EPSRC
Pioneering research and skills

The Council for the Mathematical Sciences

Mathematical sciences research

Leading the way to UK economic growth

Engineering and Physical Sciences Research Council

Working in partnership with the Council for the Mathematical Sciences (CMS), the Engineering and Physical Sciences Research Council (EPSRC) commissioned an independent study which has shown that 10 per cent of jobs and 16 per cent of Gross Value Added (GVA) to the UK economy stems from mathematical sciences research.

The report, by consulting firm Deloitte, was the first study of its kind, and reflects the excellence of the UK mathematics research base, that has generated a range of impressive and far-reaching impacts.

The fruits of mathematical research affect the daily lives of everyone in the UK, for example:

- Smart-phones which use mathematical techniques to maximise the amount of information that can be transmitted
- Weather forecasting is based on complex mathematical models
- The latest Hollywood blockbusters take advantage of the mathematics behind software for 3D modelling to showcase cutting-edge special effects
- Elite athletes at the 2012 Olympic Games used tools based on sophisticated maths to maximise their performance.

It is not just contemporary mathematics research that can have an impact. Research from the last century has paved the way for technology used in a range of activities, goods and services, such as mobile telecommunications and medical devices.

Economic impact

The report, which EPSRC commissioned working with UK learned societies coordinated by the Council for the Mathematical Sciences, estimated the contribution of maths to the UK economy in 2010 to be 2.8 million in employment terms (around 10 per cent of all jobs in the UK) and £208 billion in terms of GVA contribution (around 16 per cent of total UK GVA).

In addition to these direct impacts, mathematical research activities by organisations and employees have impact across the supply chain (indirect effects) and also affect household spending (induced effects). There are also wider impacts and benefits generated by organisations using the research.

Productivity (as measured by GVA per worker) is significantly higher in mathematical science occupations compared to the UK average, and as such the direct GVA impact of maths in 2010 is proportionately higher than the share of employment (16 per cent versus 10 per cent).

Within different sectors of the economy, the direct contribution of maths is highest in research-dependent industries such as computer services, aerospace and pharmaceuticals. Maths is playing a key role in tackling the modern-day challenge of cybersecurity, ensuring that the UK is a safe place to do business and that we all benefit from a secure and resilient cyberspace. It is also playing its part in the 'big data revolution' with the development of massive databases and energy-efficient computing – both key areas highlighted by the Government for potential excellence and contribution to economic growth – resulting in the need for new tools from the mathematical sciences across science and engineering, business and government.

The UK manufacturing sectors such as aerospace, the second largest in the world, benefits from a highly-skilled home-grown workforce, superior manufacturing processes and sophisticated quality management systems – all made possible by superior research and training in mathematics.

Contribution of mathematical sciences

- 10% of UK jobs, 16% of UK GVA
- Productivity of mathematical science occupations is double the UK average
- UK maths accounts for:
  - 4% of world maths researchers
  - 6% of mathematical articles
  - 11% of mathematical citations
  - 14% of highly-cited articles.

High absolute levels of direct employment associated with maths also include sectors such as public administration and defence, architectural activities and technical consulting, construction and education.

Individuals in mathematical science occupations include professional mathematicians and statisticians, engineers, physical scientists, IT professionals, social scientists, finance professionals, medical practitioners, administrators and senior managers.

How maths contributes to the UK economy and society

Through its contribution to the development of a skilled workforce, the production of high-end, high-value products and the development of quality processes, maths enables us to:

- Make sense of data and better understand the world by building the 'information infrastructure' upon which myriad businesses and individuals rely, and supply the tools and techniques to analyse and interpret large datasets
- Safeguard society by modelling the impacts of natural disasters, testing drugs and contributing to national security
- Create robust forecasts to address uncertainty and allow for better planning and optimising processes to increase efficiency.

Thus the generation and application of maths can help drive economic growth and develop greater prosperity.

UK life sciences sector

Without mathematics research and training, the UK life sciences sector would not be in as strong a position to contribute to economic growth, providing as it does the expertise integral to the development of areas such as personalised healthcare and pharmaceuticals, and underpinning the development of many medical technologies.

In the pharmaceutical industry, statisticians are typically involved in the design of clinical trials of new drugs, but also work across all areas of R&D in the pharmaceutical industry, from the initial identification of medicines to product manufacture. In 2010 R&D expenditure in the pharmaceutical sector amounted to £4.6 billion – 29 per cent of all UK R&D spend and the greatest in Europe.

Britain is a leading location for running the complex and often multinational studies needed to develop new medicines. The industry now makes a substantial contribution to the British economy in terms of both income and employment and has generated a trade surplus for the past 13 years; earnings from exports exceeded those from imports by over £5 billion in 2011.

> **"Without mathematics there would be no smart phones, MRI scanners, new medicines, aeroplanes or bank accounts."**

The Government has identified the pharmaceutical sector as one of the key industries to pull the UK out of the current recession.

