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REFLECTIONS ON RESEARCH ASSESSMENT OF COLLABORATIVE RESEARCH BETWEEN UNIVERSITIES AND EXTERNAL PARTNERS

David Livesey, Lidia Borrell-Damian and John H. Smith

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Reflections on Research Assessment of Collaborative Research between Universities and External Partners[1]

David Livesey,[2] Lidia Borrell-Damian[3] and John H. Smith[4]

Contents

[1] Although the views expressed in this paper have been developed as a result of stimulating discussions with colleagues whilst David Livesey was a senior adviser to the EUA EUIMA Collaborative Research Project, they are those of the main author and not necessarily those of EUA. I am indebted to my EUA colleagues, especially Lidia Borrell-Damian, as I am to Ruth Livesey and Stephen Watson for their very helpful comments.

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Introduction

Considerable attention has been paid in recent years to the transformative nature for both parties of the intensification of university and industry collaborations into strategic partnerships. Much of the discussion has focussed on the characteristics of the institutional change needed to initiate, develop and sustain an effective research collaboration[5]. Helpful taxonomies have also been developed to distinguish between the various outcomes of research collaboration not only for the parties involved but also between the various economic and social benefits to localities and regions[6]. In this context, this discussion paper focuses on how both parties assess the research output of universities resulting from external collaborations. It does this by reflecting on what can be learnt from the case studies of the EUIMA Collaborative Research Project, and on the effective and useful interpretations of the impact of research collaborations, not only for universities but also for their external partners[7],[8].

Research collaborations between universities and external partners cannot be studied in isolation from the current political and social context in which universities have to survive. Martin[9] provides a very useful introduction to the wider debate, academic literature and historical perspective on not only the issues which this paper will examine arising from the EUIMA project but also on the broader questions such as whether universities and academic research are under threat as a result of their 'third mission' – i.e. their contributions to industry, the economy, the local region or society more generally. Although that debate is beyond the scope of this paper, it is demonstrated below that there is plenty of evidence in the case studies and workshop contributions that, at least for those universities involved in the EUIMA project, external research collaborations are invigorating initiatives providing new ways and opportunities for re-enforcing the "traditional" research mission of universities.

This paper's starting point[10] is the question - what is the nature of the activity in which universities engage in collaborative research? The answer emerges by examining some other key questions. What are the distinctive features of the learning associated with teaching and research? What are the public as opposed to the private benefits from such learning? Who should therefore pay for the costs incurred? All universities are significantly dependent upon public funding as a major source of support for their research

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[5] e.g. Leydesdorff, L., Etzkowitz, H., 1996, 'Emergence of a Triple Helix of university–industry–government relations', *Science and Public Policy*, 23, pp. 279–86.

[6] e.g. Science|Business, 2012, *Making industry-university partnerships work: Lessons from successful collaborations* (Brussels, Science|Business); League of European Research Universities, 2007, *Universities and Innovation: The Challenge for Europe* (Leuven, LERU); Lester, R. K., 2005, 'Universities, Innovation, and the Competitiveness of Local Economies' Industrial Performance Center Working Paper 05-010, Massachusetts Institute of Technology.

[7] The definition of collaborative research which the project used was: "Activities where several parties are engaged in research towards shared objectives, collectively building on their individual background and sideground in the creation of new foreground knowledge." The same definition had been used in the EUA's previous work on responsible partnering between universities and external partners. See "Joining Forces in a World of Open Innovation: Guidelines for Collaborative Research and Knowledge Transfer between Science and Industry" published by EUA, EIRMA, ProTon Europe and EARTO, 2009.

[8] Details of the case studies and workshop presentations which constituted the EUIMA Collaborative Research Project are available at www.eua.be/euima-collaborative-research. The full list of contributing organisations to the EUIMA Collaborative Research project can be found in the Annex.

[9] Martin, B. R., 2012, 'Are universities and university research under threat? Towards an evolutionary model of university speciation', *Cambridge Journal of Economics*, 36, pp. 543–65.

[10] By contrast the starting point for Martin's analysis is the historical evolution of the higher education "species" and their different national "environmental niches", which provides the context for his analysis of the changing social contract between universities and wider society, as represented by the state and/or local government. His focus on modes of research and on systems of innovation is discussed later in this paper.

programmes. The difference between private and public universities is in the nature of their accountability for public funding. Whereas a private university is only accountable to government for that which is publicly funded, a public university is accountable for everything whether publicly funded or not. Hence for a public university income from external collaborations brings limited freedom.

Some of the answers to the question “who should pay for the costs incurred by universities?” explain the funding incentives/pressures which have contributed to the recent evolution of universities. However, the answers to the question "what are the public as opposed to the private benefits from the learning associated with university teaching and research?” suggest reasons why the audit culture with its metrics-only approaches will never capture the essentially private and personal experiences and benefits derived from high quality learning. Glimpses of those benefits and why they are pursued emerge best in the narratives and qualitative indicators found in studies such as EUIMA.

This discussion paper starts by providing an economic analysis of the issues with which it is concerned. It then discusses the nature of the activities in which universities engage by considering the role of knowledge in teaching and research. This leads into a discussion of how the perception of the balance between the public and private benefits and costs of universities’ public funding has been influenced by, and influenced in turn: the literature on higher education; higher student participation rates; and, a broader research agenda including collaborations between universities and external partners.

By this route we come to a consideration of research as a mechanism for the acquisition and transmission of new knowledge. There the apparent dichotomy between basic and applied research in the Frascati manual [11]is discussed in the context of the literature on modes of research. That literature has, as has the evolving pattern of research assessment of universities, established that this dichotomy implies a distinction between the research which is deemed increasingly irrelevant and the excellent research which emerges from external research collaborations that entered into by universities.

We then seek to establish why focussing on those aspects of external research collaborations which are amenable to a quantitative assessment of their impact, fails to capture fully the essence of those collaborations.

The analysis of the EUIMA case studies begins by discussing appropriate frameworks for collaborations between universities and their external partners. These frameworks are then used as evidence from which is drawn a set of characteristics of both universities and businesses engaged in successful external research collaborations. The full list of contributing organisations to the EUIMA-Collaborative Research project can be found in the Annex.

We conclude by considering what the evidence from the EUIMA case studies has to say about the effective and useful interpretations of the impact of research collaborations, not only for universities but also for their external partners. The discussion considers whether the lessons learnt enable universities not only to encourage within their institution more active participation in collaborative research partnerships, but also to understand how to partner more effectively and how to become more competitive and select the preferred partner. We ask whether there are ways in which universities can better explain to governments the nature, and potential means to evaluation, of successful outcomes of external research collaborations and why public funding is needed to facilitate such partnerships.

[11] Organisation for Economic Co-operation and Development (OECD), 2002, *Frascati Manual: Proposed Standard Practice for Surveys on Research and Experimental Development*. (Paris, OECD).

An economic analysis of universities' activities

The focus of governments' higher education policies on their role in generating economic growth has led some academics to be suspicious of economic analyses of universities' activities. This is to be regretted because economics is still a useful analytical tool when not a football of predetermined government policy.[12]

The context for the economic analysis of the issues is that which economists such as Alan Hughes have used to elucidate how universities can play a role in innovation and in the generation of economic growth without harming their primary purpose[13].

The starting point for an economic analysis of the issues is the role of investment in generating economic growth. Investment involves the purchase of goods and services which will enhance future productive capacity. It can take many forms: buying more machines, building more factories or educating the workforce more. The cost of purchasing more and/or better machines and/or generating a more highly skilled labour force reduces current consumption but brings benefits in terms of the potential for greater output, and hence consumption in the future.

