

STEM professionals in the UK civil service – an international comparative study

A review of government approaches to the attraction, recruitment and retention of STEM professionals in the UK, USA, Germany, Singapore and South Korea

— Policy Links Unit, IfM ECS, University of Cambridge | July 2021



Contributors

The contributors to this briefing note are Liz Killen, Jennifer Castaneda Navarrete, Michele Palladino, David Leal-Ayala, Carlos López-Gómez and Victor Aramburu Cano. With thanks to Eoin O’Sullivan at the Centre for Science, Technology & Innovation Policy at the University of Cambridge for academic guidance and useful comments.

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Cambridge Industrial Innovation Policy, 17 Charles Babbage Road, Cambridge, CB3 0FS, United Kingdom

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1 Executive summary

Promoting the study of STEM fields has become a priority in many countries, as science-related competencies, problem-solving and quantitative analysis are considered essential in today's data-based and innovation-driven economy.¹ STEM skills are believed to play an important role in developing the technical and scientific innovation that will drive the next generation of high-value products and services across industries.

As such, successive governments, in the UK and elsewhere, have given much prominence to ensuring that the flow of graduates from STEM degrees into economic activity is appropriate and fit for purpose.² However, most of the discussions have focused on STEM professionals in the private sector, with less attention being paid to their contribution to the public sector.

Recently, there have been calls for more people with STEM qualifications to be employed within the UK civil service, for a number of reasons.

Some suggest that STEM skills are directly and vitally important to the workings of the UK government,³ for example, in the analysis that they provide.^{4,11} Some suggest that STEM skills are required for understanding certain policy issues related to science and technology, with a lack of these skills putting the UK at a disadvantage compared to other nations. Some believe that STEM offers unique insights into the future implications of new developments in science and technology,¹⁰ while others suggest that those with STEM skills bring different lenses to policy problems.¹⁶ Some propose that they operate as “translators” between the policy and science worlds, for example, in policy-making and research commissioning,¹⁰ while others suggest that they operate as links between the worlds of academia and policy.¹⁰

While there are calls for more people with STEM qualifications within the UK civil service, it is unclear how many people currently have STEM qualifications within the civil service, and how the UK compares to other nations. Do other countries' governments have more civil servants with STEM qualifications? If so,

what strategies are they using to attract and retain this talent?

This report has been prepared for the Gatsby Foundation, and it reviews levels of STEM qualifications within the civil service in the United Kingdom, aiming to extract lessons through comparison with case studies on Singapore, the United States, Germany and South Korea. This comparison study reviews STEM graduate levels between countries, and the proportion of civil service employees who are STEM graduates, identifying the influence of the government R&D landscape on the latter. These countries allow us to illustrate a diversity of practices within civil service structures, with a detailed focus on attraction, retention and remuneration for STEM professionals.

This study finds a fundamental ‘accounting’ issue of how civil servants are defined between countries, particularly around STEM researchers in governmental research organisations. This issue means it is not possible to readily separate out and compare numbers related to a “Whitehall” civil service. This study finds that the proportion of civil servants with STEM qualifications is poorly comparable between nations, because of differences in centralisation of government R&D and the fact that many countries do not report these figures.

Where figures are available, they appear to show that the UK civil service has lower proportions of employees with STEM backgrounds or in STEM occupations (~2.2–6.8%) than comparator countries, such as the USA (15.9%) and South Korea (~30%). It is likely, however, that these figures for the UK are under-estimated and may be at least as high as

9–13%. This report echoes the findings of other recent reports in identifying that better data on skills within the civil service is needed.

This is supported by analysis showing that the UK may be expected to have lower proportions of STEM-trained individuals within the civil service than comparator countries. Lower proportions of STEM-trained graduates are taking up positions in the civil service in the UK compared to non-STEM graduates,⁵ potentially because of the lower starting salaries and the lower likelihood of undertaking skilled work in their area of training. While the UK has high proportions of STEM graduates, the UK has a relatively low proportion of graduates in engineering and manufacturing compared to Germany and Korea, which may influence the relative ability of the UK civil service to attract this subset of STEM talent.

Currently, government recruitment mechanisms designed to target those with STEM qualifications, particularly those within the UK, are of insufficient size to substantially influence the proportion of STEM professionals in the overall civil service workforce. Other countries provide potential avenues for improving STEM concentrations within the civil service. For example, some countries such as Singapore use salary-matching to market-competitive rates for STEM professionals, and, unlike the USA, the UK does not have the potential to pay by performance within the civil service. The main findings of this report are summarised overleaf.

**“Science and technology
have a vital role to play
at the heart of informed
policy making.”**

**Patrick Vallance, UK Government
Chief Scientific Adviser, in 2018**



1.1 Main findings

Current evidence on STEM qualifications within the UK civil service is patchy.

- There are poor statistics around STEM qualifications within the UK civil service, while other countries such as the US and South Korea have records including degree type and STEM occupations within the civil service.
- There are general calls for more civil servants with STEM skills in the UK, primarily from the STEM community. The reasons for this are multifaceted, though in practice many are poorly evidenced and anecdotal. While shortfalls may exist, there is a lack of available evidence around any shortfalls of STEM qualifications within departments of the UK civil service.
- The proportion of civil servants with STEM qualifications is poorly comparable between nations for two reasons: (1) numbers are more of a reflection of how the country's R&D funding structures are classified within or outside government; and (2) data is limited for many countries, including the UK.

- The UK could improve its understanding of STEM qualifications within government through gathering this information through its internal HR systems, including during recruitment and annual surveys.

It is likely that there is a lower proportion of STEM professionals in the UK civil service.

- Despite overall high levels of STEM graduates, the UK has a relatively low proportion of graduates in engineering, manufacturing and architecture, which may influence the ability of the civil service to attract this subset of STEM talent. The proportion of STEM graduates overall is broadly similar to comparator nations in this report.
- Lower proportions of STEM-trained graduates are taking positions in the civil service in the UK compared to non-STEM graduates. Almost double the proportion of non-STEM graduates enter the public service in the UK (7%), compared to STEM graduates (4%), resulting in over 100%



more non-STEM graduates entering the public service than STEM graduate numbers, despite there being only around 25% more non-STEM than STEM graduates overall.

- The UK has the lowest proportion of R&D performed by government of all comparator countries in this report.
- Furthermore, the numbers of government scientists within the UK decreased by almost 20% between 2003-2018, while the number of government researchers in other countries including Germany (+52%), Korea (+141%) and Singapore (+98%) have grown significantly.

Targeted programmes for the recruitment of individuals with STEM qualifications are too small-scale to change the overall civil service workforce STEM qualifications.

- Current recruitment mechanisms designed to target STEM qualifications within the UK are of insufficient size to meaningfully increase the proportion of STEM graduates in the civil service workforce in the absence of wider, more systematic interventions.

Other countries provide examples of strategies around pay for STEM graduates, which may inform UK practice.

- Some countries such as Singapore use salary-matching to market-competitive rates for STEM professionals. The UK government does not systematically undertake salary-matching to market-competitive rates, though some newer measures are being introduced for small additional “loadings” for specific technical roles, in the same way that “London loading” increases salaries for those living within the capital.
- Unlike the USA or South Korea, the UK does not have the potential to pay by performance within the civil service.
- The more STEM graduates are in demand in the workforce, the more likely that the civil service will have to compete on benefits, job stability and performance recognition.

2 Introduction

Calls to employ more people with Science, Technology, Engineering and Mathematics (STEM) skills within the UK civil service are often framed as a question of competitive advantage, relative to other nations. However, it is unclear how many people currently have STEM skills within the UK civil service, and how the UK compares to other nations. Do other countries' governments have more civil servants with STEM qualifications? If so, what strategies are they using to attract and retain this talent?

This report aims to compare STEM graduate levels between countries, and the proportion of civil service employees who are STEM graduates, and identifies the influence of the structure of government R&D on these factors. This study aims to review international practices and mechanisms used in the recruitment, retention and training of STEM professionals in the civil service. The focus on these factors allows us to understand the key systematic factors influencing the proportion of STEM graduates in the civil service.

This report has been prepared for the Gatsby Foundation, and it reviews STEM graduates within the civil service in the United Kingdom in-depth, with brief case studies from Singapore, the United States, Germany and South Korea. While selection was supported by comparability with the UK context and evidence availability, these countries were chosen to allow us to illustrate a diversity of practices, settings and civil service structures. This includes a detailed focus on their attraction, retention and remuneration as key mechanisms by which STEM qualifications are attracted and rewarded.

Why study STEM skills?

Promoting the study of STEM fields has become a priority in many countries, as science-related competencies, problem-solving and quantitative analysis are considered essential in today's data-based and innovation-driven economy.⁶ STEM skills are believed to play an important role in developing the technical and scientific innovation that will drive the next generation of high-value products and services across industries. As such, successive governments, in the UK and elsewhere, have given much prominence to ensuring that STEM subjects at earlier years⁷, and the flow of graduates from STEM degrees into economic activity, is appropriate and fit for purpose.⁸

However, most of the focus thus far has been on the development, provision and accessibility of the pipeline of STEM workers for the business sector. Little attention has been paid to the role of STEM professionals in the civil service. While civil service reform has been a recurring concern for governments, the focus has primarily been on managerial, governance and budgetary practices.⁹

This study aims to review international practices and mechanisms used in the recruitment, retention and training of STEM professionals in the civil service. The focus on these factors allows us to understand the key systematic factors influencing the proportion of STEM graduates in the civil service. In a 2013 UK government report, the challenges to the recruitment of STEM skills within the UK civil service were identified, including the fact that, "as a modern employer, we should expect flow of staff in and out of the civil service",¹⁰ highlighting the importance of these recruitment and retention mechanisms, as well as the level of STEM skills in the wider economy. While remuneration levels and recruitment strategies may have varying levels of importance at an individual level, they are important systematic factors, known to drive trends in labour forces, which will have a significant effect when considered in aggregate across the civil service.

STEM professionals within the UK civil service

Within the UK, the idea of a “scientific civil service” dates back as far as the end of the Second World War,^{10,11} with the “Scientific Civil Service” White Paper making recommendations around the employment of scientists, while the first Government Chief Scientific Adviser (GCSA) was appointed in 1964.¹² In 1968 the Fulton Report’s controversial idea of the “amateur” civil servant, who moved from job to job every two to three years, “often in a very different area of government activity”,¹³ caught on, and the preference for generalists within the civil service still resonates today. Speaking at the launch of the UK’s Civil Service Workforce Plan in 2016, MP Matt Hancock proclaimed: “Gone are the days of the gifted amateur. Today’s world is too complex and demands are too high.”¹⁴ In recent years the identification of skills required in government has been supported by the development of “functions”,²¹ which include science, engineering and data, among other topics such as policy skills.

Why are STEM skills needed within the UK civil service?

While increased levels of STEM skills are called for in the UK civil service, this is primarily from within the scientific community itself, and the rationale behind this varies between sources:

- Some suggest that STEM skills are directly and vitally important to the workings of the UK government,¹⁵ for example, in the analysis that they provide.^{16,11}
- Some insinuate that those without STEM skills are not capable of understanding issues related to science and technology, putting the UK at a disadvantage.¹⁷
- Some believe that they offer unique insights into the future implications of new developments in science and technology,¹⁰ while others suggest that those with STEM skills bring different lenses to policy problems.¹⁶
- Some propose that they operate as “translators” between the policy and science worlds, for example, in policy-making and research commissioning.¹⁰
- Others suggest that they operate as links between the worlds of academia and policy,¹⁰ though this is primarily for high-visibility posts such as CSAs.
- Others suggest that individuals with STEM skills should be intrinsically motivated to work in the civil service, because of the types of work available.¹⁶
- Some suggest that people with STEM skills should work in non-STEM roles.¹⁸

Box 1: The UK government’s chief scientific adviser, Sir Patrick Vallance, argues that the civil service needs more scientists and engineers.

