, many of which align with those identified by the Newton Fund (such as agriculture and technology). MOSTI has a set of research funds for areas including biotechnology. The Malaysian government also supports several financing options available at organisations such as the Cradle Fund and the Malaysia Technology Development Corporation (MTDC). Table 2 below outlines details of some of the research grants provided by the Malaysian government.

The utilisation of grant schemes is mixed and has varied considerably over time. The ScienceFund applications were 440 in 2010, having followed a downward trajectory during the previous years. However, after that, applications increased rapidly, reaching 2,191 in 2012. It was noted in a recent SEA-EU-Net study that "*current system of funding and government structures are somewhat complex*".[4]

MOHE has the following public R&D grants:[5]

- Fundamental Research Grant Scheme: *"For basic research that can develop theories, concept and new ideas towards knowledge development"*. Pure Science; Applied Science; Social Sciences and Literature; Medical Science; Technology and Engineering; Natural Science and National Heritage.
- Long-term Research Grant Scheme: This scheme provides funding for multi-disciplinary research projects that involve long-term collaboration between multiple Research Universities (RUs), in the seven following areas of high impact: Global warming; Contagious diseases; Tropical medicine; Energy and water security; Food self-sufficiency; Advanced manufacturing; ICTs.
- Exploratory Research Grant: This scheme provides funding for research that can "generate new ideas and knowledge domain that has not been fully explored", in the areas of: Pure and Applied Sciences; Technology and Engineering; Clinical and Health Sciences; Social Sciences; Arts and Applied Arts; Natural Sciences and National Heritage; Defence and Security.
- Protoype Research Grant Scheme: PRGS aims to bridge the gap between the laboratory stage and the pre-commercialisation stage for new technology, by offering support in aspects such as proof of concept, evaluation, up-scaling, pre-clinical trials and field testing.

MOSTI has the following public R&D grants:[6]

- ScienceFund: Funding for R&D in the applied sciences, with focus on high impact and innovative research, in priority areas such as Life Sciences, Engineering, etc.
- TechnoFund: Funding for technology development by Malaysian technology enterprises, with support up to pre-commercialisation for start-ups.
- InnoFund: Funding for innovation (smaller grants) for new or existing products.

Funding initiatives similar to Newton

Table 3. Summary of major funding initiatives similar to Newton

Funding initiative	Description of activity
SEA-EU-NET	EU funding for research collaboration activities between EU member states and ASEAN countries, as part of ASEAN participation in Horizon 2020 economic development programme. Activities have involved 21 institutions and focus in particular on these areas: health; food security and safety; water management.
ASIA-LINK and Trans-Eurasia Information Network	ASIA-LINK grants funded by the EU since 2001 for multitlateral networking between institutions in Europe and Southeast Asia. The Trans-Eurasia Information Network since 2001 aids universities and research institutions in Asia in the

[4] Degelsegger et al 2014, p. 42.
[5] MASTIC n.d.: *Research & Development Grants - Portal Rasmi MASTIC*.
[6] *Ibid.*

	development of their technological capacities, with connections to Europe's GÉANT network.

The EU funds the SEA-EU-NET project that seeks to "*expand scientific collaboration between Europe and Southeast Asia*" and is coordinated by the German Aerospace Centre, with additional aims to bring more ASEAN countries into Horizon 2020 participation and the FP7 programme. The four-year long SEA-EU-NET 2 was launched in October 2012 and involves 21 institutions, including the SIRIM Berhad research institution in Malaysia. The S&T projects specifically focus on societal challenges of Health, Food Security and Safety, Meteorology and Water Management. Activities include workshops, knowledge exchange, fellowships and a bi-regional funding scheme.

The EU has also had previous engagement with ASEAN countries on research, through initiatives under FWPs such as ASIA-LINK and the Trans-Eurasia Information Network (TEIN). A 2009 evaluation for the European Commission contended that the programmes strengthened research networks and their leverage (such as Malaysian use of e-learning from Leicester).[7]

M&E Measures

The Malaysian government has its own range of indicators and surveys that it uses for benchmarking of innovation activity in the country, which include:

- National R&D Survey: a biennial study developed following OECD Frascati Manual guidelines about organisations' R&D activities, which is used to measure performance for international comparison and for government targets.
- National Survey of Innovation: survey of activity in services and manufacturing, developed under the OECD Oslo Manual guidelines.
- Bibliometric Study: a rich dataset which uses sources such as Thomson Reuters and Scopus, as well as indexing of Malaysian journals that are not internationally recognised. This includes data on aspects such as citations by field of research and by Malaysian universities.
- Public Awareness of Science, Technology & Innovation in Malaysia: a biennial study on citizens' awareness of science, technology & innovation issues.
- Science, Technology & Innovation Indicators Report: nine reports have been published since 1994, with specific aim to benchmark Malaysia in the S&T field with other countries in the world (including ASEAN and OECD countries, as well as China and India).

Overview of Business-Academia collaborations

The University of Nottingham has a campus at Semenyih in Malaysia, which was opened in 2000 and is the first campus of a British university to be established outside the UK. The campus includes 'Research Priority Centres' that produce research that "*reflect priorities unique to Malaysia and Southeast Asia*": in particular, the UNMC Interdisciplinary Centre for Tropical Environmental Studies (Mindset) and Centre of Sustainable Palm Oil Research (CESPOR) align with priority areas identified by the Newton Fund, such as environmental sciences.[8]

Australian universities have led the way in opening branch campuses in Malaysia; their strategic rationale being to build greater business–academia links in an international context. Monash University established its first branch campus in Malaysia in 1998, followed shortly by Curtin University of Technology and Swinburne University of Technology, which opened branch campuses in the Malaysian state of Sarawak by 2000. These branch campuses are specialised in fields such as mechatronics engineering, biotechnology, agri-business, medicine and health. SEA-EU-Net highlights that the collaboration between industry clusters in and these universities has encouraged international technology transfer, and recommends that the government further strengthen the clusters, particularly on aspects like commercialisation.

[7] European Commission 2009.
[8] OECD 2015, p. 48.

There are many examples of business–academia collaborations at branch campuses in Malaysia, often with funding by national governments. Monash Malaysia is taking part in an international MyMAP Accelerator project co-funded by the Indian and Malaysian governments, with the aim of promoting innovation on medicinal and aromatic plants, and its Environment & Green Technology team receives funding from local industry for projects on heat systems (such as thermoelectric heating) to improve energy efficiency in air conditioners.

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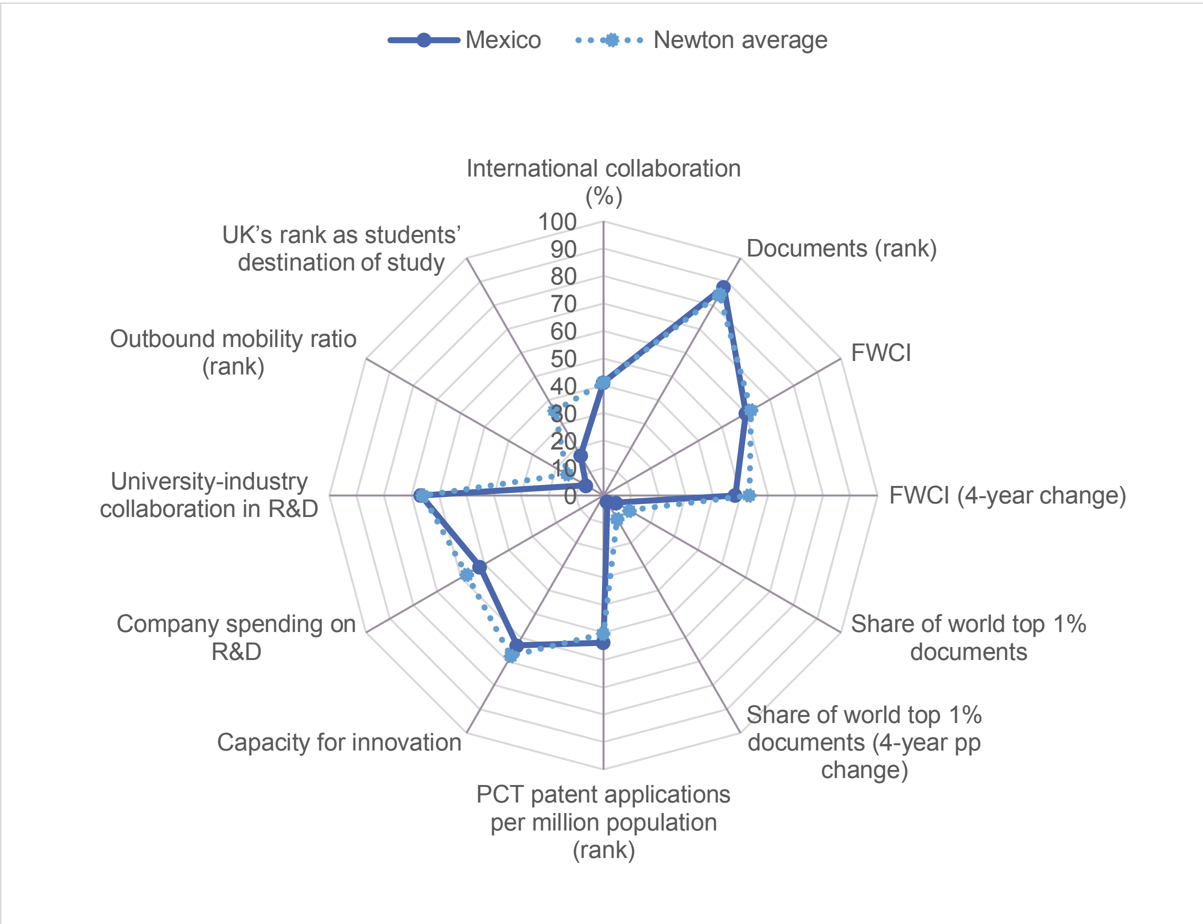
Mexico

Summary of baseline research capacity

Mexico is committed to increasing science capacity and developing a more knowledge-based economy associated with it. Newton maintains a strong focus on partnership building through doctoral student exchange and helping develop compatible systems. The Mexican government has recognised the Newton Fund as best practice, and has had notable success in coordinating in-country partners. **The funding allocated to Newton projects in Mexico is £4 million per annum, with matched funding for research and innovation partnerships**.

Activities in Mexico have a focus on the following priority areas: researcher mobility; training and researcher exchanges; joint research collaboration on development topics; commercialisation of science; and collaborative R&D for applied science. In 2014, the proposed balance of activities by Newton Pillar was as follows: 30% People; 40% Programmes; 30% Translation. Internal documents on Newton in Mexico indicate that the current administration has science and innovation collaboration as a priority, and is working towards an improved local ecosystem, with stronger international links, as the means to help address global and local challenges such as food and energy security; sustainability in its broadest sense; health and education challenges; and poverty.

Figure 1. Country Profile



The baseline profile for Mexico shows that its particular strengths in the baseline performance are university–industry collaboration and patent applications.

Indicators of Present and Future Potential

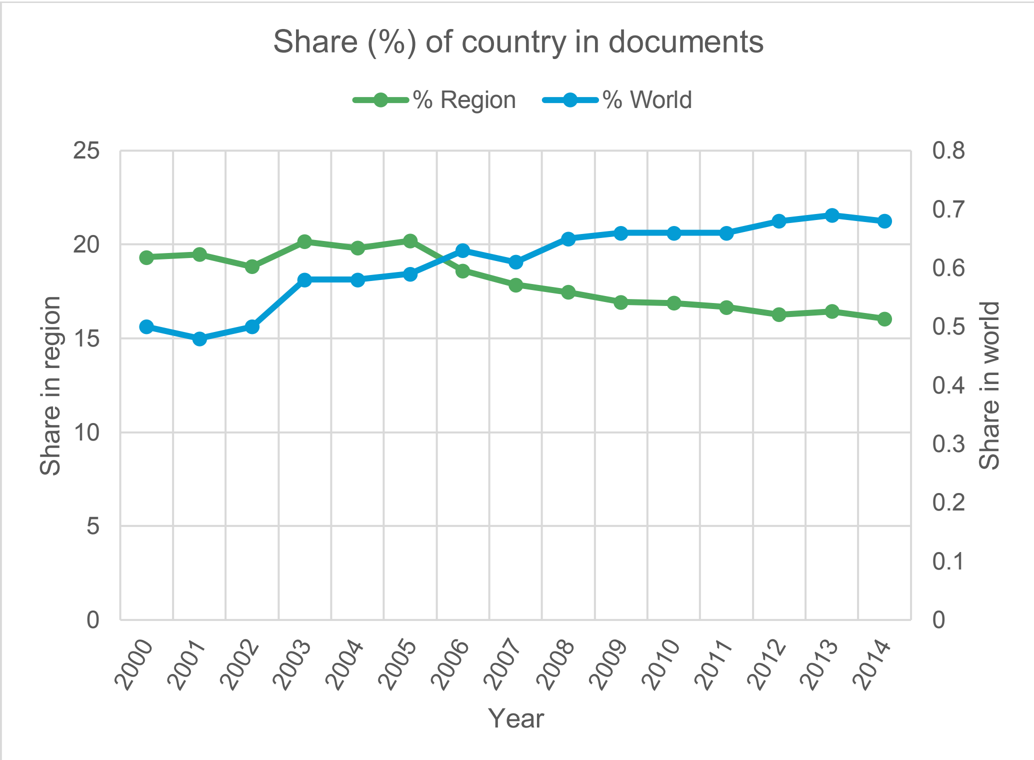
Table 1. Profile Indicators (present and future potential)

International Collaboration (%)	Documents	FWCI	FWCI (4-year change)	Share of world top 1% documents	Share of world top 1% documents (4-year pp change)
41.18	29/229	0.833	0.018	0.74	0.21

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Mexico ranks 29th out of 229 countries for the production of published research documents. It produces 0.68% of documents in the world and 16.05% of documents in the region[1] (see Figure 2). Mexico's share of world documents has been increasing since 2000.

Figure 2. Production of documents



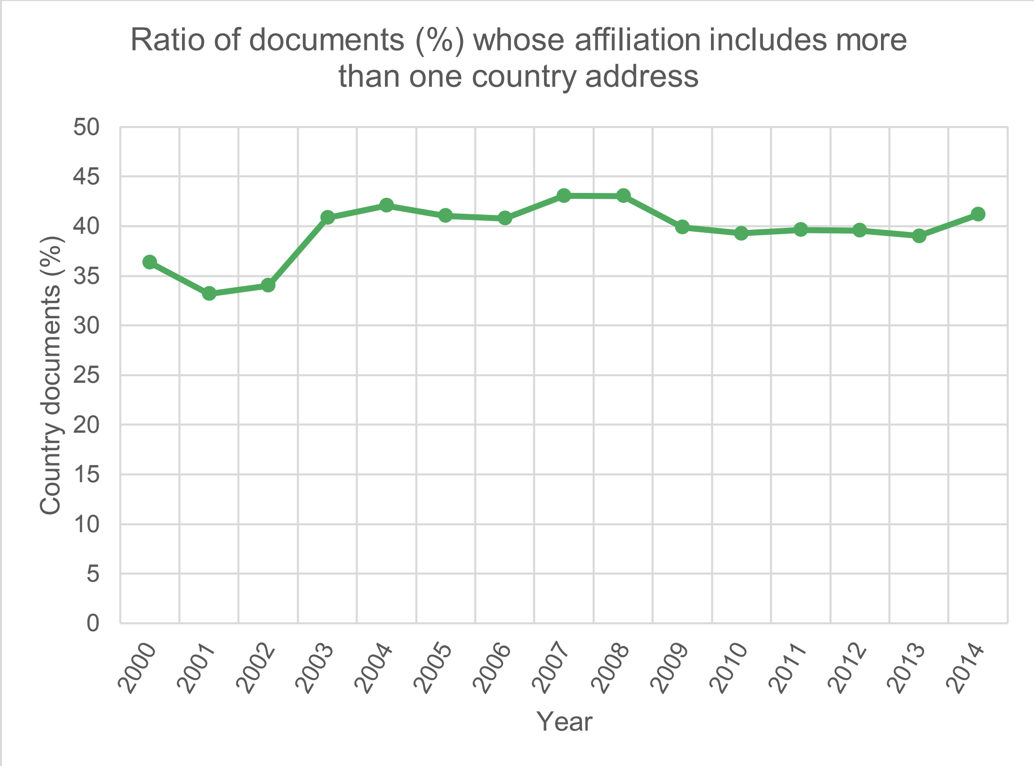
Source: SCImago Journal & Rank; PACEC

According to Research Trends in 2012, the main subject area for research in the country is Physical Sciences (which *"appear to be a priority for Mexico"*[2]). The report also highlights Mexico's strengths in the field of Physical Sciences, such as Physics and Astronomy.

Mexico's proportion of publications with more than one country affiliation is 41%. This level was on an upward trend during the early 2000s (see Figure 3).

[1] SCImago defined region: see Table A2 in the main baseline report appendix for information on countries and their regions.
[2] Huggett 2012.

Figure 3. International Collaborations



Source: SCImago Journal & Rank; PACEC

Mexico has a field-weighted citation impact of 0.833, which has increased by 0.018 between 2008 and 2012. Mexico has 0.74% of the world's top 1% documents by citations and increased by 0.21pp between 2008 and 2012.

