The marketization of higher education: A causal analysis of innovation in UK universities

www.enterpriseresearch.ac.uk

The marketization of higher education: A causal analysis of innovation in UK universities

Nola Hewitt-Dundas
Queen's University Belfast
Nm.Hewitt@qub.ac.uk

Stephen Roper
Warwick University
stephen.roper@wbs.ac.uk

ABSTRACT

Higher education is increasingly a marketised service sharing many characteristics with other professional services such as legal, medical or financial services. With marketization comes competition, and the need for HEIs to develop and maintain attractive undergraduate programmes to attract and retain strong faculty and fee-paying students. Here, we consider the drivers of programme innovation – the introduction of new programmes – and the withdrawal of existing programmes in UK universities. Using panel data for all UK universities provided by UCAS we identify significant resource, internationalisation and business engagement effects. Financial stringency encourages both programme innovation and withdrawal. More extensive international market engagement and research collaboration with business have similar effects increasing programme innovation. The results have both strategic and systemic implications.

Keywords: Higher education; Under-graduate: Innovation; Globalisation; Business engagement

CONTENTS

INTRODUCTION

Internationally higher education 'is moving from being a public good, funded through governments, to a private good where more of the cost is put on students and families' (Kandiko and Blackmore 2010, p. 29). This trend positions undergraduate higher education as a 'marketable service' sharing many characteristics with other professional services such as legal, medical or financial services - i.e. their intangible nature, inseparability, and extensive inter-activity between client and provider (Miozzo and Soete 2001). With this marketization comes competition, and the need for HEIs to develop and maintain attractive programme portfolios which can help to attract and retain strong faculty and fee-paying students. This requires programme innovation – the development and implementation of new programmes – and potentially the withdrawal of programmes which are out-dated, unattractive or unviable. To date studies of programme innovation have been case-based, focussing on the formulation of organisational strategy in HEIs and the delivery of programme change (Brennan et al. 2014; Kandiko and Blackmore 2010)[1]. Here, we provide an alternative, quantitative, perspective identifying the drivers of programme innovation and withdrawal across the UK university sector.

Our starting point is a recognition of the complex stakeholder pressures and organisational objectives of universities (Jarzabkowski 2005), and the inherently interactive and social nature of the innovation process in which outcomes depend on the capabilities of those contributing to the process, and the level and openness of interaction between actors (de Medeiros, Ribeiro, and Cortimiglia 2014; Harrison and Leitch 2010). As such, systemic perspectives provide a useful analytical framework in both the commercial (de Zubielqui et al. 2015; Kauffeld-Monz and Fritsch 2013; Trippl 2011) and higher education contexts (Brennan et al. 2014) of examining innovation. Brennan et al. (2014, p. 37), for example, define a

---

[1] As Perkmann et al. (2013, p. 431) suggest the result has been that 'extant analyses have neglected to consider [innovations'] impact on educational output, such as time devoted to teaching, curriculum and programmes development, and teaching quality'.

higher education innovation system as 'a sub-set of an [economy wide] innovation system concentrated particularly in higher education institutions (universities and associated research institutes, vocational training institutions, master's colleges, etc.), which are in close connection with other institutional spheres, such as industry, government and non-government agencies, and the society at large'. Here, we therefore consider three main drivers of undergraduate programme innovation and withdrawal: the financial performance of each HEI, engagement with international markets and the extent of business engagement.

Our programme analysis is based on data provided by the Universities and Colleges Admissions Service (UCAS), and draws on concepts from the study of innovation in commercial organisations. We make three main contributions. First, we develop a range of new quantitative indicators of programme innovation and withdrawal in HEIs and use these metrics to profile the main trends in UK HEIs' programme innovation and withdrawal over the last decade. Second, we use panel data econometric techniques to examine the impact of financial performance, international engagement and business engagement on programme innovation and withdrawal across the UK higher education sector. Each turns out to play a significant role in shaping some aspects of HEI's undergraduate programme portfolio. Finally, we consider separately levels of programme innovation and withdrawal in the priority STEM and non-STEM programmes.

The remainder of the paper is organised as follows. Section 2 outlines our conceptual framework and hypotheses focussing on the role of resources, internationalisation and business engagement on programme innovation and withdrawal. Section 3 describes our data which covers the period 2005-2013 and draws on information provided by UCAS and the Higher Education Statistics Agency (HESA). Section 4 reports our empirical analysis and Section 5 considers some of the strategic and systemic implications of the findings.

CONCEPTUAL FRAMEWORK AND HYPOTHESES

Definitions of innovation vary, but generally in the context of 'for profit' enterprises the commercialisation of new knowledge or technology to generate increased sales or value for consumers or related stakeholders is stressed. The US Advisory Committee on Measuring Innovation, for example, defines innovation as: 'The design, invention, development and/or implementation of new or altered products, services, processes, systems, organisational structures or business models for the purpose of creating new value for customers and financial returns for the firm' (Advisory Committee on Measuring Innovation in the 21st Century Economy 2008, p. i). Our focus here is on the introduction of new programmes at an undergraduate level which may be attractive – offer value – to students, and which may generate financial returns or strategic or reputational benefits for universities (Schatzel, Calantone, and Droge 2001). We are also concerned here with the withdrawal or cancellation of programmes, a subject which has received considerably less attention in the management literature outside pharmaceuticals (Bunniran et al. 2009).

Both programme innovation and withdrawal are inherently social and inter-active processes, in which outcomes are dependent on the pressures on the actors involved in the process, the capabilities of those contributing to the process, and their level and openness of interaction (de Medeiros, Ribeiro, and Cortimiglia 2014; Harrison and Leitch 2010). As a result, little commonality emerges in innovation processes with heads of department in leading universities adopting varied top-down and bottom-up mechanisms to manage change (Gibbs et al. 2008). As Jarzabkowski (2005) outlines, 'Curriculum change is often a contentious and political endeavour' (p.26) as a result of a complex stakeholder landscape (Jarzabkowski 2005) and a frequent lack of agreement about objectives between academic and administrative staff (McInnis 1998). Systemic perspectives which can embody this diverse group of success factors for innovation processes have proved valuable in both the commercial (de Zubielqui et al. 2015; Kauffeld-Monz and Fritsch 2013; Trippl 2011) and higher education contexts. The higher education system is an integral part of a wider

economy-wide innovation system comprising commercial, social and political actors and institutional contexts (Brennan et al. 2014).

Beyond actors and institutional characteristics, innovation systems also comprise 'functions' which, in the case of higher education, Brennan et al. (2014) suggest can be identified as education, research and third mission activities. Programme innovation and withdrawal are central to the education function of the higher education innovation system, and may be driven either by endogenous processes, factors outside the immediate innovation system, or a complex combination both (Kandiko and Blackmore 2010).

At a systemic level, drivers of innovation in higher education may include economic crises as witnessed during the 2008 global economic recession, budget increases or cuts to the funding structure of higher education etc. In recent years, many countries have replaced trust-based funding regimes where universities automatically received a grant allocation from government with little account of their output and outcomes, to performance-based or competitive funding mechanisms (Geuna and Martin, 2001; Conraths and Smidt, 2005; Orr et al 2007; Sorlin, 2007). The rationale for this being that this leads to more efficient allocation of public resources and creates diversity in the university sector (Sorlin, 2007).