The benefits of any particular investment are uncertain even when it is simply, for example, for purchasing more machines with existing technology to meet future demand, or for its output which may not materialise. As far as better machines incorporating new technologies are concerned, they are not available to be purchased until someone has funded the expenditure on research and development that will hopefully generate the required innovative technology that those better machines incorporate. Hopefully, because it is only hindsight which enables us to identify, not only which was the research and development expenditure that generated the necessary innovative technology, but also which of many possible new machines improved its predecessors. History tells us that much effort went into developing new machines which turned out to be no better than their predecessors or their rivals. History also tells us that investments in new labour force skills have been critical to the development and deployment of those better machines. To the extent that history is written by the winners, it does not always give us the full picture, but at least it is clear that there are considerable risks in investing in new technologies and skills. For the winners the awards are great. For those who invest in a wide range of new technologies and/or a diversity of different approaches to similar problems, the chances of coming up with a winner are higher. The chances may be higher or lower but the only certainty is the cost of trying.

Those countries and/or companies characterised by their use of established technologies and skills can only generate the surplus/profit needed to fund investment in new technologies and skills by having low labour costs and/or by restricting current consumption. By contrast those countries and/or companies characterised by their development of new technologies and skills fund their investment from the premium prices that they are able to command for their newly proven technologies. Consequentially, the universal truth that the uncertain benefits of tomorrow's investment are purchased today by consuming less does not imply a levelled playing field.

This uneven playing field is a consequence of the legal protection afforded to patents and copyright which enables innovators to earn considerable profits from their successful innovations. The system is justified on

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[12] This is well illustrated by Stefan Collini in "Browne's Gamble" reprinted in "What are Universities for?" (Collini, S., 2012, *What Are Universities For?* (London, Penguin Books), in which he rightly expresses his concern about Browne's analysis "focussed narrowly on the potential implications for the individual student" and using the language of economics Collini suggests that what is omitted by Browne is a view of "higher education as the provision of a public good".

[13] See for example Hughes, A., Kitson, M., Bullock, A., & Milner, I., 2013, *The Dual Funding Structure for Research in the UK: Research Council and Funding Council allocation methods and the pathways to impact of UK academics. A Report from the Centre for Business Research and the UK~IRC for the Department for Business, Innovation and Skills* (London, Department for Business, Innovation and Skills).

the grounds that it is the incentive needed to fund the Research and Development (R&D) which will generate new innovations[14]. The consequence is that, although these new technologies can and are made available to all countries, it is on terms which favour those who already have the competitive advantage in innovation. For example, the production of the components of new technologies quite often takes place in low-wage economies, in facilities financed by inwards foreign investment using licensed know-how on terms which leave most of the profits with the innovator rather than the manufacturer. Hence, facilitating the manufacture of new technologies does not necessarily make any easier the sort of investment required to achieve a domestic breakthrough to a more developed economy with its own indigenous innovation.

Accordingly, all governments, whatever their level of economic development, are critically aware of the benefits of being able to generate new technologies. "Innovation" is therefore seen as the key driver of economic growth and taken to be also the route to social progress. Particular attention has focussed on the process of innovation understood as the translation of new ideas into new products. Given the role of research in the generation of new ideas, governments regard universities as key actors delivering their script for an innovative economy.

Innovation, which is about learning-by-trying, therefore has many characteristics and values in common with universities. However, the generation of new ideas and new products is not a case of the latter flowing from the former, with universities as the reservoir from which the pipeline of innovative ideas flows. Interactions between those generating new ideas and those developing new products are critical to success. Innovation is about knowing the context in which existing or yet to be generated knowledge is to be used and passing it on in a way that will facilitate its translation into new innovative outcomes. Accordingly, as actors in an innovative economy, universities have to engage with entrepreneurs, who like academics, see a certain amount of failure as part of the learning which leads to ultimate success.

The innovations of one firm spill over into the innovations of another. Hence, it is argued that everyone benefits, despite the too high a price that may be charged for access to an innovation, because of the consequential innovations and productivity growth which it stimulates. These are the 'public' benefits or "spillovers" from the way in which these innovations yield yet more innovation and productivity for other firms. Universities also generate "spillovers" and exist for the public benefit rather than to charge a high price for access to ideas. Accordingly, there are significant direct and "spillover" benefits from university or publicly funded research (Hughes & Martin[15]).

The role of the university in the innovative economy has been enhanced by the perception that the innovations of one firm spilling over into the innovations of another is less mutually beneficial than an open system of innovation. An open system is one in which 'new ideas are co-produced and new products emerge in an innovation systems might best be defined as an "ecology" in which interactions between different actors produce emergent behaviour that is highly adaptive to circumstance and opportunity'.[16]

The key role of universities and their external collaborations in that ecology is premised on the significance of what it is that universities do, i.e. both in their teaching and research

The role of knowledge in teaching and research

Teaching and research are often discussed as separate activities. However, expenditure on teaching and expenditure on research are both investments in human capital. Participation in either teaching or learning

[14] However what the patent holder charges for access to the innovation may yield larger profits than are needed to incentivise the funding of R&D. If those excess profits are difficult to tax, publicly funding the R&D with the consequential intellectual property being for the public benefit have a better outcome.

[15] Hughes, A., & Martin, B., 2012, *Enhancing Impact: The Value of Public Sector R&D*. (London, UK Innovation Research Centre).

[16] Boulton, G., & Lucas, C., 2008, What are Universities for? (Leuven, League of European Research Universities – LERU).

expands an individual's stock of competencies - knowledge, social and personality attributes. The embedding of each of these three competencies in an individual is important, not only for the personal development and for the quality of life of that individual but also for what economic and social contribution to society that individual can make. Of the three competences, it is knowledge which is the one most often discussed in the context of a university. Universities are not only custodians of existing knowledge but also generators of new knowledge.

New knowledge is embedded in the individual who originates it, but it has the characteristic of a public good, namely that it can be relatively costless to communicate it to others without diminishing the significance held by its originator. Although communicating new knowledge widely may diminish the monopoly value of it to its originator, society as a whole benefits, since some of those to whom it is communicated may utilise it and/or extend it in innovative ways, thereby generating additional value. This is the essence of one of the cases for universities. The new knowledge which they generate is a public good and hence there are public benefits derived from its widespread communication. The distinction between teaching and research is relevant to any situation in which knowledge is an answer/solution to a question/problem. This can be illustrated by reference to what is known and what is unknown. Teaching expands the stock of private knowledge that an individual possesses. It not only increases how much s/he knows but also clarifies what s/he knows and does not know. In an uncertain world knowing what you do not know is helpful. However, it is the problems that you did not know existed which are responsible for the greatest uncertainty and, by definition, these cannot be taught. Research is more helpful here since it either expands the public stock of what is known about what were hitherto unknowns, or more rarely but importantly when it does, it reveals a hither too unknown and hence puts the need for its solution on the agenda.

Distinguishing between teaching and research on the basis of their different outcomes does not provide a description of the process – learning - by which those outcomes are achieved. Teaching is sometimes described as passive learning and research as active learning. However, some conscious or unconscious engagement by the recipient is required in teaching for knowledge to be communicated and acquired. Clearly, the more interactive the communication between the people involved is, the more active is the learning, and at some point there may be no teacher and no student but just peers learning together. But it is only when learning is generating new knowledge that it can be properly described as research rather than teaching.