Indicators of Innovation Collaboration Potential

Table 2. Profile Indicators (collaboration and mobility)

PCT patent applications per million population	Capacity for Innovation	Company spending on R&D	University-industry collaboration in R&D	Outbound mobility ratio	UK's rank as students' destination of study
58/124	3.72	3.09	3.97	153/165	5

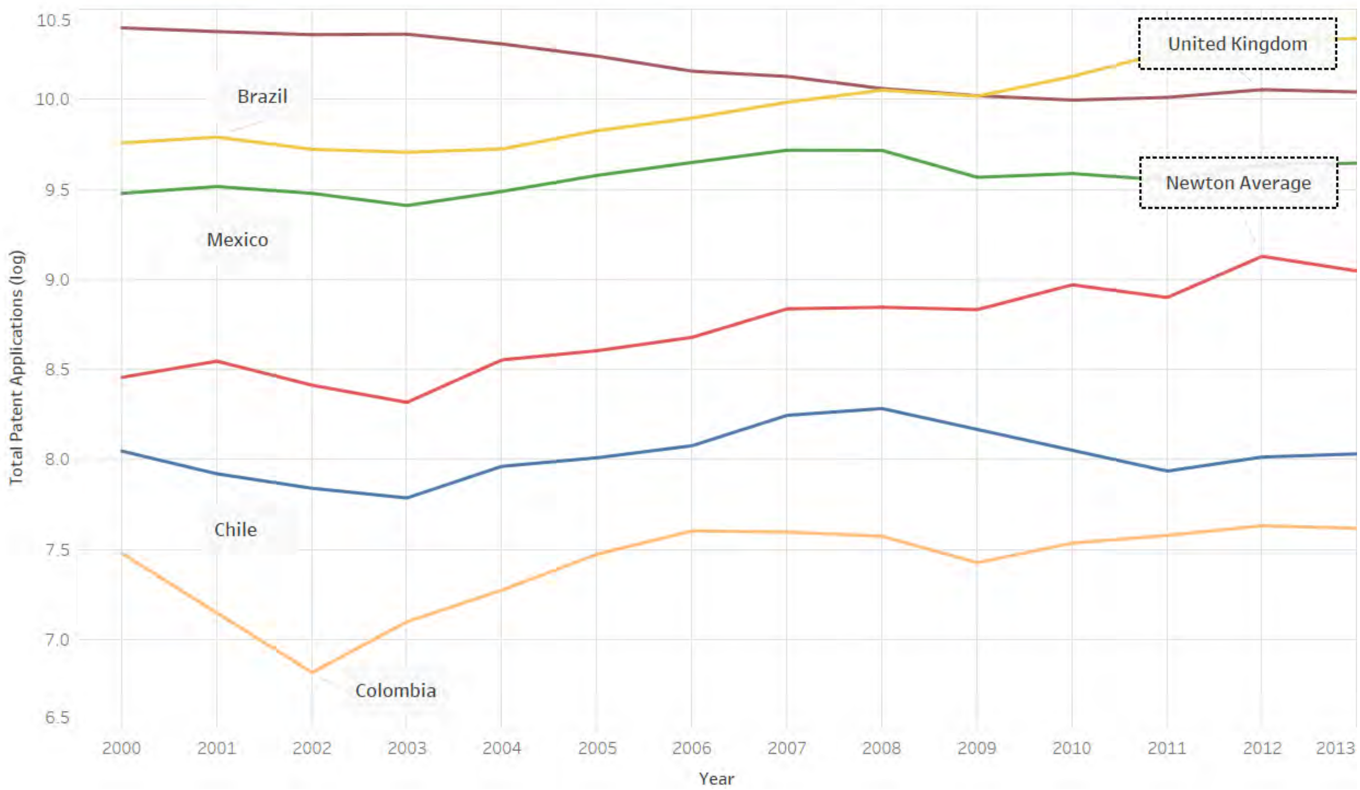
Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Mexico has 1.83 PCT patent applications per million people. Patent applications in Mexico have steadily increased in the last 10 years.

The country scores 3.72 on the Capacity for Innovation indicator used in the Global Competitiveness Index (GCI).

For the company spending on R&D indicator, Mexico scores 3.09. Mexico's strongest performance is in university–industry collaboration in R&D, with a score of 3.97.

Figure 4. Patent Applications



Source: WIPO; PACEC. Total patent applications (direct and PCT national phase entries). Log scale.

Indicators of student and research mobility

Mexico's outbound mobility ratio was 0.85% in 2012, which is in line with the regional average[3]. The UK is the 5th main destination for study by Mexican students, with the top four countries being the United States, Spain, France and Germany.

Overview of research funding structure

Mexico's science and innovation system is complex, with a wide variety of stakeholders. The National Council for Science and Technology (CONACyT) promotes science and technology, sets government policies, and funds postgraduate studies, including studies abroad. CONACyT also administers the National System of Researchers (SNI), which provides additional merit-based funding to researchers in the public sector. CONACyT manages 27 public research centres across Mexico.

Relevant Government ministries include the Secretariat of Environment and Natural Resources (SEMARNAT), the Ministry of Energy, the Ministry of Economy, and the Ministry of Education.

In 2012, as outlined by the OECD, Mexico offered the following programmes and funding (public and private sources) in support of new technology-based firms:

- **Incubators** funded by the Ministry of Economy and Ministry of Education;
- **Early stage development:** such as the Technological Innovation Fund (FIT) and the Innovation Stimulus Programme (PEI);
- **Venture capital support** through the Fund of Funds Venture Capital Programme.

[3] UNESCO Institute for Statistics defined region

Funding initiatives similar to Newton

Table 3. Summary of major funding initiatives similar to Newton

Funding initiative	Description of activity
United States–Mexico Foundation for Science (FUMEC) bilateral activities	Bilateral collaboration between FUMEC and the US government (e.g. National Science Foundation) on developing entrepreneurship and innovation for both countries. There are joint initiatives for supporting research (e.g. commercialisation) • Intelligent Manufacturing Initiative (IMI) • Innovation Corps (I-Corps) • Industry–University Cooperative Research Consortia (I/UCRC)
Pacific Alliance student exchange & researcher mobility programme	Student exchange and researcher mobility programme launched in 2012 by the four Pacific Alliance countries (Chile, Colombia, Mexico and Peru). It is a reciprocal programme that provides 100 scholarships per year for each country (75 for undergraduates and 25 for doctoral & teaching candidates). The World Economic Forum has described the programme as a "*benchmark of excellence for scholarship programmes in Latin America*".

The UK has previously worked closely with Mexico in this field; for instance, it supported the creation of the Mexican Knowledge Transfer Offices, which won the world prize for best national innovation policy from Licensing Executives Society International. There have also been research collaborations between Mexico and the UK in areas of joint interest such as the built environment, carbon capture and storage, and digitalisation of cities. The UK Prosperity Fund has supported the creation of the national Seed, Angel, and Venture Capital Fund, designed to support researchers and R&D-intensive SMEs to commercialise science.

Mexico has established international collaboration programmes, particularly with the USA and Europe. In 2006, 1.6% of gross expenditure on R&D (GERD) was financed from abroad. Major Mexican Universities are participating in the European FP7 and Horizon 2020 programmes, which include a call for research by the EU and Mexico on geothermal energy. An Implementing Arrangement has recently been signed between CONACyT and the European Research Council (ERC) to allow Mexican researchers to work temporarily on ERC research teams.

The United States–Mexico Foundation for Science (FUMEC) promotes bilateral collaboration in science and technology. The Mexico–United States Entrepreneurship and Innovation Council (MUSEIC) and the Bilateral Forum for Higher Education, Research and Innovation (FOBESII) are partnerships chaired by FUMEC that have strengthened co-operative ties. Recent initiatives include Innovation Corps (I-Corps), which is running a pilot scheme and setting up 15 I-Corps work teams in Mexico to commercialise scientific research; the Intelligent Manufacturing Initiative for the Border (IMI), which has agreed to set up a Bi-national Intelligent Manufacturing Institute (BIMI) to coordinate manufacturing in the border region and attract new investment; and Industry–University Cooperative Research Consortia (I/UCRC), which boost cooperation between academia and industry in joint projects. The latter project was established in the USA and began in 2014, setting up three I/UCRC Consortia in Mexico: Logistics and Distribution; Intelligent and Preventive Maintenance; and Advanced Non-Ferrous Structural Alloys. In 2014, FUMEC and CONACyT encouraged the production of 32 State Innovation Agendas in Mexico to create a shared vision between government, academia, industry, and society; to set state-specific strategic sectors and areas of specialisation; and to identify and suggest mechanisms for implementing these strategies.

Mexico has many other international research arrangements, including the India–Mexico Programme of Cooperation on Science and Technology, the Canada–Mexico Partnership, the Franco–Mexican Forum for Research and Innovation, and the Mexico–Israel Cooperation Program for Industrial Research and Development and Innovation. As of 2012, Mexico has 122 agreements with the European Union and with 36 countries through CONACyT.

In 2015, the World Economic Forum recommended the creation of either a Latin America student exchange programme or a research mobility programme. Mexico is a participant in the region's government-led Pacific Alliance student and researcher mobility programme, launched in 2012 and described by the World Economic

Forum as a "*benchmark of excellence for scholarship programmes in Latin America*".[4] The other participants are Chile, Colombia and Peru. In the first two years, the programme awarded 658 scholarships for students, including 177 by the Mexican government. Environmental Sciences and Climate Change are some of the priority areas for the courses undertaken by scholars in the mobility programme.

CONACyT funds international scholarship programmes for Mexican students; it supported 4,196 scholars in 2013, which is an increase from the 1,650 students in 2011. In 2011, France and Germany contributed towards dozens of scholarships through their own bilateral agreements. The majority of scholarships supported doctoral studies. CONACyT is also increasing its international student mobility through 500 scholarships for students residing in countries within the Organization of American States.

M&E Measures

Mexico undertakes a biennial national innovation survey, which is based on the internationally recognised Oslo Manual guidelines. The National Institute of Statistics & Geography (INEGI) and CONACyT are responsible for the innovation survey. The OECD notes that the focus is slightly different from the EU standard Community Innovation Survey (CIS), although the survey does incorporate some CIS questions to the extent that they form almost half of its design (as of the 2010 report methodology).[5]

Overview of Business-Academia collaborations

CONACyT manages the National Registry of Institutions and Businesses in Science and Technology (RENIECYT) and offers financing to technological and technology development projects. The Innovation Incentives Programme provides financial incentives for technology transfer and collaboration between academia and industry. The INNOVAPYME fund supports micro firms and SMEs, with higher levels of funding if a collaborating HEI is involved. The INNOVATEC fund is directed at large firms, and provides more funding if HEIs are involved. The PROINNOVA fund supports product development based on frontier scientific research. CONACyT, together with the Ministry of Economy, has set up knowledge transfer offices (KTOs).

Mexico has advanced in the commercialisation of public research through technology transfer and spin-offs.

Most industry cluster successes have arisen in certain regions, particularly in Nuevo León and Mexico City, as local governments also have a critical role in innovation policy. Nuevo León has established a "city of knowledge": the Monterrey International City of Knowledge. This includes an academic cluster, with over 25 technology incubation cells at the Monterrey Campus at ITESM, which has developed as "*industry collaboration is at the heart of the institute's research activities*".[6] The Nuevo León Fund for Innovation (FONLIN) receives funding from the local government, CONACYT and the Interamerican Development Bank. The Fund currently supports 36 high-tech projects with an average of $500,000 (approx. £330,000) each. It also supports 42 projects with the privately owned Monterrey Global Ventures in industries such as nanotechnology and health. Mexico City has recently emerged as 'a City with Competitive Industry', which aims to support university incubation and spin-offs through its large STI budget.

Mexico's Research Centre for Advanced Studies, CINVESTAV, is the leading research centre in the country and the most successful institution at commercialising research and technology transfer. Its technology transfer centre has evaluated and focused commercialisation efforts in industries such as pharmaceuticals and food technology. ITESM supports 25 NTBFs, and between 2009 and 2011 has had an IP licensing revenue of almost $130,000 (approx. £90,000), which is described as "*a significant amount for Mexican HEIs*".[7] ITSEM has a portfolio of 200 patents, with commercialised research focused in areas of applied science.

[4] World Economic Forum 2015, p. 36.
[5] OECD 2013a.
[6] *Ibid.*, p. 59.
[7] *Ibid.*, p. 57.

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Philippines

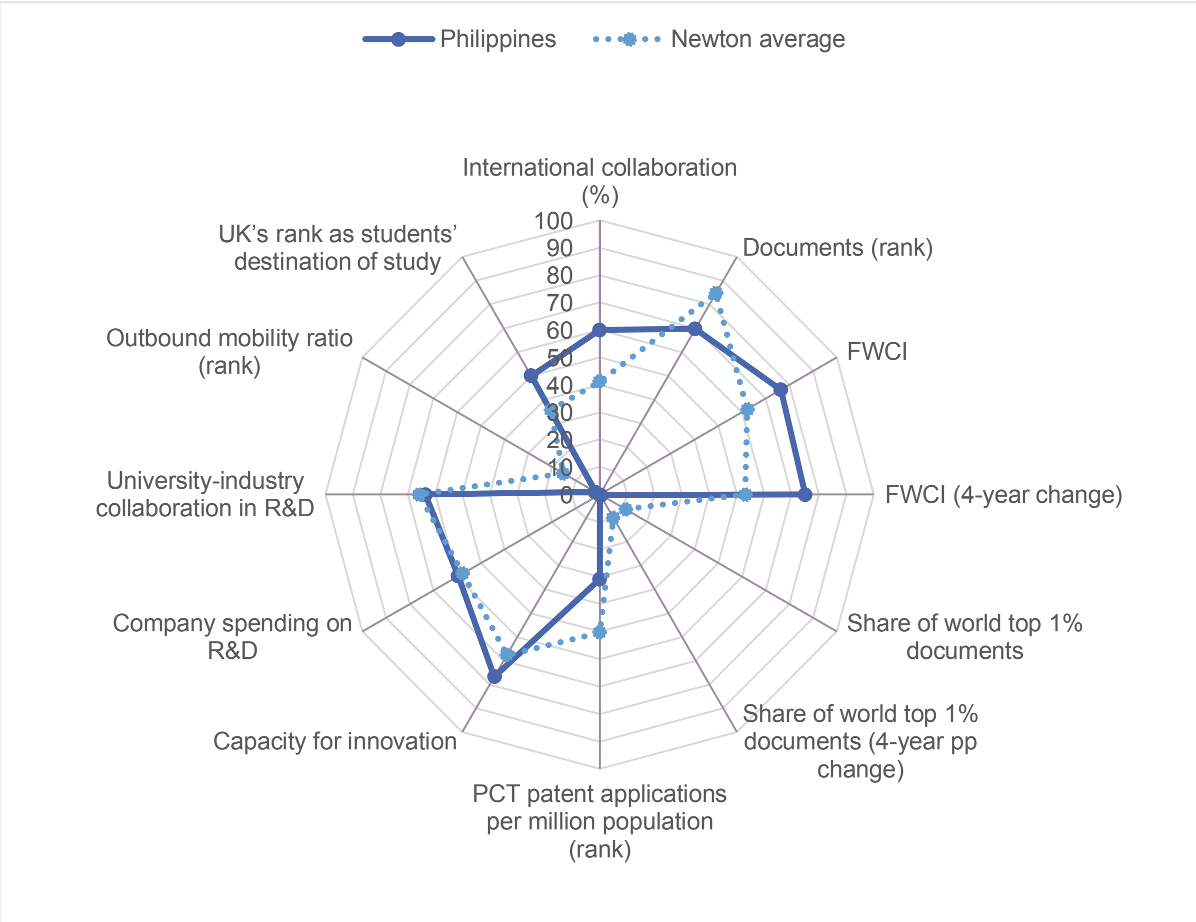
Summary of baseline research capacity

The Philippines has an appetite for engagement, with an active policy push to create a strong research base, and an innovation environment that has been formed with support for technology transfer. Newton interventions are focused on partnership and capacity-building, with a view to long-term collaboration with the UK in the future.

The Governance Board decided to work with South East Asian countries on a regional framework basis, but with distinct bilateral relationships with each country. Early discussions with the Philippines indicated an appetite for involvement in Newton Fund activities and the possibility of match funding.

Newton Fund framework themes of cooperation in the Philippines are health and life sciences; improving environmental resilience and energy security; future cities; agricultural technologies; and digital, innovation, and creativity. In 2014, the proposed balance of activities by Newton Pillar was as follows: 40% People; 40% Programmes; 20% Translation.

Figure 1. Country Profile



The Philippines has good capacity for innovation and company spending for R&D. It has some of the strongest performance on research impact metrics, which may be reflected in the high level of international collaboration in its research output.

Indicators of Present and Future Potential

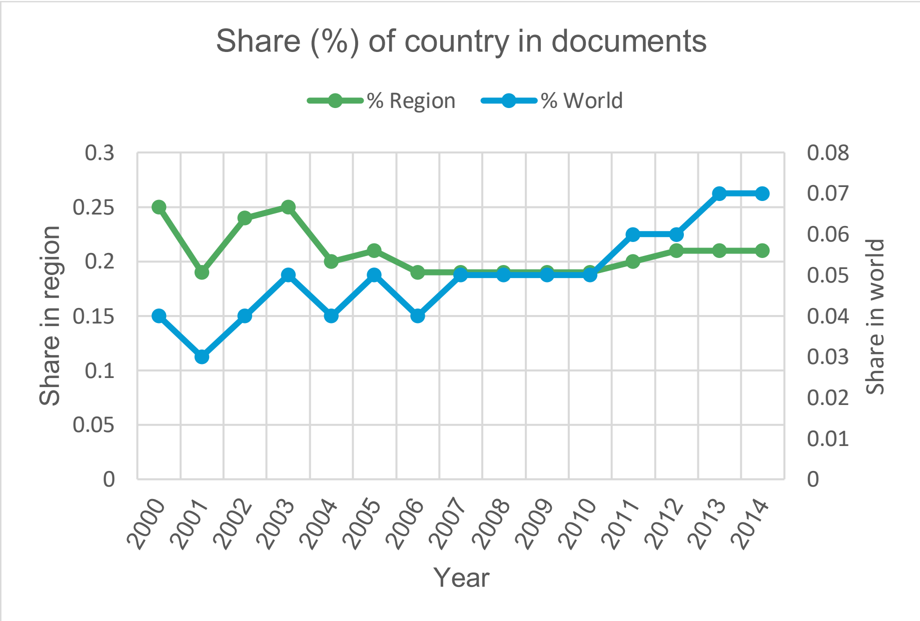
Table 1. Profile Indicators (present and future potential)

International Collaboration (%)	Documents	FWCI	FWCI (4-year change)	Share of world top 1% documents	Share of world top 1% documents (4-year pp change)
59.93	70/229	1.313	0.100	0.08	0.01

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

The Philippines produces 0.21% of the documents published in the region[1] and 0.07% worldwide (see Figure 2).