In the UK, the adoption of a performance-based funding regime was coupled in the 1990s with a greater emphasis on the inter-relatedness of research and economic benefit and the realisation that differentiation existed in the university sector (HM Treasury 2007). This 'diversity of excellence' in the research base was described as distinguishing between 'research universities focusing on curiosity-driven research, teaching and knowledge transfer, and business-facing universities focusing on the equally important economic mission of professional teaching, user-driven research and problem-solving with local and regional companies' (HM Treasury 2007, p.5). In other words, research quality was a key differentiating feature of heterogeneity in knowledge transfer strategies and activities in the university sector. In terms of programmes being offered by

universities, government pressure to increase the economic benefit of universities was evidenced in proposals to reduce support for arts-based degree programmes (Kandiko and Blackmore 2010).

Aligned to changes in government funding priorities, at an organisational level, factors such as the autonomy of a university can be a key determinant of innovative activity (Brennan et al. 2014). Financial stringency may be used by senior managers in universities as a pretext for driving programme change: 'Finance and marketing often provide the motivation for change but may be part of an agenda that is not made explicit, and is sometimes perceived to be hidden' (Kandiko and Blackmore 2010, p.28). We therefore suggest that (Figure 1):

> Hypothesis 1a: Stronger HEI financial performance will be associated with *reduced* programme innovation rates;

> Hypothesis 1b: Stronger HEI financial performance will be associated with *reduced* programme withdrawal rates.

Sorlin (2007) argues that performance-based funding acts as an important policy instrument in the allocation of resources to universities. Specifically, through the use of metrics to measure deliverables and outputs, it allows governments to invest more efficiently in R&D while also creating diversity in the university sector. In the UK, a meritocratic funding system for higher education, tends to reward successful research universities creating differentiation in the university sector as the 'existing research elite is further reinforced and the status quo is maintained' (Guena and Martin 2001, 28) through vertical differentiation with the potential for functional specialization (Sorlin 2007). In other words, the effects of financial performance on innovation activity will be greater where teaching is a higher proportion of total university income. This leads to our second hypothesis:

> Hypothesis 2: The more important teaching income is in the revenue mix of a university, the stronger the financial performance

effect on innovation and withdrawal rates.

Brennan et al. (2014) argue too that one of the key external forces on higher education innovation has been pressures from the globalisation of competition for students and faculty and the changing supply of, and demand for, higher education [2]. For example, following McMahon et al.(1992) analyses of the study choices of international students have emphasised quality and reputational factors as the primary drivers of institutional choice. Gatfield and Chen (2006), for example, analysed the preferences of 518 Taiwanese students and suggested that UK universities should 'continue to emphasise and promote the high quality and reputation of [their] educational services' (2006, p.90)[3]. Similarly, Maringe and Carter (2007, p. 460) investigated the preferences of African students studying in the UK and argued that 'a good understanding of students' decision-making processes creates a sound basis for developing curriculum programmes that address the real rather than the perceived needs of this group of scholars'. They explored the preferences of 28 African students studying in England, and while the quality of UK higher education qualifications was the primary 'pull' factor at the country level, the primary institutional pull factor was programme availability (Mariange and Carter, 2007, Figure 1, p. 471). In the UK, based on a sample of 160 predominantly post-graduate students Wilkins et al. (2011) also found that the factors most often identified as being "very important" in determining their decision to study in the UK were quality of education, high international league table rankings, employment prospects and opportunities to improve English language skills. Students' choice of institution then depended most strongly on the reputation of a university,

---

[2] In terms of programme innovation specifically we might also add the potential impact of initiatives such as the European Bologna Process although the impact of this remains 'patchy' across UK universities. See, for example, 'UK must wake up to Bologna benefits, Times Higher Education Supplement, April 6, 2007.

[3] Some other issues are perhaps more difficult to overcome, viz 'according to the results from in-depth interviews, some Taiwanese people have the stereotype of the UK that it has a cloudy, snowy and cold winter, not an exciting place to live and with some personal safety problems' (Gatfield and Chen, 2006, p. 90).

the quality of programme, rankings, programme content, and the reputation of faculty.

In terms of the domestic environment for higher education, the removal of the cap on domestic undergraduate student numbers announced in the UK Autumn Statement in 2013 removed one major constraint on competition, a trend which may be exacerbated if – as some have anticipated – the cap on tuition fees is removed in future[4]. Interestingly, however, recent studies have suggested that home students' institutional choices are only weakly linked to the level of tuition fees (Burge et al. 2014), or as one study put it, there is little evidence that 'student mobility is driven by economic rationality' (Wakeling and Jefferies 2013, p.510). Instead, what seems to dominate students' choices are quality – as reflected in student satisfaction surveys - and employability. In Australia, Maazzarol et al. (2001), for example, surveyed 828 domestic students and found that future employment prospects were the primary factor governing institutional choice followed by a range of factors linked to 'resources and programmes'.

This suggests that the incentives for effective programme innovation are strong particularly where 'national systems have become heavily dependent on the recruitment of overseas students paying high fees in order to sustain their internationally-focussed layer of universities' (Kandiko and Blackmore 2010, p.26). We therefore suggest that (Figure1):

> Hypothesis 3a: Greater engagement with international markets will be associated with *increased* innovation rates;

> Hypothesis 3b: Greater engagement with international markets will be associated with *increased* withdrawal rates;

---

[4] Scott, P (2014) 'End to cap on university student numbers clears path for private equity', The Guardian, 4th March 2014. Available at: http://www.theguardian.com/education/2014/mar/04/george-osborne-fee-cap-policy-private-equity. Accessed 21st May 2015.

Alongside the marketization of UK universities' teaching activities in recent years there has also been a considerable development of third mission activities related primarily to business engagement (Muscio, Quaglione, and Vallanti 2015). These linkages create the potential for knowledge co-creation and the more effective tailoring of university programmes to meet industry needs, hence: as Kandiko and Blackmore (2010, p.27) found, 'In general, we found institutions that made successful change worked with external agencies to gather opinions about curricula and graduate attributes, feeding the ideas into the processes of change'. More recently Plewa et al. (2015) investigated the role of five different forms of university-business interaction on the design and delivery of university programmes across a range of countries and concluded that 'the instruments examined in this study emerge as encouraging business to collaborate with HEIs in the context of curriculum design and development, aimed at co-creating value with the business community' (Plewa et al., 2015, p. 46). Evidence on this relationship is limited (Plewa et al, 2015) however based on these findings we suggest that (Figure 1):

> Hypothesis 4a: Greater engagement with business will be associated with increased *innovation* rates;

> Hypothesis 4b: Greater engagement with business will be associated with increased *withdrawal* rates;

DATA AND METHODS

Our empirical analysis relates to the 2005 to 2013 period and is based on data compiled from three main sources: programme data for each individual degree programme was provided by UCAS; data on business interaction by each HEI is taken from the HE-BCI survey; and, data on institutions' financial performance and market positioning was derived from the Higher Education Statistics Agency (HESA) HEIDI database. Each is described in turn.

Programme data: This was provided on a year-by-year basis for all individual programmes offered through the UCAS system from 2005 to

2013. For each programme we were provided with a unique identifier, programme title, the number of places accepted and the breakdown of places accepted by UK, EU and non-EU applicants[5]. This data was collated into a time series for each programme providing an indication of whether programmes were in place for the whole of the 2005 to 2013 period or whether they were newly introduced or withdrawn in each year during this period[6]. Programme innovation we then define as the introduction of a new programme by an HEI[7]. Programme withdrawal is when a programme is dropped from the range of programmes provided by an individual HEI.