From The Guardian,¹ January 2020:

Britain’s civil service is suffering from a serious lack of scientific talent that threatens its ability to compete with nations such as China. That is the stark view of the government’s own chief scientific adviser, Sir Patrick Vallance.

In a rare interview, Vallance said a dearth of scientists and engineers in government posed major problems for the nation as it attempts to deal with the threats of climate change, an ageing population and tightened national security.

Vallance is backing a major push inside the civil service to boost numbers of science and engineering graduates. ““This is the one thing in my tenure that I want to get fixed,” he said.”

Not everyone agrees that the answer lies in more STEM skills alone.¹⁹ The OECD report on “Skills for a High Performing Civil Service” identified key skills in order for a civil service to be: developing policy, citizen engagement, service delivery, commissioning and contracting services, and for managing in and through networks²⁰ – though subsets of these undoubtedly involve STEM competencies. There are also some organisations that suggest that sufficient STEM skills may be present within government, yet under-utilised because of poor data.²¹ However, there is a general view within the government science community that more civil servants with STEM skills would result in a net positive for government policy-making (see Box 1).

There is insufficient data to assess whether there is a shortage of STEM skills within the UK civil service

Despite the rationale behind increasing STEM representation, the STEM backgrounds of civil servants within the UK are not recorded, and there are no reliable figures on whether these numbers are increasing, decreasing or stagnating, and how they compare with other specialisations. It is unclear what type of government departments or agencies most commonly employ STEM professionals, and in what functions they are employed (e.g. technology-related work or generic tasks). It is unclear whether there are any shortages or difficulties in recruiting civil servants in STEM roles within the UK government, or any differences in the quality of STEM graduates attracted relative to industry. While it may be the case that there is a need for further STEM skills in the civil service, there is no clear evidence around how explicit requirements for STEM qualifications have failed to be addressed using existing recruitment procedures.

It is also unclear in many cases how STEM qualifications would serve to enhance role performance above role-specific training, and, if these are required, why they would not be explicitly included in job descriptions upon hiring. There is a lack of evidence on the role of STEM expertise in driving successful policy design and implementation across government departments and agencies. Furthermore, it is uncertain whether STEM skills are used or valued to their full potential in the civil service – in a 2013 survey of over two thousand

government scientists and engineers,¹⁰ 40% felt their skills were under-used or under-valued, and 45% were negative about the career prospects in the civil service. This is supported by IfG research, which proposes that: “Despite criticism, there is no shortage of skills in areas like science, engineering, digital, data and analysis, but poor-quality data on staff skills means that the civil service under-uses the wide range of skills it should be able to access.”²¹

For the purposes of this report, it is still worth examining the STEM qualifications within government, as the multi-faceted nature of the rationale behind increased STEM skills suggests that even without an explicit deficit of STEM skills, increased STEM skills may still provide positive results. Furthermore, anecdotal evidence suggests that there are STEM skills shortages within government, but these appear to vary in severity by subject.

Civil service versus public service

Definitions of a country’s civil service, as distinct from its wider public service, are captured in each of the individual case studies. Generally speaking, the public service includes members of the armed forces and police and employees of health systems, while the civil service does not include these. The civil service generally includes central government departments, and the degree to which it includes their agencies, and non-departmental government bodies, varies between countries.

As such, this study finds a fundamental ‘accounting’ issue of how civil servants are defined between countries, particularly around STEM researchers in governmental research organisations. This issue means it is not possible to readily separate out and compare numbers related to a “Whitehall” civil service.

STEM roles within the civil service

Box 2: Definition of STEM, from the UK's National Audit Office, 2018:²²

STEM stands for science, technology, engineering and mathematics. In education, it means the study of these subjects, either exclusively or in combination. In employment, STEM refers to a job requiring the application of science, technology, engineering and mathematics skills or a qualification in a relevant subject, or located in a particular industry or sector. There is no universally accepted definition in either setting.

STEM skills are believed to play an important role in developing the technical and scientific innovation that will drive the next generation of high-value products and services across industries. The importance of STEM skills for the UK (see Box 3, below) identifies their role in competitiveness, productivity, growth and the economy more widely. The overwhelming majority of reports in this area identify a current and ongoing STEM skills shortage within the UK, though some, including the UK's National Audit Office, suggest that "Existing evidence indicates that there is a STEM skills mismatch rather than a simple shortage",²² a view echoed by the OECD.²³

Box 3: The Importance of STEM skills for the UK

*STEM skills are widely accepted to be of critical importance to the future international competitiveness of the UK and play a key role in driving productivity, growth and higher living standards.*²⁴ – UK Commission for Employment and Skills, 2015

*Since the early 2000s there has been growing concern, including from government, about how to achieve higher productivity and economic growth in an era of rapid technological change. Over time, this has generated the widely held belief that one of the UK's key economic problems is a shortage of STEM skills in the workforce. Most recently, the November 2017 policy paper, *Industrial Strategy: Building a Britain fit for the future*, stated that "...we need to tackle particular shortages of STEM skills. These skills are important for a range of industries from manufacturing to the arts".*²⁰ – The UK's National Audit Office, 2018

*STEM skills are critical to innovation and in creating a competitive edge in knowledge-intensive economies.*²⁵ – European Commission, 2015

*STEM skills are crucial for the UK's productivity, and a shortage of STEM skills in the workforce is one of our key economic problems.*²⁶ – House of Commons Committee on Public Accounts, 2018

The STEM skills identified are hard to identify, but some idea of the most in-demand skills can be obtained by looking at job descriptions. For example, some STEM skills identified as desirable by employers in UK STEM job descriptions in 2018 included: management, engineering, testing, communications, operations, manufacturing, training, maintenance, auditing, finance, repairing, analysis, information technology, technical support, computer-aided design, information security, computer science, programming, agile software development and infrastructure.²⁷ In specific industries, skills further included: ecology, mechanical engineering, software development, pharmaceuticals and chemistry.

For civil servants, the applications of STEM qualifications vary. STEM civil servants occupy a wide range of roles within government (see Box 4 below).

Box 4: Roles for individuals with STEM qualifications within the civil service

While this box lists general roles that may be filled by individuals with STEM qualifications, there are further examples of specific STEM roles in Box 5 on page 24.

STEM specialist roles within the civil service may include:

- conducting STEM R&D within public or national laboratories;
- providing technical advice and technical expertise (e.g. vets, engineers, microbiologists);
- providing science and engineering advice and analysis to inform policy;
- championing science and engineering evidence within government;
- working in STEM roles within state-owned enterprises or public laboratories*;
- IT design, management, maintenance and support;
- designing, developing, testing and evaluating science and engineering services; and
- analysing results of R&D for government.

Further roles in which people with STEM backgrounds may provide added value, yet not all individuals within these roles will necessarily have a STEM background:

- project management on scientific or engineering projects;
- strategic roles, for example, foresight, horizon scanning, emerging technologies;
- evidence synthesis;
- grant coordination and monitoring roles;
- commissioning and managing R&D;
- monitoring, inspecting, enforcing and advising on regulations; and
- quality assurance.

People with STEM backgrounds may also work in non-specialist roles within the civil service:

- civil servants may also bring their STEM qualifications, knowledge and the scientific method to bear in roles that do not explicitly require STEM skills. These roles include policy development and delivery, regulation and management, among others.

*Inclusion of these individuals as civil servants varies by government and organisation.

Interestingly, most of those calling for increased STEM qualifications within the UK government exclude economists from this category. While economics relies on core statistical skills common to many STEM subjects, and there are trends toward classifying economics as within STEM, particularly at university level.²⁸ What this does show us is the contrast of the status of economics as a well-established, institutionalised source of evidence within government, with the perception of STEM inputs as less structurally embedded within policy-making.

While the importance of STEM qualifications at all levels is acknowledged, in many instances this study is forced to limit itself to graduate-level STEM qualifications because of the lack of availability of data for technician-level STEM qualifications.

3 Comparative study

This section collates the findings from comparative case studies within this report and draws out their implications for the UK context.

Section 3.1 identifies that the UK has comparable proportions of STEM graduates at the tertiary level; however, the proportion of engineering graduates is low relative to Germany and South Korea, for example.

Section 3.2 identifies that the proportion of civil servants with STEM qualifications is poorly comparable between nations because of differences in the categorisation of those conducting government R&D, and the fact that many countries do not report these figures. From what data that is available, we might expect there to be proportionately fewer STEM graduates within the UK civil service than in international counterparts. There is poor information for the proportion of STEM graduates in the civil service in the UK (~2.2-6.8%), Singapore and Germany, but better information for the USA (15.9%) and South Korea (~30%). The UK has the lowest proportion of R&D performed by the governments of all comparator countries, and the total number of government researchers in the United Kingdom has been steadily falling since 2000, unlike other countries in this sample where numbers have been increasing.

Section 3.3 identifies the fact that recruitment mechanisms designed to target STEM qualifications, particularly those within the UK, are of insufficient size to substantially alter the characteristics of the civil service workforce in the absence of wider, systematic interventions. Unlike Singapore and South Korea, the UK does not have mechanisms to “headhunt” talent into roles.

Section 3.4 identifies that, within the UK, the civil service is generally not seen as a desirable employer for recent graduates in STEM fields. The combined potential for a lower starting salary, alongside the lower likelihood of undertaking skilled work in their area of training, results in lower proportions of science-trained graduates taking roles in the UK civil service. These are elaborated within the UK case study in Section 4.2.

Section 3.5 gives a brief overview of interesting practices identified in other countries, which are expanded on in the appendix.

3.1 STEM graduate levels between countries

Differences in the STEM qualifications within the civil service may reflect the differences in the availability of STEM qualifications between countries.

Overall, the tertiary-educated proportion of the population is largely similar between the countries studied (see Table 1 below), and the UK’s level of tertiary education attainment in 25-64 year olds at 47% is well above the OECD average of 38%. However, the perceived ease of access to skilled employees in countries varies, and it is not necessarily commensurate with the education rate in the wider population – particularly in the case of South Korea. It is possible that differences in competition for skilled labour from industry may drive differences in the public-sector responses to skilled labour.

TABLE 1 TERTIARY EDUCATED POPULATION AND HUMAN CAPITAL INDICES OF THE COUNTRIES STUDIED. SOURCE: WORLD ECONOMIC FORUM HUMAN CAPITAL INDEX 2016. NOTE: IN BOTH RANKINGS, HIGHER SCORES INDICATE MORE FAVOURABLE RESULTS, AND RANKINGS ARE THE POSITION OUT OF 130 COUNTRIES. *DATA FROM THE UK INNOVATION REPORT, 2021.

WEF Human Capital Index 2016 *unless otherwise indicated	Germany	South Korea	Singapore	United States	United Kingdom
Total population ('000s)	80,682	50,504	5,697	324,119	65,111
Tertiary-educated population (% total pop.)	19%	26%	22%	21%	21%
Tertiary education, % 25-64 years, 2019*	30%	50%	Not available	48%	47%
Ease of finding skilled employees (rank)	21	46	20	10	28
Human Capital Index 2016 overall (rank)	11	32	13	24	19

Within this labour market, how does the distribution of STEM-educated individuals vary between subjects in each country's graduate market? Looking at the most recent figures available in Table 2, we can see that the proportions of STEM graduates between these countries are remarkably similar, albeit distributed differently between the sciences, engineering and health fields, with 35% of graduates in the UK being in STEM fields. The total number of students enrolled in STEM undergraduate courses in the UK between 2009/10 and 2017/18 increased by 17.6%, while non-STEM subject areas increased by 9% over the same period⁵.