Figure 2. Production of documents

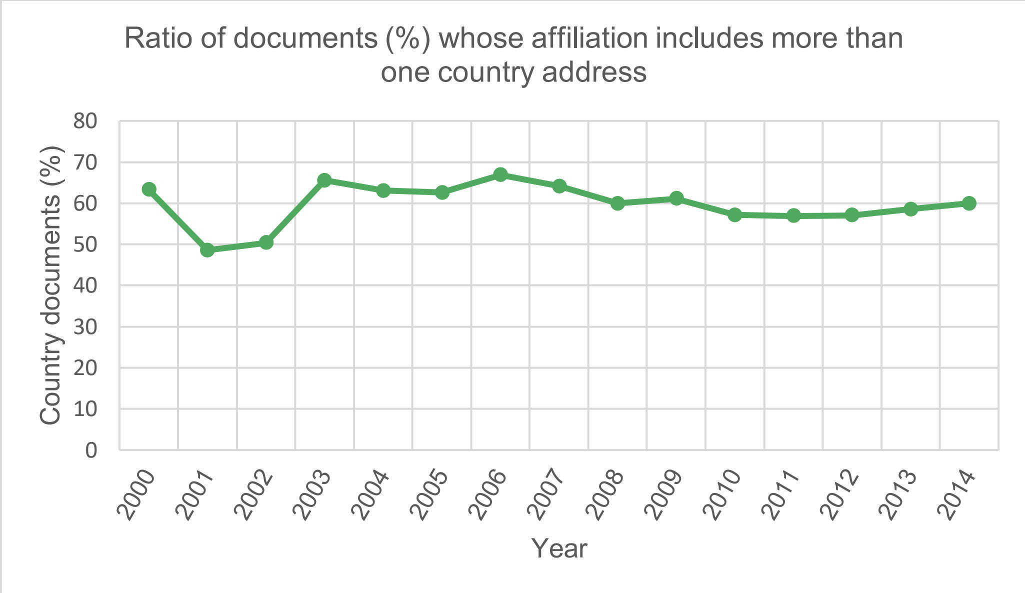


Source: SCImago Journal & Rank; PACEC

The Philippines has a very high proportion of publications with more than one country affiliation in the author list, amounting to 60% of all publications. The proportion of documents with international affiliation amongst the authors has been fairly constant, near 60% since 2008.

[1] SCImago defined region: see Table A2 in the main baseline report appendix for information on countries and their regions.

Figure 3. International Collaborations



Source: SCImago Journal & Rank; PACEC

The Philippines has a field-weighted citation impact of 1.313, which is much higher than the world average. The FWCI increased by 0.100 between 2008 and 2012.

Indicators of Innovation Collaboration Potential

Table 2. Profile Indicators (collaboration and mobility)

PCT patent applications per million population	Capacity for Innovation	Company spending on R&D	University-industry collaboration in R&D	Outbound mobility ratio	UK's rank as students' destination of study
86/124	4.52	3.54	3.79	162/165	3

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

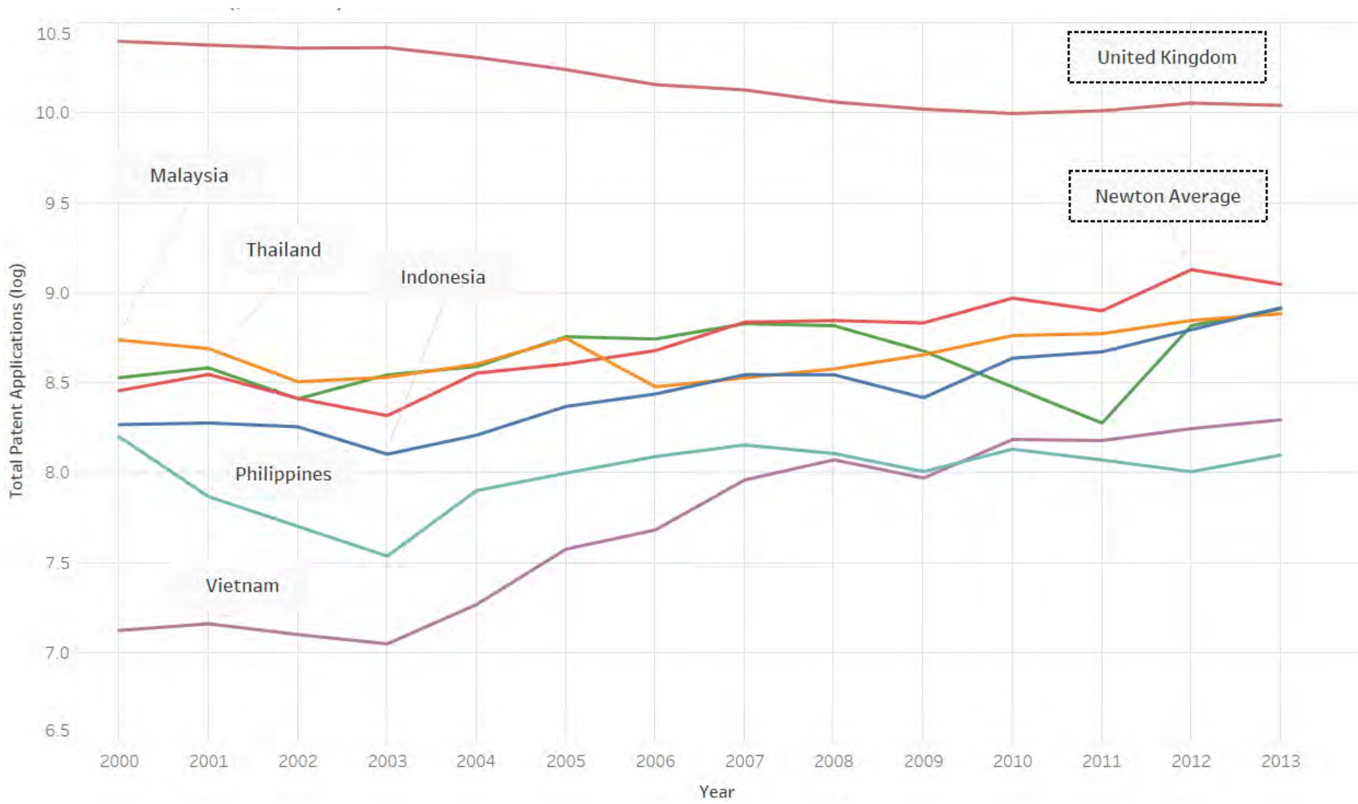
The Philippines has 0.32 patent applications per million people. Patent applications have been broadly constant since 2000, with the dip in 2001-2002 coinciding with the period when the Philippines became a signatory of the PCT (see Figure 4).

The World Intellectual Property Office (WIPO) has set up a network of Innovation and Technology Support Offices (ITSOs) in the Philippines, which should support IP development.

The Philippines scores 4.52 on the Capacity for Innovation indicator in the Global Competitiveness Index (GCI). Its score has been rising consistently since 2010, ranking 30th in the world, and above the regional average.

The Philippines ranks 42nd in the world for company spending on R&D; again, this is higher than the regional average, and has been rising since the start of the baseline period. For university–industry collaboration, the rank is 55th, and the score is following an upward trend.

Figure 4. Patent Applications



Source: WIPO; PACEC. Total patent applications (direct and PCT national phase entries). Log scale.

Indicators of student and research mobility

For students studying abroad, the UK is the third destination of choice, after the USA and Australia.

Overview of research funding structure

The Department of Science and Technology (DOST) funds projects under Research Councils and Research and Development Institutes; and provides funding to universities. DOST holds the majority of funding for research, but additional fudning is also provided by the Commission on Higher Education (CHED) and the Department of Agriculture (DA) (both of which provide co-funding for Newton Fund activities).

The Research Councils funded by MOST are the National Research Council of the Philippines (NRCP; 55 projects funded since 2010), the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD; 455 projects since 2003), the Philippine Council for Health Research and Development (PCHRD; 187 projects since 2005), and the Philippine Council for Industry, Energy and Emerging Technology Research and Development (PCIEERD; 571 projects since 2003). The Institutes are the Advanced Science and Technology Institute (ASTI; 88 projects funded since 2004), the Food and Nutrition Research Institute (FNRI; 261 projects since 2003), the Forest Products Research and Development Institute (FPRDI; 60 projects since 2003), the Industrial Technology and Development Institute (ITDI; 440 projects since 2003), the Metal Industry Research and Development Centre (MIRDC; 467 projects since 2003), and the Philippine Nuclear Research Institute (PNRI; 453 projects since 2003). DOST also developed the national innovation strategy, Filipinnovation, launched in 2007.

There are 1,200 colleges and universities in the Philippines[2]. The Engineering Research and Development for Technology (ERDT) plan has identified eight key Universities[3] and is offering scholarships, with a view to increasing post-graduate qualifications and high-impact research.

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[2] Degelsegger, 2014.
[3] Ateneo de Manila University (ADMU), Central Luzon State University (CLSU), De La Salle University (DLSU), Mapua Institute of Technology (MIT), Mindanao State University – Iligan Institute of Technology (MSU-IIT), University of the Philippines (U.P.) Diliman, U.P. Los Baños and University of San Carlos (USC) constitute the consortium.

The National Academy of Science and Technology (NAST) advises the government on science and technology issues.

The Balik Scientist Program (BSP) of the Department of Science and Technology (DOST) seeks to encourage highly-trained overseas Filipino scientists and technologists, experts, and professionals to return to the Philippines, either short-term or permanently, and share their expertise for the acceleration of the scientific, agro-industrial and economic development of the country, as a brain gain initiative. The program was set up in 1975 and was relaunched in 2014, by which date 477 Filipino scientists had been involved[4].

The Grants-In-Aid Programme of the Department of Science and Technology (DOST-GIA) aims to harness the country's scientific and technological capabilities by providing financial grants to Science and Technology (S&T) programmes, with the aim of fostering sustainable economic growth for the country. It encourages participation of various sectors in Science and Technology (S&T), particularly in Research and Development (R&D), Technology Transfer, Human Resources Development, S&T Promotion, and Advocacy and Linkages.

The International Technology Co-operation Unit (ITCU) provides the central machinery for the planning, development, implementation, coordination, monitoring, harmonization and integration of DOST's programmes on international S&T relations. It plans, develops and implements a programme aimed at strengthening and expanding linkages in international cooperation in scientific and technological research and development with foreign governments, international/regional organizations, private entities, and similar organisations. The Philippines is a member of the Asia-Pacific Advanced Network (APAN), the Asian and Pacific Centre for Transfer of Technology run by the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP APCTT), the Asia-Pacific Economic Co-operation (APEC), ASEAN and its Committee on Science and Technology (COST), the Asia-Europe Meeting (ASEM), the Convention on Biological Diversity, the International Centre for Genetic Engineering and Biotechnology (ICGEB), the International Atomic Energy Agency (IAEA), the Trans-Eurasia Information Network (TEIN2), the UNDP, and the World Meteorological Association (WMA).

Funding initiatives similar to Newton

Table 3. Summary of major funding initiatives similar to Newton

Funding initiative	Description of activity
SEA-EU-NET	EU funding for research collaboration activities between EU member states and ASEAN countries, as part of ASEAN participation in Horizon 2020 economic development programme. Activities have involved 21 institutions and focus in particular on these areas: health; food security and safety; water management.
Science, Technology, Research and Innovation for Development (STRIDE) Program (US AID)	STRIDE is a joint US-Philippines project that aims to improve economic growth and development. The five-year $32m project began in 2013, and works with universities to create a more supportive research and technology transfer ecosystem. It also promotes linkages between university and industry, and engages with the government to improve regulatory capacity.

The EU is funding the SEA-EU-NET project, which is "*deepening science and technology (S&T) cooperation between Europe and Southeast Asia*"[5], and is coordinated by the German Aerospace Centre. Its additional aims include bringing more ASEAN countries into Horizon 2020 participation and the FP7 programme. The four-year long SEA-EU-NET 2 was launched in October 2012 and involves 21 institutions. Its S&T projects specifically focus on societal challenges of Health, Food Security & Safety, Meteorology, and Water Management. Project activities include workshops, knowledge exchange, fellowships and a bi-regional funding scheme. The EU has also had previous engagements with ASEAN countries on research, through initiatives under Framework Programmes such as Asia Links and the Trans-Eurasia Information Network (TEIN). A 2009 evaluation of these programmes contended that these strengthened research networks and their leverage.

[4] Embassy of the Philippines, 2014.
[5] SEA-EU-NET (n.d.).

There is an established Agreement on Scientific and Technological Cooperation between the Manila Economic and Cultural Office (MECO) and the Taipei Economic and Cultural Office (TECO) for funding joint projects.

M&E Measures

The DOST is responsible for conducting biennial national innovation surveys in the Philippines, the Survey of Innovation Activities by Establishments. The survey is produced in line with the internationally recognised Oslo Manual guidelines. According to UNESCO, it is modelled on the EU standard Community Innovation Survey (CIS), more specifically on CIS 4, in the case of the 2010 survey. It is based on the CIS, with refinements on the questionnaire to consider the Philippine setting[6].

Overview of Business-Academia collaborations

The Philippine Technology Transfer Act (2010) set out to increase intellectual property registration by allocating IP rights to R&D institutions rather than funding organisations. The Technology Application and Promotion Institute (TAPI) provides capital and connects VC funders with innovators. It also includes start-up funding and mentoring. Specific programmes include the Small Enterprise Technology Programme (SETUP) and the Technology Incubation for Commercialisation Programme (TECHNICOM).

The World Intellectual Property Organization (WIPO) has a network of about forty Innovation and Technology Support Offices (ITSOs) in the Philippines, based in Universities, Institutes, and the National Museum.

Some countries run business support operations, for example, the Japan External Trade Organization (JETRO) and the French Chamber of Commerce and Industry in the Philippines. The Japan International Cooperation Agency (JICA) aims to generate jobs and attract investments through a National Industry Cluster Capacity Enhancement Project (NICCEP).

[6] UNESCO, 2013.

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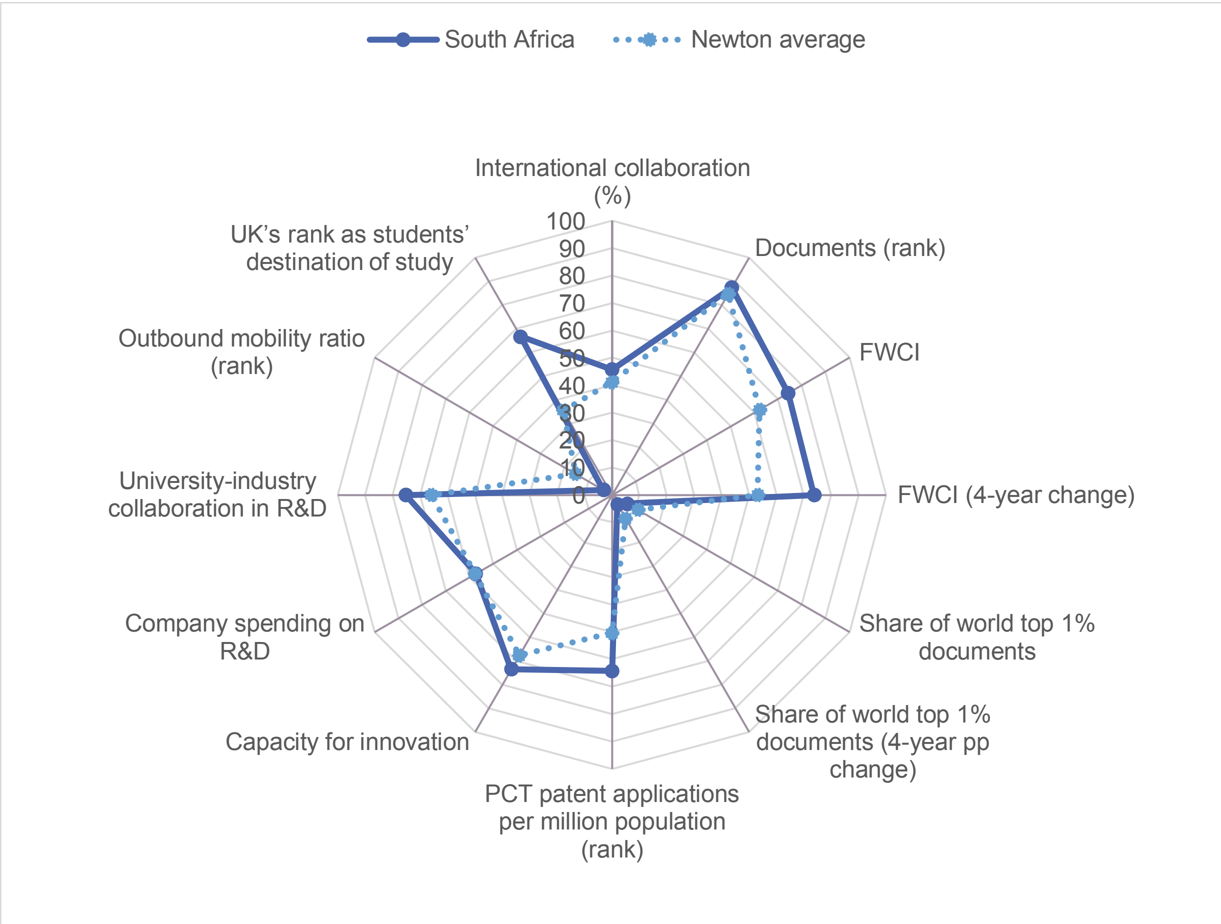
South Africa

Summary of baseline research capacity

South Africa has high levels of science capacity and advanced innovation systems. Newton maintains a strong focus on research collaboration managed in-line with UK Research Councils peer reviewed systems. It is hoped that South Africa will act as a hub for joint investment, facilitating trilateral projects with third countries in Africa. Activities in South Africa receive £4 million per annum for UK–South Africa and wider African collaboration. In 2015, internal documents indicated that a pilot will be implemented in Kenya, and activities commenced in the country in 2016.