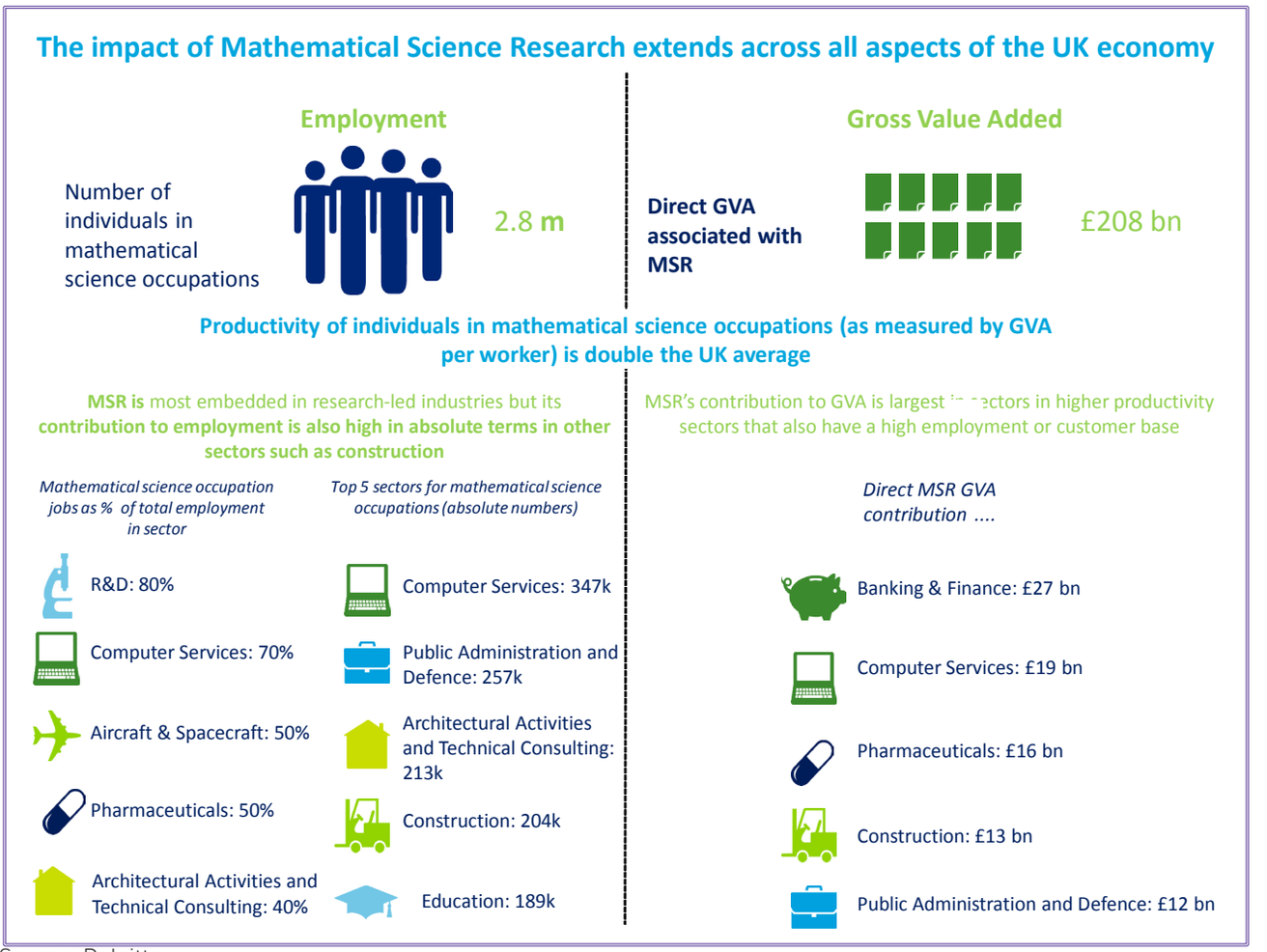
Weather forecasting

Maths continues to play a pivotal role in weather forecasting and modelling. The cost of not understanding and predicting changes in the physical world can be immense. Natural disasters were estimated to have cost the global economy over £100 billion worth of damage in 2011 – the costliest year in over 300 years of the insurance industry. With the effects of climate change becoming ever clearer, through extreme weather events, the demand for robust weather forecasts is greater than ever.

Around 2,000 mathematicians are employed by the UK Met Office to analyse and evaluate vast amounts of atmospheric trends and information.

The UK is regarded in the meteorological industry as a talent hub with many institutions choosing to locate research facilities in the UK to take advantage of the high-quality workforce.

The quantifiable impacts of mathematical sciences research in 2010



Source: Deloitte

A definition of mathematical sciences research

For the purposes of this study mathematical sciences research was defined as high-end research in mathematics carried out in academic institutions, research centres, the private sector, government and by individuals that adds to the store of accumulated mathematical knowledge. Mathematical sciences occupations were therefore those which either entail maths or which directly require mathematics-derived tools and techniques.

The timing of economic impact

The study took into account the contribution of both contemporary research and past mathematics research since the full economic impact of a given piece of research may not be felt immediately.

A classic example is the Radon Transformation in topography, first introduced by mathematician Johann Radon in 1917. This research provided the mathematical basis for non-invasive imaging technology used in CAT scans and barcode scanners introduced over 50 years after Radon's breakthrough. Clearly, research performed nearly a century ago continues to benefit the UK economy and society today.

The Engineering and Physical Sciences Research Council (EPSRC) is the UK's main agency for funding research in engineering and physical sciences. EPSRC invests around £800 million a year in research and postgraduate training, to help the nation handle the next generation of technological change. The areas covered range from information technology to structural engineering, and mathematics to materials science. This research forms the basis for future economic development in the UK and improvements for everyone's health, lifestyle and culture. EPSRC works alongside other Research Councils, working collectively on issues of common concern via Research Councils UK.

The Council for the Mathematical Sciences (CMS) provides an authoritative and objective body that exists to develop, influence and respond to UK policy issues that affect the mathematical sciences in higher education and research, and therefore the UK economy and society in general. Speaking with one voice for five learned societies, the CMS represents the Institute of Mathematics and its Applications, the London Mathematical Society, the Royal Statistical Society, the Edinburgh Mathematical Society and the Operational Research Society.

The full report can be found on the EPSRC web site.