These individual time series for each programme were then aggregated to provide time series for each institution. While the absolute number of programme innovations and withdrawals may be interesting in its own right we focus here on the innovation and withdrawal rates, both of which provide an indication of the dynamism of the portfolio of programmes offered by an institution normalised for institution size. If I_{it} is the number of programme innovations made by institution i in period t, W_{it} the number of programme withdrawals and P_{it} the total number of programmes on offer by institution I, then the innovation and withdrawal rate are defined as:

$$Innovation\ rate_{it} = \frac{I_{it}\ x\ 100}{P_{it-1}}$$

---

[5] UCAS provides access to undergraduate programmes provided by both Higher Education and some Further Education providers. The Higher Education Statistics Agency identifies 164 Higher Education Providers in the UK (Source: https://www.hesa.ac.uk/component/heicontacts. Accessed: 10 April 2015) of which fifteen do not accept applications through UCAS either because they are specialist institutions and handle their own admissions (e.g. the Royal Northern College of Music, Open University) or because they are postgraduate only institutions (e.g. Cranfield, London Business School). Our analysis therefore covers 149 or 90.8 per cent of higher education providers in the UK, i.e. those engaged in the provision of undergraduate programmes and who accept applications through UCAS. In terms of the programmes on offer through UCAS this group of HE providers accounted for 90.1 per cent of all programmes on offer in 2013 (2006, 94.1 per cent) with the remainder being offered primarily by further education providers.

[6] In a limited number of cases programmes accepted no applicants in year t but did have acceptances in years t-1 and t+1. In this situation the programme was said to be 'in place' throughout the t-1 to t+1 period.

[7] A programme may be new-to-the-institution, having previously been provided elsewhere, or new-to-the-market, the first time a programme is introduced across the HEI sector.

$$Withdrawl\ rate_{it} = \frac{W_{it} \times 100}{P_{it-1}}$$

On average over the 2005 to 2013 period HEIs' average innovation rate averaged 18.8 per cent while the withdrawal rate was marginally higher at 20.2 per cent (Table 1).

Within HEIs' programme portfolios we make two other distinctions. First, we distinguish between the innovation and withdrawal of STEM and non-STEM programmes. Here, we use the JACs 3 programme coding to allocate programmes to either the STEM or non-STEM categories[8]. On average around 35.4 per cent of programmes were in STEM subjects (Table 1). Second, we distinguish between single subject programmes, those involving joint subjects and those which offer a major-minor combination. Single subject programmes include traditional disciplinary degrees (e.g. Zoology, Veterinary Science) but also more contemporary additions such as Visual Communications, Web Technologies and Viking Studies[9]. Joint subject programmes are those where two subjects are named, where each one might be a single subject programme in its own right, and where no prioritisation is implied in the programme name. Examples would be: Sport and Physical Education, Business and Management, Theology and Religious Studies. Finally, major-minor programmes would be those where again each element of the degree might be a single programme in its own right but where there is clearly a primary discipline. Examples here would be: Zoology with Animal Ecology, Theatre Studies with English Literature or Politics with History. Over the 2005 to 2013 period single subject courses accounted for around 53.5 per cent of all undergraduate programmes on offer, 11.8 per cent were major/minor combinations and the remainder joint programmes (Table 1).

---

[8] Where degrees are joint or major/minor we base the allocation on the first named subject. So biology and French would be STEM while French and Biology would be categorised as non-STEM.

[9] One limitation of this approach – and one which it is hard to overcome with our data – is the extent to which new programmes are inter-disciplinary focussing on specific topic areas. European Studies, for example, is generally an inherently inter-disciplinary degree programme but would be categorised in our data as a single-subject programme.

Financial performance data: To reflect the financial viability of the HEI and the importance of teaching income as a source of revenue we extracted three indicators from the Key Financial Indicators section of the Higher Education Information Database for Institutions (HEIDI) database run by the Higher Education Statistics Agency. These are: the percentage ratio of tuition fees & education contracts to total income (%); the percentage ratio of historical surplus/(deficit) for the year after taxation to total income (%); and the ratio of current assets to liabilities.

External market engagement: We measure HEIs' engagement with international markets using the percentage of non-EU students accepting places in each year. This is derived from the UCAS data.

Business engagement: This is measured using two indicators derived from the Higher Education – Business and Community Interaction Survey (HE-BCI) database which is the main source of information on knowledge exchange activities in UK universities. Collected by HESA this is an annual and mandatory survey of all UK Universities and therefore provides a comprehensive profile of engagement activities[10]. The survey provides information on specific interactions with external partners, such as contract and collaborative research, consultancy, continuing professional development and intellectual property. We derive two measures from the HE-BCI survey designed to reflect the breadth of university-business interaction. In each case measures from the HE-BCI survey are normalised by the number of academic staff in the institution. The two measures are: income from research contracts with business per academic staff employee and income from facilities and equipment contracts per academic staff employee.

---

[10]
https://www.hesa.ac.uk/index.php?option=com_studrec&Itemid=232&mnl=14032

Control variables: Three groups of time-variant control variables are included in the estimation. First, it is often argued that organisations with more diverse staff composition may be more likely to innovate (Konnola, Brummer, and Salo 2007; Ostergaard, Timmermans, and Kristinsson 2011; Winkler and Bouncken 2011). We therefore include three indicators to represent the diversity of university staff based on categorical breakdowns of staff by age band, ethnicity and gender derived from the HEIDI database. In each case we construct Blau indices where p is the proportion of staff in a category and N is the number of categories (Blau 1977) :

$$B = 1 - \sum_{i=1}^{N} p_i^2$$

Higher values of the Blau indices occur when staff are divided equally between either age, gender or ethnicity groups suggesting greater diversity. Second, we include four measures intended to control for the resource base of the HEI: an indicator of the overall size of the HEI (log employment), a measure which is standardly used in studies of innovation as a proxy for corporate resources (Jordan and O'Leary 2007); a staff-student ratio derived from the HEIDI database; and two indicators of the (log) number of academic staff and number of students per programme[11]. Third, recognising that levels of programme innovation and withdrawal may also vary between different subject groups we also include variables representing the share of programmes in STEM subjects and those which are either single subject or major/minor combinations. Each of these variables was derived from the UCAS programme data.

In addition to these time-variant controls we also include a number of time invariant controls intended to reflect other aspects of HEIs' profile. We include a set of locational variables which will capture policy differences between the home nations. We also include variables which identify the

---

[11] In each case staff and student numbers were derived from the HEIDI database. The number of programmes per institution is taken from the UCAS data.

mission groups to which individual HEIs belong[12]. Here we consider three mission groups:

- The Russell Group (www.russellgroup.ac.uk) is a consortium of (now) 24 research intensive universities including Oxford, Cambridge, Imperial, Queen's Belfast and most recently Durham and York;
- The University Alliance (www.unialliance.ac.uk/member) is a group of 20 universities most of which were established in the post-1992 period. The grouping includes universities such as Manchester Met, Coventry, Greenwich and Huddersfield.
- The Million+ (www.millionplus.ac.uk) formerly the Campaign for Mainstream Universities (CMU) represents 17 universities established since 1992 including London South Bank, the University of the West of England and Abertay University.

The remaining universities have no established mission group alliances and form the reference group in our analysis.