Activities in South Africa have a focus on the following areas: Science and Technology Capacity Building; Environment and Food Security; and Public Health. In 2014, the proposed balance of activities by Newton Pillar was as follows: 45% People; 40% Programmes; 15% Translation.

Figure 1. Country Profile



South Africa has a strong baseline profile for all of its indicators.

Indicators of Present and Future Potential

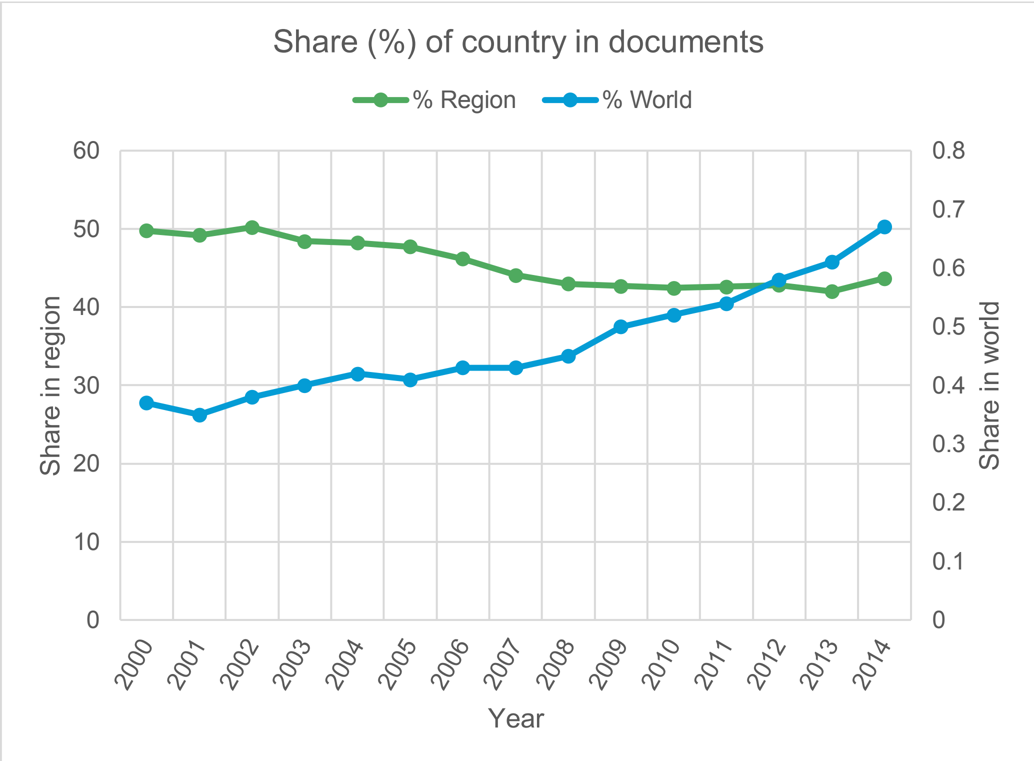
Table 1. Profile Indicators (present and future potential)

International Collaboration (%)	Documents	FWCI	FWCI (4-year change)	Share of world top 1% documents	Share of world top 1% documents (4-year pp change)
45.75	30/229	1.233	0.096	0.89	0.30

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

South Africa ranks 30th out of 229 countries for the production of published research documents. It produces 0.67% of documents in the world and 43.69% of documents in the region[1] (see Figure 2). Its share of world publications has been on a persistent upward trend since 2000.

Figure 2. Production of documents



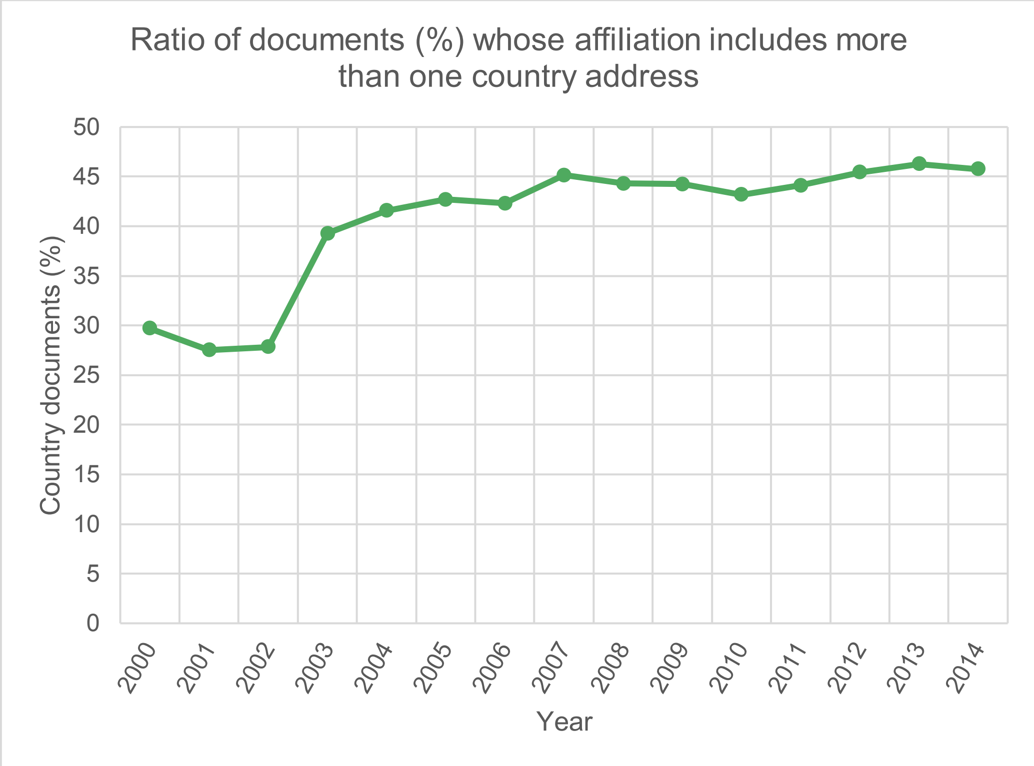
Source: SCImago Journal & Rank; PACEC

South Africa has strengths in particular research areas, such as Plant Sciences and Medicine, "*which remain a country strength*", as well as in emerging fields such as infectious diseases (Kahn, 2011).

South Africa's proportion of publications with more than one country affiliation is 46%, which is higher than average. This level was lower than 30% before 2003, but there was a steep increase in the same year (see Figure 3). Since then, there has been a gradual increase in the level of international collaboration.

[1] SCImago defined region: see Table A2 in the main baseline report appendix for information on countries and their regions.

Figure 3. International Collaborations



Source: SCImago Journal & Rank; PACEC

South Africa has a field-weighted citation impact of 1.233, which is much higher than the world average. The FWCI increased by 0.096 between 2008 and 2012, which is higher than the average increase. South Africa has 0.89% of the the world's top 1% documents by citations. The increase in share in highly-cited documents is 0.30pp higher in 2012 compared to 2008.

Indicators of Innovation Collaboration Potential

Table 2. Profile Indicators (collaboration and mobility)

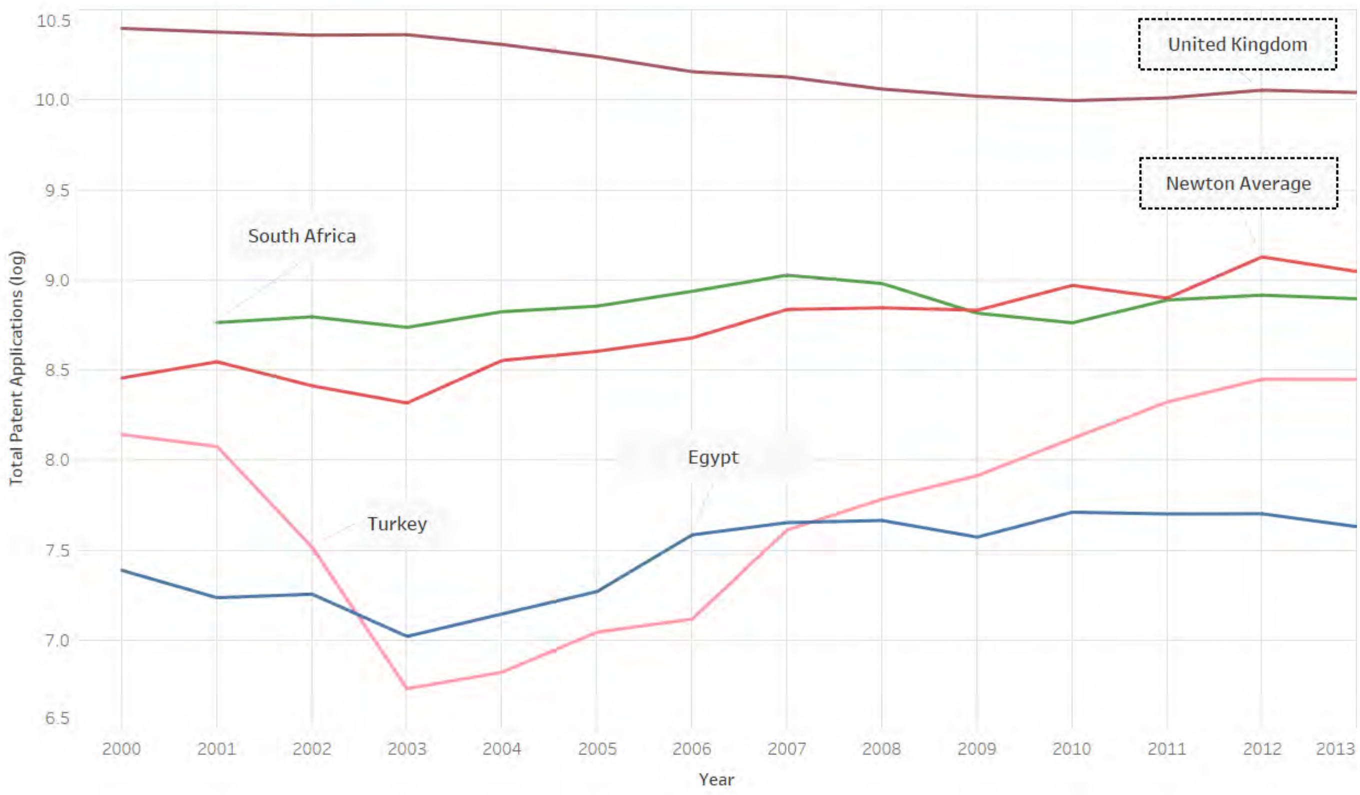
PCT patent applications per million population	Capacity for Innovation	Company spending on R&D	University-industry collaboration in R&D	Outbound mobility ratio	UK's rank as students' destination of study
45/124	4.33	3.41	4.49	N/A	2

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

South Africa has 6.48 PCT patent applications per million people, which is much higher than the average of 1.18 found for the Sub-Saharan Africa region (as defined in the GCI), ranking it 45th out of 124 countries in the world. Patent applications in South Africa have followed an upward trend during the 2000s.

The country scores 4.33 on the Capacity for Innovation indicator used in the Global Competitiveness Index (GCI), which ranks 35th of 144 countries. In the 2014-15 GCI report, in terms of competitiveness it is noted that South Africa "*does reasonably well in more complex areas such as business sophistication (31st) and innovation (43rd), benefitting from good scientific research institutions (34th) and strong collaboration between universities and the* *business sector in innovation (31st)".*[2] For the company spending on R&D indicator, South Africa scores 3.41. University–industry collaboration in R&D has a score of 4.49.

Figure 4. Patent Applications[3]



Source: WIPO; PACEC. Total patent applications (direct and PCT national phase entries). Log scale.

Indicators of student and research mobility

South Africa's outbound mobility ratio was approximately 0.6% in 2012. This could be due to the fact that the country has an indigenous research capacity that is strong by regional standards, leading students to opt to remain in the country. The UK is the 2nd main destination for South African students, behind the United States, with the next three countries being Australia, Cuba and Bahrain.

South Africa is one of the main destinations for students from Africa. In 2010 almost 15% of African international students elected to study in South Africa, which is only behind France (29%) as a study destination, but African student numbers are growing faster in South Africa.[4]

Overview of research funding structure

The National Development Plan (NDP) aims to eliminate poverty and reduce inequality by 2030. It identifies three priorities: raising employment through faster economic growth; improving the quality of education, skills development, and innovation; and building the capability of the state to play a developmental, transformative role. The R&D strategy aims to transform universities into centres of excellence at the cutting edge of technology, by increasing the academic base. The NDP aims to increase the number of doctoral graduates per million people to 100, from a level of 34 in 2012. Another aim is to increase the doctoral graduates per year to 5,000. Attracting students from abroad is a key component of the strategy, which will involve a specific focus on the link between innovation and business requirements.

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[2] Schwab 2014, p. 39.
[3] The year 2000 is excluded from the figure due to South Africa's membership of the PCT in 1999 affecting the data for that year.
[4] ICEF Monitor 2013

The Department of Science and Technology (DST) aims to increase wellbeing and prosperity through science, technology, and innovation. Its International Cooperation and Resources Programme has three components:

- Increasing the flow of international resources into the country;
- Increasing participation in strategic African bilateral and multilateral organisations;
- Promoting and facilitating collaborative activities and leveraging resources from outside Africa, with a specific focus on developing a knowledge-driven economy.

DST delivers many of its National Development Plan goals through the National Research Foundation (NRF) whose mandate is to promote and support research through funding, human resource development and the provision of the necessary research facilities in order to facilitate the creation of knowledge, innovation and development in all fields of science and technology to contribute to the improvement of the quality of life of all South Africans.

The DST has a range of other programmes for promoting its science & innovation goals. The Technological Innovation Programme prioritises bio-innovation, hydrogen and energy, space science and technology, innovation priorities and instruments, and intellectual property management. The Socio-Economic Innovation Partnerships Programme develops strategic innovation partnerships between government departments, industry, research institutions, and communities.

The South African Medical Research Council (MRC) aims to promote health and an improved quality of life through research, development, and technology transfer. It focuses particularly on the ten highest causes of death in South Africa, which include TB, HIV, chronic diseases, alcohol and drug abuse. The MRC's Innovation Centre is responsible for managing and commercializing the Intellectual Property emanating from the MRC's research.

South Africa introduced a new funding formula "f*or the provision of incentives by the Department of Education to universities*" by 2001, through changes in the funding mechanisms and higher gross expenditure in R&D (GERD). A World Bank report indicates that "*it is clear that this [new funding formula] led to a sharp rise in the number of publications*".[5] The report shows that the country's level of publications began an upward trajectory since the late 1990s.

Funding initiatives similar to Newton

Table 3. Summary of major funding initiatives similar to Newton

Funding initiative	Description of activity
Bilateral initiatives with Europe	Major bilateral initiatives to promote joint research between South Africa and European countries, including Switzerland, Sweden (STINT programme since 2015) and Russia.
South African Research Chairs Initiative (SARChI)	South African government programme since 2007, which funds expat South African researchers for 10–15 years to return to the country's universities. Over 150 Research Chairs have been awarded since the start of the programme. The scheme aims to develop the scientific base of institutions in the country.

South Africa has a very developed science and research base and is keen to encourage regional development through international collaboration initiatives.

There has been previous bilateral collaboration with Kenya, which also has strong research productivity, with strong growth in publications and a commitment to increase research and innovation funding. Joint bilateral funding programmes are in place with a number of countries, including Switzerland, Sweden, India, Taiwan and Russia. Newton is now the largest bilateral funding programme in South Africa.

The USA has created a university co-operation programme with Africa (Africa US Higher Education Initiative) worth just over £1 million.

[5] The World Bank 2014, p. 38.

The South African Research Chairs Initiative (SARChI) was introduced in 2007, with the aim of attracting researchers who work in industry or abroad to work in Universities in the country, so as to develop the scientific base of national academic institutions. The programme is funded by the DST and has been described as a 'flagship programme'. The initiative is creating new public-private partnerships (PPPs) that are strengthening links between industry and academia. Researchers are funded for a period of either 15 or 10 years, for Tiers 1 and 2 respectively. The highest level of funding for Tier 1 researchers is ZAR 2.5 million (approximately £110,000) per annum. There have been over 150 Research Chairs awarded since the start of the programme, which had a five-year review in 2012. SARChI will continue to be part of the country's innovation policy to achieve its 2030 vision.

