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Campaign for Science and Engineering in the UK

CaSE 05/19

Funding science and engineering in the universities

A framework for discussion sent to the Higher Education Minister

Introduction

Science and engineering in the universities are traditionally categorised into three separate sets of activities, namely:

- teaching
- research
- other activities, including knowledge transfer and outreach to a wider community

Teaching and research form the core of what the universities do, accounting for about 85% of their total expenditure[1].

In this document, CaSE starts from the point of view that these activities are valuable and should continue, not least because the UK has an enviable track record of the highest quality teaching, research and knowledge transfer.

The discussion of what universities are really for is an important one, but whatever the philosophical debates to be had, most people agree that higher education and research are important[2]. Whether these activities need to take place in institutions that happen to be called universities is a different question. For example, a great deal of research could (at least in theory) be moved out of the universities into specialised institutes (as it is in Germany) and much of the teaching that currently occurs in higher education institutes could in principle be delivered by further education colleges.

But wherever they occur, the costs of these activities must be born, and the arguments in this document apply equally forcefully.

The document aims to discuss the problem of underfunding of science and engineering in the current university system, and to examine some of the merits of the possible ways in which that problem could, *in theory,* be attacked. It is not primarily intended to deal with the intricacies of how the available money is used (such as whether there should be more or less concentration of research funding into fewer institutions), although it does not ignore these where they may be important to the debate about overall funding levels.

The document starts from the assumption that the level of science teaching and research current being undertaken is seriously underfunded, which we believe is obvious, and has been widely acknowledged, both within Government and elsewhere. But this paper is not intended as a special plea to Government for more public funding for science, although it considers the case for more public funding as one of several options for addressing the current financial shortfall.

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The problem seen from the perspective of the universities

Research

For the volume of research currently undertaken (across all subjects), accounting evidence suggests that higher education institutions have a shortfall of about £2billion, a gap of more than 40% of the true costs, although the Government believes that inaccuracies in the way data were reported overestimated the true level of about £1.4billion[3]. Since four fifths of research funding supports work in the sciences and engineering, these subjects are suffering a minimum shortfall of £1.1 billion per year.

Much of this shortfall is in publicly-funded research, so the universities have essentially no realistic opportunity to recover it. For that part which relates to privately-funded research, the universities could deal with the shortfall either by charging funders more or by not taking the work. Refusing the work would, on average, be harmful in the broadest sense because it would deny the institutions' researchers access to benefits of collaborating with industry. Expecting private sector funders to pay more would carry the risk that they looked elsewhere for partners. In a global research landscape, they may well choose to work with universities elsewhere in the world, if they could obtain the same kind of research at lower prices. This is particularly true of large companies that make substantial investments in research and have a worldwide outlook.

However, it is only fair to point out that the current Government has made a number of significant steps towards dealing with the overall problem of funding science and engineering research in the universities.

First, it has increased levels of funding rapidly, so that the science budget has more than doubled in real terms over a period of a few years. Funding levels for research in universities are higher, in real terms, than they have ever been.

Second, the Government has made important moves towards making research funding in universities sustainable and towards encouraging more private sector funding. A system of funding full economic costs for the former and tax credits for the latter are important signals of how seriously the Government takes the funding of science.

Teaching

Across teaching, the current funding shortfall is harder to estimate, but the public official with responsibility (in England), the Chief Executive of the Higher Education Funding Council for England, has stated unequivocally that "the sector is losing money on its undergraduate teaching; in other words, teaching is underfunded in the university system"[4].

It is important that within any given amount of funding, there should be a level playing field across subjects. At present, it is easy to stop teaching a science subject, but the entry barriers to starting a new science course are very high, and almost no university is likely to consider doing so, even if it were confident of attracting the number of students to justify it – it would simply be too big a drain on resources.

Just as funding for research has been altered to ensure long-term sustainability, so the funding of teaching should become sustainable.

Vice Chancellors of science-led institutions believed the true costs of teaching laboratory-based students to be around £10,500 per year in 2002, basing this on Government data[5]; after three years of inflation, the current figure must be approximately £11,000. At present, universities in England receive £6,134 of public money per science student per year, and charge fees of £1,175, giving a total of £7,309[6]. This leaves a shortfall of £3,691 per student per year against the estimated true cost of £11,000. A new regime is about to begin in which students will be charged fees of up to £3,000 per year (paid retrospectively), some of which must be used to provide bursaries for poorer students. Assuming all students were to be charged the full amount and that there was no cost involved in collecting the fees, this would narrow the funding gap to £1,866 per full time science student per year. There are approximately 280,000 full time undergraduates who are studying science or engineering at English universities and who are domiciled in the UK (not including medicine and allied subjects)[7]. This means the shortfall in teaching funds, even after the new top-up fees are introduced, will be about £500 million per year. This assumes that everyone will pay the fees, and ignores the costs of collecting the money and of providing bursaries. In reality, the shortfall will probably be nearer £1 billion.