---

[12] 'The mission groups ... are a product of the desire of different self-identified groups of universities to express policy positions that they believe will enhance the welfare of their own members (although invariably making their case with reference to the general welfare of the higher education system) and to lobby to achieve their implementation. (Filippakou and Tapper 2015, p. 123).

Estimation approach

Our data forms a balanced panel from 2006 to 2013 and we therefore use panel data estimation approaches. Our dependent variables – the innovation and withdrawal rates – are percentages, and panel tobit models with lower limits are therefore appropriate. We therefore report panel tobit estimates with random effects designed to capture the full population effect. For robustness we also report panel regressions with both random and fixed effects, with the latter intended to capture specific institutional effects. In all models we include a lagged dependent variable and all independent variables are all lagged one year to eliminate any issues of reverse causality.

EMPIRICAL ANALYSIS

The total number of undergraduate programmes on offer from UK HEIs has fallen steadily over the last decade peaking at over 17,500 in 2006 and falling below 14,500 in 2013, a fall of around 7.4 per cent relative to 2005 (Figure 1). Around 1:5 programmes are newly introduced or withdrawn each year (Figure 2) with the withdrawal rate running ahead of the innovation rate from 2010 to 2012 (Figure 3). The largest number of individual programmes on offer in 2013 was from Manchester Metropolitan University (316) with a number of other universities offering more than two hundred separate programmes (Kingston, 229; Leeds, 229; Edinburgh, 218; Manchester, 218; Central Lancs, 211 and Kent, 203). The mean number of programmes offered per institution was 98.9 (SD=60.6). Interestingly – and perhaps counter-intuitively given the focus of UK public support on STEM subjects – the number of STEM and non-STEM programmes on offer have experienced a very similar time profile over the last decade (Figure 4). The proportion of STEM programmes on offer has only increased marginally from 36.7 per cent in 2005 to 37.5 per cent by 2013 with most of this increase coming prior to 2008. Innovation and withdrawal rates for each type of programme have also been similar, with withdrawals running ahead of innovation in most recent years (Figure 6). As a result there has been little change in the STEM/Non-STEM mix of

programmes with the number of both declining slightly in recent years.

Models for the innovation and withdrawal rates for all programmes are given in Table 2. For both the innovation rate and withdrawal rate we present three models for robustness: a panel tobit estimator with random effects, a panel regression with random effects and a panel regression with fixed effects for each institution. All models include a lagged dependent variable and year dummies as well as the range of control variables described earlier. Hypothesis 1 suggests that where an HEI is in a stronger financial position this might reduce the impetus to make costly programme innovations or withdrawals. For all programmes we find strong support for both hypothesis H1a (innovation rates) and H1b (withdrawal rates) across each of the different model specifications (Table 2).

Looking more specifically at STEM and non-STEM programmes suggests a slightly more complex picture with a stronger financial position having its most significant effects on reducing withdrawal rates for STEM programmes and – in the fixed effects models at least – on reducing the introduction of non-STEM programmes (Tables 3 and 4). Table 6 provides a summary of the key results. The implication is of a strong link between financial stringency and programme innovation and withdrawal: When UK universities are in a stronger financial position rather than encouraging programme innovation this has a negative effect. Conversely, financial stringency drives both programme innovation and withdrawal.

Hypothesis 2 suggests that the link between financial well-being or stringency and the innovation and withdrawal rates will be stronger where teaching income is a more important source of revenue for the institution. We again find strong support for this hypothesis for all programmes (Table 2) and non-STEM programmes (Table 4). The effect on STEM programmes is weaker but takes the same sign. The effect of any given level of financial stringency on HEIs' programme innovation will therefore vary dependent on the institution's revenue profile. For example across our sample, universities in the Russell Group derived 26.2 per cent of their income from teaching compared to an average of 38.0 per cent for all other universities.

The implication being that financial stringency will have a stronger impact on both innovation and withdrawal rates in non-Russell Group universities.

Reflecting other evidence that internationalisation can be a spur to innovation (Boso et al. 2013; Chen 2012; Golovko and Valentini 2011; Roper and Love 2002) Hypothesis 3 suggests that internationalisation will have a positive stimulus on innovation and withdrawal rates. Again we find strong support for this hypothesis in terms of all (Table 2), STEM (Table 3) and non-STEM (Table 4) programmes. On average across our sample of universities non-EU students accounted for 13.1 per cent of accepted places in Russell Group universities and 4.8 per cent elsewhere suggesting that internationalisation will be a more important driver of programme innovation and withdrawal rates in Russell Group institutions [13]. It is important to acknowledge, however, that within both the Russell Group and other universities there is wide variation in the proportion of non-EU students[14].

Our final hypothesis, reflecting the increasing importance of third mission activity and university-business engagement, suggests that the greater university engagement with business the higher will be innovation and withdrawal rates. Here, we find strongly contrasting results between different types of university-business engagement. Contract research has the anticipated positive sign: greater the university's level of contract research income the higher are levels of programme innovation and withdrawal (Table 6). However, where universities are engaged in facilities and equipment contracts with businesses this has a strong and unanticipated negative effect on programme innovation and withdrawal. Both business engagement effects are consistent across all programmes (Table 2), STEM and non-STEM programmes (Tables 3 and 4). Two potential – and non-exclusive - explanations are possible for the observed

---

[13] These figures are based on the number of places accepted by non-EU students through the UCAS system. They do not include places offered directly from any universities and may therefore under-estimate the share of non-EU students
[14] The coefficient of variation in terms of the share of accepted places by non-EU students for the Russell Group universities is 0.67 while that for other universities is 1.26.

negative effect of facilities and equipment contracts. First, it may be that these contracts act as a distraction for staff leading to lower levels of engagement with programme innovation and withdrawal. Another, perhaps more plausible, interpretation is that these contracts are a source of additional revenue for departments and may be reducing the pressure for programme innovation and withdrawal.

While the value of facilities and equipment contracts is broadly similar among the Russell Group and other universities, the Russell Group universities have a level of contract research income from business (per academic employee) which is four times as high as that of other universities. The positive influence of university-business engagement on innovation and withdrawal rates is therefore likely to be much stronger for Russell Group universities with more uniformity to the negative effect of facilities and equipment contracts.

CONCLUSIONS

A key function of universities is the provision of under-graduate education. The increasing marketization of higher education requires that to remain attractive to potential students and faculty, HEIs have to update and change their portfolio of programmes. Here, we believe for the first time, we adopt a quantitative approach to investigate the drivers of programme innovation and withdrawal in the university sector. Five key empirical results follow which prove broadly consistent across the STEM and non-STEM subject areas. First, financial stringency stimulates both programme innovation and withdrawal. That is, universities which are facing greater financial pressures are more likely to introduce new programmes and drop programmes from their undergraduate portfolio. Second, this financial stringency effect is stronger where universities are more dependent on teaching income. Third, internationalisation – and therefore a need to appeal to international students – is a spur to both programme innovation and withdrawal. Fourth, business engagement through contract research increases programme innovation while engagement through facilities and

equipment contracts has the opposite effect.

Over the period covered by our estimation (2007-13) the number of study programmes on offer to undergraduates in the UK fell markedly (Figure 2). This is consistent with an increasingly difficult funding climate for higher education and the consequent rationalisation of programmes which has seen higher withdrawal than innovation rates (Figure 3). Two factors seem likely to have offset this general trend – internationalisation and the development of greater third mission activity through contract research for businesses. An exacerbating factor has been an increase in the importance of facilities and equipment contracts.