M&E Measures

The Human Sciences Research Council is commissioned by the DST to undertake the annual Survey of National Research and Experimental Development, which produces R&D statistics in line with the internationally recognised Frascati Manual guidelines.

The biennial South African Innovation Survey is produced by the Centre for Science, Technology and Innovation Indicators (CeSTII). South Africa has adopted the Oslo Manual and has also incorporated the EU's Community Innovation Survey methods into its innovation survey.

Overview of Business-Academia collaborations

The Technology Innovation Agency supports the development and commercialisation of competitive technology-based services and products. It invests in the following technology sectors: Advanced Manufacturing, Agriculture, Industrial Biotechnology, Health Biotechnology, Mining, Energy and Information and Communications Technology.

Support to SMEs is channelled through the DST's Technology Stations Programme, which assists them with product research and development.

The OECD noted that large companies have a major influence on the creation of knowledge-intensive start-up firms. This is achieved via spin-off agreements and through the movement of their staff to set up new businesses themselves. The Innovation Hub in Pretoria included 50 companies as of 2008, the majority of which were created from spin-out arrangements. This has led to the development of clusters that foster collaboration. For example, Sappi (a large paper firm) has developed one of its main technology centres in the Innovation Hub.[6]

Since 2004, the DST has established various "centres of competence" (CoCs), which are platforms for collaborative technology partnerships between key innovation actors, namely industry, universities and research institutions. CoCs support the commercialisation of R&D and have a budget of ZAR 5 million (approx. £230,000) per year for 10 years, with funding of approx. £3.75 million per year for 10 years from the DST. The CoCs are similar to the Competence Centres (CCs) found in the European Union.[7] Since 2010, 28 CoCs have been introduced, including seven in Biotech and Health.

Hydrogen South Africa (HySA) is a key CoC, which contributes to value-added manufacturing and aims to supply 25% of the global hydrogen and fuel cells market by the end of 2020. Strategic goals for the DST through this CoC include greater energy security and potentially zero-emission energy. There has been collaboration between organisations such as the University of Cape Town, Anglo American and Impala Platinum in the development of the projects at HySA. The CoCs programme was reviewed in 2015 and departmental documents indicate that the programme is likely to be extended further.

Perhaps the initiative with the longest history of developing collaborations between business and academia is the Technology for Human Resources in Industry Programme (THRIP), which was established in 1991. The programme is one of the main government innovation initiatives, and aims to enable researchers to access industry networks and to foster the mobility of academics and managers. The initiative is funded by the Department for Trade and Industry (DTI) and the National Research Foundation (NRF), with a budget of over £21 million per year. An average of 235 projects is supported by the THRIP every year, with an additional £34 million estimated to be provided per year by industry actors. THRIP projects are proposed by a research body and industry expertise is

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[6] OECD 2007, pp. 157–163.
[7] OECD 2014.

leveraged to undertake market research. In recent years, THRIP has targeted engineering research as a major priority, since it had been identified as an industry in crisis by the OECD's innovation review in 2007.[8]

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[8] OECD 2007, pp. 122–123, 171–173.

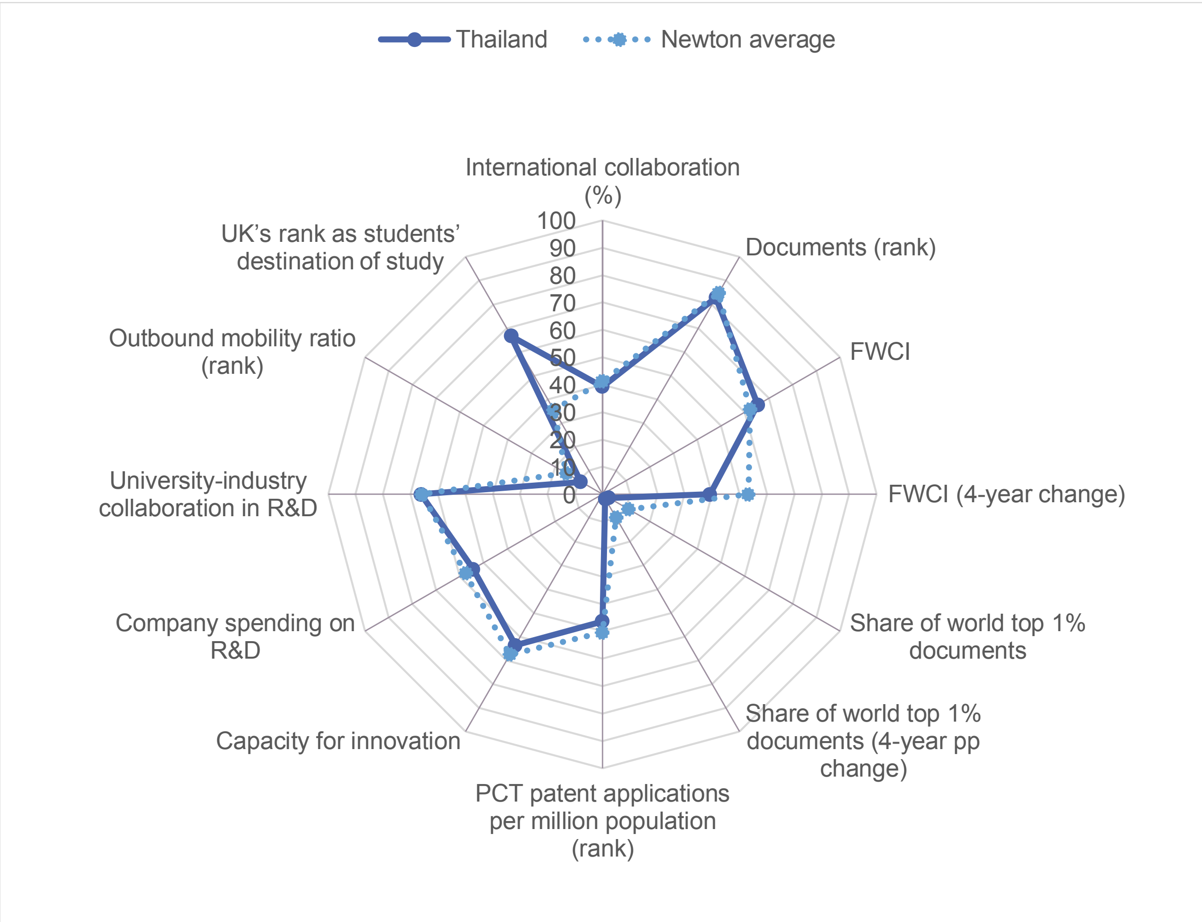
Thailand

Summary of baseline research capacity

Thailand is increasing science capacity and moving towards a more knowledge-based economy. Newton has a strong focus on partnership building through developing capacity in science, technology and innovation (STI), improving scientific research standards and infrastructure, building capacity for translating research and innovation to commercial outcomes, and building network of STI Practitioners. Thailand is included in the South East Asian group of countries for Newton funding purposes.

Newton activities in Thailand are focused on five strategic priority areas: Health and life sciences; Improving environmental resilience and energy security; Future cities; Agritech; and Digital, innovation and creativity. In 2014, the 1st year of implementation, the activities focused on developing a human capital in research and innovation so the proposed balance of activities according to Newton Pillar was as follows: 86% People; 0% Research; 14% Translation.

Figure 1. Country Profile



Thailand's performance on baseline indicators places it in a strong position to develop all elements of its indigenous research capacity.

Indicators of Present and Future Potential

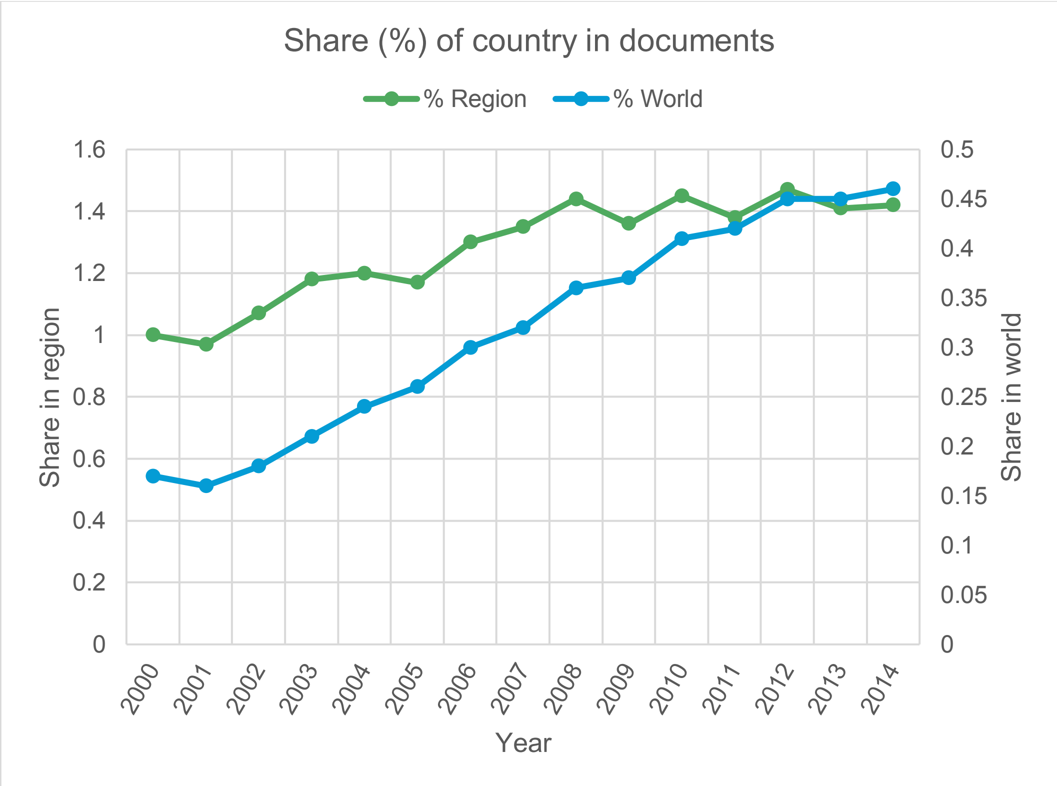
Table 1. Profile Indicators (present and future potential)

International Collaboration (%)	Documents	FWCI	FWCI (4-year change)	Share of world top 1% documents	Share of world top 1% documents (4-year pp change)
39.34	40/229	0.965	-0.009	0.37	0.16

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Thailand ranks 40th out of 229 countries for the production of published research documents. It produces 0.46% of documents in the world and 1.42% of documents in the Asiatic region[1] (see Figure 2). Thailand's share of world publications has increased steadily since 2000. Similarly, the country's share in the region's published research was increasing in the 2000s.

Figure 2. Production of documents

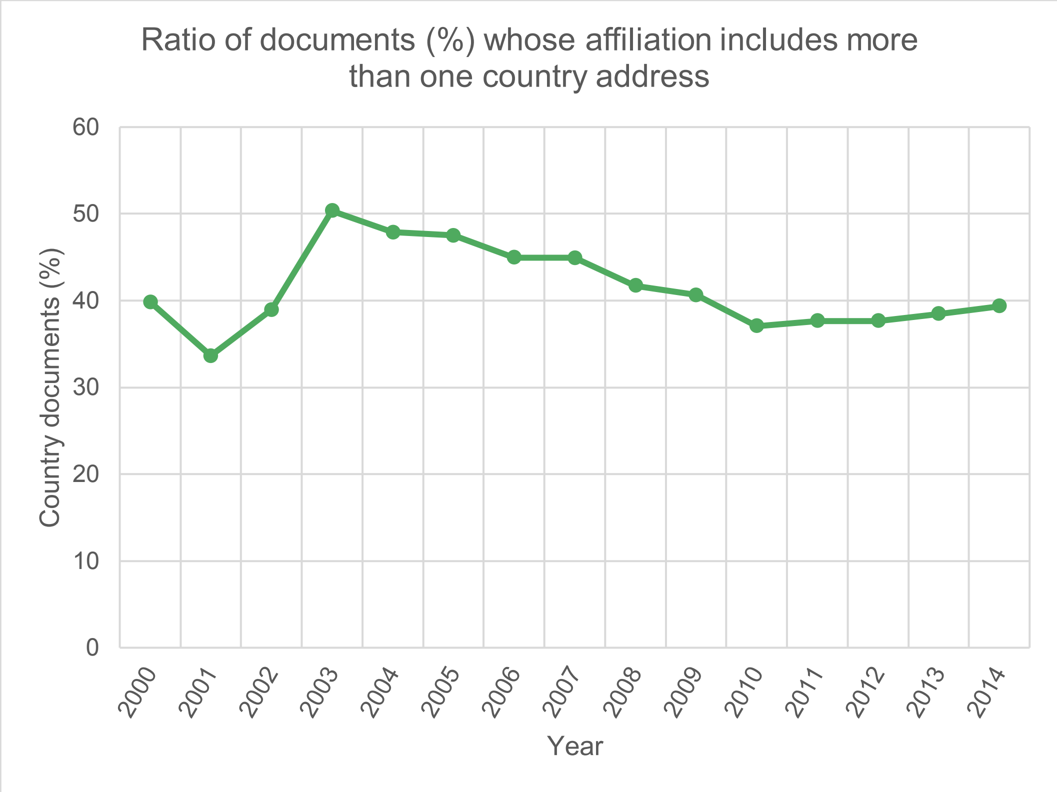


Source: SCImago Journal & Rank; PACEC

A recent SEA-EU-NET study analysed Scopus data and concluded that medicine and engineering, followed by agriculture, biological sciences, biochemistry, genetics and molecular biology are the most prominent areas for research output in the country.[2] Thailand's proportion of publications with more than one country affiliation is 39%.

[1] SCImago defined region: see Table A2 in the main baseline report appendix for information on countries and their regions.
[2] Degelsegger *et al.* 2014, p. 87.

Figure 3. International Collaborations



Source: SCImago Journal & Rank; PACEC

Thailand has a field-weighted citation impact of 0.965.

0.37% is the country's share in the top 1% of documents by citations in the world.

Indicators of Innovation Collaboration Potential

Table 2. Profile Indicators (collaboration and mobility)

PCT patent applications per million population	Capacity for Innovation	Company spending on R&D	University-industry collaboration in R&D	Outbound mobility ratio	UK's rank as students' destination of study
67/124	3.75	3.24	3.95	150/165	2

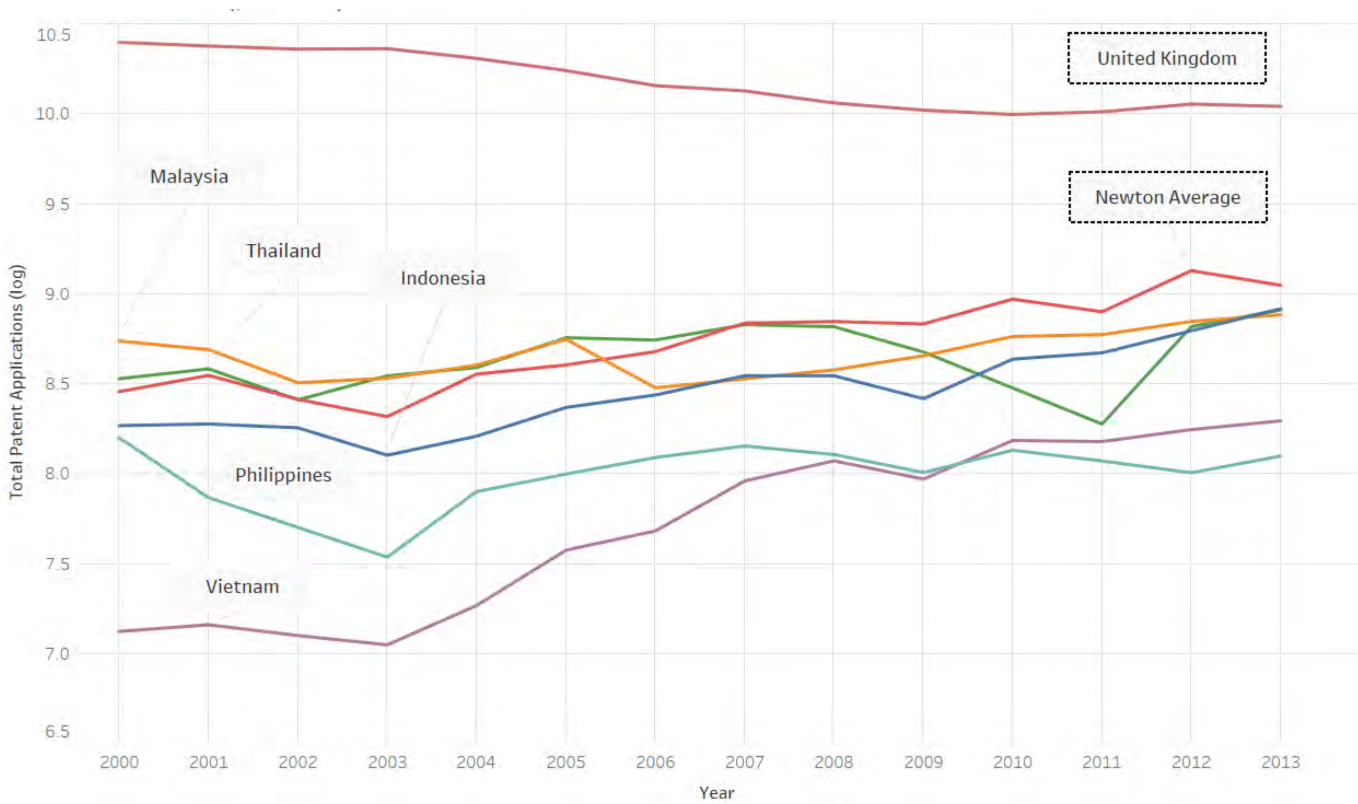
Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Thailand has 1.23 PCT patent applications per million people. Patent applications in Thailand have increased at a slow rate. The notable dip in 2010 coincides with Thailand's entry into the PCT in December 2009.