Overall pattern of underfunding for research and teaching

The figures above demonstrate that the real cost of the teaching and research in science and engineering subjects currently being undertaken in the UK's universities is about £2 billion per year more than the funds actually available.

There is thus a broad consensus that, at present, universities do not have the income to support in a sustainable way the levels of activity they are undertaking across the areas of science and engineering. The precise degree to which each of the three categories of work (teaching, research and knowledge transfer) is underfunded is open to question, partly because, in practice, Vice Chancellors and Heads of Department must balance the books of complete institutions not merely subsets of them, and in any case, the edges between the activities are blurred. Cross-subsidy among the three categories undoubtedly occurs, and while it might be essential for accounting purposes to attribute all costs to one of the three categories, in reality this involves a significant degree of arbitrariness. It would be a disproportionate burden to expect institutions to allocate in a precise way the cost of lighting a corridor that is used by researchers, students, knowledge transfer officers and academic staff (who may undertake all three kinds of activity).

The possible solutions

Although everyone can agree that underfunding is a problem, there is no consensus on how the problem should be solved.

The potential solutions fall into two approaches:

(a) find more money or
(b) reduce the expectations of what universities do.

Reducing expectations could involve:

A lowering standards
B reducing student numbers
C contracting the volume of research undertaken, or

D cutting back on activities that are not part of the core functions of education and research.

For different reasons, each of these is currently seen as politically unacceptable. Lower standards would negate the point of much teaching and research, participation rates in higher education are already lower in the UK than in many other countries, and the current volume of research is considered a significant part of the country's economic future. Other activities, particular transferring knowledge from universities into private companies, have come to represent a central plank of economic policy that is not going to be easily overturned.

Finding more money means one of four things (or a combination of more than one):
E allocating extra public resources from general taxation
F extracting more money from individual students (or graduates), for example by charging higher fees or levying a graduate tax
G convincing private institutions or individuals to contribute more, either in on-going funding or by encouraging greater endowments, or
H moving money within the system out of non-science subjects into the sciences.

While public investment in higher education continues to rise, the system already receives an average of about £400 per year from every income tax payer in the country[8]; with many other demands on the public purse, it is unlikely that additional funds from taxation will plug the funding gap in the near future. Although in the longer term, students may be asked to make a bigger financial contribution to their education, the current regime is already extremely unpopular, and is fixed for several years to come. Large endowments would clearly be advantageous, but will take decades to generate. Moving existing money between different classes of discipline on a large scale has a recent precedent; the Higher Education Funding Council recently changed the funding formula but even if this decision were reversed, staying within the current budget, universities would not receive enough extra income to plug the science gap.

So although there is a clear problem that almost everyone agrees is serious, and although the potential solutions are intellectually simple to enumerate, most of the resolutions that are theoretically possible either would not work or are opposed by a sufficient political alliance that they are not currently being given serious consideration.

This document attempts to move the debate forward by expressing the problems succinctly and seeking credible arguments for reform.

A Lowering standards

Although nobody overtly advocates the lowering of standards, the fact is that the past few decades of educational policy have qualitatively and quantitatively altered the nature of a university degree. The fall in funding per student, for example, means that science courses typically contain less direct experimental work than they used to. Moreover, the introduction of foundation degree courses has created the possibility for students to experience higher education without undergoing the expensive and rigorous training of an honours degree.

So, in some senses, the average standard of content in degree courses has already fallen, although full honours degrees at the best universities are clearly of the same quality as those of the past.

The question is whether further changes could be used to alleviate funding deficiencies. For example, should more people undertake cheaper foundation courses and fewer study for three or four year science degrees?

B Cutting student numbers

Cutting the number of students in the system without cutting the level of public-sector funding would certainly go some way to softening the financial hardship of running a university science course. Indeed, the current Secretary of State for Education has already said that the official target of 50% of young people attending university is 'odd'. In fact, it is an arbitrary number with no obvious justification.

However, it is plain that more and more people want and can benefit from learning opportunities beyond the level of compulsory education. The economy requires highly skilled workers, and they must be educated somewhere. So if the target for university entrance was set at, say, 35%, some of the funding problem could be ameliorated, but it would certainly not be cost-free for the economy. The remaining young people would still need to be trained and educated elsewhere.