The strength of these effects is likely to be uneven across the UK university sector. Financial effects prove more important where teaching represents a greater proportion of an institution's revenue – a characteristic of less research intensive universities (Hewitt-Dundas, 2012). Conversely, internationalisation and business engagement (through research contracts) are likely to be more important drivers of programme innovation and withdrawal in more strongly internationalised and research oriented universities. The implication is that the key drivers of programme innovation and withdrawal are likely to differ between institutions in a rather predictable pattern.

At a systemic level our results suggest that trends towards internationalisation and greater business engagement are having a significant influence on the nature of the undergraduate programmes on offer in the UK. These effects therefore go beyond the well-recognised impacts on the content or delivery modes of particular programmes to influence the subject focus of the programmes themselves (Brennan et al. 2014). The implication is that both the globalisation of under-graduate higher education and the increasing importance of third mission activity are re-shaping the UK university sector with a particularly strong impact on the more research intensive universities. This creates potentially conflicting pressures on HEIs' programme offerings and raises potentially significant structural issues. In terms of globalisation, HEIs' reshaping of their

programme portfolios increases their exposure to the uncertainty associated with international student demand. In terms of business engagement, a move towards more 'business friendly' programmes would be welcomed by many but may raise pedagogic issues related to the depth of disciplinary training.

At a strategic level our study emphasises the complexity of influences which shape university agendas (Jarzabkowski 2005). Changes in under-graduate programmes are influenced by internal resource availability and the priority given to teaching by each institution. They are also importantly influenced by other elements of the higher education innovation eco-system (Brennan et al. 2014), through links to international markets and businesses. The latter link in particular emphasises the value of adopting a systemic approach to HEI innovation, and the legacy effects of activities such as collaborative research with businesses and facilities and equipment contracts (Muscio, Quaglione, and Vallanti 2015). This emphasises the importance of the governance arrangements covering such interactions and institutions' ability to capture the potential learning from such relationships for subsequent programme development (Geuna and Muscio 2009; Young et al. 2008).

Our study is subject to a number of limitations, some of which suggest interesting avenues for further research. First, our study is limited to the UK and inevitably therefore reflects national policy and institutional specificities. International replication has obvious potential. Second, our study is confined to under-graduate programmes while arguably the area of most innovative activity in the HE sector in recent years has been at the post-graduate level. Extending the type of analysis conducted here to look at the influences on innovation in specialist masters programmes would be a valuable next step but, for the UK at least, would be complex operationally due to the lack of any co-ordinated student application system. Finally, at present the range of innovation and programme withdrawal indicators we use is relatively limited and does not reflect the revenue impact of programme changes on each institution. Extending the existing study to explore the revenue implications of programme innovation

and withdrawal is an obvious next step reflecting standard measures of the impact of innovation on business revenues and the entire innovation value chain in higher education (Roper and Arvanitis 2012; Hansen and Birkinshaw 2007; Ganotakis and Love 2012).
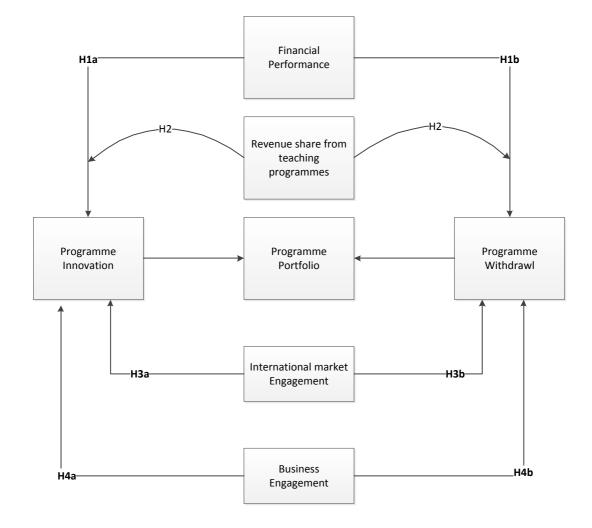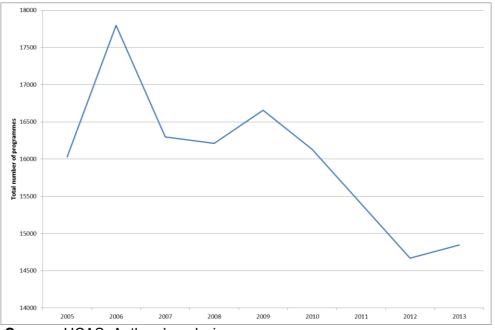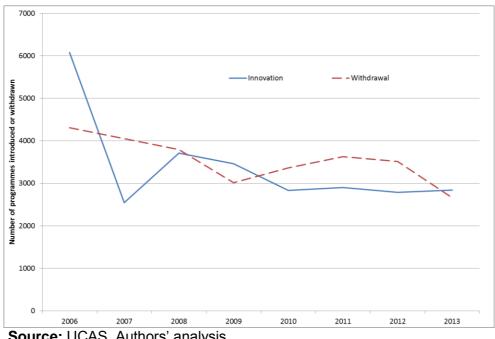
Figure 1: Conceptual framework

Figure 2: Total number of programmes offered by UK HEIs
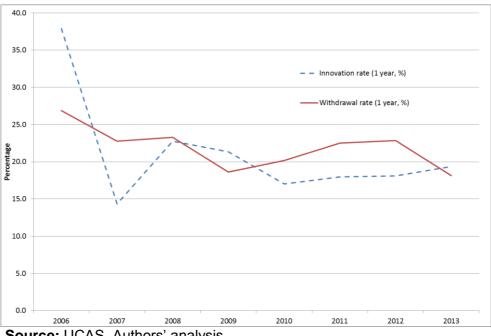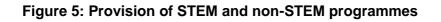

Source: UCAS, Authors' analysis

Figure 3: Number of new and withdrawn programmes by HEIs

Source: UCAS, Authors' analysis

Figure 4: Innovation and withdrawal rates (%)

Source: UCAS, Authors' analysis

Figure 5: Provision of STEM and non-STEM programmes

Source: UCAS, Authors' analysis

Figure 6: Innovation and Withdrawal rates: STEM and non-STEM programmes

A. Innovation and Withdrawal rates – STEM programmes

B. Innovation and Withdrawal rates – Non-STEM programmes

Table 1: Panel data descriptives

Variable	Number of observations	Mean	Std. Dev
Innovation rate (%)	1028	18.820	13.237
Withdrawal rate (%)	1028	20.160	11.219
Asset to liability ratio	984	1.780	1.232
Teaching (% of income)	984	38.796	14.295
Non-EU students (%)	874	6.512	7.617
Business research contract income (£000)	967	1.620	4.338
F&E contracts revenue (£000)	967	0.501	1.314
Control variables			
University size (employment, log)	990	6.633	1.090
Staff-student ratio (log)	987	2.846	0.305
Russell Group university	1028	0.163	0.370
University Alliance member	1028	0.136	0.343
Million+ member	1028	0.116	0.320
English university	1028	0.804	0.398
Scottish university	1028	0.115	0.319
Northern Ireland university	1028	0.020	0.142
Faculty per programme (log)	1007	2.314	0.726
Students per programme (log)	1007	4.429	0.688
STEM subject programmes (%)	1000	35.380	17.227
Single subject programmes (%)	938	53.535	12.685
Major-minor programmes (%)	938	11.827	9.632
Age diversity of staff	990	0.878	0.007
Gender diversity of staff	990	0.489	0.013
Ethnic diversity of staff	990	0.167	0.109

Notes and sources: See text for variable definitions and sources of individual variables. Sources: UCAS, HE-BCI Survey, HESA HEIDI database.