The country scores 3.75 on the Capacity for Innovation indicator used in the Global Competitiveness Index (GCI). In the 2014-15 GCI report, it is noted that Thailand is competitive in areas such as market efficiency and financial development.

For the company spending on R&D indicator, Thailand scores 3.24. University–industry collaboration in R&D has a score of 3.95, making it its strongest indicator in the innovation pillar.

Figure 4. Patent Applications



Source: WIPO; PACEC. Total patent applications (direct and PCT national phase entries). Log scale.

Indicators of student and research mobility

Thailand's outbound mobility ratio was 1.01% in 2012. The UK is the 2nd main destination for study by Thai students behind the United States, with the next three countries being Australia, Japan and Malaysia.

Overview of research funding structure

To enhance economic competitiveness and social well-being, the government setup the Thailand Research Organisations Network (TRON) to systematically help identify, manage, and ensure coordination among the research agencies on various research programmes. The network consists of seven research agencies:

- National Research Council of Thailand (NRCT) is a governmental organisation which was inaugurated by the National Research Council Act 1959 and was designated by the Cabinet as the national body responsible for laying down research policy and plan, and considering of consideration of research projects and plans in particular. The NRCT is also assigned to give comments to the Prime Minister when requested.

- National Science Technology and Innovation Policy (STI) advises the Government on policy formulation, coordination, and promotion for science technology and innovation. The office works with industry, government, academia, and local communities, and supports collaborative networking with strong linkages and exchange programmes with local, overseas, and international organisations.

- National Science and Technology Development Agency (NSTDA) is an autonomous entity reported to the Governing Board chaired by Minister of Science and Technology. NSTDA plans and executes four mandated mission: research and development, technology transfer, human resources development, and infrastructure development. NSTDA runs four national research centres (BIOTEC, MTEC, NECTEC, NANOTEC) and a technology management centre (TMC). Its R&D strategy has five key areas: agriculture and food; energy and the environment; health and medicine; bioresources and community; and manufacturing and services.[3] There are also

[3] See list of areas at for example http://www.nstda.or.th/eng/index.php/research/foods-and-agriculture#

four cross-cutting programmes: functional materials; sensors and intelligent systems; digital engineering; and service research.

- Thailand Research Fund (TRF) was established in response to the Research Endowment Act 1992. Although it is part of the government system, TRF lies outside the government administrative bureaucracy. TRF's main role is to assist in the development of researchers and research-based knowledge through making research grants and assisting with research management. TRF does not itself conduct and research.

- Health Systems Research Institute (HSRI) has an arm's length relationship with the Ministry of Public Health. HSRI is responsible for supporting research that assists in the formulation of a national health policy and acts as the coordinator and/or facilitator for mobilising health system reforms in Thailand.

- Agriculture Research Development Agency (ARDA) is an independent organization under the guidance of Ministry of Agriculture and Cooperatives. ARDA manages fund according to the Royal Decree B.E.2546 to pursue these objectives of supporting agricultural research, providing study and research on agricultural information technology, academic partnering with government and private industries in order to develop Ag-Research both domestic and international.

- Office of the Higher Education Commission (OHEC) is responsible for managing higher education provision and promoting higher education development on the basis of academic freedom and excellence.

On 10 June 2016, the Prime Minister spoke on the TV programme "Return Happiness to the People" that the Government is taking steps to develop a new twenty-year national research strategy as a framework for a reform of the entire research system in Thailand. The National Research and Innovation System Policy Committee had been set up to supervise the country's policy on research and innovation. Unified operations must be carried out, in terms of direction setting, budget allocation, creation of local and international research networks, human resource and infrastructure development, and revision of related laws and regulations, as well as the registration of intellectual property.

Funding initiatives similar to Newton

The Nationally Targeted Research Grant is managed by NRCT who is a central agency whose responsibility under the National Research Council Act is to formulate an overall national research policy and strategy. Researcher must prepare research proposals in the form of research projects or a series of research projects to be submitted to the National Research Management System (NRMS).

Harmonising with the National Research Policy and Strategy, each agency under TRON initiates its Strategic Research Funding Programmes. For instance, the International Research Networks (IRN) which is one of funding programmes initiated and operated by TRF. Up to THB 15 million will be funded to each network for 4-6 PhD fellowships, 2-4 post-doctorate fellowships, and a three-year research activities. These are focused on selected research programmes including alternative energy; food security and food safety; health and demographic changes; logistics and supply chains; and water, land, forest and environmental management.

Another major programme of funding with aim to build the country's innovation capacity is the Talent Mobility Programme which was initiated by STI and managed by STI and OHEC. The programme funds researchers from public research organisations to join enterprises for up to 2 years and then return to public research with stronger networks. The aim is that the researchers apply their knowledge to enterprises in knowledge-based industries and then utilise their networks upon return to public research. This initiative can support arrangements such as spin-off enterprises and advisory roles in companies. According to a SEA-EU-NET study, "*THB 7.5 billion (around €180 million) [approx. £135 million] is reserved for this programme for the five years from 2014 until 2018*".[4]

Table 3. Summary of examples of funding initiatives similar to Newton

Funding initiative	Description of activity
International Research Networks	The Thai Research Fund offers three years of funding to International Research Networks, which consist of PhD fellowships, post-doctorate fellowships and

[4] Degelsegger *et al.* 2014, p. 84.

	research grants. The priority areas for research projects at the Networks include alternative energy, food security and supply chains.
Talent Mobility Programme	Programme by the Thai government with approximately £135 million in funding across the 2014-2018 period. It funds researchers from public research institutions to join industry for up to 2 years and then return to public research with greater experience.

M&E Measures

Led by NRCT, TRON has developed the system of Thai National Research Repository (TNRR) which divides into 2 parts:

1. Thai National Research Repository (TNRR) is used to collect research data, research result, researcher data and research for commercial application from research agencies' database across the country, by linking without centralized data. The database owner can maintain and improve accuracy of data in real time system for sharing information, publish to public by internet without charge at http://www.tnrr.in.th It also provides an overview of the country research for planning the management of research and development in various dimensions. Consists of 3 subsystems:
    - (i) Database of finished research projects managed by NRCT
    - (ii) Database of researchers and research results managed by NSTDA
    - (iii) Database of utilization from state – supported researches managed by STI

2. National Research Management System (NRMS) is a systematic approach to manage the country's overall research budget, with efficiency and unity reducing redundancy of funding, can be used as for a database granting holistic funding of the country. Consists of 2 subsystems :
    - (i) Database of Single Window & Data Entry managed by HSRI
    - (ii) Database of ongoing research projects managed by TRF

Both parts are integratedly operating, liking/exchanging and forwarding information, by the following steps:

- (i) Researchers register in TNRR for information backup.
- (ii) When the researcher applies for granting , the system will retrieve the researcher information automatically, and show in Database of Single Window & Data Entry (NRMS).
- (iii) Information will be forwarded to Database of ongoing research project (NRMS) for further monitoring, as planned.
- (iv) Lastly, research result of the finished research project will be forwarded to TNRR for utilization.

http://www.tnrr.in.th is the channel through country's researches and management of the country's research funding, with completeness, easy to access the site which helps to reduce information redundancy, optimize in management of country research and country research funding. Administrators and researchers, both government and public can seek the co-researchers and those with talents from expert finder in TRNN.

Overview of Business-Academia collaborations

The Thailand Graduate Institute of Science and Technology (TGIST) was established by NSTDA to facilitate collaboration between industry and academia and promote science and technology.

TRF has a Research and Researchers for Industry (RRI) programme, which funds Master's and PhD students and supports innovative and collaborative research to solve industrial problems, particularly for SMEs. It also develops networks between industry and academics, both nationally and internationally.

A SEA-EU-NET study indicates that there is a wide range of funding instruments, namely through TAIST and the Talent Mobility Program, available to Thai enterprises for utilising public research networks.[5]

As of 2015, the government is developing Special Innovation Zones to foster business–academia collaboration through the establishment of industry clusters, which will have special incentives to encourage investment. The Zones will allow 10-year exemptions from corporate income tax for businesses and a 10-year arrangement of reduced or waived personal income tax. The first ‘super cluster’ planned is the ASEAN Food Innopolis, an innovation centre that aims to increase the value of the country’s commodities in the food processing sector. There are plans to build six of these large industry clusters in the country and the government is seeking to generate FDI for sustainable activity therein.

[5] Degelsegger *et al.* 2014, p. 84.

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Turkey

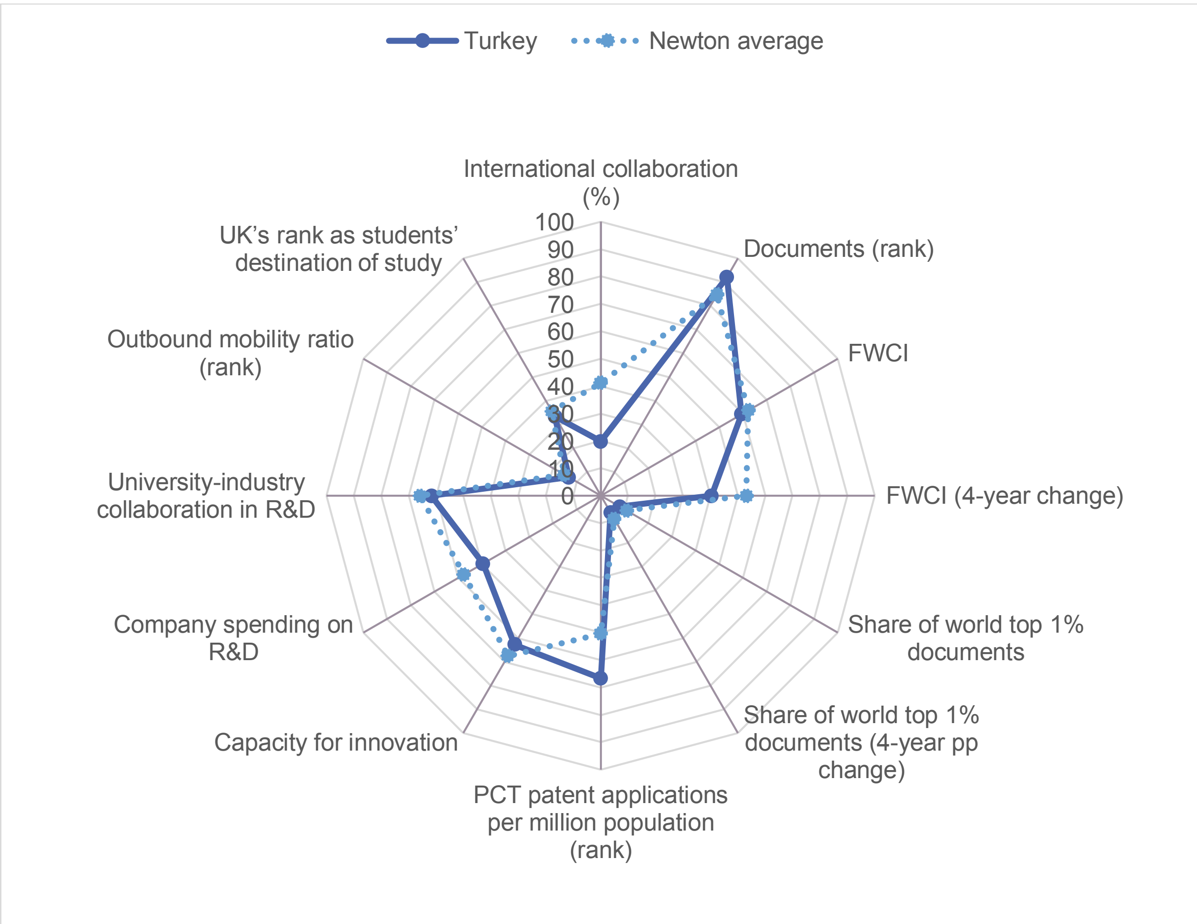
Summary of baseline research capacity

Turkey has high levels of science capacity and advanced innovation systems. Newton maintains a strong focus on innovation and research collaboration, managed in-line with UK Research Councils peer review systems. Activities in Turkey receive £4 million per annum for UK–Turkey collaboration.

In 2014, the proposed balance of activities by Newton Pillar was as follows: 40% People; 40% Programmes; 20% Translation. The priority areas are:

- Lifelong Health And Wellbeing (including antimicrobial resistance, disease prevention, diagnostics, prevention, and health education);
- Agriculture and Global Food Security (including improved yields, disease eradication, water security, and supporting women in the labour market);
- Disaster and Emergency Management (including earthquake early warning systems and geological monitoring, information systems, and development of resilient materials);
- Energy and Climate Change (including renewables, clean coal, efficiency, smart grids, and green transportation and buildings).

Figure 1. Country Profile



Student and researcher mobility is quite strong for Turkey, and patent applications is its strongest indicator. The country has one of the largest shares in highly-cited research.

Indicators of Present and Future Potential

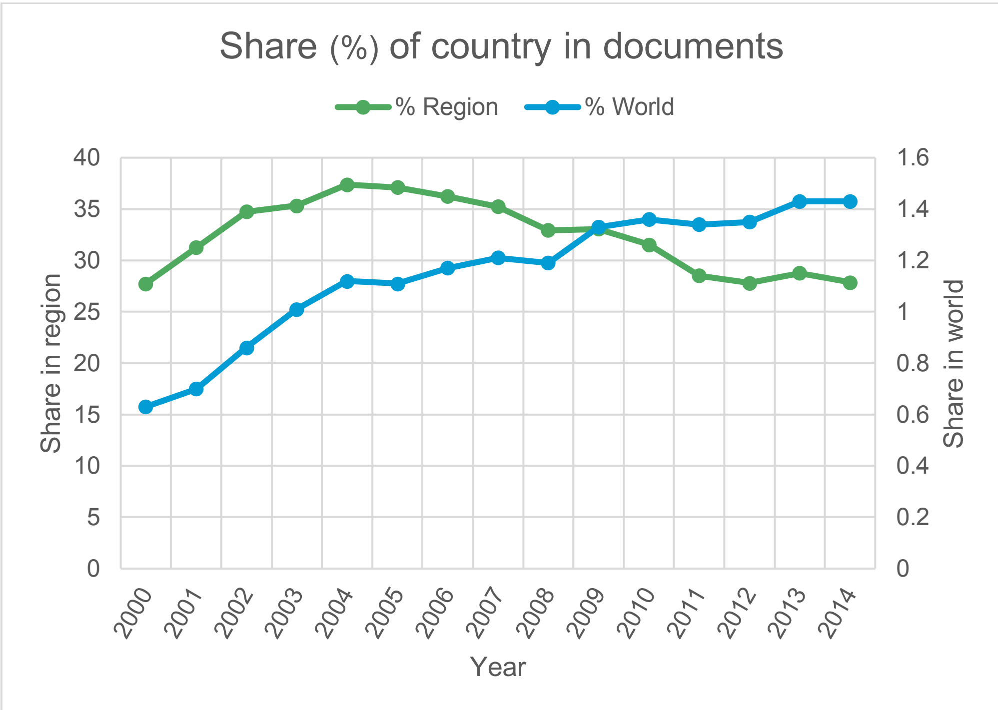
Table 1. Profile Indicators (present and future potential)

International Collaboration (%)	Documents	FWCI	FWCI (4-year change)	Share of world top 1% documents	Share of world top 1% documents (4-year pp change)
19.74	19/229	0.819	-0.005	1.08	0.54

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Turkey ranks 19th out of 229 countries for the production of published research documents. It produces 1.43% of documents in the world and 27.86% of documents in the Middle East region[1] (see Figure 2). Turkey's share of world publications has increased consistently since 2000.

