Higher Education Commission Postgraduate Education Inquiry

Response from the Council for the Mathematical Sciences

About the Council for the Mathematical Sciences (CMS)
The CMS (www.cms.ac.uk) was established in 2001 by the Institute of Mathematics and its Applications (IMA), the London Mathematical Society (LMS) and the Royal Statistical Society (RSS). They were joined in 2008 by the Edinburgh Mathematical Society (EMS) and the Operational Research Society (ORS). The 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.

- The IMA is the UK's learned and professional society for mathematics and its applications and has around 5,000 members.
- The LMS, founded in 1865, is the UK's learned society for mathematics. The Society has as its purpose the advancement, dissemination and promotion of mathematical knowledge in the UK and worldwide.
- The RSS, founded in 1834, is the UK's learned and professional society for statistics, with around 7,000 members. It aims to nurture and promote statistics, encouraging statistical knowledge and disseminating good practice in society at large.
- The EMS was founded in 1883 and has around 450 members. Its aims are the promotion and extension of the Mathematical Sciences, particularly in Scotland.
- The ORS is the world's oldest-established learned society catering to the Operational Research profession, with 3,000 members in 53 countries.

Questions to which responses are submitted are underlined below.

Q1: How well does the current postgraduate system meet the needs of businesses? How can the system become more responsive?

The Commission would particularly welcome evidence on:
• Demand for, and utilisation of, postgraduate skills
• Postgraduates' role in R&D
• The response of Higher Education Institutions to emerging industries
• Frameworks for dialogue between businesses and HE on postgraduate issues
• The role of government
• Professional qualifications

Subject	First degree	Postgraduate (excl. PGCE)
Biological sciences	£16,500	£22,500
Physical sciences	£19,000	£24,000
Computer science	£21,000	£24,000
Engineering & technology	£23,000	£25,500
Mathematical Sciences	£22,500	£27,000

Table 1: Average salaries of those with first and higher degrees, six months after graduation in 2007/08[1]

As shown in Table 1 above, mathematical sciences PhD graduates attract the highest starting salaries of all PhD graduates. The value placed by employers outside academia on the doctorate can be seen from the fact that in 2006, six months after graduation, the average salary of someone with a mathematical sciences first degree was £22.5k, whereas the average for someone with a PhD in mathematical science was £27k. According to the annual HESA surveys for 2004-2008, 42% of doctoral graduates in mathematical sciences find work in the education sector, 34% in finance, business and IT, and 18% in other sectors.

Q2a: What is required for the UK to maintain its ability to attract and retain high-quality international students and international researchers?

Q2b: What are the long-term implications of the postgraduate sector's dependence on international students?

Based on the first destination data gathered for the 2004-2008 HESA surveys, we estimate that about 10% of mathematical sciences PhDs become lecturers in UK HE. Since demand for UK PhDs in the mathematical sciences greatly exceeds supply, it would be damaging for this percentage to increase, so that at least 500 UK mathematical sciences PhDs are needed annually to maintain the academic research base from within.[2] We estimate that the UK in fact produces about 400 PhDs in the mathematical sciences annually. However, as Table 2 shows, **a considerable majority of the new appointments over the past decade have not come from those educated in the UK.** The UK is indeed very fortunate to have been able to recruit such large numbers of top quality mathematical scientists from around the world, but there are obvious risks arising from this development: there are dangers of instability; and there is a serious risk that UK students will come to believe that a career in mathematical sciences research is not a viable option for someone educated in the UK.

Appointed up to and including 2000	Trained in the UK	348
	Trained overseas	129
Appointed after 2000	Trained in the UK	371
	Trained overseas	460

Table 2: Background of UK HE mathematical sciences staff in post in November 2011[3]

[1] Taken from the table on p 94 of Adrian Smith's report One Step Beyond: Making the most of postgraduate education (March 2010)

[2] One might argue that overseas PhDs should correct any shortfall. But if the system works well, any supply from overseas should be balanced by UK PhDs going to academic posts abroad.

[3] From an LMS survey of UK mathematical sciences departments carried out in November 2011, for another report, 39 departments supplied data, out of 47 approached.

Q2c: How might UK-domiciled students be encouraged to engage in doctoral study?

The obstacle here is a scarcity of funded scholarships – demand from prospective PhD students is vibrant, but many good students have to be turned away due to lack of financial support.

A second reason concerns the **pipeline from PhD to academic position.** The academic jobs market in the mathematical sciences is truly international, and few people are appointed to a permanent UK academic position without a substantial research track record. Given the short duration of the UK PhD (normally 3.5 funded years after first degree[4]), UK PhD graduates typically need one or more postdoctoral positions in order to successfully apply for a permanent academic post. A good pipeline from UK PhD to academic career thus **needs around 100 postdoctoral positions per year for newly graduating PhDs in the mathematical sciences.** Unfortunately this is far from the case and we regard this as a **very serious threat to the research base.** In recent years there have typically been (in addition to a number of RC-funded posts as Research Assistant) about 10 EPSRC-funded 3-year Postdoctoral Fellowships per year in the mathematical sciences. These have been discontinued by EPSRC in 2011, except in Statistics and Applied Probability, a decision which has caused alarm and outrage in the community, and has prompted letters to the Prime Minister from a group of prominent mathematical scientists and from 300 young researchers.[5] Thus**, a pipeline which was already badly malfunctioning has been seriously damaged by EPSRC decisions.**

Q2d: In what areas can UK postgraduate provision be considered outstanding internationally?