Table 2: Modelling innovation and withdrawal rates for all programmes

	Innovation Rate			Withdrawal Rate		
	Panel Tobit RE	Panel OLS RE	Panel OLS FE	Panel Tobit RE	Panel OLS RE	Panel OLS FE
Innovation rate (-1)	-0.035	0.019	-0.114***			
	(0.030)	(0.027)	(0.035)			
Withdrawal rate (-1)				0.055	0.114***	-0.074**
				(0.038)	(0.030)	(0.036)
Asset to liability ratio	-2.346	-1.812	-4.112**	-3.230***	-2.866**	-2.815**
	(1.524)	(1.478)	(1.640)	(1.211)	(1.186)	(1.413)
Teaching (%)	-0.065	-0.043	-0.077	-0.181**	-0.168**	-0.145
	(0.103)	(0.091)	(0.159)	(0.079)	(0.073)	(0.137)
Teaching x A. to ratio	0.037	0.027	0.075*	0.056*	0.048	0.069*
	(0.039)	(0.038)	(0.041)	(0.031)	(0.031)	(0.035)
Non-EU students (%)	0.099	0.032	0.324**	-0.112	-0.102	-0.038
	(0.100)	(0.084)	(0.146)	(0.074)	(0.067)	(0.125)
Business research contracts	0.872***	0.760***	1.175***	0.698***	0.613***	1.152***
	(0.278)	(0.238)	(0.448)	(0.215)	(0.192)	(0.376)
F&E contract income	-0.994**	-0.860**	-3.008***	-1.464***	-1.287***	-2.842***
	(0.498)	(0.414)	(0.857)	(0.384)	(0.335)	(0.735)
University size (employment, log)	-0.312	-0.217	-39.213***	1.689**	1.285**	5.024
	(1.014)	(0.796)	(6.142)	(0.746)	(0.642)	(5.339)
Staff-student ratio (log)	-8.326***	-7.058***	-5.44	-2.777	-2.804	-0.747
	(2.947)	(2.624)	(3.881)	(2.227)	(2.083)	(3.285)
Russell Group university	-5.702***	-4.425***		-4.680***	-4.237***	
	(2.009)	(1.537)		(1.474)	(1.248)	
University Alliance member	-1.714	-1.418		-0.441	-0.174	
	(1.674)	(1.294)		(1.232)	(1.042)	
Million+ member	2.538	2.282*		2.387*	2.253**	
	(1.698)	(1.316)		(1.253)	(1.063)	
England	-5.058**	-4.045**		-0.927	-0.853	
	(2.338)	(1.823)		(1.713)	(1.467)	
Scotland	-6.291**	-4.871**		-1.546	-1.301	
	(2.741)	(2.122)		(2.006)	(1.712)	
Northern Ireland	-9.749**	-6.336*		-2.06	-0.78	
	(4.251)	(3.235)		(3.084)	(2.602)	
Faculty per programme (log)	-4.152*	-3.002	44.608***	-3.070*	-2.602*	-10.106
	(2.304)	(1.915)	(7.599)	(1.687)	(1.500)	(6.565)
Students per programme (log)	1.966	-1.261	1.87	-6.842***	-6.546***	-2.784
	(2.903)	(2.259)	(6.660)	(2.025)	(1.813)	(5.774)
SEM programmes (%)	-0.089**	-0.084**	-0.043	-0.071**	-0.061**	-0.07
	(0.043)	(0.034)	(0.132)	(0.032)	(0.028)	(0.114)
Single subject programmes (%)	-0.045	-0.042	-0.258**	-0.083**	-0.080**	-0.191*
	(0.050)	(0.041)	(0.117)	(0.038)	(0.033)	(0.101)
Major-minor programmes (%)	0.099*	0.097**	0.03	0.154***	0.121***	0.454***
	(0.054)	(0.045)	(0.091)	(0.043)	(0.037)	(0.079)
Age diversity index	46.138	36.057	-129.574	29.525	25.782	67.565
	(78.903)	(67.290)	(123.888)	(60.339)	(54.249)	(106.592)
Gender diversity index	-162.595***	-145.769***	-224.184*	-92.971**	-86.941**	-93.713
	(53.331)	(43.180)	(124.057)	(39.851)	(34.779)	(106.585)
Ethnic diversity index	0.822	1.557	-28.451	9.165*	9.142**	-45.004**
	(6.406)	(5.047)	(24.967)	(4.729)	(4.059)	(21.547)
N	833	833	833	833	833	833
chi2	159.011	205.383		287.468	355.694	
bic	6426.49	.	6039.733	6087.329	.	5794.339

Notes and Sources: See text for variable definitions and sources. Marginal effects are reported. All models include year dummies. * denotes p<0.10; ** p<0.05 and *** p<0.01.

Table 3: Innovation and withdrawal rates for STEM programmes

	Innovation Rate			Withdrawal Rate		
	Panel Tobit RE	Panel OLS RE	Panel OLS FE	Panel Tobit RE	Panel OLS RE	Panel OLS FE
Innovation rate (-1)	-0.018	-0.023*	-0.071***			
	(0.014)	(0.013)	(0.025)			
Withdrawal rate (-1)				0.016	0.057*	-0.129***
				(0.045)	(0.034)	(0.040)
Asset to liability ratio	-4.09	-3.036	-0.701	-3.773*	-3.341*	-4.129*
	(2.570)	(2.473)	(2.708)	(1.965)	(1.825)	(2.282)
Teaching (%)	-0.115	-0.074	0.157	-0.199*	-0.177*	-0.158
	(0.153)	(0.153)	(0.232)	(0.116)	(0.104)	(0.196)
Teaching x A. to ratio	0.086	0.062	0.037	0.086*	0.075	0.089
	(0.065)	(0.062)	(0.066)	(0.050)	(0.046)	(0.056)
Non-EU students (%)	0.069	0.099	0.134	-0.092	-0.073	-0.124
	(0.139)	(0.141)	(0.208)	(0.105)	(0.093)	(0.175)
Business research contracts	0.793**	0.794**	0.89	0.602**	0.535**	0.929*
	(0.390)	(0.397)	(0.707)	(0.297)	(0.262)	(0.524)
F&E contract income	-0.424	-0.435	-3.596***	-1.405***	-1.279***	-3.008***
	(0.680)	(0.710)	(1.251)	(0.526)	(0.456)	(1.022)
University size (employment, log)	-0.066	-2.201	-62.758***	3.300***	1.604*	11.223
	(1.391)	(1.437)	(8.853)	(1.062)	(0.889)	(7.507)
Staff-student ratio (log)	-11.675***	-12.314***	-15.233**	-0.48	-0.486	2.067
	(4.392)	(4.332)	(6.018)	(3.164)	(2.867)	(4.620)
Russell Group university	-5.375**	-5.553**		-4.945**	-4.216**	
	(2.641)	(2.814)		(2.014)	(1.707)	
University Alliance member	-4.024*	-3.354		-4.603***	-3.764***	
	(2.207)	(2.382)		(1.695)	(1.431)	
Million+ member	2.581	2.385		1.663	1.304	
	(2.262)	(2.440)		(1.711)	(1.464)	
England	-5.644*	-5.707*		1.672	1.963	
	(3.109)	(3.311)		(2.333)	(2.009)	
Scotland	-8.017**	-8.018**		-2.073	-1.552	
	(3.610)	(3.871)		(2.747)	(2.349)	
Northern Ireland	-15.066***	-14.935**		-1.717	-0.364	
	(5.712)	(5.944)		(4.235)	(3.577)	
Faculty per programme (log)	-6.950**	-4.345	66.543***	-5.261**	-2.803	-16.440*
	(3.262)	(3.343)	(11.039)	(2.378)	(2.061)	(9.294)
Students per programme (log)	3.716	5.347	0.844	-7.384***	-7.465***	5.834
	(4.043)	(3.913)	(9.627)	(2.838)	(2.488)	(8.120)
SEM programmes (%)	-0.108*	-0.174***	-1.308***	0.091**	0.037	0.697***
	(0.061)	(0.062)	(0.191)	(0.045)	(0.038)	(0.163)
Single subject programmes (%)	-0.117	-0.111	-0.676***	-0.065	-0.041	-0.233
	(0.071)	(0.073)	(0.172)	(0.054)	(0.046)	(0.144)
Major-minor programmes (%)	0.092	0.098	0.023	0.011	0.017	0.119
	(0.077)	(0.080)	(0.135)	(0.059)	(0.051)	(0.114)
Age diversity index	-2.125	3.355	-119.381	85.096	73.796	59.165
	(110.496)	(113.813)	(178.847)	(84.736)	(74.819)	(150.353)
Gender diversity index	-112.974	-96.696	-96.144	-57.564	-39.426	-119.369
	(74.561)	(78.246)	(188.427)	(57.078)	(49.007)	(156.479)
Ethnic diversity index	-1.137	-0.621	-63.538*	6.821	6.981	-23.689
	(8.703)	(9.271)	(35.967)	(6.561)	(5.625)	(30.285)
N	819	819	819	819	819	819
chi2	105.92	104.499		143.762	153.258	
bic	6693.366	.	6519.484	6311.104	.	6239.423