Figure 2. Production of documents



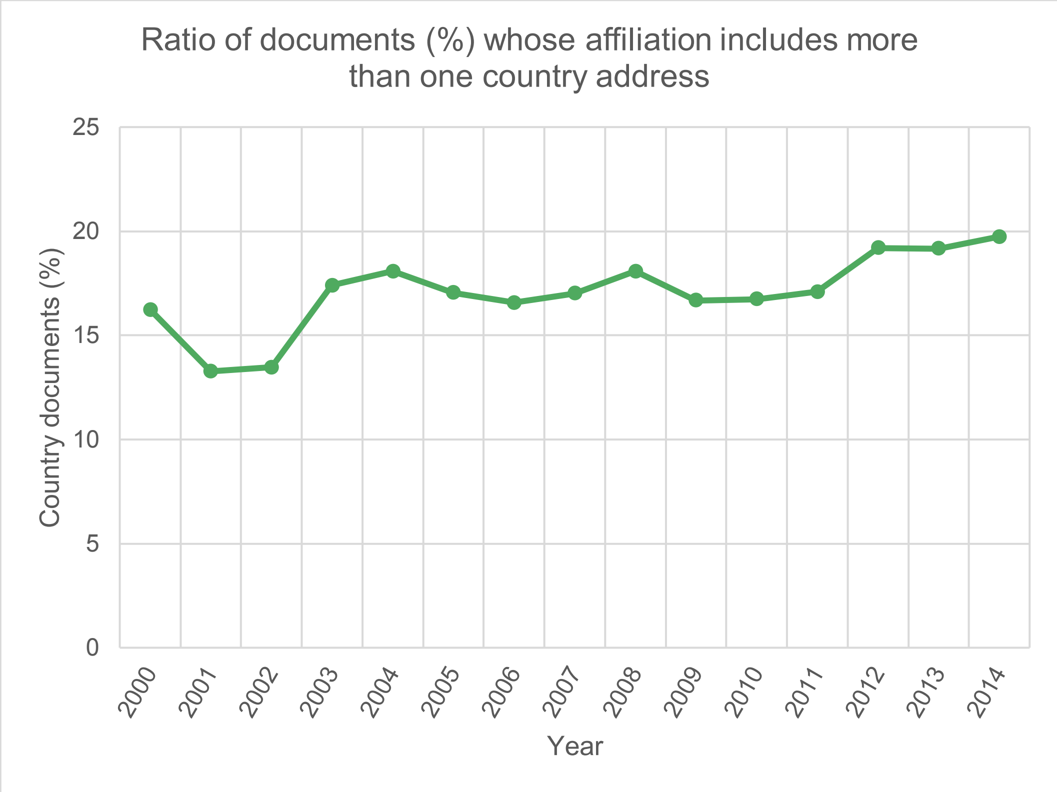
Source: SCImago Journal & Rank; PACEC

According to Research Trends (2007), "*medical and life science research is currently leading the way in terms of published output, but […] significant contributions are also being made to the physical and mathematical sciences*".[2] Medicine and Life Sciences together accounted for almost 46% of Turkish publications in 2006.

Turkey's proportion of publications with more than one country affiliation is 20%. This level has been fairly constant since 2000 but with a marginal increase over that period (see Figure 3). This could reflect a large indigenous capacity for innovation, perhaps due to Turkey's size and economic history.

[1] SCImago defined region: see Table A2 in the main baseline report appendix for information on countries and their regions.
[2] Research Trends 2007.

Figure 3. International Collaborations



Source: SCImago Journal & Rank; PACEC

Turkey has a field-weighted citation impact of 0.819. The country's research impact is essentially unchanged (-0.005) between 2008 and 2012. Turkey has 1.08% of the world's top 1% documents by citations and this increased by 0.54pp between 2008 and 2012, so Turkey has one of the highest levels of research impact as measured by citations.

Indicators of Innovation Collaboration Potential

Table 2. Profile Indicators (collaboration and mobility)

PCT patent applications per million population	Capacity for Innovation	Company spending on R&D	University-industry collaboration in R&D	Outbound mobility ratio	UK's rank as students' destination of study
42/124	3.7	2.95	3.65	143/165	4

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

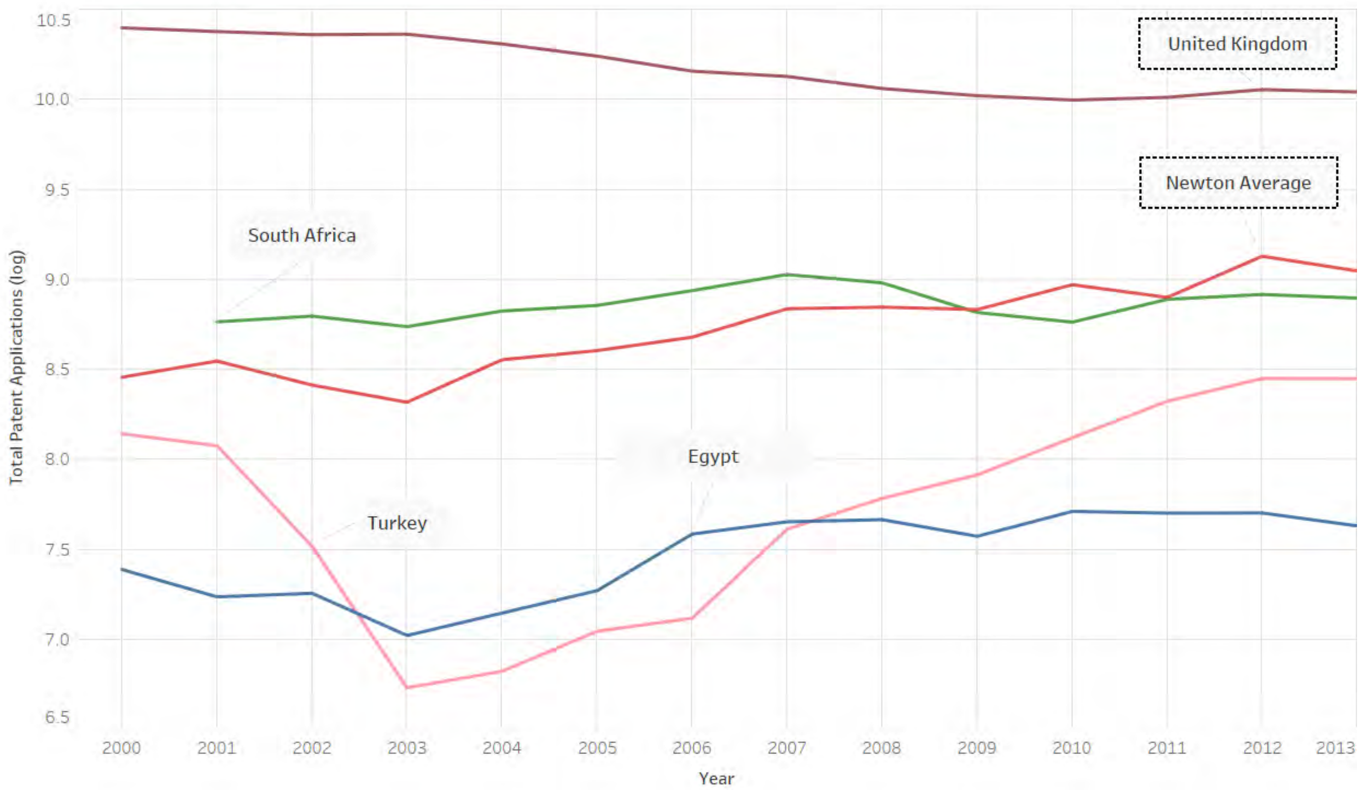
Turkey has 6.83 PCT patent applications per million people, which is much higher than the average of 1.49 for the region[3].

The country scores 3.70 on the Capacity for Innovation indicator used in the Global Competitiveness Index (GCI). The 2014–15 GCI report did not discuss competitiveness indicators in detail, even though the country's strongest pillars include market size and goods market efficiency.

For the company spending on R&D indicator, Turkey scores 2.95. University–industry collaboration in R&D has a score of 3.69.

[3] Region defined in the GCI.

Figure 4. Patent Applications



Source: WIPO; PACEC. Total patent applications (direct and PCT national phase entries). Log scale.

Indicators of student and research mobility

Turkey's outbound mobility ratio was 1.18% in 2012. The UK is the 4th main destination for study by Turkish students, followed by Azerbaijan, with the top three countries being Germany, the United States and Bulgaria.

Overview of research funding structure

The main Turkish funding partner is the Scientific and Technological Research Council of Turkey (TÜBİTAK). TÜBİTAK has set up the Turkish Research Area (TARAL) to mobilise businesses, the public sector, and NGOs to focus on innovation and R&D.

TÜBİTAK funds international highly qualified PhD students and young post-doctoral researchers to pursue their research in Turkey in Natural Sciences, Engineering and Technological Sciences, Medical Sciences, Agricultural Sciences, and Social Sciences and Humanities. This has the objective of improving international collaboration in these areas.

The Supreme Council for Science and Technology is accountable to the Prime Minister and is responsible for developing the country's science policy. The government's long-term Vision 2023 strategy outlines three innovation targets for the country to meet by the year 2023: raise government expenditure on R&D (GERD) to 3% of GDP; increase in full-time equivalent researchers to 300,000; increase in the role of the private sector in carrying out research (operating over 60% of GERD). In 2014 GERD was 1.01% of GDP and 51% of GERD was financed by the private sector; both of these have been on an upward trend in recent years[4].

In December 2010 the SCTC has published the National Science, Technology and Innovation Strategy (UBTYS) 2011-2016, which has the overarching aim to "*contribute to new knowledge and develop innovative technologies to improve the quality of life by transforming the former into products, processes, and services for the benefit of the*

[4] See https://www.tubitak.gov.tr/en/news/rd-activities-survey-2014-results-are-announced

country and humanity."[5] The UBTYS is the latest strategy by the government, which is funding a range of programmes for stimulating innovation including the following research grant funding initiatives:[6] [7]

- 1511 Program – R&D Projects in Priority Areas Grant Program: research funding calls targeted at the private sector, for developing products in technologies in priority areas such as ICT and manufacturing.
- 1003 Program – Support Program for R&D Projects in Priority Areas: research funding calls similar to the 1511 Program but targeted at universities and research institutes.
- R&D Projects for Technology Development – e.g. grants of up to approx. £120,000 for SMEs to develop products and technologies (1507); grants for universities to collaborate with industry and bring concepts to the market (1505); grants for national research projects initiated by the private sector, with no budget limit (1501).

The Scientific and Technological Research Council of Turkey (TÜBİTAK) advises the government and supports the Supreme Council for Science and Technology. It manages R&D institutes and coordinates scientific research in line with policies set by the Turkish Academy of Sciences (TÜBA).

Currently, research is focused in the urban centres, and one of the aims of the Newton collaboration is to assist with capacity building across the country. It is hoped that, by the end of the programme, Turkish researchers will be able to enter mainstream international funding competitions, for example, for EU funds. The agricultural and food security focus is particularly suited to research taking place in rural areas.

Funding initiatives similar to Newton

Table 3. Summary of major funding initiatives similar to Newton

Funding initiative	Description of activity
Participation in European research programmes	Examples of participation in European research programmes: • COST (European Cooperation in the field of Scientific and Technical Research) • ESA (European Space Agency) • ESF (European Science Foundation) • EMBC (European Molecular Biology Conference)
TÜBİTAK fellowships	The Turkish funding agency TÜBİTAK has funded fellowships for Turkish PhD and post-doctorate students since 1978, including 10 fellowship programmes for foreign researchers. Over 4,000 researchers have been supported through these fellowships since 2000.[8]

According to TÜBİTAK, the research council has involvement in 27 bilateral agreements with institutions across 22 different countries[9].

Turkey also participates in a variety of European research programmes, such as COST (European Cooperation in the field of Scientific and Technical Research), ESA (European Space Agency), ESF (European Science Foundation) and EMBC (European Molecular Biology Conference). It also participates in regional organizations, such as the Organisation of the Black Sea Economic Cooperation (BSEC); and international organisations including NATO, OECD and UNESCO. Turkish scientists participating in the events organised by these

[5] See https://www.tubitak.gov.tr/en/about-us/policies/content-national-sti-strategy-2011-2016
[6] TÜBİTAK 2015.
[7] OECD 2014.
[8] *Ibid.*
[9] Agreements are present with the following countries: USA (NSF, NIH), Bulgaria (BAS), Belarus (NASB), India (CSIR), Germany (DFG, BMBF), Slovakia (SAS), Greece (GSRT), Mongolia (MAS), Italy (CNR, Ministry of Foreign Affairs), France (CNRS, Bosphorus Program with Ministry of Foreign Affairs), Slovenia (ARRS), Ukraine (NASU, DKNII), Hungary (NKTH), Korea (NRF), Romania (ANCS), Pakistan (MoST), Russia (RFBR), China (MOST), Czech Republic (AS CR), Belgium (FWO).

organisations are supported or monitored by TÜBİTAK. TÜBİTAK is also the contact organisation for the EU's Framework Programme 7, to be superseded by HORIZON 2020.[10]

Since 1978, TÜBİTAK has provided a set of fellowship programmes for Turkish PhD and post-doctorate students; as of 2013 there are 29 for science research, of which 10 are international fellowships that can be inclusive of foreign researchers (these 10 are under a separate International Graduate Scholarship Programme). Almost 4,000 researchers have been supported through the fellowships since 2000, with 75 million Turkish lira (approx. £18 million) allocated to the researchers for their studies outside of Turkey for a maximum of one year.[11]

M&E Measures

The Ministry of Science, Industry & Technology (MoSIT) undertakes evaluations of public R&D initiatives in impact assessment studies. Turkey undertakes a Community Innovation Survey (CIS) for its biennial national innovation survey through TurkStat, in line with internationally recognised Oslo Manual methodology guidelines and the methodology used for innovation surveys in EU member states. According to the OECD, all questions in the CIS are in line with the EU standard CIS.[12]

Overview of Business-Academia collaborations

A major government scheme to foster industry–science co-operation in R&D is the Industrial Thesis Supporting Programme (San-Tez), which has been in operation since 2007. It has a budget of $218 million (approx. £145 million) for the period 2006–13 and is run by the Ministry of Science, Industry & Technology (MoSIT). The programme supports graduate students in the development of technological products for their graduate theses, with the aim to translate their research into industrial applications. Funding is up to 75% of a project's budget, with the remainder funded by companies. The projects are sponsored based on industry requests and support is also available for foreign companies that have established operations in Turkey. In the first phase, 880 projects were funded and almost half of them had been completed successfully by 2014. There is particular focus on high-value manufacturing, as 44.6% of applications in 2013 were for research in the high-tech manufacturing sector.

MoSIT has established Technology Development Zones (TDZs) since 2001, in conjunction with universities and Research Institutes, where businesses have tax incentives to undertake R&D through agreements with the Ministry of Finance. Tax exemptions are currently being provided until the end of 2023 for items such as salaries, insurance premiums and VAT on expenditure. In 2011, there were 32 TDZs in operation, acting as bases for 1,771 firms, of which 4% were foreign companies.

The Undersecretariat of Foreign Trade (DTM) supports industrial R&D, co-operating with TÜBİTAK to fund R&D and innovation in the private sector.

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[10] See list of partners at https://www.tubitak.gov.tr/en/international/content-multilateral-cooperation
[11] OECD 2014.
[12] OECD 2013.

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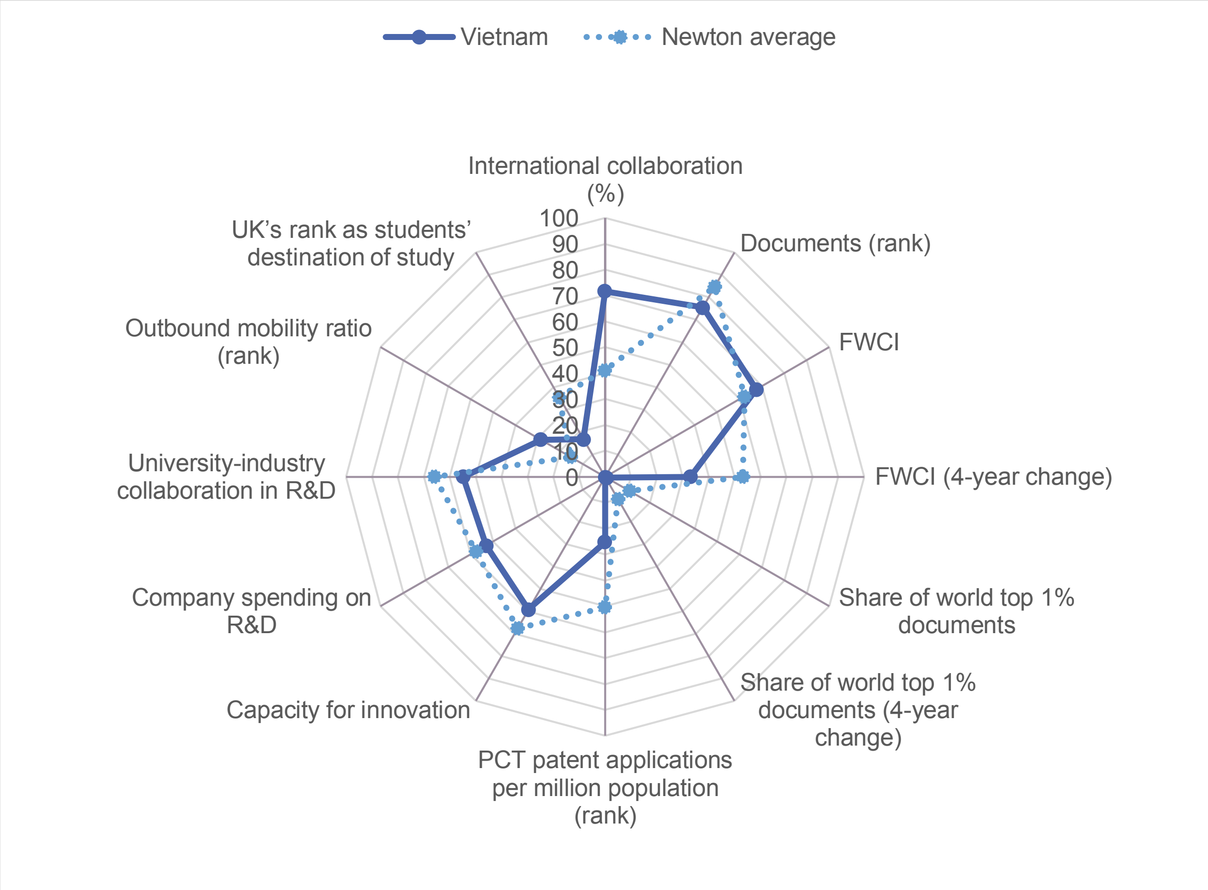
Vietnam

Summary of baseline research capacity

Vietnam has an appetite for engagement, with Newton interventions focused on partnership- and capacity-building, with a view to long-term collaboration with the UK in the future.