From this perspective, the UK has a relatively low proportion of graduates in engineering, manufacturing and architecture (9%), which may influence the ability of the civil service to attract this talent.

TABLE 2 GRADUATES BY FIELD OF EDUCATION, AS A PERCENTAGE OF ALL GRADUATES. BASED ON OWN ANALYSIS OF OECD DATA FOR 2018. CATEGORIES BASED ON ISCED 97 DEFINITIONS. DATA FOR SINGAPORE WAS NOT AVAILABLE.

Graduates by field of education, 2018, as a % of all graduates						Total STEM graduates (% all grads)
Country	Sciences, maths, computing	ICT	Engineering, manufacturing, construction, architecture	Health	Agriculture, forestry, fishery	
Singapore	5%	9%	20%	9%	0.2%	42%
Germany	6%	5%	23%	5%	2%	42%
Korea	6%	5%	21%	13%	2%	46%
United States	10%	4%	7%	14%	1%	37%
United Kingdom	17%	4%	8%	13%	1%	44%

3.1 STEM graduate levels between countries

The expenditure on R&D by the government, including the extent to which this is done within-government, can affect the number of individuals with STEM qualifications within a civil service. The degree of centralisation and classification of R&D activities within or outside the government varies between countries, and this is the primary determinant of the total number of researchers within the civil service.

There are significant differences in spending on R&D between countries within this study, with the United Kingdom performing the most poorly over the past 20 years as a proportion of GDP spent on R&D. This R&D expenditure has obvious repercussions for the proportion of researchers in each country, particularly in the case of Korea, which has both the highest R&D as a percentage of GDP and the most researchers per capita. The UK has the lowest proportion of R&D performed by government of all comparator countries (see Figure 1).

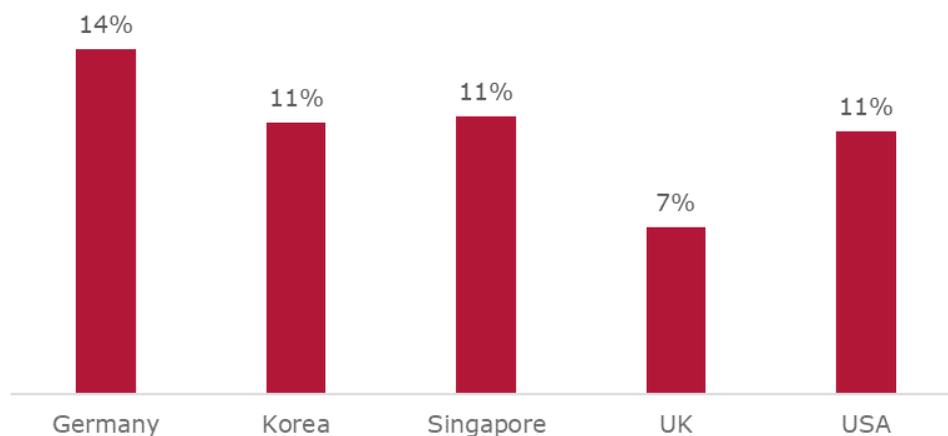


FIGURE 1 THE PROPORTION OF GERD PERFORMED BY GOVERNMENT, AVERAGE FOR 2013-2018, AS A % OF TOTAL GROSS EXPENDITURE ON RESEARCH & DEVELOPMENT. SOURCE: UNESCO DATA

Rather than being the result of any active strategy, the overall numbers reflect the bureaucracy of research funding, and as such they represent a relatively unhelpful statistic when comparing systems between countries (see Figure 2).

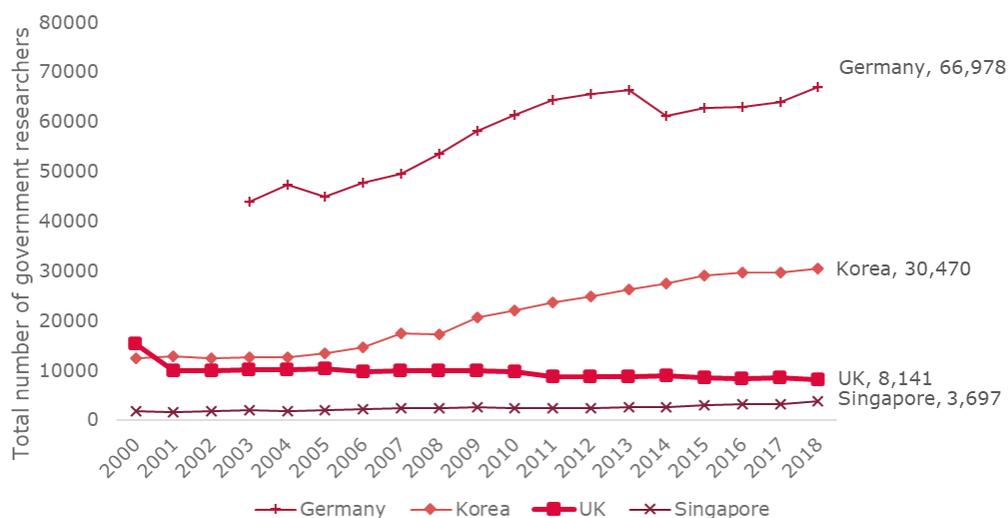


FIGURE 2 TOTAL NUMBER OF GOVERNMENT RESEARCHERS BY COUNTRY, 2000-2018. NOTE THAT DATA IS NOT AVAILABLE FOR THE USA. SOURCE: OECD DATA

Only 2.8% of all UK researchers between 2010 and 2014 worked in the government sector.²⁹ However, it is interesting to note within-country variations over time. For example, within the United Kingdom the total number of government researchers has been steadily falling since 2000, while numbers for all other countries in this sample have been increasing.

Difference in the number of government researchers between 2003 and 2018



FIGURE 3 DIFFERENCE IN THE NUMBER OF GOVERNMENT RESEARCHERS BY COUNTRY BETWEEN 2003 AND 2018, AS A PERCENTAGE OF 2003 NUMBERS. 2003 DATA WAS USED, AS EARLIER DATA IS NOT AVAILABLE FOR GERMANY. NOTE THAT DATA IS NOT AVAILABLE FOR THE USA. SOURCE: OECD DATA

As a result of these differences in the statistics around the R&D landscape of government, most statistics around the proportion of STEM professionals in the civil or public service are poorly comparable and more dependent on what is classed as a public service role within that country. This can vary even within, the UK, where Government Science Engineering (GSE) profession includes members from public laboratories not necessarily classified as civil servants.

3.3 Recruitment mechanisms

Recruitment mechanisms designed to target STEM qualifications, particularly those within the UK, are of insufficient size to substantially alter the characteristics of the civil service workforce in the absence of wider systematic interventions.

Within the UK, recruitment mechanisms promoted to specifically attract scientists and engineers to the civil service are of insufficient scale to affect the overall composition of the workforce. Within the UK, for example, the Science and Engineering Fast Stream takes fewer than twenty candidates each year,³⁰ while the Government Office for Science Graduate Internship programme has an annual intake closer to a dozen – together these represent 0.007% of the size of the UK civil service.³¹ In comparison, on any given day there are regularly as many as 600–1,000+ current jobs advertised externally through the civil service website.³² It is clear that, despite the contribution and symbolic importance of these schemes, without large-scale programmes, the overriding influence on the proportion of STEM graduates in the civil service will be affected by standard recruitment practices and the differential retention of STEM graduates within the civil service.

Extending this, the use of internal recruitment, particularly in times of austerity or reductions in numbers, as was the case between 2009 and 2017 in the UK,³³ should be expected to perpetuate existing levels of skills and diversity within the civil service. This policy of internal-only advertising of roles, except under exceptional circumstances, highlights that, within the UK civil service that, policy experience and skills are deemed more valuable than external experience and skills.

There are some examples of active recruitment of STEM specialists in other countries. South Korea manages a database with the curricula of specialists in different areas and uses it to headhunt candidates for highly specialised posts. Unlike Singapore and South Korea, the UK does not have mechanisms to “headhunt” talent into roles. While this assists in avoiding corruption within the civil service, it prevents managers from promoting

employees based on their performance. Currently, there is no way that prior performance can be factored into consideration of a promotion, except in an applicant's self-report, when they apply for a higher role. Headhunting is more limited in the UK civil service and primarily done through the use of contracted recruiters for extremely senior specialised positions only (e.g. CSAs).

3.4 Remuneration and retention of STEM professionals

As detailed in the UK case study in Section 4.2, within the UK the civil service is generally not seen as one of the most desirable employers for recent graduates in STEM fields. Despite its positive attributes, including work-life balance, pensions and meaningful work, the combined potential for a lower starting salary, alongside the lower likelihood of undertaking skilled work in their area of training, results in lower proportions of science-trained graduates taking roles in the UK civil service.

The employment status of STEM professionals in the public service varies depending on the structure of public-funded R&D. In some countries, central public administration agencies perform R&D, and in these cases STEM professionals are subject to most of the same rules and payment scales of civil servants, while in the second they have their own guidelines and salaries. This can significantly affect recruitment processes, job security, pay scales, opportunities for promotion and performance pay, and benefits – all of which combine to affect the desirability of a role in the civil service either positively or negatively. Similarly, wider trends in unemployment can be seen to increase the desirability of civil service roles to all individuals, including STEM individuals, in cases of higher unemployment.

Unlike in Singapore, the UK government does not match salaries to market competitive rates, though some newer measures are being introduced for small-scale increases for specific skills. Unlike the USA, the UK does not have the potential to pay people by performance within the civil service.

3.5 Interesting practices identified in other countries

This report identified a number of interesting practices within other countries, which are elaborated on further in the Appendix. Some of these include:

- Singapore's civil servant bonuses are partially linked to the nation's economic performance.
- In Singapore, government scholarships sponsor study at local and international universities, and upon graduation these individuals are bonded to work for a fixed number of years in the civil service. It is illustrative that 16 of the 20 permanent secretaries in post in 2009 had previously held these scholarships³⁴.
- In the US civil service there is a special classification, the service and professional, for posts that "[...] are engaged in research and development in the physical, biological, medical, or engineering sciences, or a closely related field",³⁵ and agencies pay these employees according to internally agreed performance targets.
- Within Germany, large numbers of scientists are employed in highly regarded research associations, with mixtures of public and private funding mechanisms, as public servants.
- South Korean civil servants have mechanisms to appoint those with Master's or PhD qualifications at higher entry-level positions.



4 STEM Professionals in the UK Civil Service

4.1 Overview of the UK's civil service and STEM

STEM professionals in the UK civil service

As of March of 2020, the UK civil service workforce amounted to 456,410 people. The exact number of people within the UK civil service with a STEM background is not known, even to the government. There are various estimates:

- According to the ONS, 3.6% of civil servants were working in science and engineering, which is equivalent to 16,431 people, and 3.2% in digital, data and technology, equivalent to 14,605 people.³⁶
- The civil service has 12 “functions”, of which two are closely related to STEM: analysis and digital. The analysis function encompasses around 17,000 civil servants that generate research and disseminate studies. The Government Digital Service works to digitise public services; to build platforms for digital identity; to ensure the quality of government data; and to provide support on information technology procurement. It employs approximately 750 people.^{37,38}
- Office For National Statistics data identifies the proportion of those working as Science, Engineering, Tech Professionals within the broader category of “Public administration and defence; compulsory social security” as 5.5% between 2009-2018³⁹.