Notes and Sources: See text for variable definitions and sources. Marginal effects are reported. All models include year dummies. * denotes p<0.10; ** p<0.05 and *** p<0.01.

Table 4: Innovation and withdrawal rates for Non-STEM programmes

	Innovation Rate			Withdrawal Rate		
	Panel Tobit RE	Panel OLS RE	Panel OLS FE	Panel Tobit RE	Panel OLS RE	Panel OLS FE
Innovation rate (-1)	--0.096**	-0.001	-0.181***			
	(0.038)	(0.033)	(0.036)			
Withdrawal rate (-1)				0.051	0.120***	-0.044
				(0.038)	(0.032)	(0.037)
Asset to liability ratio	-3.103*	-2.375	-5.522***	-4.035***	-3.794***	-2.617
	(1.804)	(1.728)	(1.921)	(1.433)	(1.397)	(1.639)
Teaching (%)	-0.105	-0.063	-0.175	-0.237**	-0.227***	-0.171
	(0.123)	(0.106)	(0.187)	(0.095)	(0.086)	(0.159)
Teaching x A. to ratio	0.049	0.037	0.098**	0.070*	0.066*	0.062
	(0.046)	(0.044)	(0.048)	(0.037)	(0.036)	(0.041)
Non-EU students (%)	0.122	0.05	0.449***	-0.125	-0.106	-0.032
	(0.119)	(0.098)	(0.171)	(0.090)	(0.079)	(0.145)
Business research contracts	0.963***	0.921***	0.864*	0.929***	0.824***	1.152***
	(0.333)	(0.279)	(0.514)	(0.260)	(0.227)	(0.439)
F&E contract income	-1.286**	-1.067**	-3.224***	-1.899***	-1.726***	-2.550***
	(0.601)	(0.485)	(0.998)	(0.462)	(0.396)	(0.854)
University size (employment, log)	-0.321	-0.346	-34.170***	1.403	0.924	8.842
	(1.227)	(0.932)	(7.208)	(0.907)	(0.756)	(6.176)
Staff-student ratio (log)	-8.624**	-7.959***	-1.289	-4.033	-3.909	-2.323
	(3.437)	(3.045)	(4.493)	(2.669)	(2.456)	(3.815)
Russell Group university	-6.948***	-5.341***		-5.127***	-4.653***	
	(2.435)	(1.804)		(1.797)	(1.471)	
University Alliance member	-0.258	0.212		2.223	2.249*	
	(2.031)	(1.515)		(1.508)	(1.229)	
Million+ member	2.952	2.682*		3.651**	3.315***	
	(2.058)	(1.542)		(1.539)	(1.254)	
England	-5.708**	-4.904**		-2.748	-2.795	
	(2.811)	(2.134)		(2.096)	(1.733)	
Scotland	-4.866	-3.58		-2.203	-2.168	
	(3.302)	(2.484)		(2.451)	(2.018)	
Northern Ireland	-9.692*	-6.117		-2.607	-1.03	
	(5.110)	(3.783)		(3.768)	(3.064)	
Faculty per programme (log)	-4.095	-3.002	44.323***	-2.295	-2.005	-12.661*
	(2.711)	(2.211)	(8.896)	(2.037)	(1.770)	(7.611)
Students per programme (log)	2.141	-0.707	1.758	-7.839***	-6.882***	-5.305
	(3.337)	(2.637)	(7.820)	(2.462)	(2.136)	(6.690)
SEM programmes (%)	-0.05	-0.062	0.522***	-0.088**	-0.066**	-0.487***
	(0.053)	(0.041)	(0.156)	(0.040)	(0.033)	(0.133)
Single subject programmes (%)	-0.058	-0.069	-0.155	-0.109**	-0.110***	-0.103
	(0.061)	(0.048)	(0.137)	(0.046)	(0.039)	(0.117)
Major-minor programmes (%)	0.149**	0.133**	0.173	0.203***	0.156***	0.526***
	(0.065)	(0.053)	(0.107)	(0.052)	(0.043)	(0.091)
Age diversity index	21.083	-0.073	-203.447	-26.784	-35.703	81.323
	(94.667)	(78.883)	(145.450)	(72.922)	(63.970)	(123.723)
Gender diversity index	-189.771***	-160.808***	-161.706	-124.571**	-119.828***	-105.424
	(64.542)	(50.729)	(145.219)	(48.448)	(41.032)	(123.698)
Ethnic diversity index	-0.187	1.388	-42.946	9.908*	10.253**	-52.684**
	(7.747)	(5.896)	(29.300)	(5.772)	(4.782)	(25.004)
N	832	832	832	832	832	832
chi2	116.885	151.53		256.042	329.705	
bic	6642.09	.	6298.516	6336.379	.	6034.332

Notes and Sources: See text for variable definitions and sources. Marginal effects are reported. All models include year dummies. * denotes p<0.10; ** p<0.05 and *** p<0.01.