Long before the distinction was drawn between teaching and research, universities were the place where people, not just Newton, were seeing a little further "by standing on the shoulders of giants". Increasingly companies are realising that access to knowledge is facilitated by close proximity to a university as well as by specific collaborations. Companies benefit when their employees expand the stock of knowledge that they possess through the learning that networking with academics stimulates. They benefit even more when their employees' collaborations with academics make those academics aware of known unknowns of which they were previously ignorant and stimulate them into solving some of those unknowns. Accordingly, companies are willing to pay for access to university knowledge. Governments have traditionally funded universities because of the public benefits gained from a highly educated workforce and innovative research. But the increasing cost of an expanded higher education sector in the current economic and social context is generating fundamental questions about who pays and why.

Changing perceptions of the balance between the public and private benefits and costs of universities

Research collaborations between universities and external partners cannot be studied in isolation from the current political and social context in which universities have to survive. All universities are significantly dependent upon public funding as a major source of support for their research programmes. The difference between private and public universities is in the nature of their accountability for public funding. Whereas a private university is only accountable to government for that which is publicly funded, a public university is accountable for everything whether publicly funded or not. Hence, for a public university, income from

external collaborations brings only limited freedom. In addition to having to account publically for how it spends such funding, in some countries the need to achieve such external sources of income may be a condition attached to a public university's receipt of public funding.

How public funding is allocated to universities differs between countries and between funding for teaching and research. However, global competition means that countries are subject to similar economic and social trends and pressures, and their consequences on the demand and supply of public funding for universities. Historically, when participation in higher education was restricted to the small percentage of the relevant age cohort which was deemed to be qualified to participate, the public costs of funding, what was principally undergraduate education, was a small part of total public expenditure. In those countries in which the public cost was compared to the private benefits, they were judged to be incidental to the significant public benefit of having highly educated elite. In those countries in which not only student fees[17] but also maintenance[18] was publicly subsidised it was the size of the public benefit generated which justified the selection and funding of those deemed to be qualified. Although there was evidence in many countries that higher incomes were earned by the educated elite, this was not evident to students from low-income households. Accordingly, most countries, even if they did not provide maintenance payments, charged no or low fees to encourage participation in university education from across all social classes. Since higher incomes were taxed at higher marginal rates, the future lifetime earnings of today's students, higher than they would have been if non-university educated, could be regarded as contributing additional future tax revenue that in part or whole offset the cost of their university education.

More recently the rise in the standard of primary and secondary education has increased very significantly the numbers of those qualified to participate in higher education. The consequential higher participation rates have been deemed essential by governments so that their economies can have the skilled workforce required by a "knowledge economy". Hence, current public policy on higher education has an interest not only in the role of universities in innovation but also in their role in producing a highly educated workforce. At the same time all aspects of public expenditure, especially increases therein, are under intense scrutiny as a result of the perceived need to reduce public borrowing.

The case for more university students, the current costs of whose education is covered by the additional future tax revenues which they pay later in life, is a case for increased rather than reduced public borrowing. It is a case which is weakened in several ways. More university-educated workers cannot command the premium salaries that were earned when fewer were that educated. Accordingly, governments are re-examining the balance between the average public and average private benefits gained per student. In the UK for example, comparisons of the private benefits, measured using the historic lifetime earnings profile of previous generations[19], have now been produced to justify requiring current students to fund their own education, using loans repayable from their future earnings[20]. Governments are also scrutinising and holding down in whatever way they can the costs of university teaching[21] and trying to

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[17] "Fees" are here taken to mean that which is charged to students to recover in whole or part the cost of their university education.

[18] "Maintenance" is a payment to students to cover in whole or part their living costs whilst pursuing a university course.

[19] Using the historic lifetime earnings profile of previous generations ignores the observation that historical rates may well not apply when there are more university-educated workers.

[20] Loans may one day be "the straw that broke the camel's back" since they are for today's young an intergenerational inequality to be added to others, such as the requirement to fund more generous entitlements for current retirees than will be granted to them, being imposed on them by today's elders.

[21] Since the loans in the UK are both more generous than the system which they replaced and are government backed, they do not reduce public borrowing in the current period. The pressure on public expenditure would be greater now than in the past, even if there had not been a global financial crisis, since premium salaries - assuming that they can be commanded by university graduates - are now taxed at lower marginal rates than previously.

assess and ensure that it is value for money. Few countries have gone as far as has the UK. However, some have increased student fees adding to the deterrent effect of high graduate unemployment and no maintenance funding for students. The consequence is a lower participation rate in higher education from those who would most benefit given their background and whose ability would most benefit future generations.

The academic literature on higher education, particularly as it relates to students' learning and to the management of institutions, has not only received little recognition from cognate disciplines but also has had little impact on either institutional or public policy. It provides no basis on which the outcomes of teaching programmes in one institution could be compared with those in another either for all students or for individual students or for the subjects studied. Consequently there is no rational basis for selective public funding of some but not all institutions or of some subjects[22] but not others.

By contrast, perhaps on account of its links with the history of science and more recently with industrial innovation and the economics of technology change, the literature on the outcomes of university research is shaping both institutional and public policy[23]. In particular, the literature on the apparent correlation of economic benefits with the significant federal funding of research in top US private and public universities has become in many countries the justification for the selective allocation of state funding for university research. The copious compilation of research rankings of institutions, subjects and authors based on the widespread availability of publication and citation data has provided the ingredients and the mechanisms for highly selective allocations of significant sums of public funding for research to some but not all universities. It is not just in the UK, where research assessment is used to allocate selectively funding for "blue sky" research, but also elsewhere that competitive allocations of "excellence" funding for research infrastructure posts and contracts are informed by rankings. Although it is recognised in these selective allocation mechanisms that a lot of innovation has been an unforeseeable outcome of "blue sky" research, it has not completely forestalled the natural tendency of funders to issue calls for research proposals which address particular topics as opposed to their funding of the best proposals, regardless of the topic. Inevitably universities have adopted research strategies to maximise their chances of benefitting from the way in which research funding is now allocated.

It has not gone unnoticed by government funding agencies that universities have been benefitting from industrial and business funding. Accordingly in the UK, funding allocations have been adjusted to reward those who have benefitted so as to incentivise all to increase industrial and business funding and thereby reduce the higher education sector's dependence on public funding. The increasing mix of public and private funding has been one of the drivers of the development and public reporting of full costing in European universities so as to identify the costs of all their activities and projects. Full costing has also been used by universities to judge their share of the cost of each research collaboration. Recognition by universities in the UK that research collaborations have enhanced their income and not harmed their research ratings, has encouraged them to bear their appropriate share of the costs. The EUIMA project's related focus on university financing yielded a wealth of information on the drivers, development and current state of play of the implementation of full costing in universities across Europe[24]. The range of the industrial liaison activities, all of which link to the research agenda of a university, as evidenced in the EUIMA case studies, have been covered in the companion discussion paper "The Evolution of University-Based Knowledge Transfer Structures" by Stephen Trueman.

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[22] Differential fees for university courses in different subjects do not always reflect the differential cost of providing those courses nor do they necessarily reflect differential private benefits.

[23] This difference is in part a consequence of and reflects the difference between the changing perceptions, given the growing participation rate in higher education, of the nature of the benefits and the costs of teaching and research, especially the responsibility for meeting the costs discussed earlier in this section.