- The Government Science and Engineering (GSE) profession is one of five government analytical professions in the civil service that provides evidence for policy. The GSE Team in the Government Office for Science (GO-Science) manages the profession. The profession comprises approximately 10,000 people, including researchers at labs and institutes⁴⁰ – though more recent estimates put this figure as high as 30,000.⁴¹

All of these estimates place the number of STEM graduates within the UK civil service at approximately 2.2–6.8% of the total workforce. However, these are very likely to be under-estimates. In 2018 STEM disciplines accounted for 44% of all graduates in the UK, and 18% of the total UK workforce are STEM graduates.⁵

Our analysis of the 2020 civil service statistics indicate that 9–13% of the civil service are likely to be within STEM professions. This is a figure significantly higher than previous estimates, and while this may be an overestimate due to lack of detail in profession classification, we believe the existing values of 2-7% may be underestimates for the proportion of those with STEM backgrounds within the civil service.

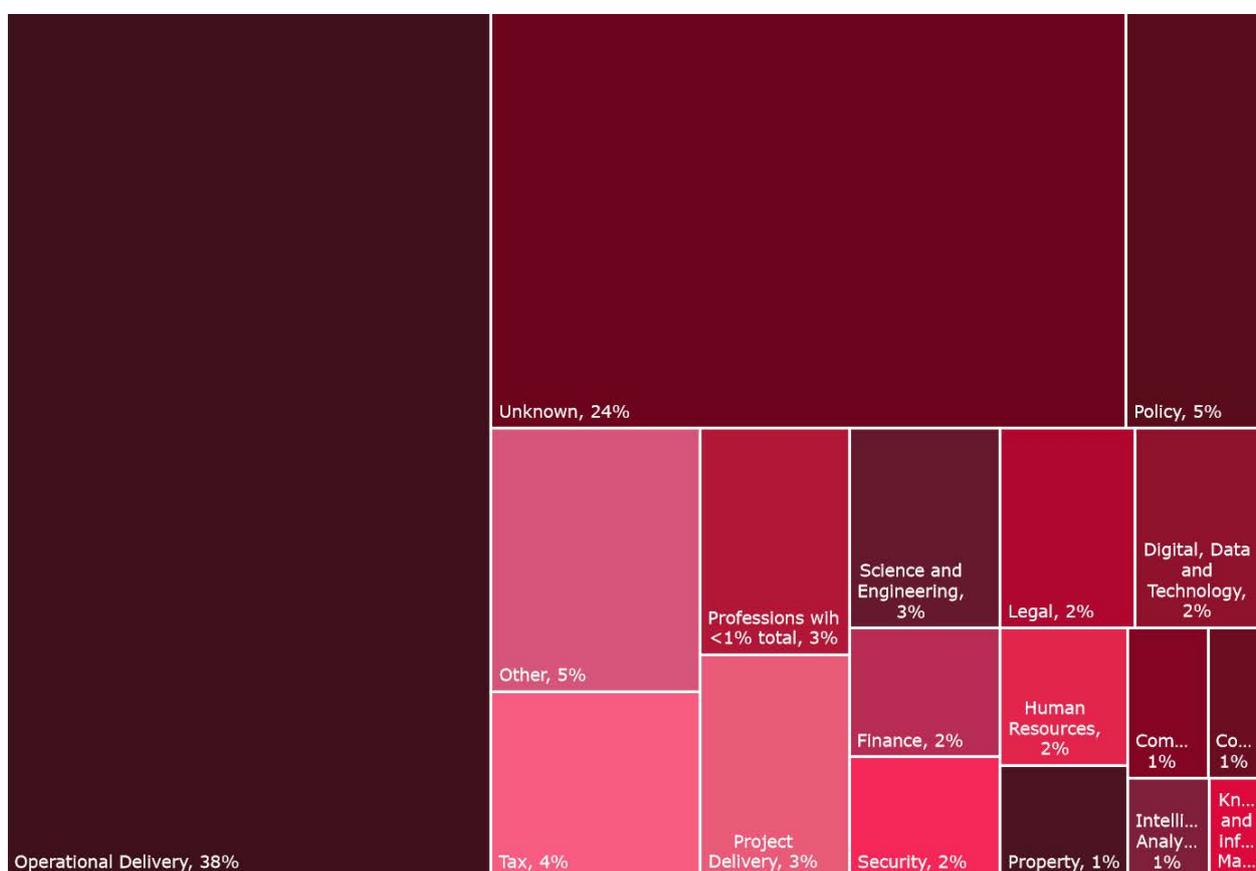


FIGURE 4 CIVIL SERVICE EMPLOYMENT; PROPORTION OF FTE EMPLOYEES BY PROFESSION, 31 MARCH 2020 (THESE REPRESENT THE ROLE CLASSIFICATION, RATHER THAN TRAINING OF THE INDIVIDUAL WITHIN THAT ROLE. VALUES THAT REPRESENT LESS THAN 2% OF THE TOTAL CIVIL SERVICE EMPLOYMENT, IN ORDER OF DECREASING SIZE, INCLUDE: PROPERTY, COMMERCIAL, COMMUNICATIONS, INTELLIGENCE ANALYSIS, KNOWLEDGE AND INFORMATION MANAGEMENT. PROFESSIONS WITH <1% TOTAL ARE NOT LISTED HERE.)⁴²

Departmental concentrations of STEM graduates

In a survey levied in 2013 of over two thousand government scientists and engineers,⁴³ many worked for departments including BIS (now BEIS), Defra and the MoD, agencies including the Defence Science and Technology Laboratory (dstl), the Met Office, the Environment Agency, the Animal Health and Veterinary Laboratories Agency, and Natural England, as well as the wider public sector (NHS, Research Council, local governments, etc.). However,

the survey was sent to people who had self-identified and registered for the GSE profession within government, and visibility varies between different departments, rendering these figures unreliable.

More reliable are estimates based on the professions in the ONS Civil Service Statistics 2020, but there are still some gaps in the available figures because of non-reporting by large proportions of the civil service, particularly within the DfT and DWP.

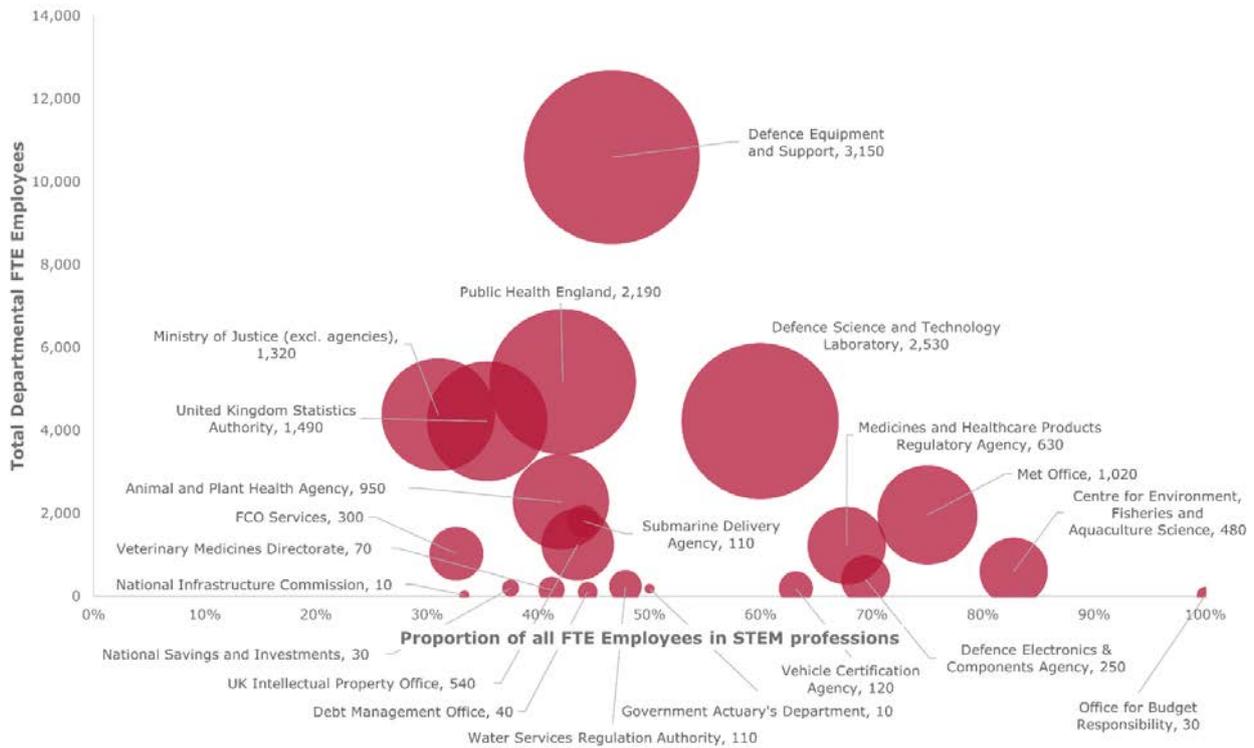


FIGURE 5 THE TOP 20 UK GOVERNMENT DEPARTMENTS AND AGENCIES, BY PROPORTION OF STEM PROFESSIONALS⁴⁴. THE X-AXIS REPRESENTS THE PERCENTAGE OF EMPLOYEES WITHIN STEM PROFESSIONS WITHIN THAT DEPARTMENT, THE Y-AXIS REPRESENTS THE TOTAL SIZE OF THE DEPARTMENT, AND THE SIZE OF THE BUBBLE AND NUMBER ATTACHED TO THE LABEL REPRESENTS THE NUMBER OF STEM PROFESSIONALS WITHIN THAT DEPARTMENT. THIS ANALYSIS IS BASED ON ONS CIVIL SERVICE STATISTICS: 2020.

An assessment of areas within government with higher proportions of STEM professionals, as defined by government professions, is shown in Table 3 (below).⁴⁵ The agencies with the highest total number of STEM professionals include: the Ministry of Defence, Defence Equipment and Support, the Defence Science and Technology Laboratory, Public Health England and HM Revenue and Customs. The agencies with the highest proportion of STEM professionals include: the Office for Budget Responsibility: Centre for Environment, Fisheries and Aquaculture Science, the Met Office, Defence Electronics and Components Agency, Medicines and Healthcare products Regulatory Agency, the Vehicle Certification Agency and the Defence Science and Technology Laboratory.