The further education sector, the technical apprenticeship system, and other educational institutions would need to expand, and the opportunities they offered would need to be paid for. It possible that people would perceive the problem differently (for example, some employers might be prepared to make a larger financial contribution to apprenticeships than to degree courses), but the costs would still exist. Moreover, the economic effect of cutting student numbers at university would take some time to kick in, as the vast majority of costs are fixed costs.

So while reducing student numbers in the university sector may solve some of its financial problems at the margins, it is not the answer to the nation's overall problem of funding the educational needs of its young people.

C Contracting the volume of research

In a world of limited resources, it is generally better to do a few things well that many things badly, and if the Government does not provide the extra resources needed to finance the current volume of publicly-funded research, then a contraction of volume may be necessary.

In effect, it has been part of Government policy for several years to concentrate resources into a smaller and smaller number of centres, and this has been evidenced by the increasing degree of selectivity with which funds are allocated on the basis of the Research Assessment Exercise (RAE).

However, this method of reducing the number of institutions that receive substantial investment in research will not solve the funding problem, for two reasons. First, it will not necessarily reduce the volume of research; indeed, the RAE has hitherto had built-in incentives for departments to grow rather than consolidate. Second, it will eventually mean that only one kind of research activity will be funded; the system will ossify, and new ideas from new teams in previously unrecognised centres will have no opportunity to flourish.

Although it continues to pursue this policy of concentration, the Government has said explicitly that it wishes to retain the current volume of research, and has put in place a mechanism (through the implementation of a system of full economic costs) that will make this possible and sustainable as new resources become available. An extra £200 million per year has so far been allocated, and more has been promised when the universities and Research Councils are in a position to provide the data needed to demonstrate with some degree of accuracy the magnitude of the current funding shortfall.

D Cutting back on other areas

In times of financial hardship, organisations typically concentrate on getting their core business right, and in the face of funding difficulties, universities could emphasise their teaching and research roles, while not bothering so much about knowledge transfer.

Such a strategy is not only politically impossible in the current climate, it would not in fact solve the universities' current funding difficulties. Even if they save their entire budgets for such activities and applied them to teaching and research, there would not be nearly enough money to plug the gap. The latest round of the Higher Education Innovation Fund will involve about £120 million per year, about 6% of the estimated requirement of £2 billion per year.

E More public money

There is a strong case for high levels of public investment in higher education teaching and research. The graduate workforce that is generated and the economic growth that springs from the discovery of new knowledge are worth investing in. The question of how much to invest in them is one to which there is no right answer.

In research, substantial new money has indeed been invested in recent years, and the explicit aim is to create a sustainable funding system for the current volume of research. The fact that Research Councils will pay the full economic costs of the research they support will be a significant step in this direction.

The case for more public money for teaching is harder to make, largely because other parts of the education system also require additional investment, and improving the education of, say, primary school children not only benefits everyone directly (by comparison with the 45% of people who benefit directly from university education) but also potentially provides a sounder educational grounding than exists at present on which to build success in higher education.

However, international comparisons do provide a case for higher public investment. The ratio of public and private rates of return on investment in higher education is higher in the UK than in almost any other industrialised country except Italy. Relative to the individual student, taxpayers in the UK get a better deal (in terms of effects on the economy) from investing in universities than the taxpayers of Canada, the USA, Germany, Sweden or the Netherlands. They get a relative return twice as great as the taxpayers of Japan, Denmark and France.

In other words, far from being a cost, public money invested in higher education in the UK delivers considerable positive returns to the economy, and the Government should consider the potential benefits of higher levels of investment.

F Increased tuition fees

From the tone of the Government's debate over the introduction of top-up fees, it is clear that ministers introduced them reluctantly, as a way of plugging the growing gap in higher education funding, rather than because they believe it to be desirable *per se* that individuals should invest in their own education. This view also appears to be shared by the major opposition parties, both of which offered to abolish the current system of top-up fees if elected at the last general election.

Thus, it is politically unlikely that the Government will break its promise to retain the cap of £3,000 per year for the next few years, or indeed that even then, the cap will be lifted quickly, substantially or with any enthusiasm.

However, the case for doing so is twofold. First, taking into account the arguments about the other possible sources of funding, increased tuition fees are one of the few options that could actually deliver new resources on anything like the timescale needed. Increases would have to be coupled with proper safeguards concerning the need for entry to higher education to be based on ability rather than income [so-called 'needs-blind' admission] but this is not impossible.

Second, there is an argument that students will value their education more if they contribute more fully towards its costs. In principle, it may be regarded as a good thing for those who benefit from higher education to bear the costs. The benefits come both to society at large (for a whole variety of reasons) and to the individual students.