[24] Estermann, T., & Claeys-Kulik, A-L., 2013, *Financially Sustainable Universities - Full Costing: Progress and practice* (Brussels, EUA),

Where the literature on the research performance of universities has had the most effect on the organisational structure of universities has been in what relates to research outreach, and the institutional characteristics most often associated with the successful translation of research outputs into product innovation. Institutions have developed industrial liaison and technology transfer activities to stimulate patent and licensing activity. Although there is no consensus on the best organisational structure for these activities, it is accepted, at least within universities, that although they should be expected to break even they should not be expected to be a source of significant additional discretionary income. These increasing industrial liaison activities have both generated and been required by the increased industrial and business funding that could be/has been won for university research activities. Hence, institutional structures now embrace and encourage not only industrial liaison and technology transfer activities but also entrepreneurship, incubators, networks of start-ups and SMEs, science parks and spin-outs. These activities have increased industrial and business funding to universities for provisions which meet a variety of the funders' corporate goals, not just research collaborations which are the focus of this paper. Since at best they break even, these activities may not generate additional discretionary income but they do enhance the choice of sources of research funding for academics and widen their research horizons through new networking opportunities offered.

As it has been indicated previously, we are discussing here external research collaborations by focusing on the essence of research in universities. It therefore requires some definitions of the terms and concepts used in descriptions of research activities which link to the discussion in a previous section of the nature of learning involved in teaching and research.

Research as a mechanism for the acquisition and transmission of new knowledge

The internationally recognised methodology for collecting and using R&D statistics is the Frascati Manual. Research and experimental development (R&D) is defined as comprising creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.

Definitions from Frascati Manual

Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.

Applied research is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.

Experimental development is systematic work, drawing on existing knowledge gained from research and/or practical experience, which is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed. R&D covers both formal R&D in R&D units and informal or occasional R&D in other units.

In the context of external research collaborations, from a superficial reading of the Frascati definitions one might mistakenly assume that basic research is what happens in universities, that experimental development is what happens in business and industry and that applied research is what happens in collaborations between universities and industry. In fact the definitions helpfully distinguish between different types of and stages in research collaboration. However their contrasting emphases on the applicability and implementation of the new knowledge generated by research retain some implication that only basic research is what universities see as their mission. The definitions are therefore less helpful when it comes to differentiating between the three types of research than one of the examples cited in the Manual.

Example from Frascati Manual

"The determination of the amino acid sequence of an antibody molecule would be basic research. Investigations undertaken in an effort to distinguish between antibodies for various diseases would be applied research. Experimental development would then consist of devising a method for synthesising the antibody for a particular disease on the basis of knowledge of its structure and clinically testing the effectiveness of the synthesised antibody on patients who have agreed to accept experimental advanced treatment."

What lies hidden in this example is the extent to which some or all of these activities might require the generation of original and new insights before they can be completed. In this respect, the definition used in the UK for its Research Excellence Framework (REF)[25] is very relevant – "Research is defined as a process of investigation leading to new insights, effectively shared". This definition is inclusive, embracing the Frascati definition as a whole, and its exclusions[26] are helpful in delineating the current domain of university research.

From a historical perspective, what is interesting about the REF definition is the absence of any specific reference to the historic distinction between applicable and/or practice-based research and basic research which was made in the original 1986, 1989 and 1992 UK research assessment exercises. This distinction had generated criticisms, which were cited in the Roberts Review[27], that, since all research was assessed by common criteria which were alleged to reflect the characteristics of "good basic research or mainstream scholarship", it was to the disadvantage of applicable and practice-based research. Roberts therefore concluded that: "this perception may impede the development of applicable and practice-based research as institutions allow for what they believe to be the preferences of the panels. We believe that panels should be asked to ensure that their criteria statements enable them to guarantee that practice based and applicable research are assessed according to criteria which reflect the characteristics of excellence in those types of research, where these may differ from the characteristics of excellence in basic research or mainstream scholarship."

The REF exists to make assessments of research outcomes for the purpose of determining future allocations of UK government funding for research in universities. The assessments consist of the "originality, significance and rigour" of each of the research outcomes, principally publications, being judged on whether it is world-leading in terms of originality, significance and rigour or by how much it falls short of the highest standards of excellence from an internal and national perspective. These assessments, made by panels of their peers, of the research of university staff are inevitably controversial and have generated extensive debates, some of which, such as those cited by the Roberts Review, have informed the evolution of the assessment exercises.

Another of the debates which is relevant here followed on from social science research on the production of knowledge. Gibbons[28] distinguished between two 'modes' or models of the way in which knowledge is advanced. In

> 'Mode 1' problems are set and solved in a context governed by the, largely academic, interests of a specific community. By contrast, in

[25] http://www.ref.ac.uk/

[26] It excludes routine testing and routine analysis of materials, components and processes such as for the maintenance of national standards, as distinct from the development of new analytical techniques. It also excludes the development of teaching materials that do not embody original research.

[27] Review of research assessment. Report by Sir Gareth Roberts to the UK funding bodies. Issued for consultation May 2003

[28] Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M., 1994, *The new production of knowledge: The dynamics of science and research in contemporary societies* (London, Sage Publications Limited).

'Mode 2' knowledge is generated 'in a context of application'.

Since, as Alsop[29] has observed, "'Mode 1' problems are set and solved in a context governed by the, largely academic, interests of a specific community" 'Mode 2' is seen by some academics as a threat to the independence and integrity of their research agenda. This is not surprising given that, as Hughes has observed

> "In Mode 1 pure experimental or theoretical activity is seen as hierarchically privileged. The identification and pursuit of new knowledge is driven by the investigation of 'objective' natural and social world phenomena. The quality of this research endeavour is linked to; the autonomy of universities; the freedom of scientists (whose activities the universities house) to identify and prioritise the objectives of research; the maintaining of disciplinary boundaries which are privileged against interdisciplinary activities; and a model of scientific accountability which is driven by internally refereed peer review."[30]

Clearly external research collaborations, which were the focus of the EUIMA project, are 'Mode 2' activities. However, since 'Mode 2' complements rather than substitutes for and indeed depends for its rational on a bedrock of 'Mode 1' research, it is not so much a threat as an opportunity to access strong private research funding.

The distinguished social anthropologist Marilyn Strathern is very favourably disposed towards 'Mode 2' seeing it as descriptive of the essential features of the methodology of her academic discipline.

> "It is arguable … that some of its features echo those which flourished in older institutional settings, such as networks of communications among scholars and, I would add, ethnographic research … Mode 2 is interactive and non-linear, with 'peer and user input', and may knowingly merge the investigator with the subjects of investigation. Moreover Mode 2 knowledge sits well alongside a whole stable of management techniques stressing the virtues of flexibility in time management, small-scale teamwork, trust among colleagues, risk-taking and so forth. Whether or not anyone recognizes the old-fashioned university department in this, many of these techniques present no novelty to the social scientist, nor would they, one suspects, to the laboratory scientist either. What is novel is the role they are given in the (self-) description and internal organization of knowledge-producing organizations. For anthropology I want to press the point that, beyond no novelty, there is a profound sense in which there is simply no other way of doing ethnographic research. For there is—and has been—no other way (than adopting similar techniques) of grasping what the ethnographic method grasps, namely how to make room for the unpredictable."[31]

Strathern's endorsement of the academic validity of 'Mode 2' research is important because she has made important contributions to the debate on the audit culture of which research assessment is a part. The focus on 'Mode 2' research has led to the notion of impact measures as part of research assessment.