TABLE 3 PROPORTION OF STEM PROFESSIONALS BY DEPARTMENT. OWN ANALYSIS BASED ON ONS CIVIL SERVICE STATISTICS, 2020

Proportion of STEM professionals by department or agency		% STEM, Low-bound estimate	% STEM, High-bound estimate
Department or agency	Total number of STEM professionals	% STEM professionals of all FTE employees	% STEM professionals of all FTE with identified professions
Office for Budget Responsibility	30	100%	100%
Centre for Environment, Fisheries and Aquaculture Science	480	80%	83%
Met Office	1,020	52%	75%
Defence Electronics and Components Agency	250	63%	69%
Medicines and Healthcare products Regulatory Agency	630	52%	68%
Vehicle Certification Agency	120	63%	63%
Defence Science and Technology Laboratory	2,530	60%	60%
Water Services Regulation Authority	110	46%	48%
Defence Equipment and Support	3,150	30%	47%
Debt Management Office	40	36%	44%
UK Intellectual Property Office	540	43%	44%
Public Health England	2,190	42%	42%
Animal and Plant Health Agency	950	42%	42%
Veterinary Medicines Directorate	70	44%	41%
United Kingdom Statistics Authority	1,490	35%	35%
National Infrastructure Commission	10	33%	33%
FCO Services	300	29%	33%
Ministry of Justice (excl. agencies)	1,320	30%	31%
Companies House	280	29%	29%
Department for Environment, Food and Rural Affairs (excl. agencies)	1,280	27%	27%
UK Hydrographic Office	200	25%	26%
Office of Rail and Road	80	26%	26%
The National Archives	110	22%	26%
UK Supreme Court	10	20%	25%
Food Standards Agency	240	20%	23%
Ministry of Defence	5,460	15%	23%
Wilton Park	20	25%	22%
Department for International Development	510	20%	22%
Department of Health and Social Care (excl. agencies)	340	21%	22%
Ofqual	50	23%	21%
Health and Safety Executive	470	20%	20%
Competition and Markets Authority	170	20%	20%
Charity Commission	70	18%	19%
UK Export Finance	60	18%	18%
Welsh Government	860	16%	18%
Department for Education	860	17%	18%
Office of Gas and Electricity Markets	150	16%	18%
Crown Commercial Service	100	16%	16%
Ministry of Housing, Communities and Local Government (excl. agencies)	350	16%	16%
Office for Standards in Education, Children's Services and Skills	230	14%	16%

Proportion of STEM professionals by department or agency		% STEM, Low-bound estimate	% STEM, High-bound estimate
Department or agency	Total number of STEM professionals	% STEM professionals of all FTE employees	% STEM professionals of all FTE with identified professions
HM Treasury	240	15%	15%
Department for International Trade	330	15%	15%
Department for Business, Energy and Industrial Strategy (excl. agencies)	610	14%	14%
Driver and Vehicle Licensing Agency	710	13%	13%
Department for Digital, Culture, Media and Sport	140	11%	12%
HM Land Registry	600	12%	12%
Serious Fraud Office	40	9%	9%
Advisory, Conciliation and Arbitration Service	80	9%	9%
UK Space Agency	20	9%	8%
Maritime and Coastguard Agency	80	7%	7%
Planning Inspectorate	50	7%	7%
Institute for Apprenticeships and Technical Education	10	6%	7%
Registers of Scotland	70	6%	6%
Insolvency Service	100	6%	6%
HM Revenue and Customs	3,340	6%	6%
Home Office	1,710	5%	6%
Driver and Vehicle Standards Agency	250	6%	6%
National Crime Agency	230	5%	5%
Scottish Courts and Tribunals Service	80	5%	5%
Government Internal Audit Agency	20	5%	5%
Scottish Prison Service	160	4%	4%
Criminal Injuries Compensation Authority	10	4%	4%
Education and Skills Funding Agency	60	3%	3%
Crown Office and Procurator Fiscal Service	60	3%	3%
Crown Prosecution Service	160	3%	3%
Her Majesty's Courts and Tribunals Service	380	3%	3%
Government Legal Department	50	2%	3%
Her Majesty's Prison and Probation Service	1,260	3%	3%
Legal Aid Agency	20	2%	2%
Valuation Office Agency	50	2%	2%
Foreign and Commonwealth Office (excl. agencies)	20	0%	0%
Attorney General's Office	0	0%	0%
Crown Prosecution Service Inspectorate	0	0%	0%
Standards and Testing Agency	0	0%	0%
Teaching Regulation Agency	0	0%	0%
Rural Payments Agency	0	0%	0%
ESTYN	0	0%	0%
Office of the Public Guardian	0	0%	0%
Northern Ireland Office	0	0%	0%
Wales Office	0	0%	0%

R&D funding in the UK civil service

The UK government's own review of government science capability reported in its findings that:

Whilst there are pockets of excellence, science activity and expenditure is variable across government and weak and fragmented in some departments. Science budgets have reduced in many departments and spend on R&D in some cases is a fraction of one percent of total spend. Better leadership and delivery of science, and a greater use of science in departments and across government would create a stronger evidence base for decision making, enhance government performance and contribute to government social goals and economic growth.

PATRICK VALLANCE, GOVERNMENT CHIEF SCIENTIFIC ADVISER

IN THE FORWARD TO THE SCIENCE CAPABILITY REVIEW CONDUCTED BY THE UK GOVERNMENT OFFICE FOR SCIENCE, NOVEMBER 2019

Excluding protected department R&D budgets, such as expenditure on foreign aid by what was the Department for International Development, expenditure on R&D has been steadily declining since 2005. The disproportionate reductions and lack of R&D funding⁴⁶ for many departments may contribute to the lack of ability of civil servants to commission relevant research from UK academics on policy issues of interest, and this type of activity would require STEM-literate individuals for the framing, commissioning and interpretation of this sort of R&D, the commissioning ability of which varies significantly by department, as do the budgets devoted to R&D expenditure (see Figure 6, below).

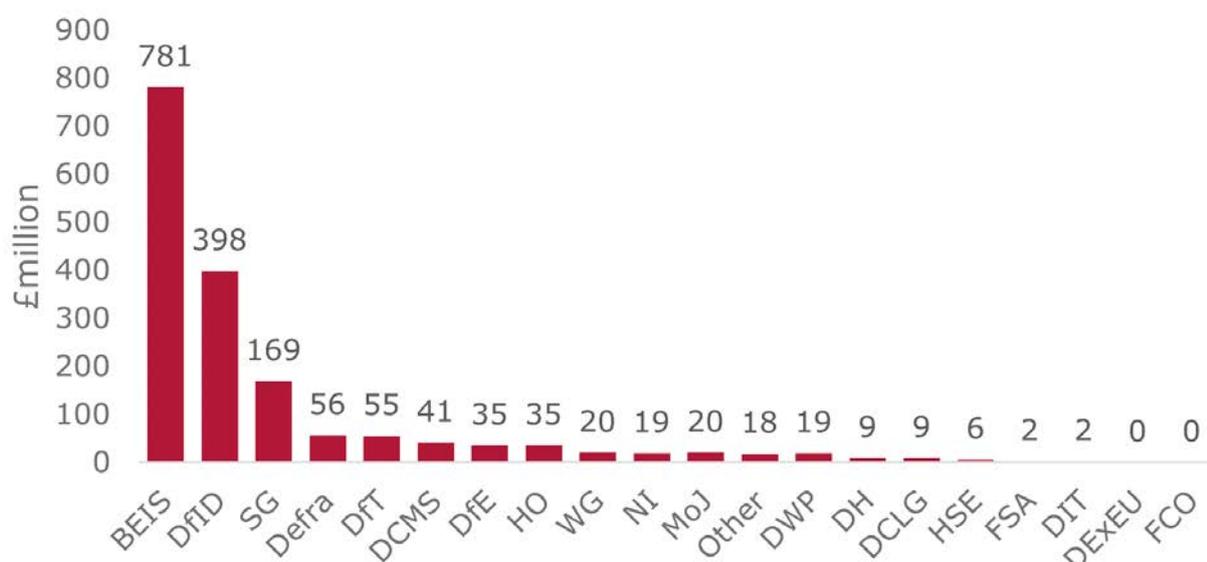


FIGURE 6 RESEARCH AND DEVELOPMENT EXPENDITURE BY UK GOVERNMENT DEPARTMENT 2018, FROM ONS, 2020. NOTE THAT THIS IS DEPARTMENTAL AND DOES NOT INCLUDE RESEARCH COUNCILS FUNDING THROUGH UKRI.

Types of work conducted by UK civil servants with STEM backgrounds

In a 2013 survey of the GSE profession levied by Government Science and Engineering (GSE), 64.8% of respondents said that they had a background in science, 23.1% in engineering and the rest in both. Regarding their current role, 54.5% worked as operational delivery, 23.7% implementing programmes and projects and 21.8% on advising on policy and supporting ministers. A total of 87.6% of respondents stated that they were recruited because of their scientific or engineering background. While generic STEM roles for civil servants are outlined in the introduction, further specific examples are given in Box 5 (below).

Box 5: Examples of STEM roles within the UK government

The examples below are extracts taken from the 2020 GSE Career Framework⁴⁷ by the UK Government Science and Engineering profession, to illustrate real STEM roles within the UK government.

Caroline, a GSE affiliate, is an H&S lead advisor/corporate affairs manager. *My current role ensures NIBSC meets all legal requirements and scientists can fulfil their roles in ensuring and improving public health. Elements include business continuity, risk assessment, policy and procedures, information management, assurance mapping of governance and quality-related activities, staff inductions, learning and development, supporting STEM activities, line management and internal communications.* Caroline has a PhD in Gene Regulation and Chromosome Structure.

Jennie, a cross-disciplinary GSE, is the UK Mission Innovation lead. *I am Head of Secretariat for Mission Innovation (MI) and also lead the international energy innovation strategy in BEIS. I lead a virtual international team based in governments in the UK, EC, Austria, Canada, China and South Korea that drives forward the vision and impact of MI to support our 25 member governments.* Jennie has a PhD in Chemistry from the University of York.

Laura is a deep specialist in the GSE, as head of behavioural science. *I am currently seconded to the Cabinet Office, having set up a behavioural science team supporting the Brexit Communications Centre.* Laura has a PhD in Cognitive Decision Sciences from University College London.

Masaya is a deep specialist in the GSE, as science area leader of the Quantum Electrical Metrology Group. *I am a semiconductor physicist working at the National Physical Laboratory (NPL). I lead a team of scientists developing new technologies that will improve the system of electrical measurements..* Massaya has a PhD in Physics from the University of Cambridge.

Helen is a GSE specialist, as head of the patent examining group. *I currently head up a team of 15 Patent Examiners, made up of 3 Associate Patent Examiners, 5 Patent Examiners and 7 Senior Patent Examiners, all of whom have STEM degrees. The team examine Patent applications relating to various modes of transport including aircraft, trains and boats.* Helen has a BSc in Astrophysics from Cardiff University.

The UK government's own review of government science capability noted that the government's public laboratories are a significant resource. While the review believes that several decades of their devolution from central government have created obstacles to more strategic deployment of this resource, this decentralisation is a key feature of Germany's Helmholtz and Fraunhofer institutes, so often raised as gold-standard comparisons. Despite the UK being an outlier nation in having one of the largest proportions of research funding allocated based on performance (~52%),⁴⁸ most public-sector research establishments are ineligible to bid for these funds awarded for research excellence.⁴³

4.2 Recruitment, attraction, retention, career

Attraction

In the UK the civil service is seen to offer an opportunity to do “interesting and important work”.⁴¹ For recent graduates, the attraction of a civil service career varies for different facets of the civil service (see Table 4 below). Despite the relatively poor performance of the civil service in the ranking of employment destinations,⁴⁹ some specific public institutions rank higher. For example, in the case of natural science students, some of their public-sector options before the civil service are: the NHS in first position; the Environment Agency in third position; UK Research and Innovation (UKRI) in fifth position; the BBC in eighth position; the police in eighth position; and the Met Office in eleventh position.

TABLE 4 PERFORMANCE OF THE UK CIVIL SERVICE IN RANKINGS FOR EMPLOYMENT. UNIVERSUM (2020)

Graduate degree	UK civil service, in Universum's 2020 ranking
Engineering graduates	61st place
IT graduates	35th place
Natural sciences students	12th place
Health and medicine students	16th place

The main reasons that the GSE found as motivations for scientists and engineers to choose the civil service as a career were: 1) the attractiveness and relevance of the work; 2) application of their knowledge in several areas; 3) it being a gateway for engaging and networking with industry, academia and international experts; 4) good pensions relative to other employers in the science and engineering community; and 5) flexible working conditions.

According to the GSE, “starting points in the civil service ranged from joining as an apprentice, direct recruitment into a specialist post, science and engineering fast streamers, or direct appointment as Grade 7 in the civil service as a scientist or an engineer. For some prominent senior science or engineering posts (Chief Scientific Advisers) the norm is external recruitment”.⁴¹ It should be noted that the majority of

these entry routes attract salaries up to a maximum of £50k.