As the rough calculations above demonstrate, to pay the full costs of teaching science, fees would need to rise to about £5,000 per student per year (the figure proposed by the Russell Group of leading universities), even if there were no costs involved in collecting the fees, and if all students paid the full amount and all of the extra income generated were to be available directly for teaching. Since universities are (rightly) expected to offer bursaries to poorer students to create a needs-blind admission system, it will not be the case that all of the extra income will be available to fund university teaching directly.

Thus, increased fees could be a substantial element of the solution to the challenge of funding university science teaching, but even if they were raised to a level that obliterated the teaching deficit, they will not plug the research funding gap.

G.1 Increased on-going funding from private industry

British universities already attract a larger proportion of their research funding from private industry than their counterparts in almost any other comparable country except Canada or Germany[9].

However, it is clear that the Government intends an increasing proportion of funding for the science base to come from the private sector, as evidenced by its constant reiteration of the need for closer links between the universities and industry, and its insistence that universities raise matching funds to unlock much of the Government's own investment.

The introduction of a system of Full Economic Costs, while admirable in principle, appears to have made it less likely that industry will continue to invest significantly in

British university research. One effect of the process that has led to the Full Economic Costs model being adopted has been to expose the underlying opaqueness of university funding. Industry is unwilling to bear costs that it cannot see fully justified.

Moreover, even once that problem is sorted out (and new accounting mechanisms will make a big difference), industry is finding that it can obtain the same quality of research at a cheaper price in other countries, including both the USA and parts of Europe. The reasons for that are not necessarily to do with the inherent costs involved in these different countries but because the calculation of full economic costs varies among them, so that industry is not expected to pay for some infrastructural costs (maybe the relevant proportion of heating and lighting a shared building) in some countries, but will be expected to do so under the model of full economic costs introduced in the UK.

Overall, the UK system of higher education must decide whether it is prepared to accept industrial collaborations that do not fund these costs, because if it is not, industrial decision-makers will simply take their work elsewhere. The cost of this would not only include the loss of the jobs associated with the research, but the loss of fruitful collaborative links, facilities and ideas that come from working with private-sector partners.

Whatever happens regarding the funding of research by industry, there is no real scope for industry to meet the unfunded costs of teaching. Companies pay their taxes, and have legitimate expectations that the services they are buying by doing so will be properly resourced; except in specific cases (for example if a firm is commissioning a training course tailored its needs), they are not going to pay substantial additional sums into the general higher education pot.

G.2 Endowments

Substantial endowments might conceivably go some way towards taking the pressure off university funding. At some American universities, for example, endowments provide a stream of unencumbered income, which can be applied to the institution's own priorities, freeing them in some measure from state control. However, no higher education institution could hope to survive exclusively or even primarily on endowment income; the benefits of endowments are the 'icing on the cake' – the cake will always be provided from other sources.

At present, few British universities have endowments of any magnitude. Oxford and Cambridge, the only two with major endowments have funds of about £3 billion each, little more than one tenth of the endowment enjoyed by Harvard[10]. In fact, only the largest American institutions have substantial endowments, and it is easy to exaggerate the role they play in funding university science.

There are two big differences between the American and British experiences. First, many American universities have been building up their endowments over decades, and in some cases centuries. It would be unrealistic to expect British universities to build up sufficient endowments rapidly enough to come anywhere near solving the current crisis. Second, the culture of alumni giving is different in the USA, where society in general is based more on individual contribution (to healthcare, education and other services) and less on taxes being allocated by the state. Whatever the merits of the two systems in general, no system of generating endowments for UK

universities will succeed (at least in the short to medium term) if it assumes that British people will suddenly start behaving like Americans.

Despite these potential challenges, there can be little doubt that in the long term, building up greater endowments by British universities must form an important part of the way in which their funding will be increased. There is no strong political objection from any quarter to the idea of building endowments, they would not place as great a pressure on the stretched public purse as other possibilities, and the experience of other countries demonstrates that the idea can work in practice.

In his pre-Budget speech in December 2004, the Chancellor of the Exchequer said that he would "pilot a matched-funding scheme to help universities to build up their resources through new endowments"[11]. No details were given in the full pre-Budget report[12] and the scheme was not mentioned at all in the Budget report in three months later[13]. In answer to a Parliamentary Question in October 2005, the DfES revealed that a total of £7.5 million was involved, an average of less than £60,000 per university[14]. The phrase 'matched funding' in the pre-Budget speech had led many to believe that the Chancellor was intending to offer substantial rewards, perhaps through tax relief, to universities that worked hard to build up donations from alumni.