Narratives approaches to the assessment of collaborative research

So far we have discussed the external collaborative research undertaken by universities in the context of their generating and promoting active learning throughout society by undertaking excellent teaching and research. In the previous section it was established that both in terms of the definition of research and in the assessment of its excellence "the old dichotomy between 'basic' and 'applied' research is misleading

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[29] Alsop, A., 1999, 'The RAE and the Production of Knowledge', *History of the Human Sciences,* 12(4), pp. 116-20.

[30] Hughes, A., 2011, *Open Innovation, the Haldane Principle and the new Production of Knowledge: Science policy and university-industry links in the UK after the financial crisis* (Cambridge: Centre for Business Research, University of Cambridge).

[31] Strathern, M, 2000, *Audit cultures: anthropological studies in accountability, ethics and the academy* (Oxon: Routledge).

and indeed increasingly irrelevant"[32]. This section sets out why focussing on those aspects of external research collaborations which are amenable to a quantitative assessment of their impact fails to capture the essence of those collaborations. Whilst not exempting qualitative assessments from the same reservations, it does suggest that narrative approaches hold out the best chance of glimpsing the most valuable parts of organisations that are beyond all qualitative and any single quantitative description.

Universities and the businesses with whom they collaborate are complex organisations. Trying to understand, describe and analyse complex organisations and their internal and external relationships is challenging. We observe them from a helpful perspective using whatever means seems to be most fit for the purpose. When the perspective is argument by analogy we must avoid the resulting illumination of some hitherto unnoticed similarities obscuring the real differences which have been omitted in selecting the analogy. Building up a picture with descriptions of individual relationships can seem slight and unable to bear the weight of rhetoric used to describe the community as a whole. However, when those descriptions are narratives written by individuals in the organisation, they are an important and relevant perspective.

The EUIMA case studies are narrative accounts written by their participants of external research collaborations and in discussing them it is therefore natural to take a 'narrative' approach to the impact of their assessment outcomes. The narratives were produced to communicate to third parties a description of the collaborations. Most of the narratives are not about the research outcomes or assessments of the outcomes of the collaborations. We argue, by reference to 'active learning' being the essence of collaboration, that those narratives which are outcomes and/or assessments of outcomes are not the principal benefits which sustain and enhance collaborations. The benefits, although co-produced by the collaboration, are personal private goods in the form of self-improvement which enable the individual participants to enhance either their "knowledge production" or their "business innovation" depending upon how their employer describes the public goods for which they are being paid. Not only are those outcomes of learning, termed "impact", too personal to be properly articulated but also extend to the take-up of learning by others. This occurs because learning stimulates the learner to have consequential discourses with colleagues and collaborators thereby extending the take-up of that learning to others, including what Brewer[33] calls an "educated citizenry". Hence, as he says, "complexity is the very nature of the process of impact."

Such a delving into the complex detail of social interactions, familiar to social anthropologists, triggers the cautions of Marilyn Strathern[34] that descriptions of complex societies, in which the most valued relationships are beyond description, inevitably omit the key elements. This is not only unfortunate but it becomes tragic when those societies themselves come to be organised and/or audited upon the basis of these descriptions since the most valued relationships then get lost. This is the essence of her criticism of the audit culture. It is the reason why 'narrative' approaches to the impact of research assessment[35] have

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[32] Hughes, A. & Martin, B., 2012, *Enhancing Impact: The Value of Public Sector R&D* (London: Council for Industry and Higher Education and UK-Innovation Research Centre).

[33] Brewer, J. D., 2011, 'The impact of impact', *Research Evaluation*, 20(3), 255-6.

[34] Strathern, M., 2000, *Audit cultures: anthropological studies in accountability, ethics and the academy* (Oxon, Routledge).

[35] A narrative approach to research assessment is to be incorporated into the 2013 and future UK Research Excellence Frameworks (REF). It will be used to assess the 'impact' arising from excellent research. The assessment of impact will be based on expert review of case studies submitted by higher education institutions. Case studies may include any social, economic or cultural impact or benefit beyond academia that has taken place and was underpinned by excellent research produced by the submitting institution within a given timeframe. The REF assessment panels for different subject areas have provided guidance on the kinds of impact that they would anticipate from research in their area. It is instructive to consider what this guidance implicitly or explicitly implies about the role of universities and whether it fits in with this paper's view that universities exist to generate and promote active learning throughout society by undertaking excellent teaching and research.

to be as suspect as quantitative ones. Accordingly, our conclusions, derived from drawing together the narratives to give a picture of the whole as being more than a sum of its parts, should have in mind that the most important parts of relationships are beyond description and so that any evaluation of relationships based on descriptions may omit the most important parts.

This paper's approach to using its conclusions to analyse "how best to understand and manage the connections between differently funded and motivated research efforts in an overall system of knowledge production and innovation"[36] is derived from the discussion in its earlier sections of the role of knowledge in teaching and research. Its view is that what the "number of different channels or 'pathways to impact' through which research in the university base may contribute to innovation" is the promotion of 'active learning'. 'Active learning' is not "amenable to quantitative assessment of impact" which is why "the time-scale to the main impact may be a couple of decades or more, long after the assessment has been carried out". In its view "the exploitation of publicly funded research often depends on private sector organisations possessing the requisite absorptive capacity and complementary assets" and "the requisite absorptive capacity" involves external collaborators being 'active learners' not just recipients of new knowledge.

Frameworks of collaborations between universities and their external partners

One of the criticisms of the audit culture discussed above is its tendency to focus on a narrow set of measures and as a consequence distort what is taken to be important in what universities do and how they do it. Audits of the benefits derived from the "third mission" and/or the "impact" of universities research activities have tended to measure those "commercialisation" activities, such as consultancy, entrepreneurship, incubators, licences, networks of start-ups and SMEs, patents, science parks and spin-outs, which fall under the aegis of universities' industrial liaison and/or technology transfer offices. The auditor no doubt believes that these activities which cover the ways in which the results of research are commercialised are the relevant outputs. However, these activities are indicators of, at best, the secondary benefits of the primary teaching and research missions of a university.

The primary benefits of teaching and research in universities have been discussed above so as to establish the view about the pathways by which knowledge is communicated that underlies the analysis and approach adopted in this paper. Knowledge acquisition is the reason why companies enter into research collaborations with universities. The EUIMA case studies have been used to discuss and assess the benefits of external research collaborations by examining how knowledge is acquired and transmitted in a way in which the partners benefit themselves and others.

To avoid the auditor's approach of deciding *ex-ante* what are the relevant outputs, another approach is needed, which sets all the relevant teaching and research activities of a university in a framework that allows a relevant assessment system to emerge *ex-post* from what is observed. In what follows in this section, three different approaches drawn from the recent literature are examined for the insight that they shed on the pathways by which knowledge is communicated and has an impact. We start with the Science|Business approach which since it covers both teaching and research is too broad for the detail of external research collaboration contained in the EUIMA material but which nevertheless serves to examine the private secondary benefits for the partners in external research collaboration. The Boulton-Lester approach serves to distinguish between the public benefits to the wider community of such collaborations. The Hughes-Kitson approach not only delivers the detailed analytical typology required by the EUIMA material but also being rooted in the literature on knowledge exchange ties in with this papers views about the pathways by which knowledge is communicated.

[36] All the "quotations" in this paragraph are from Hughes, A., & Martin, B., 2012, *Enhancing Impact: The Value of Public Sector R&D* (London: Council for Industry and Higher Education and UK-Innovation Research Centre).