The main obstacles that the GSE identified for recruiting scientists and engineers into the civil service were as follows: 1) there are no formal standards of entry and performance, and each department or agency applies its own criteria; 2) there is a feeling that it is easier to get promoted as a generalist rather than a specialist – in some cases, having a PhD was seen as a disadvantage; 3) the lack of a sense that the civil service can be a career pathway for scientists and engineers; 4) the lack of a reputation that scientists and engineers make relevant contributions to the policy process; 5) the sense that there is a glass ceiling for career progression as scientists or engineers; 6) the fact that, although the fast stream is a good option for recruiting, it is not widely used; 7) the feeling that scientists and engineers spend more time managing contracts than engaging with the policy community; 8) the lack of state-of-the-art equipment; and 9) geographical disconnection because, while the civil service is centralised in London, science and technology are decentralised elsewhere.

Another reason for increased sorting of STEM graduates away from the civil service could be the relative salaries offered by STEM professions. At first glance, government data on graduate salaries appears to show only a slight earnings premium for science-related subjects (see Figure 7).



FIGURE 7 MEDIAN SALARY OF UK-DOMICILED FULL-TIME GRADUATES WHO OBTAINED FIRST DEGREE QUALIFICATIONS AND ENTERED FULL-TIME PAID EMPLOYMENT IN THE UK, BY SUBJECT AREA OF DEGREE AND SKILL MARKER. 2017/18 GRADUATE COHORT. DATA: HESA, 2020

However, this belies the total volume of high-skilled jobs available to science graduates. Of jobs taken by science graduates 82% are high-skilled, while only 71% of jobs taken by non-science graduates are high-skilled.⁵⁰ As shown in Figure 8 (below), non-science graduates in the UK are over-represented at lower salaries (<£25k), with science graduates being over-represented at higher salaries (>£30k). Furthermore, in 2013, 43% of vacancies for professionals working in STEM were deemed hard to fill because of skills shortages – twice the average for all occupations.⁵¹

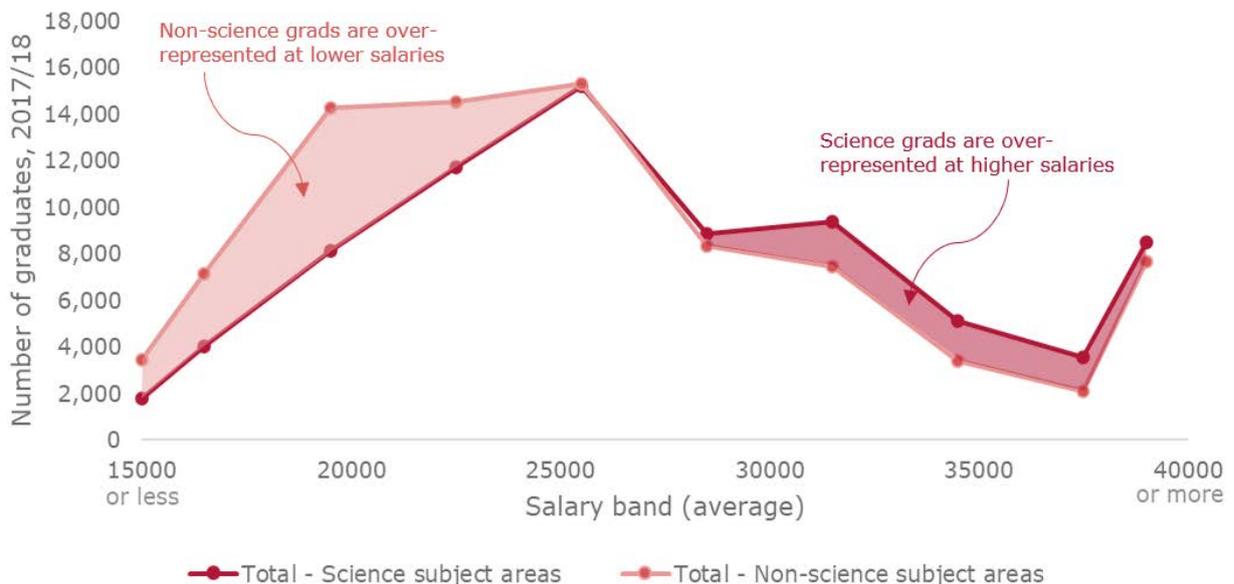


FIGURE 8 UK-DOMICILED GRADUATES IN FULL-TIME PAID EMPLOYMENT IN THE UK, BY SUBJECT AREA OF DEGREE AND SALARY BAND. 2017/18 GRADUATE COHORT. DATA: HESA, 2020

The combined potential for a lower starting salary, alongside the lower likelihood of undertaking skilled work in their area of training, combines to result in lower proportions of science-trained graduates taking roles in public service, as shown in Figure 9 (below, left). This, combined with the larger overall numbers of non-science

graduates (125,000 in 2017/18 vs 100,000 science graduates – approximately 25% higher) results in over double the number of non-science graduates entering the public service in the UK (Figure 9, below, right).

Ratios of STEM to non-STEM in 2017/18

As a proportion of all graduates:

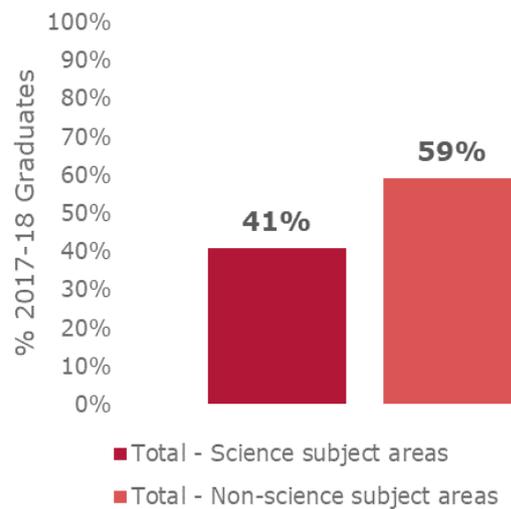
1 : 1.25

As a proportion of graduates entering public admin, defence, total social security

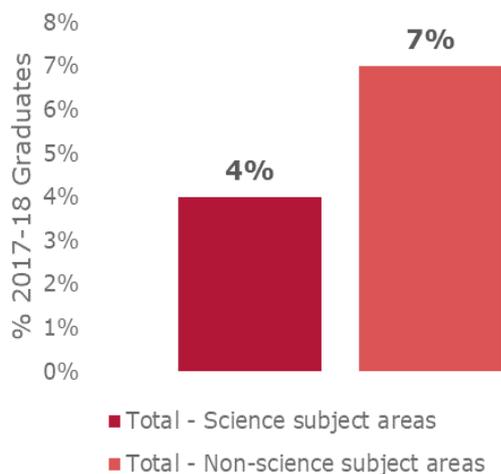
1 : 2.15

i.e. over there were over double the number of non-STEM graduates entering the public sector vs STEM graduates in 2017/18.

Percentage of all graduates, by subject area



Percentage of graduates entering public administration and defence, or compulsory social security



Total number of graduates entering public administration and defence, or compulsory social security

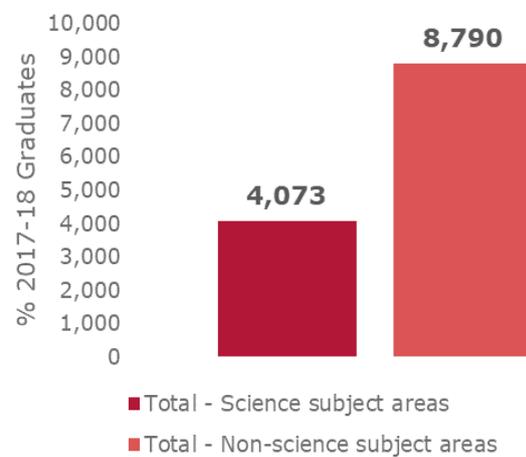


FIGURE 9 PERCENTAGE OF ALL GRADUATES BY STEM OR NON-STEM SUBJECT AREA (TOP). – PROPORTION (LEFT) AND NUMBER (RIGHT) OF GRADUATES OF SCIENCE AND NON-SCIENCE DEGREES ENTERING ROLES IN PUBLIC ADMINISTRATION AND DEFENCE, OR COMPULSORY SOCIAL SECURITY, IN 2017/18. DATA SOURCE: HESA,2020, FIGURES 10,11

Another issue worth noting is gender. A 2013 survey of over two thousand government scientists and engineers⁴¹ identified that 82% were men, with women predominantly in more junior grades. This is consistent with UK data, which shows that women make up less than a quarter of the core STEM workforce in the UK⁵².

Recruitment mechanisms

There are three major types of recruitment mechanism for civil servants. The first one is through mainstream campaigns, which can be individual or bulk recruitment for jobs advertised by departments. Almost all opportunities are advertised through a central Civil Service Jobs website, with recruitment processes managed by the hiring teams, except in cases of bulk recruitment, where a department's HR function may lead. There are well-regarded annual Fast Stream programmes for economists, statisticians, operational researchers, social researchers and digital data and technology. Finally, there are smaller programmes, including a relatively new intake stream of degree apprenticeship programmes, and other smaller intake streams, such as internship programmes with the Government Office for Science.

One of the most attractive and selective routes into the civil service is the Fast Stream, which, while not specific to STEM, does include a dedicated science and engineering route. All of these schemes have a three-year duration, rotating candidates through a variety of departments on six- to twelve-month placements. It is generally understood that graduates from this programme can comfortably assume to move from their salary of ~£30k to a salary of around

£50k upon completion of their programme, as a result of the high esteem in which the experience is held within the civil service. For those on the STEM route, there is no guarantee that candidates will work in their field of study; however, efforts are made to place the Fast Streamers within STEM-facing departments and agencies. While the Fast Stream programme is timed to be competitive with other firms operating in the graduate job market, the Government Office for Science internship scheme opens in the summer, after many STEM graduates may have already secured a position.

In all civil service roles, recruitment is done according to the "Success Profiles" framework, which is designed to allow individuals to demonstrate ability, technical skills, behaviours, strengths and experience.⁵³ These applications rarely include a conventional CV, with written answers to questions often used as the initial screening criteria, which may be followed by online tests and finally interviews or presentations.⁵⁴ Roles can specify a degree in a specific field as essential or desirable criteria for employment. The introduction of "functions" to the civil service means that some roles can attract a small premium for specialist skills, above the normal pay grade for that band.

Retention, remuneration and career progression

One factor that attracted scientists and engineers to the civil service was the possibility to continue working in their professions. In fact, they joined the civil service because the job advertisement explicitly targeted scientists or engineers.⁵⁵ Mobility is low, and scientists and engineers working in the civil service have never worked in another department or agency.⁵² The government's own Science Capability Review identified that:

There is a need within government for certain scientific knowledge and skills (e.g. data analytics), however these are more highly paid in alternative industries, leading to a lack of scientific knowledge within government. Government typically finds it easy to recruit entry-level positions in such fields, but retention after training is difficult.

Science Capability Review, UK Government Office for Science, November 2019

One issue within the government is the speed at which individuals move between roles and departments, favouring generalists over specialists when it comes to career progression. It is common, if not favoured, for individuals to only spend two to three years in a role before moving on. This is disadvantageous for specialised STEM professionals who may wish to remain in their area of expertise. This frequency of movement has become embedded in civil service culture, with the networks built up through cross-departmental moves contributing

to a civil servant's personal value offer, and acting as informal government communications pathways in the absence of more formal structures. This is exacerbated by the lack of ability to directly appoint individuals for promotions, which, while good for addressing diversity and reducing cronyism, contributes to the drive to move between departments for individuals looking for career progression. This issue is recognised within government, with the Civil Service Workforce Plan⁵⁶ noting that:

We need to ensure people are encouraged to develop deep expertise, not move too frequently from job to job.