Newton activities in Vietnam are focused on five strategic priority areas: Health and life sciences; Environmental resilience and energy security; Future cities; Agriculture; and Digital innovation and creativity. The country is aiming to increase higher-level research activities as it seeks to derive future growth from improvements in technology and labour productivity. In 2014, the proposed balance of activities by Newton Pillar was as follows: 30% People; 40% Programmes; 30% Translation.

Figure 1. Country Profile



Vietnam has the highest level of international collaboration of Newton countries, and a field-weighted citation impact greater than the world average. Student mobility is relatively high.

Indicators of Present and Future Potential

Table 1. Profile Indicators (present and future potential)

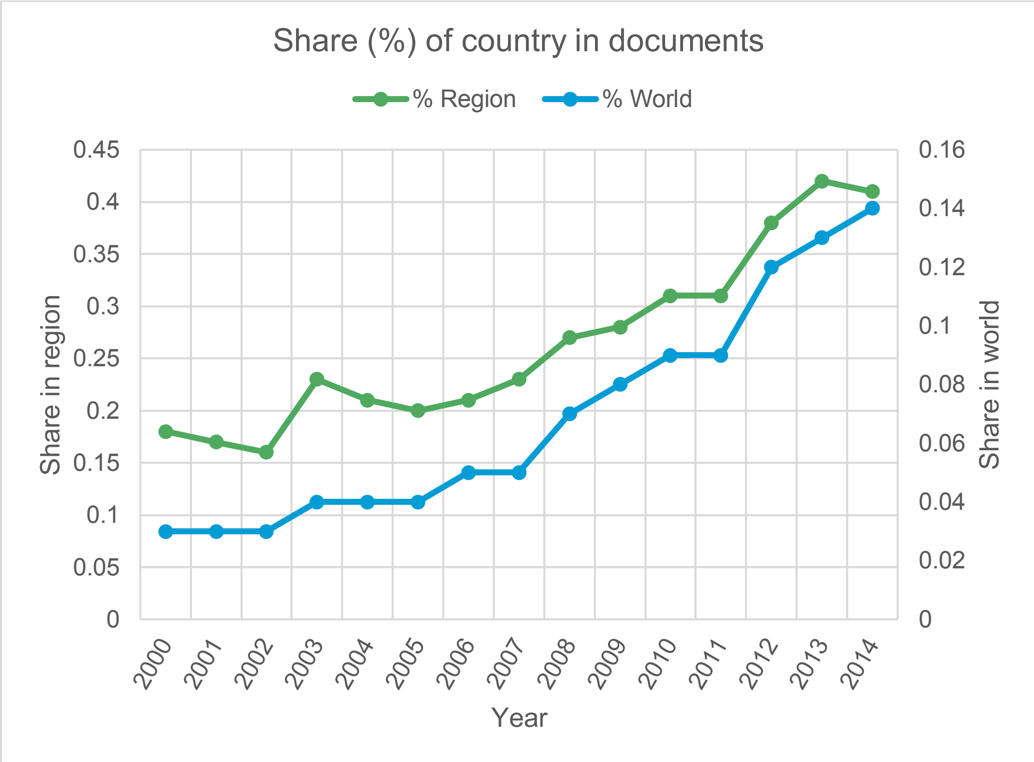
International Collaboration (%)	Documents	FWCI	FWCI (4-year change)	Share of world top 1% documents	Share of world top 1% documents (4-year pp change)
71.61	57/229	1.019	-0.028	0.10	0.02

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Vietnam ranks produces 0.14% of documents in the world and 0.41% of documents in the region[1] (see Figure 2). Vietnam's share of world publications has accelerated since 2000.

According to a recent SEA-EU-NET study conducted using the Scopus database, Agricultural and Biological Sciences; Mathematics; Engineering; Physics, Astronomy and Biochemistry; Genetics; and Molecular Biology are the most important fields in Vietnam's research output.

Figure 2. Production of documents

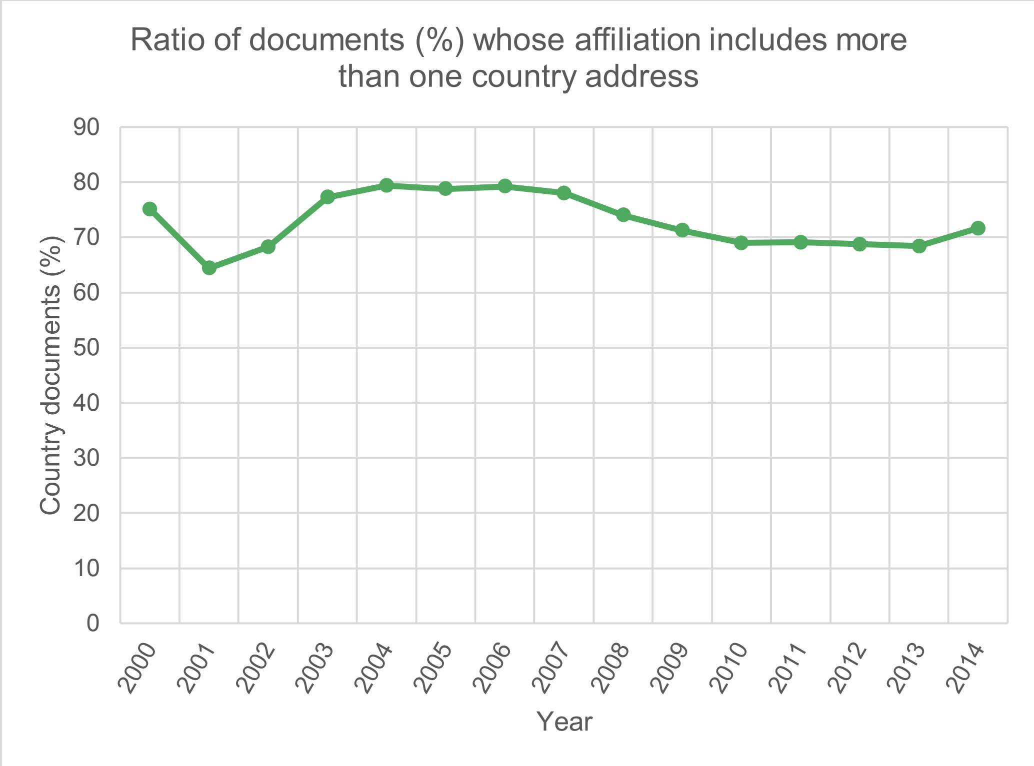


Source: SCImago Journal & Rank; PACEC

Vietnam's proportion of publications with more than one country affiliation is 72%.

[1] SCImago defined region: see Table A2 in the main baseline report appendix for information on countries and their regions.

Figure 3. International Collaborations



Source: SCImago Journal & Rank; PACEC

Vietnam has a field-weighted citation impact of 1.019, which is higher than the world average. Vietnam has 0.1% of the world's top 1% documents by citations. In terms of research impact, Vietnam's citation impact is high due to its level of international collaboration.

Indicators of Innovation Collaboration Potential

Table 2. Profile Indicators (collaboration and mobility)

PCT patent applications per million population	Capacity for Innovation	Company spending on R&D	University-industry collaboration in R&D	Outbound mobility ratio	UK's rank as students' destination of study
93/124	3.48	3.15	3.27	118/165	5

Source: SCImago Journal & Rank; World Economic Forum; UNESCO; PACEC

Vietnam has 0.22 PCT patent applications per million people[2] (as defined in the GCI). Patent applications in Vietnam have been on an upward trend since 2000, with particularly significant levels of growth in the mid-2000s.

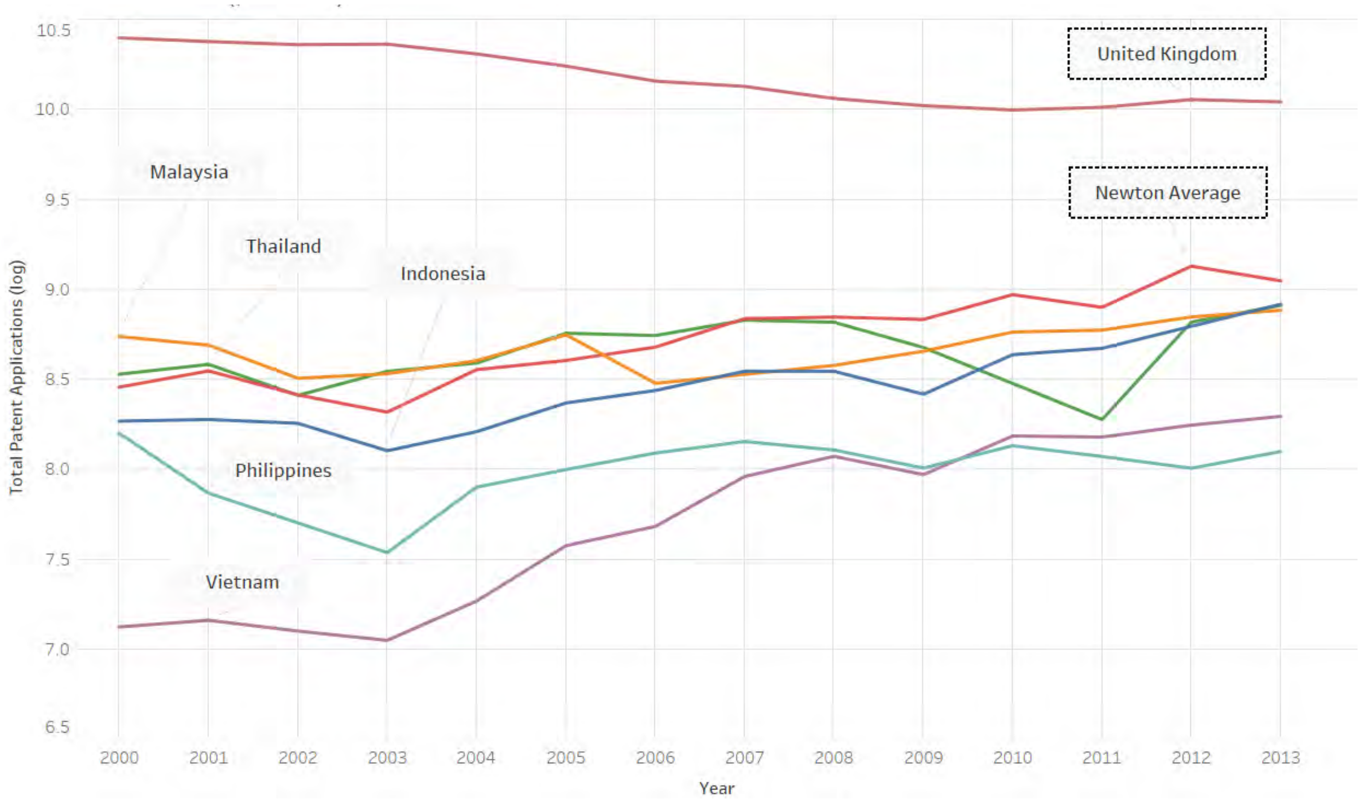
The country scores 4.76 on the Capacity for Innovation indicator used in the Global Competitiveness Index (GCI). In the 2014-15 GCI report, there was no specific discussion about Vietnam's innovation performance, although the country has significantly improved in areas such as efficiency.

For the company spending on R&D indicator – one of the country's strongest indicators in the GCI innovation pillar – Vietnam scores 3.15. University–industry collaboration in R&D has a score of 3.27.

[2] GCI defined region

The Strategy for Science and Technology Development (2011–2020) states that hi-tech products and applications should form 45% of GDP by 2020. This entails a growth rate of 5%-17% per annum, and a doubling in the IP registration rate from 2011-2015 values. It is predicted that investment in science and technology will rise to over 2% of GDP in 2020, thus training a larger number of managers and engineers. The Ministry aims to set up 60 basic research and development organisations; 5,000 science and technology enterprises; and 30 hi-tech technology and enterprise incubators by 2020.

Figure 4. Patent Applications



Source: WIPO; PACEC. Total patent applications (direct and PCT national phase entries). Log scale.

Indicators of student and research mobility

Vietnam's outbound mobility ratio was 2.38% in 2012, which is higher than the East Asia and the Pacific region[3] average. The UK is the 5th main destination for study by Vietnamese students, behind the United States, Australia, France and Japan.

Overview of research funding structure

The institutional setup has begun to incorporate market-based elements in innovation policy. In central government, broad policy guidance is provided by the executive, while more detailed policy implementation is the responsibility of ministries and agencies relevant to innovation.

The Ministry of Science and Technology (MoST) is the main ministry responsible for innovation policy design, as it is responsible for the overall governance and management of S&T policy in the country. Such policies include the development of technological potential, intellectual property, quality control and measurement.

The Ministry of Finance (MoF) has a role in developing the financing mechanisms for S&T policies, in collaboration with MoST and the Ministry of Planning and Investment (MoPI), in addition to responsibility in allocating and supervising the funds for S&T. Several important agencies are affiliated with the MoST, including the NISTPASS

[3] UNESCO Institute for Statistics defined region

think tank (National Institute for Science and Technology Policy and Strategy Studies) and the NASATI (National Agency for Science and Technology Information).

In 2008, the National Foundation for Science and Technology Development (NAFOSTED) was established, aiming to be the main funding agency for research in Vietnam. The agency's structure is based on standard international practice, in terms of the relationship between its Board of Trustees and other innovation actors such as ministries and scientific committees. In its first two years of operation, the agency has funded almost 500 research projects in natural sciences and approximately 100 in social sciences and humanities, amounting to a total approved funding of VND 400 billion (approximately £12 million).

NAFOSTED has become a significant player in R&D funding. The agency also provides support to researchers that participate in funded projects, such as collaborative research. In addition, it offers researcher mobility fellowships, international workshop organisational assistance, as well as support programmes such as the Enterprise Support Programme.

Some recent changes to the funding structure for research could considerably increase the research capacity of the country. The Vietnam National Technology Innovation Fund (NATIF) was created in 2011 with a budget of nearly VND 1,000 billion (approximately £30 million) and the aim the role of promoting the commercialisation of innovative research.

Funding initiatives similar to Newton

Table 3. Summary of major funding initiatives similar to Newton

Funding initiative	Description of activity
Innovation Partnership Programme (IPP)	Bilateral initiative between Vietnam and Finland. The programme aims to promote capacity-building and knowledge brokerage for the innovation sector in Vietnam. 60 projects were funded in the first 2009-13 phase.
Fostering Innovation through Research, Science and Technology (FIRST)	The largest science & technology programme in Vietnam with an international donor, funded by the World Bank and launched in 2013. The two priority areas of the programme are specific reforms to innovation policy and the development of Vietnam's national innovation system. The project has £73 million of funding, mostly from ODA funding.

Vietnam has collaborated with more than seventy countries, regions, and international organisations in the areas of science and technology. According to a recent SEA-EU-NET study, "*currently there are two significant international cooperation programmes in existence: the IPP (with Finland), and FIRST (with the World Bank)*".[4] These are:

- **Innovation Partnership Programme (IPP):** an ODA initiative co-funded by the Vietnamese and Finnish governments. The first phase (IPP1) took place in 2009-13 and undertook 60 projects. An evaluation of the programme found that 49% of projects had produced 'good outcomes'. Programmme activities involve forming partnerships between enterprises, public authorities and universities, with the aim of fostering capacity-building and knowledge brokerage. Finnish partner organisations, such as private sector enterprises, develop relationships with Vietnam and can establish operations and collaborations in the country.
- **Fostering Innovation through Research, Science and Technology (FIRST):** defined as "*the biggest project in science, technology and innovation funded by an international donor in Vietnam*". The project is funded by the World Bank and has two priority areas: developing Vietnam's national innovation system (NIS); and supporting specific reforms. There are three components to this project's activities, namely: supporting a stronger S&T policy framework; supporting the reform of Government Research Institutes (GRI); and developing stronger linkages between supply and demand of research. The project was allocated $110 million (£73 million) in total, with $100 million (£67 million) from ODA financing and the

[4] Degelsegger *et al.* 2014, p. 105.

remainder funded by the Vietnamese government. It began activities in 2013 and will be implemented for four years.

M&E Measures

NASATI is responsible for "*developing, analysing and diffusing S&T-related information, statistics and indicators*".[5]

The FIRST project funded by the World Bank (discussed above) is currently supporting the development of monitoring and evaluation and S&T statistics for Vietnam's innovation system. The Strategy for Science and Technology Development (2011-2020) also includes plans to develop systems of measurement, calibration, and quality control, including of science and technology enterprises and human resources.

Overview of Business-Academia collaborations

The OECD notes that in the 1996-2002 period, industry and public research organisations began to develop greater links. There was an introduction of new innovation infrastructures such as the Hoa Lac and the Saigon High-Technology Parks (SHTP).[6] During the same period, 17 Key National Laboratories were also established, with the aim to facilitate "*breakthrough research in some priority sectors of national socio-economic development*".[7]

The SHTP in Saigon was established with support from the national government and the Ho Chi Minh City administration. The park is now a base for foreign companies such as Intel and Sonion, with over 25 enterprises in operation there in 2012 (half of which were involved directly in R&D activities). The park has been "*effective in attracting foreign companies, stimulating economic activity, including employment, and integrating Vietnam in GVCs [global value chains]*".[8] The park is attractive for foreign investment because it is close to downtown Ho Chi Minh City and near to universities. An on-site training and research centre has been set up for skills development. As of July 2016, 316 industrial parks had been approved.

[5] OECD 2014, p. 187.
[6] *Ibid.*, p. 22.
[7] *Ibid.*, p. 183.
[8] *Ibid.*, p. 120.

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