Science|Business

A recent survey[37] by Science|Business of industry-university collaborations has chosen to distinguish between:

A. Partnerships that impact teaching and learning
B. Partnerships that develop new funding streams
C. Partnerships that rethink the role of research universities
D. Partnerships that go strategic

This classification covers too broad a range of activities for it to have the granularity needed to distinguish between the details of research collaborations contained in the EUIMA material. However, not only is it a useful reminder that - although a specific collaboration might have entered into for the primary purpose of achieving particular research outcomes, there will also be secondary benefits for one or both of the partners in the collaborations -, but also it is a way of addressing the secondary benefits of a research collaboration.

A. There is an **impact on teaching and learning** from a university's external research collaborations because what distinguishes a university from a research performing organisation is the active engagement of researchers in designing and delivering teaching programmes. Hence, researchers involved in research collaborations will inevitably import into their teaching the new perspectives and problems which the collaboration has generated. They may also become aware of new teaching and learning opportunities from which their collaborators or their colleagues could benefit.
B. **New funding streams** are developed as a result of external research collaborations because they widen horizons and awareness of other perspectives and opportunities. Not surprisingly, therefore, a secondary benefit of a research collaboration may well be the ability to access funding that would not otherwise have been available to either partner acting alone.
C. **Rethinking the role of research universities** is a secondary benefit of each external research collaboration into which a university enters since each is capable of acting as an exemplar to others in the same discipline and/or to other disciplines. This leads to a growing recognition of the role and contribution which those outside the university can make to the generation of the context for and the questions being addressed by basic research. Equally, the lone scholar or the exclusive inward-looking close-knit group around professors in their ivory towers are ceasing, if they ever were, to be the norm in a research university.
D. A **strategic** approach to research collaboration inevitably emerges since many of the collaborators with whom a university jointly conducts research will have interests covering many disciplines and a global perspective on where best to find its research partners. The strategic secondary benefits are derived individually by both the university and its external collaborator using the experience and lessons that they themselves have learned from their current relationship how to choose and partner more effectively in other contexts with other potential collaborators on very different research agenda.

However, this approach does not admit the existence of direct secondary benefits to others from external research collaborations. Like the primary benefit, of even more excellent and relevant basic research publications, the secondary benefits to others are indirect and arising as a result of university teaching being more relevantly focused on students' needs for learning and universities being better funded, having wider horizons and being more strategic.

[37] Science|Business, 2012, *Making industry-university partnerships work: Lessons from successful collaborations* (Brussels, Science|Business).

Boulton-Lester approach

Some of the direct secondary benefits for others were set out in a paper discussing the role of universities in innovation by Boulton[38] who extended Lester's[39] typology of industrial transformation processes:

I. Indigenous creation
II. Transplantation from elsewhere
III. Diversification into technologically-related industries
IV. Upgrading of existing industries

to distinguish between

Ia. Indigenous new businesses creation and

Ib. Knowledge economy node creation

With this enhanced typology, Boulton was able to provide examples of the many different ways in which universities could support innovation in their local and national economies, as a result of the range of their teaching and research activities, and not solely on the basis of their doing world-class research. Whilst this classification is too broad to capture the distinctions between the details of research collaborations contained in the EUIMA case studies, it too will be helpful below in capturing some of the secondary benefits for one or both of the partners in the collaborations. However, unlike the private secondary benefits to the partners of an external research collaboration identified by Science|Business, the Boulton-Lester approach describes the public benefits of such collaborations to the wider community. Accordingly, a university's external research collaboration is just as likely, if not more so, to lead to:

Ia. The creation of an industry which has little or no precursor in the region based on exploitation of university-developed technologies but which strikes a market chord with local entrepreneurs.

Ib. A clustering of knowledge-intensive companies in the vicinity of a university with a powerful, internationally competitive research capacity and significant collaborative research partners.

II. The relocation of the activity of a company, not necessarily that of the external research collaborator, because of its manpower needs, regional internal investment policies or increased proximity to important markets as a result of the opportunities afforded by the research university and its research collaborations.

III. An existing business in a region, which has gone into decline, re-deploying its core technologies so as to lead to the emergence of new businesses where such a re-deployment has been possible on account of the university's research collaborations.

IV. The introduction of new technologies that lead to enhancement of products, processes or services as an outcome from the research generated by the university's research collaborations.

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[38] League of European Research Universities, 2006, *Universities and Innovation: The Challenge for Europe* (Leuven, LERU). www.leru.org/files/general/Universities%20and%20Innovation%20The%20Challenge%20for%20Europe%20(November%2006).pdf

[39] Lester, R. K. 2005a. Universities, Innovation, and the Competitiveness of Local Economies A Summary Report from the Local Innovation Systems Project – Phase I Richard K. Lester Industrial Performance Center Massachusetts Institute of Technology 13 December 2005 MIT Industrial Performance Center Working Paper 05-010 http://web.mit.edu/lis/papers/LIS05-010.pdf

Hughes-Kitson approach

In a recent paper reporting the results of separate academic[40] and business surveys examining the pattern and extent of knowledge exchange and pathways to (research) impact in the UK for the academic respondents, who had engaged in commercialisation activities, Hughes and Kitson[41] distinguished three aspects of the broad spectrum of knowledge exchange:

1. multiple mechanisms comprising:
    a. people-based activities
    b. problem-solving activities
    c. community-based activities
    d. 'hard' commercialisation activities
    e. consultancy
2. many disciplines were represented by respondents with significant interactions:
    a. health sciences
    b. STEM
    c. arts and humanities
    d. social sciences
3. many partners:
    a. private sector companies
    b. public sector organisations
    c. charitable or voluntary organisations

Hughes-Kitson paper reveals a picture of extensive interactions between academics and business within which direct commercialisation activities play a relatively small role. Consultancy was the principle commercialisation activity in which 14% of their academic respondents engaged with 4% involved in spin-outs, 5% in licensed research and 7% in patenting. By contrast, 38% of the academics engaged in at least one community-based activity, 57% in a problem-solving activity and 87% in at least one people-based activity. Not surprisingly, therefore, one of their conclusions is that "neglecting this wide spectrum of interaction pathways in the pursuit of narrow strategic aims connected with 'hard' commercialisation misrepresents the potential role that universities can and do play in connecting with business and society more generally."

On the other hand, given that attending conferences was the people-based activity in which 87% of academics engaged, it will take a well-argued case to persuade governments to abandon their attachment to the well-established metrics of commercialisation activities for judging the degree of engagement between universities and business. In this paper's terminology about the pathways by which knowledge is communicated, all of what Hughes-Kitson termed people-based activities, are those by which companies benefit as a result of their employees expanding the stock of knowledge that they possess, through the learning that networking with academics stimulates.

Each of the problem solving activities covered by Hughes-Kitson also contains some element of expanding the stock of employees' knowledge by the transfer of knowledge of known solutions to known problems. However, those problem-solving activities also, and more valuably, benefit a company when its employees, through collaborations with academics, help to produce for known problems hither too unknown solutions, i.e. solutions to public problems. Most valuable of all to the company are those problem-solving activities which inform an academic of a problem known to the company but unknown to the academic for which the

[40] Their web based survey covered all individuals in the UK academic community who were active in research or teaching in 2008-9. The achieved sample of 22,170 represents a response rate of over 17% from a specially constructed sampling frame covering individual academics in all disciplines in virtually all Higher Education Institutions in the UK.

[41] Hughes, A., & Kitson, M., 2012, 'Pathways to impact and the strategic role of universities: new evidence on the breadth and depth of university knowledge exchange in the UK and the factors constraining its development', *Cambridge Journal of Economics,* 36(3), pp. 723–50.

solution is unknown and which motivates the academic to produce a solution, i.e. solutions to private problems.