Foreword, Civil Service Workforce Plan 2016–2020 (2016)

Rt Hon Matt Hancock MP and Sir Jeremy Heywood

The civil service's own development streams show low numbers of GSE professionals on Future Leaders (3 out of 400) and Senior Leaders (1 out of 95) streams.⁴³

In a 2013 survey of over two thousand government scientists and engineers,⁴¹ 45% were negative about the career prospects in the civil service, and 50% identified a lack of suitable roles in the field as their biggest barrier to fulfilling their career aspirations. It identified that there was a present, if weakening, perception of a scientific background as unhelpful in attaining promotion:

Being “labelled as a scientist or techie” is not always helpful for career development. PhDs can be seen as a negative, and some people have been advised not to use the title “Dr” if they're trying to move into more generalist jobs in case they are viewed as being too specialised. One person said that they had been advised to drop the “Dr” and did so until they got a “proper policy job”.

To be brutally honest, if I was currently actively campaigning to get promoted again, I'd minimize my science background.

Anonymous GSE Survey Respondents, The future of the Government Science and Engineering Profession, Government Office for Science (2013)

A total of 70% had never worked in another government organisation, and this is likely to be linked to the fact that 73% reported a lack of suitable roles or opportunities as the biggest barrier to fulfilling their career aspirations. The question of the use of their skills was also raised – 40.9% felt that their wider skills and capabilities were under-used or under-valued, compared to 15.6% of respondents from the wider science and engineering community.

Note that during times of austerity or other reductions in job availability, recruitment is often offered to candidates working within the civil service only. If there were a differential level of attrition of STEM professionals from the civil service – because of the same salary-related forces discussed in the Attraction section – this could result in the overall proportion of STEM professionals within the civil service decreasing during these times.

5 Appendix: Selected practices in other countries

The following sections highlight interesting practices from other countries investigated as part of this report.

5.1 Singapore

- Public service employment carries high prestige in Singapore⁵⁷. Furthermore, the Public Service Commission awards undergraduate scholarships, which are an important recruitment mechanism for talent in Singapore's public service. Government scholarships sponsor study at local and international universities, and upon graduation these individuals are bonded to work for a fixed number of years in the civil service. It is illustrative that 16 of the 20 permanent secretaries in post in 2009 had previously held these scholarships.
- Working in the government is viewed as the second-best option for engineering graduates after multinational corporations⁵⁸. To aid attraction and retention, salaries were recently increased by an average of 20% for both serving and starting engineers. In 2017 the Public Service Division:

*launched a branding campaign [...] with the objective of uplifting the profile of engineering professionals, especially in the Public Service. [...] Out of the 3474 Engineering/IT students surveyed [...], 64 percent are considering a career with the Public Sector, 41 percent of which think of the Public Sector as an IDEAL Employer and 24 percent of which either applied or will apply to one or more of the Government Agencies.*⁵⁹



- GovTech, Singapore’s government digital agency, organises TechHunt as “[...] an exclusive recruitment event [...] where [it invites] top talent to meet with [its] hiring team over an evening, post office hours”. The hiring team releases job offers two days after the event.⁶⁰
- “Public officers are paid a salary comparable with that of the private sector for an employee with similar abilities and responsibilities. Salary reviews are conducted regularly to ensure that we keep up with the market.” For example, the salaries of senior civil servants are set at two-thirds of the median salaries of the top 48 earners in 6 professions: accounting, banking, engineering, law, local manufacturing firms and multinational corporations⁵⁶.
- Individuals are also assigned a “Currently Estimated Potential”, which assesses what level within the civil service they are likely to reach. Individuals with higher potential may be promoted more quickly⁵⁶.
- The civil service also pays bonuses and increments according to performance. These bonuses can be up to 40% of the annual compensation and can be linked not only to an individual’s performance but also to the economic performance of Singapore⁵⁶. Increments are also based on the performance and market conditions, but also the potential of the individual.



5.2 The United States

- In 2020, of 348,000 federal employees (16% of total) working in STEM occupations, almost a third were in science and engineering and a quarter in technology (see Figure 11 below). Most employees in STEM occupations worked in cabinet level agencies (90.0%) or large independent agencies (9.6%).

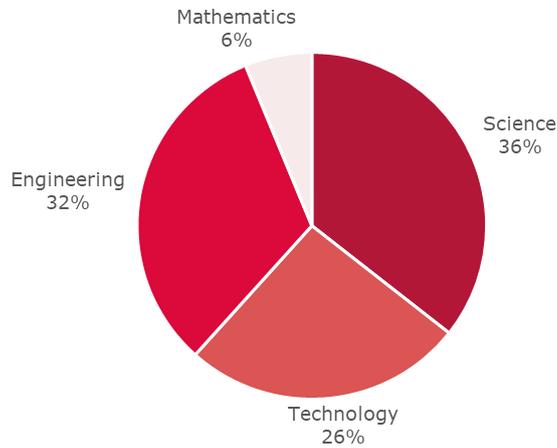


FIGURE 10 BREAKDOWN OF STEM OCCUPATIONS IN THE US CIVIL SERVICE, SEPTEMBER 2020 SOURCE: OPM, 2020⁶¹

- Departmental concentrations of STEM expertise in these cabinet-level agencies varied, with the highest concentrations of greater than 25% of employees in STEM occupations in the Department of Energy, the Department of the State, the Department of the Navy, the Department of the Interior, the Department of Commerce and the Department of Agriculture (see Figure 12 below).

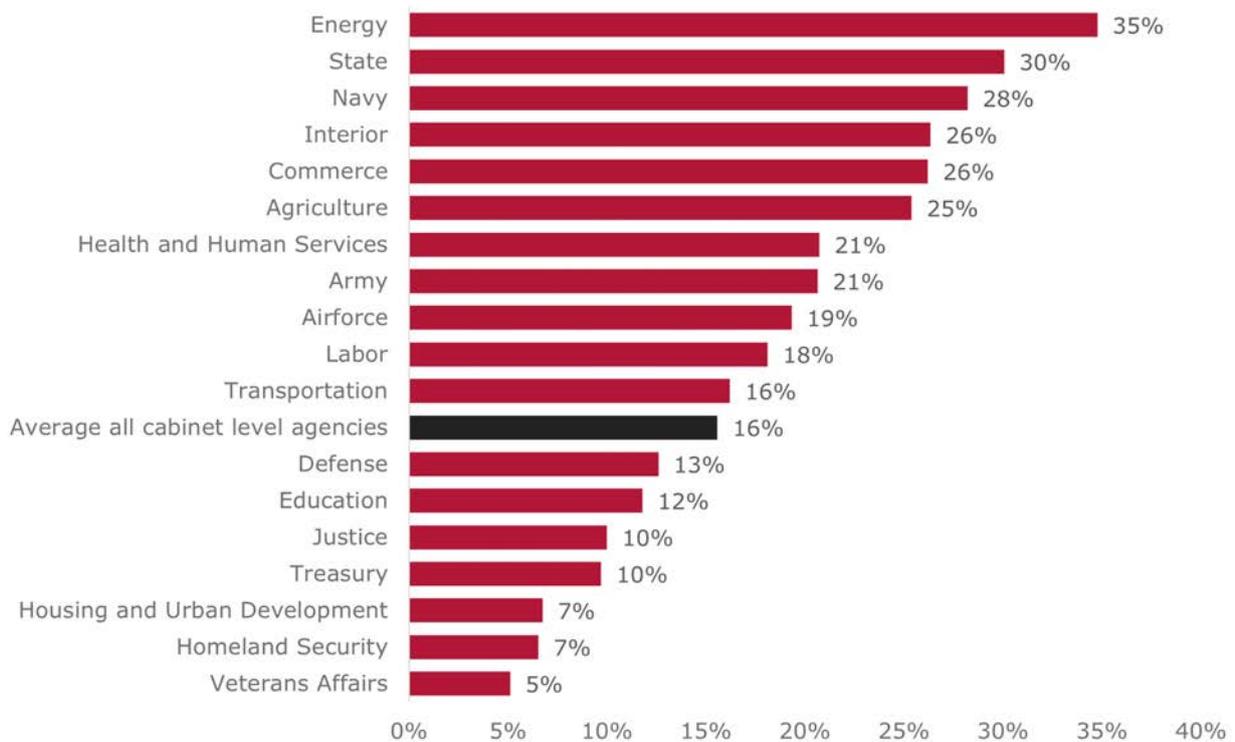


FIGURE 11 PROPORTION OF ALL EMPLOYEES IN THE DEPARTMENT WHO ARE CLASSIFIED AS BEING IN STEM OCCUPATIONS. SOURCE: OPM, 2020A

- The independent agencies with the largest numbers of STEM employees are the National Aeronautics and Space Administration (NASA), the Environmental Protection Agency (EPA), the Social Security Administration and the Nuclear Regulatory Commission.⁵⁸
- For computer science graduates, government roles do not make the top 10, partially because of the strength of the US tech sector. For engineering students, NASA ranks as the sixth most attractive employer in the US. The results are more positive for attractiveness of government roles to natural sciences students: in 2020 the National Institutes of Health ranked second, the Centres for Disease Control third, the EPA sixth, NASA eighth, the FBI ninth and the CIA tenth.⁶²
- However, there is some dissatisfaction with the hiring regime in the United States civil service, which has been described as a “Can’t Hire, Can’t Fire” system. There are workarounds to this system, which today sees high numbers of civil servants employed under an “excepted” civil service regime, under which agencies can provide more competitive compensation.⁶³
- In the US civil service 62% of the STEM labour force earned a salary of between \$90,000 and \$170,000,⁵⁸ which is higher than the national median wage of science and education occupations for 2017 (\$85,000). The annual mean salary for STEM occupations in 2017 was \$91,510.⁶⁴
- While many benefits of the civil service are not directly monetary (e.g. job stability, predictability, security, public good), some have argued that federal-employee pay freezes between 2011 and 2013 might have affected the ability of the civil service to attract and retain employees. RAND estimated that these pay freezes decreased the size of the Department of Defense workforce with at least a baccalaureate degree by 3.5–7.3%, and the size of the STEM workforce by up to 8.5%, compared to the retention expected had standard pay rises been implemented.⁶⁵
- Within the civil service, there is a special classification, the service and professional (ST), for posts that “[...] are engaged in research and development in the physical, biological, medical, or engineering sciences, or a closely related field”.⁶⁶ There were 388 ST positions at the end of 2019. The agencies with the largest ST positions are Agriculture, Commerce, Defense, EPA, HHS, Interior and NASA. For these rarer ST positions, individuals have special provisions with regards to their tasks, qualifications, entry mechanisms and payment. People with an ST position should not devote more than a fourth of their time to supervisory and managerial tasks. All ST positions are allocated on a competitive basis, but some can be appointed by statute and therefore hired more quickly. “Typically, applicants for ST positions are expected to have a graduate degree, significant research experience, and a national or international reputation in his/her field”.⁶⁷ In contrast to other classifications within the civil service, they are not expected to have held an inferior position previously. Agencies pay ST employees according to performance. Therefore, agencies have the authority to set and adjust their own performance appraisal system. However, in cases where agencies want to pay the highest possible salaries – equivalent to the vice president – the OPM should certify its performance appraisal systems. Salaries range from \$120,749 to \$181,500.⁶⁸
- Temporary or ‘Rotator’ programs are offered through the National Science Foundation (NSF), which scientists, engineers, and educators to join the NSF as temporary program directors. These individuals can come from academia or government. These temporary assignments last 1-4 years, and include input on grant funding, involvement in research, and mentoring⁶⁹. Salaries are commensurate with home institutions⁷⁰.