Q3: How well does current practice support smooth transitions from postgraduate education into industry and academia?

The Commission would particularly welcome evidence on:
- *The employability of postgraduates*
- *Support for early career researchers*

Ensuring fair access to postgraduate education

See the answers to questions 1, 2b, 2c above, especially 1 as regards employability and 2c as regards support for early career researchers.

Q4: How can postgraduate provision in the UK be made more accessible for students from less advantaged backgrounds?

The Commission would particularly welcome evidence on:
- Changes in labour markets and recruitment practices – to what extent is a postgraduate education

now necessary for entry into competitive industries?
- The role of flexible and part-time provision in promoting access to postgraduate education

Impact of the planned HE reforms

[4] The typical length is two years more in the US and in much of Europe.

[5] EPSRC's revised Fellowship schemes introduced in November 2011 continue these restrictions at the postdoctoral level.

Q5: What impact will the changes to undergraduate provision outlined in the recent Higher Education White Paper have on the postgraduate sector?

- **High undergraduate fees pose a serious risk to the future viability of Integrated Masters degrees.** (See Question 6: these are among the few funded masters level degree programmes in mathematical sciences.)
- **The 'AAB+' proposals threaten to reduce the numbers taking mathematics A-level.**

One potential risk is to the **continued viability of valuable Integrated Masters and MSc degree programmes** – if students have incurred a large debt up to BSc level, then it is reasonable to expect that fewer of them will stay for a further year of expensive education.

The 'AAB+' proposals are likely to reduce the number of university applicants who have taken mathematics A-level. This is because some A-level subjects, including Mathematics and Further Mathematics, are graded more severely than others. There is clear evidence[6] for this. By treating all A-levels as equal the 'AAB+' proposals exacerbate the harm already done by A-level league tables and UCAS tariffs[7]. There is anectdotal evidence that concern for grades (by individuals, schools or HE institutions) leads some students away from mathematics A-level even when their interest and intended area of study would make mathematics the obvious choice.

3.3 However, if the `AAB+' proposals do remain in place, then it is **essential that the list of (protected) SIV subjects continues to include mathematical sciences**. As discussed in **(1)**, the current number of students graduating in the mathematical sciences is already well below the demand.

Q6: How should postgraduate education be funded?
The Commission would particularly welcome evidence on:
• Models of funding for research courses, taught courses and professional education
• The desirability of varying funding provision by subject, level or another factor
• The financial sustainability of the postgraduate sector
• Research concentration
• The size of the postgraduate sector

See the first part of the answer to question 2c regarding PhD studentships.

At present the main "state funding" at **masters level** in mathematical sciences is for 4-year Integrated Masters degrees (such as MMath or MMathStat or MSci), with some RCUK funding for a few courses in areas of statistics and operational research. In view of the lack of first degrees in statistics and operations research, entry to professional and research posts in these disciplines now typically requires prior study at Masters level. There is thus a pressing requirement for state support for Masters degrees in such areas of particular national need. It is also to be regretted that a number of excellent Masters courses in applied and computational mathematics no longer receive such support.

[6] www.score-education.org/policy/qualifications-and-assessment/grading-severity

[7] The high percentage of A and A* grades achieved by Mathematics and Further mathematics A level candidates does not reflect more generous marking, as "linked pair" studies by each Awarding Body routinely shows.

The **EPSRC-funded Taught Course Centre model** is a cost-effective way to provide core training to PhD students while capturing most of the benefits of the large Doctoral Training Centres, but without the severe constraints, expenses and damaging effects[8] of co-location. Several successful methods have been devised to work within these constraints.[9] In the first model, there are several networks of universities (one in Scotland, MAGIC in Northern England and one based in Oxford) with videolinked lecture theatres by which the localised expertise can be distributed across students in many institutions; these are supplemented by an annual conference in which students meet in person. APTS is a longstanding organisation for training postgraduates in Statistics, training annual cohorts of the order of 80 first-year Statistics PhD students by means of four residential weeks per year, and NATCOR makes a similar arrangement in Operational Research. Another group exploits the density of institutions in London to bring groups of students together. The London Taught Course Centre is run by a consortium of universities, offering a programme of one day a week basic and advanced courses in mathematics and statistics for PhD research students as well as short intensive courses.

(ii) Institutional structures

Q7: Are you aware of any distinctive models of delivering postgraduate education which have been deployed with success in other countries?

(iii) Quality assurance and student satisfaction

Q8: How effective are quality assurance and student feedback mechanisms for postgraduate provision?

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[8] Given restricted funding, concentrating large numbers of students in one place implies few or no students elsewhere.

[9] www.epsrc.ac.uk/SiteCollectionDocuments/Publications/reports/EPSRCReviewOfTCCs.pdf