EUIMA case studies: characteristics, terminology and conclusions

The EUIMA Collaborative Research Project[42] case studies focussed on the assessment of the outcomes of the collaborative research undertaken to meet the strategic objectives of the university and its external partner(s). The definition of collaborative research used by the project was:

> "Activities where several parties are engaged in research towards shared objectives, collectively building on their individual background and sideground in the creation of new foreground knowledge."

This definition had been used in the EUA's previous work on "Responsible Partnering" between universities and external partners[43].

[42] Full details can be found in the EUIMA project main report (Borrell-Damian, L., Morais, R., & Smith, J. H., 2014, *University-Business Collaborative Research: goals, outcomes and new assessment tools. The EUIMA Collaborative Research Project Report* (Brussels, EUA).

[43] This work resulted in the publication of **Responsible Partnering**: Guidelines for Collaborative Research and Knowledge Transfer between Science and Industry, 2009. (EIRMA, EUA, EARTO, & ProTon Europe, 2009, *Responsible Partnering Guidelines*, EIRMA, EUA, EARTO, & ProTon Europe.)

Participant Universities
Aalborg University, Denmark
Autonomous University of Madrid, Spain
Ruhr University Bochum, Germany
Chalmers University of Technology, Sweden
Czech Technical University in Prague, Czech Republic
Istanbul Technical University, Turkey
Karlstad University, Sweden
Katholieke Universiteit Leuven (K.U. Leuven), Belgium
Leuphana University of Lüneburg, Germany
London South Bank University, UK
Newcastle University, UK
Norwegian University of Science and Technology, NTNU, Norway
Politecnico di Torino, Italy
Tampere University of Technology, Finland
Rovira i Virgili University, Spain
University College London, UK
Münster University of Applied Sciences, Germany
University of Cambridge, UK
University of Paderborn, Germany
Vienna University of Technology, Austria

Gathering information through a questionnaire and organising dialogue with experts at five workshops, the project assembled case studies of universities with a strong commitment to developing research with external partners. The project sought to develop assessment measures and indicators reflecting good practice in collaborative research, its strengths and weaknesses. The case studies covered different types of collaborative research, reflecting differing disciplinary/interdisciplinary inputs and different types of partners. The analysis also benefits from the workshops having involved not only:

- the description and exchange of good/best practices in diverse examples of collaborative research but also an analytical appraisal of their generic features;
- the mutual learning of the good practices relevant to particular settings but also reflecting on them to develop a research assessment tool covering the diversity of collaborative research; and,
- participants who were reflective practitioners able to describe their own learning from experience, but also to facilitate that of others.

A range of terminologies can be identified from an analysis of the narratives used by both universities and their external research collaborators to evaluate the research outcomes which they have achieved as a result of their collaborations. No common terminology could be drawn from the EUIMA case studies. Why it was not possible to do so is best illustrated by examining in detail the words and phrases used most commonly in the narratives.

Below is a categorisation of the phrases used in the free format responses to the case study questionnaire where (n) denotes the number of times that the word/phrase was used.

Organisation

knowledge-producing organizations; centre of excellence (in research) (3); science & technology parks; competence centre;

Activity

social interactions; networks of communications; entrepreneurial university activities; innovation process; business processes; innovation practice; incubator; start-ups; matchmaking; problem-based learning; bottom-up approach;

Partners

academic and business communities, competence cluster (6); early career researchers; research and technology organisations;

Purpose

business innovation; knowledge production; generation of knowledge; commercialisation of research; entrepreneurship; knowledge transfer; proof of concept; product development; technological development;

Competences (40)

Capability (8); expertise (36); innovation manager (4); competence tandems (6); socio-economic characteristics; risk analysis; research managers; clusters of excellence; identification of key communicators in SMEs role of intermediaries; bundles of competences; assurance; leadership; value chain;

Freedoms/Limitations

context of application; organisational settings; accounting/financial issues; proximity of disciplines; sustainability of posts; TTO functions; industrial need; synergies;

Description

triple helix (1); transformational experience; open innovation; knowledge structure

As is evident from the table above, which was produced using a word/phrase search on a master file of all the free format responses to the case study questionnaire, there were remarkably few common terminologies. Indeed, there were almost as many narratives as there were separate relationships between the individuals who comprised the collaborations being described.

That there was not a common terminology could be taken as evidence that external research collaborations have (not yet) been the subject of frequent scrutiny. It is not unreasonable to conjecture that following the introduction of impact into the Research Excellence Framework (discussed in footnote 31 on page 12) a more common phraseology will emerge in the UK. Indeed, it is consistent with the view taken in this paper about the audit culture to assert that were universities to be asked by their funders about the extent to which their external research collaborations involved for example “competence tandems”, there would not be a university which did not have them in droves. In other words, the EUIMA case studies were comprised of what universities and their collaborators thought that they were expected to say rather than what they knew that they had to say to maintain their funders’ approval.

In drawing conclusions from the EUIMA case studies, it is important to recognise that the universities and their external research collaborators were self-selecting in that they all either volunteered or agreed to an invitation to participate. Accordingly, the conclusions that follow, insofar as they can be taken to be representative, relate to institutions that believed external research collaborations to be important parts of their institutional strategy and were willing to explain why. By design the studies are of a diversity[44] of universities so that the conclusions which follow relate neither to a particular type of institutional mission or research funding methodology. What they all willingly evidenced were their experiences of external research collaborations as invigorating initiatives providing new ways and opportunities for re-enforcing their university's research mission. This was particularly true of those universities highly placed in world research rankings. This is because their research reputation allows them to be very selective from among the many opportunities for collaborations which they have.

It is evident from the EUIMA case studies that the outcome of research collaborations, which are part of strategic partnerships between universities and external collaborators, is excellent research[45] with advantages for the universities themselves and for their external partners. Such collaborations enable universities to play a role in innovation and in the generation of economic growth without harming[46] their primary purpose; i.e. excellent teaching and research. Accordingly, external research collaborations are not a "third mission" for universities but are an essential component of their core mission of excellent teaching and research in, about and for a global society in which knowledge and learning are at the heart of innovation and progress.

Success follows from both the university and the external partner seeing research collaborations as one of their core strategies which enables them to be alert to and take advantage of new challenges, ideas and problems that characterise innovative institutions. Although a specific collaboration might be entered into for the primary purpose of achieving particular research outcomes, there will also be secondary benefits[47] for one or both of the partners in the collaboration.

Successful research collaborations comprise interactions between those generating new applications, ideas, products or techniques. Since the research is a co-production of the partners, the interactions go both ways, with no unidirectional flow of ideas into applications. Accordingly, they are not merely a mechanism for finding a solution to a particular problem.

Both partners understand that by investing in a wide agenda of research embracing new ideas and technologies and/or a diversity of different approaches to similar problems, the chances of coming up with an answer to any particular problem are higher. Collaboration may make the chances higher but the only certainty is the cost of collaborating. However, the wider the agenda and the more central it is to the strategic goals of both parties, the more willing each partner will be to bear the costs. This is because the potential benefits from collaboration, although uncertain, are likely to exceed the costs, so that not collaborating will be a missed opportunity.

The EUIMA case studies established that universities and their external collaborators are engaged in problem-solving activities which involve: informal advice; joint research; joint publications; research consortia; hosting personnel; external secondment; and setting of physical facilities. The focus of this problem solving is the generation of shared research outcomes, collectively building on their individual

[44] This can easily be established by looking at their QS and/or Shanghai Jiao Tong rankings and their locations.