H Moving money within the system

There is little scope for moving research money into the sciences from other parts of the higher education system. The bulk of research funding already goes to science and engineering, and even if the arts and humanities were closed down altogether, the extra resources freed up would not plug the long-term gap in research funding.

In teaching the situation is slightly different. Until last year, universities in England received twice as much money for every student in a laboratory-based subject as they did for each student in a library-based one. HEFCE changed that decision so that now, universities now receive just 1.7 times as much for science students as for those in the arts.

HEFCE claimed that the decision was based on data provided by the universities themselves, and that the gap between arts and sciences had closed partly because science courses involve fewer practical experiments than in the past and partly because the arts have become more expensive to teach since they have started to use computing in a significant way[15].

On the issue of computing, it is absurd to propose that even the most electronically sophisticated history student needs anything like the computing power of someone studying electronic engineering. With regard to practical work, one of the main reasons why students undertake fewer experiments now than in the past is because overall funding per student has fallen by around 40% since the late 1980s. As the money fell, experiments were necessarily cut from the curriculum, and now HEFCE is using this as a justification to reduce investment even further.

It is plain that the decision to change the funding ratio between the arts & humanities and the sciences & engineering was badly informed, and indeed HEFCE admitted that their methodology may have been "inappropriate" for "determining subject weightings" and that there "would be merit" in using a more robust method[16].

The decision should be reversed immediately, with on effect on the overall amount of public money being invested in the higher education system. However, even if this happened, universities would gain about £128 million extra per year to teach science students, leaving a gap that would still exceed £370 million per year[17].

Conclusion

Although everyone agrees that, at current levels of activity, science and engineering in British universities are underfunded, there is no obvious resolution of the problem. Most potential solutions are either politically unacceptable, unrealistic or too long-term to deal with current difficulties. Some combination of several might go some way towards addressing medium-term funding requirements, but hard decisions will have to be taken.

If the UK wishes to preserve its enviable record of world-class science and engineering in its universities, it must decide how it intends to fund it. The decision cannot be avoided indefinitely, or the future of science in the universities will be at stake, and with it the social, economic, cultural and environmental benefits that depend on it.

November, 2005

Notes and References

[1] *Cross-Cutting review of science and research: final report,* H M Treasury, DfES, OST and DTI (2002).

[2] At a meeting in Parliament on 9 November 2005, the Minister, a Vice Chancellor and a journalist gave lists of about seven or eight purposes of a modern university, but all of them – social inclusion, stimulating local industry, etc. – can only be delivered through discovery and dissemination of knowledge.

[3] *Cross-Cutting review of science and research: final report,* H M Treasury, DfES, OST and DTI (2002).

[4] *Strategic science provision in English universities*, Eighth report of the House of Commons Science & Technology Committee, Session 2004-2005, Volume 2 [HC 220-II].

[5] *The future of higher education,* Fifth report of the House of Commons Education & Skills Committee, Session 2002-2003, Volume 2 [HC245-II].

[6] *Funding higher education in England: How HEFCE allocates its funds,* HEFCE, 2005 [HEFCE 2005/34].

[7] *All HE students by level of study, subject of study(#5), domicile and gender 2003/04,* Higher Education Statistics Agency (the figure has been calculated assuming that the ratio of full time undergraduates to all students is the same for UK-domiciled students as it is for all others)

[8] *The future of higher education,* DfES, 2003 [Cm 5735].

[9] *OECD Science, Technology and R&D Statistics,* OECD [2005 Edition]

[10] *The future of higher education,* DfES, 2003 [Cm 5735].

[11] *Hansard,* 2 December 2004.

[12] *Opportunity for All: The strength to take the long-term decisions for Britain,* HM Treasury, 2004 [Cm 6408]

[13] *Budget 2005: Investing in Our Future: Fairness and Opportunity for Britain's hardworking families,* HM Treasury, 2005 [HC 372]

[14] *Hansard* [House of Commons] 26 October 2005, column 397W.

[15] *Strategic science provision in English universities*, Eighth report of the House of Commons Science & Technology Committee, Session 2004-2005, Volume 2 [HC 220-II].

[16] *Funding method for teaching from 2004-05: Outcomes of the consultation,* HEFCE, 2004 [HEFCE 2004/24].

[17] Assuming that the ratio of full time undergraduates to all students is the same for UK-domiciled students as it is for all others, there are about 411,000 arts students and 280,000 science students in the system. The current funding levels are £3,608 for each arts student and £6,134 for those in the sciences, giving a total public investment of £3.2billion. If science students were funded at twice the level of arts students, this level of money would equate to £3,296 for arts students and £6,591 for science students.