5.3 Germany

- The German public sector has a strong internal labour market and life-long employment prospects.⁷¹ It is largely decentralised and small as a proportion of total employment, particularly compared to other OECD nations.⁶⁶ There were large reductions in public-sector employment in the 1990s, with privatisation playing a key role alongside recruitment bans and early retirement schemes.
- The main recipients of federal R&D expenditure were private non-profit organisations, whose researchers are public employees, receiving 47.2% of the budget. Of these, the main recipients are the Helmholtz Association of German Research Centres, the Fraunhofer Society, the Max Planck Society, the Leibniz Association and the German Research Foundation. After private non-profit organisations, the main receivers of federal budgets are universities and university hospitals of the Länder (German states) and communities, which receive 9.3% of the federal budget. The next relevant federal budget recipients are business

enterprises which account for 8.1% of the budget. Federal institutions with R&D tasks received 5.9% of the federal resources.⁷²

- In 2018, 36% of Germany's research and development workers were part of the public or social sector – with 109,487 people in the government sector and private non-profit institutions, and 147,160 in the higher education sector.⁷³ For natural sciences graduates, the most attractive employers of 2020 were the Max Planck Society and the Fraunhofer Society, occupying first and third position, respectively.⁷⁴ The Deutsches Zentrum für Luft und Raumfahrt (German Aerospace Centre), which is part of the Helmholtz Association, appears in fifth position, and the Bundesinstitut für Risikobewertung (Federal Institute for Risk Assessment) is ranked eighth. No government roles make it into the top 10 for engineering graduates or IT graduates. In Germany, entry-level government roles are paid above private-sector roles; however, the pay scales are more compressed, with lower increases in pay for subsequent levels.⁶⁶ Performance-related pay has been introduced but has not been seen as effective because of the limited financial



resources available and a tendency for bonuses to be distributed evenly among teams^{66, 66}

- In the case of workers at research institutions, such as the Helmholtz Association, Leibniz Association and Fraunhofer Society, as they are not part of the civil service but public employees, they participate in the collective agreement for negotiating their salaries. There are approximately 1,000 wage categories for the different employees. Collective agreement employees are also eligible for performance payments.

5.4 South Korea

- The Korean civil service is generally seen as an attractive and competitive role within Korean society, and most civil servants are recruited by examination. While there appear to be high levels of Korean public servants with graduate qualifications in STEM disciplines (~30%), there does not appear to be an explicit focus on these skills within recruitment pathways.
- According to South Korea’s Ministry of Science and ICT and the Korea Institute of S&T Evaluation and Planning,⁷⁵ a total of 43,700 researchers worked in South Korea’s public sector in 2018. A total of 49.5% of them did so at universities, 33.2% at firms, 13.7% at research institutes and just 0.1% (60 in absolute terms) at ministries. Around 30% of Korean public servants have a graduate qualification in natural sciences or engineering. Of the state public officials, 29.8% have natural sciences or engineering as their major field of studies, while in the case of local public officials, this percentage is 34.7%. A total of 11.2% of state public officials hold a Master’s degree, and 3.6% hold a PhD. For local public officials, these percentages are 7.8% and 0.7%, respectively. Within the state-level research service, 46.3% of civil servants have a natural sciences or engineering background, 22.3% in agriculture, 4.2% in pharmaceuticals, 3.8% in medicine and 3.5% in maritime and fisheries. In contrast, 60% of civil servants in the state-level advisory service have an agriculture background, and just 17% in natural sciences or engineering.⁷⁶
- In Korea the proportion of R&D conducted by government or public research institutes hovers around 13% of total R&D spending. In 2018 government funding for R&D was primarily allocated to research institutes, at 45.9%, followed by business enterprises, with 23.6%, and universities, with 22.1%. Ministries accounted for only 1.5% of public R&D expenditure. Within these ministries, the Ministry of Science and ICT expended the greatest amount, followed by the Ministry of Trade, Industry and Energy; the Defence Acquisition Program Administration; the Ministry of Education; and the Ministry of SMEs and Start-ups (see Figure 13 below).⁷⁰

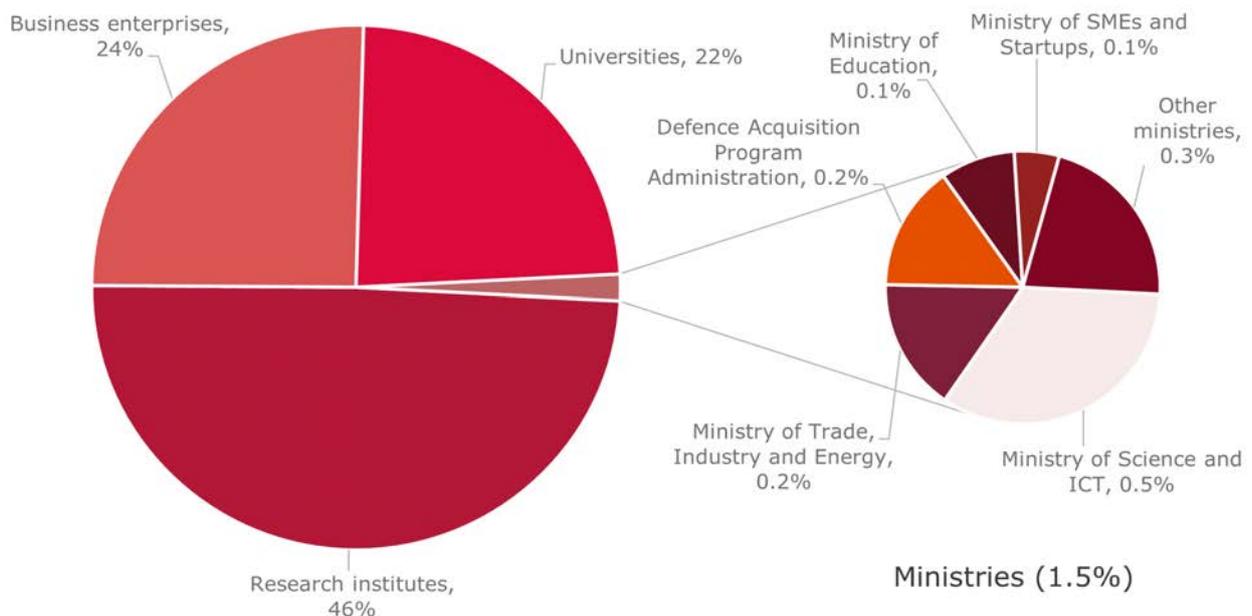


FIGURE 12 SOUTH KOREAN GOVERNMENT R&D FUNDING BREAKDOWN, 2018

- The civil service in South Korea is generally viewed as an attractive role because of its stability and reasonable working hours.^{77,78,79,80} Hundreds of thousands of people can take the Public Service Examinations in any given year, and acceptance rates are in the vicinity of 2–3%.⁷⁵ Although it has been suggested that a “public-service motivation” is responsible for the pursuit of roles in the public sector, in Korea studies have found that job security is the main driver.⁸¹ South Korea’s government recruits the majority of its public servants through examinations. There are two main recruitment mechanisms. The first is through competitive examinations administered each year, which consists of one or two rounds of written tests and interviews. This mechanism is used to recruit public officials for grades 5, 7 or 9. The second type of mechanism is professional competitive recruitment, which is used when the position requires a high degree of expertise, with certain credentials such as experience of academic degrees relevant for certain fields or positions. Depending on the years of professional experience, engineers can be appointed to different grades. Industrial engineers without work experience can only be appointed to grade 9, the lowest in the scale, while all other engineers without work experience can be appointed to grade 8, the second lowest in the scale. To appoint an industrial engineer to grade 8, they must have three years of work experience. To gain access to an immediate higher level, engineers and industrial engineers should have multiples of three years of work experience according to the previous equivalence.⁸²
- People with graduate studies (either a Master’s degree or a PhD) can be considered for professional competitive recruitment in different high-level grades according to their work experience in research (see Table 5 below). As can be seen, candidates with a PhD can be directly appointed to grade 4.

TABLE 5 ENTRY LEVELS TO THE KOREAN CIVIL SERVICE FOR THOSE WITH A MASTER’S OR PHD DEGREE. NOTE THAT LOWER GRADE NUMBERS CORRESPOND TO ROLES WITH HIGHER RESPONSIBILITY AND SALARY. SOURCE: MPM (2020D: 37)

Academic degree	Years of professional experience in research		
	Grade 5	Grade 4	Grade 3
PhD	-	4	8
Master’s degree	4	8	12

- People with a technical and vocational qualification can be appointed from grade 7. The areas to be considered are: agriculture, manufacturing, mining, fisheries, maritime health and hygiene, practical household affairs, urban planning, physics, chemistry and biology.⁸³
- Through the National Human Resources Database, the MPM “[...] collects [and] manages information on key national talent in order to make candidate referrals for public offices with outstanding knowledge and skills”⁸⁴ (see Box 6 below).

Box 6: Case study: National Human Resources Database: selected practices

The Talent Information and Acquisition Bureau collects and manages information on key national talent to make candidate referrals for public offices with outstanding knowledge and skills (MPM, 2020m). The National Human Resources Database (NHRDB) currently has records of approximately 300,000 people, including high-level civil servants, members of advisory committees, from the private sector to the public sector, university faculty, PhD-holders, research staff, high-level managers of listed companies and CEOs of promising small and medium-sized firms, and holders of professional certifications, among others. Interested candidates can send a registration form to be included in the database,⁷⁹ and citizens can also nominate people to be included in the database. There are 31 recommendation fields, including STEM areas such as: disaster prevention and meteorology; agriculture; forestry and rural affairs; maritime affairs and fisheries; industry; medicine, pharmacy and public health; environment; construction; transportation; economy and finance; audit, accounting and statistics; and science and technology.⁸⁵

The process for using the National Human Resources Database starts with an institution making an official request for information about individuals 10 days in advance of the hiring date. The MPM searches for candidates in the database and makes a recommendation. The user institution notifies the MPM of the use it has made of the information. In some cases, the user institution might search directly in the database with the approval of the MPM.⁸⁶

Recently, the MPM started a headhunting programme to actively recruit professionals from the private sector to fill open positions in the public sector. Through the National Human Resources Database and headhunting, the MPM helps R&D public institutes to fill vacancies with PhD researchers. The procedure begins with the establishment of an Examination and Selection Committee. The second step is the announcement for the open position. The Talent Information and Acquisition Bureau analyses the job requirement, conducts a market survey, selects outstanding candidates and contacts them. It receives applications, evaluates and interviews them, and submits its recommendations for the user institution.⁸⁷

- Openness and competition between the civil service and the private sector means that some posts are open to the latter. A total of 60.5% of state public officials were recruited through open competition, and the rest through professional competition. At local level, these proportions were of 71.7% and 28.3% each.⁷¹
- In the early 2000s the government set a target of reaching private-sector pay levels over a five-year period, and performance-related pay was used to increase civil service pay.⁸⁸
- The establishment of the senior civil service in 2006 was part of an effort to increase the competitiveness and openness of the government and the competency of staff filling different job specialties.⁸⁹ Senior civil servant pay is split into three levels: seniority and competence-based pay (basic pay); position-based pay (depending on job analysis); and performance-based pay.⁸⁴ These senior positions were filled according to proportions – with 20% of positions open to candidates from within and outside government, 15–30% of positions open to current government employees only, and 50–65% of positions as promotions open only to employees within that department.⁸⁴
- Performance-based payments were introduced in 1999. Each year the MPM evaluates the individual performance of high-level officials and the departments they lead. The evaluation is based on targets and indicators that the evaluated official sets in a written agreement in consultation with the evaluator. The results of these evaluations are used for their salary and promotion. Medium and low-level officials receive performance-based bonuses at least once a year. Each ministry has the authority to fix its own rating systems to allocate performance bonuses.



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Contact us

For more information, or to get in touch with the Policy Links team, contact us at:

ifm-policy-links@eng.cam.ac.uk



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Cambridge Industrial Innovation Policy, 17 Charles Babbage Road, Cambridge, CB3 0FS, United Kingdom

ciip.group.cam.ac.uk