[45] The excellence of the research is judged by the participants on the basis of their corporate and personal learning and the benefits which they derive from it. The partnering universities are clear that the research outcomes make important contributions, although these are not all directly reflected in university rankings, based as they are on peer group evaluations of research outcomes and distinctions between the types of research in universities.

[46] Indeed, the important contributions from external research collaborations which the universities reported were the enhancements of the teaching and research agenda based on the experience, knowledge and learning derived.

[47] Benefits of the type which were articulated in the section above on the role of knowledge in teaching and research.

background and sideground in the creation of new foreground knowledge, in many disciplines with many partners.

Although the EUIMA contributors were able to report traditional quantitative outcome measures - such as numbers of: scientific/technical publications and citations; patents and licences; spin-offs; collaborative doctorates; defended; and, new opportunities for achieving further research funding –, in their narrative assessments of their collaborations, other issues were more central to their evaluations of the success of collaboration.

In this sense the narrative assessment of the EUIMA case study collaborations spoke of

- Collaborative research processes as: the generation of competitive advantage; working in a network (different from networking); multidisciplinarity; access to "blue sky" research; scientific productivity/excellence; and invention disclosures: the number of possible inventions to be considered for patenting.

- Competitiveness and economic growth as: regional/national development; media impact/visibility; increase of research capacity; return on resource investments; attracting international company/university partners; social outcomes; and environmental impact.

- Expert Services as: appointments to advisory/evaluation committees in national or international - public and private organisations; and requests for consultancy.

- Human Resources as: impact on learning experience of students; employability of bachelor and master graduates; industry employment of PhD graduates; and creating and sustaining positions for research and research management.

- Sustainability of the collaboration as: material means and infrastructures; joint project applications for further research; “follow-up” projects or “taking the next step”; efficiency of contractual negotiations and management; engaging in Joint Ventures; and attracting venture capital.

Accordingly, if required, quantitative outcomes can be enumerated, but they are not central to the partners’ own evaluations of research collaborations. Insofar, as what is measured becomes what is cared about by “management”, and therefore has to be done by “those that do”, a pursuit of quantitative outcomes would be inappropriate and harmful to the generation of the research base needed for a modern knowledge economy. If there has to be an evaluation of research collaborations, then the least bad approach is the narrative “impact” statements, for example being sought in the UK’s 2013 REF, since these are reasonably aligned to how the participants in the EUIMA case studies evaluated their success.

Although some institutions had more recently developed their support services for collaborative R&D and knowledge transfer as the instrument for proactively promoting external research collaborations, it is only one of many characteristics that are required. The evidence from the EUIMA case studies is that the characteristics of universities engaged in successful external research collaborations are:

1. The leadership team treats research collaborations strategically and has a well-articulated view of the part that collaborative R&D and knowledge transfer play in meeting the university’s strategic objectives.
2. The research support services are able to identify potential partners’ expectations and understand when it is and is not appropriate for the university to seek to deliver them.
3. The recruitment and remuneration strategy encourages staff to aim for a high level of strategic engagement with appropriate external partners.
4. The institution has many and different collaborative research programmes with external partners that cover different disciplinary/interdisciplinary inputs and different types of partners.

5. The academics are reflective practitioners i.e. they are able to describe not only their own learning from experience but also to facilitate that of others.
6. There is active participation in (inter)national discussions about effective and useful interpretations of the impact of research.
7. It is an institutional goal to encourage more active participation in collaborative research partnerships but also to understand how to partner more effectively and how to become more competitive and better select the preferred partner.
8. Effective use is made of the funding and support from those government agencies whose strategies were aligned with those of the university.

It was also evident form the EUIMA case studies that the characteristics of businesses engaged in successful external research collaborations are:

1. The company's executive team treats research collaborations strategically and has a well-articulated view of the part that collaborative R&D and knowledge transfer play in meeting the company's strategic objectives.
2. The company is able to identify the potential partner universities which best suit their corporate needs.
3. The company understands what it is that a university is best placed to deliver.
4. The company has many and different collaborative research programmes with universities that cover different disciplinary/interdisciplinary inputs.

It is to be hoped that narrative assessments of research collaborations such as the EUIMA case studies and the "impact" approaches taking account of the above characteristics will be ways in which universities can better explain to governments the nature of and how to evaluate successful outcomes of external research collaborations and why public funding is needed to facilitate such partnerships.

Annex: List of contributing organisations to the EUIMA Collaborative Research project

Higher education institutions

1. Vienna University of Technology, Austria
2. Katholieke Universiteit Leuven (K.U. Leuven), Belgium
3. Czech Technical University in Prague, Czech Republic
4. Aalborg University, Denmark
5. Tampere University of Technology, Finland
6. University of Jyväskylä, Finland
7. Leuphana University of Lüneburg, Germany
8. Ludwig Maximilian University of Munich, Germany
9. Münster University of Applied Sciences, Germany
10. Ruhr University Bochum, Germany
11. University of Paderborn, Germany
12. TuTech Innovation, Germany
13. Politecnico di Torino, Italy
14. Norwegian University of Science and Technology (NTNU), Norway
15. Autonomous University of Madrid, Spain
16. Rovira i Virgili University, Spain
17. Chalmers University of Technology, Sweden
18. Karlstad University, Sweden
19. Istanbul Technical University, Turkey
20. London South Bank University, United Kingdom
21. Newcastle University, United Kingdom
22. University of Cambridge, United Kingdom
23. University College London, United Kingdom
24. University of London, United Kingdom

External partners, in partnership with the universities with which they have established research collaborations:

Companies

1. Metalogic, Belgium
2. E-power Technology ApS, Denmark
3. Nokia, Finland
4. Bernd Münstermann GmbH&Co. KG, Germany

5. HJP Consulting, Germany
6. Siemens AG, Germany
7. GM Powertrain Europe, Italy
8. STMicroelectronics, Italy
9. Telecom Italia, Italy
10. Thales Alenia Space, Italy
11. DNV, Norway
12. Accenture, Spain
13. REPSOL, Spain
14. Omnisys Instruments, Sweden
15. BP, United Kingdom
16. Rolls-Royce, United Kingdom
17. SHM Productions Ltd., United Kingdom
18. SMD (Soil Machine Dynamics Ltd.), United Kingdom

Clusters

1. Torino Wireless Foundation, Italy
2. Cluster of Steel and Engineering, Sweden
3. COMPARE, Sweden
4. Packaging Arena, Sweden
5. The Paper Province, Sweden

Public authorities

1. City of Tampere, Finland
2. Council of Tampere Region, Finland
3. Tekes, Finland
4. Knowledge Foundation, Sweden
5. Region Värmland, Sweden
6. Swedish Ministry of Enterprise, Sweden
7. VINNOVA, Sweden
8. Higher Education Funding Council for England, United Kingdom

Research institutes

1. Academy of Sciences of the Czech Republic, Czech Republic
2. Institute for Advanced Studies Berlin, Germany

Research and technology offices (RTOs) and innovation incubators

1. TuTech Innovation, Germany
2. Sapienza Innovazione, Italy
3. Service Research Centre, Sweden
4. FIMECC Ltd., Finland
5. ideaSpace Enterprise Accelerator, United kingdom
6. St. John's Innovation Centre, United Kingdom

Country breakdown – the following countries were represented in the EUIMA project:

1. Austria
2. Belgium
3. Czech Republic
4. Denmark
5. Finland
6. Germany
7. Italy
8. Norway
9. Spain
10. Sweden
11. Turkey
12. United Kingdom