Table 5: Symbolic summary of key results

Hypothesis	Anticipated Sign	All Programmes	STEM Programmes	Non-STEM Programmes
Innovation rates				
H1a: Finance	**-**	-	(-)	-
H2a: Teaching share	**+**	+	(+)	+
H3a: Internationalisation	**+**	+	(+)	+
H4a: Business engagement: contract research/consultancy	**+**	+	(+)	+
H4a: Business engagement: F&E contracts	**+**	-	-	-
Withdrawal rates				
H1b: Finance	**-**	-	-	(-)
H2b: Teaching share	**+**	+	(+)	(+)
H3b: Internationalisation	**+**	(-)	(+)	(-)
H4a: Business engagement: contract research/consultancy	**+**	+	+	+
H4a: Business engagement: F&E contracts	**+**	-	-	-

Table A1: Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12
1 Innovation rate (%)	1.00											
2 Withdrawal rate (%)	0.52	1.00										
3 Asset to liability ratio	-0.04	-0.10	1.00									
4 Teaching (% of income)	0.09	0.00	0.19	1.00								
5 Non-EU students (%)	-0.10	-0.15	-0.18	-0.12	1.00							
6 Business research contract (£000)	-0.09	0.06	-0.13	-0.33	0.16	1.00						
7 F&E contracts revenue (£000)	-0.07	-0.11	-0.10	-0.12	0.04	0.36	1.00					
8 University size (employment, log)	-0.16	-0.24	-0.12	-0.10	0.46	-0.02	-0.07	1.00				
9 Staff-student ratio (log)	0.08	0.03	0.22	0.20	-0.43	0.08	0.38	-0.53	1.00			
10 Russell Group university	-0.17	-0.21	-0.12	-0.40	0.46	0.26	0.04	0.55	-0.43	1.00		
11 University Alliance member	-0.08	-0.05	0.09	0.24	-0.20	-0.13	-0.09	0.13	0.13	-0.22	1.00	
12 Million+ member	0.09	0.09	0.08	0.18	-0.22	-0.20	-0.11	-0.20	0.18	-0.17	-0.17	1.00
13 English university	0.00	-0.03	0.03	0.38	0.08	0.00	0.00	0.10	-0.05	0.03	0.12	0.02
14 Scottish university	-0.02	0.02	-0.12	-0.37	0.00	0.26	0.06	0.43	0.18	0.31	0.09	-0.05
15 Northern Ireland university	-0.06	-0.05	0.16	-0.16	-0.12	-0.01	0.00	0.35	0.13	0.40	0.08	-0.07
16 Faculty per programme (log)	-0.25	-0.26	-0.17	-0.27	0.63	0.21	-0.02	0.70	-0.63	0.63	-0.14	-0.27
17 Students per programme (log)	-0.33	-0.28	0.02	-0.12	0.11	0.23	0.15	0.35	-0.14	0.40	0.08	-0.05
18 STEM subject programmes (%)	-0.16	-0.10	-0.25	-0.26	0.22	0.21	0.04	0.11	-0.11	0.09	0.09	-0.20
19 Single subject programmes (%)	-0.16	-0.13	0.01	0.11	-0.07	0.01	0.00	-0.04	0.15	-0.17	0.14	-0.06
20 Major-minor programmes (%)	0.02	0.00	0.20	-0.19	0.14	0.07	0.00	0.11	-0.11	0.21	-0.02	-0.06
21 Age diversity of staff	0.06	0.08	-0.09	0.13	-0.15	-0.19	-0.04	0.15	-0.11	-0.14	0.10	-0.14
22 Gender diversity of staff	-0.20	-0.18	-0.21	-0.13	0.39	0.10	0.07	0.54	-0.27	0.30	0.08	-0.10
23 Ethnic diversity of staff	-0.06	-0.06	-0.13	0.26	0.42	-0.02	0.02	0.38	-0.22	0.14	-0.05	0.07

Table A1: Correlation Matrix

#	Variable	13	14	15	16	17	18	19	20	21	22	23
1	Innovation rate (%)											
2	Withdrawal rate (%)											
3	Asset to liability ratio											
4	Teaching (% of income)											
5	Non-EU students (%)											
6	Business research contract (£000)											
7	F&E contracts revenue (£000)											
8	University size (employment, log)											
9	Staff-student ratio (log)											
10	Russell Group university											
11	University Alliance member											
12	Million+ member											
13	English university	1.00										
14	Scottish university	-0.74	1.00									
15	Northern Ireland university	-0.32	-0.06	1.00								
16	Faculty per programme (log)	0.01	0.03	0.00	1.00							
17	Students per programme (log)	0.02	0.14	0.12	0.61	1.00						
18	STEM subject programmes (%)	-0.15	0.15	-0.01	0.29	0.21	1.00					
19	Single subject programmes (%)	-0.08	0.15	-0.14	0.05	0.32	0.09	1.00				
20	Major-minor programmes (%)	-0.04	-0.07	-0.13	0.07	-0.06	-0.02	-0.21	1.00			
21	Age diversity of staff	0.08	0.15	0.04	0.05	0.15	0.34	-0.35	-0.01	1.00		
22	Gender diversity of staff	-0.12	0.05	0.04	0.43	0.15	-0.21	0.03	0.00	0.17	1.00	
23	Ethnic diversity of staff	0.31	-0.21	-0.16	0.35	0.08	0.19	0.04	-0.05	0.00	0.41	1.00

REFERENCES

Advisory Committee on Measuring Innovation in the 21st Century Economy. 2008. Innovation Measurement - Tracking the state of innovation in the US economy *A report to the Secretary of Commerce*.

Blau, P.M. 1977. *Inequality and heterogeneity*. New York: Free Press.

Boso, N.; J.W. Cadogan; and V.M. Story. 2013. Entrepreneurial orientation and market orientation as drivers of product innovation success: A study of exporters from a developing economy. *International small business journal* **31:57-81**.

Brennan, J.; S. Ryan; M. Ranga; S. Broek; N. Durazzi; and B. Kamphuis. 2014. Study on innovation in higher education: final report, ed. E.C.D.f.E.a.T.S.o.I.i.H. Education. Luxembourg: Publications Office of the European Union.

Bunniran, S.; D.J. McCaffrey; J.P. Bentley; and A.S. Bouldin. 2009. Pharmaceutical product withdrawal: Attributions of blame and its impact on trust. *Research in Social & Administrative Pharmacy* **5:262-273**.

Burge, P.; C.W. Kim; C. Rohr; M. Frearson; and B. Guerin. 2014. Understanding the impact of differential university fees in England: Rand Europe.

Chen, W.C. 2012. Innovation and duration of exports. *Economics Letters* **115:305-308**.

Conraths, B., Smidt, H., 2005. Funding university-based research and innovation in Europe, European University Association, Brussels, Belgium.

de Medeiros, J.F.; J.L.D. Ribeiro; and M.N. Cortimiglia. 2014. Success factors for environmentally sustainable product innovation: a systematic literature review. *Journal of Cleaner Production* **65:76-86**.

de Zubielqui, G.C.; J. Jones; P.-S. Seet; and N. Lindsay. 2015. Knowledge transfer between actors in the innovation system: a study of higher education institutions (HEIS) and SMES. *Journal of Business & Industrial Marketing* **30:436-458**.

Filippakou, O. and T. Tapper. 2015. Mission Groups and the New Politics of British Higher Education. *Higher Education Quarterly* **69:121-137**.

Ganotakis, P. and J.H. Love. 2012. The Innovation Value Chain in New Technology-Based Firms: Evidence from the UK. *Journal of Product*

Innovation Management **29:839-860**.

Geuna, A. and A. Muscio. 2009. The Governance of University Knowledge Transfer: A Critical Review of the Literature. *Minerva* **47:93-114**.

Golovko, E. and G. Valentini. 2011. Exploring the complementarity between innovation and export for SMEs' growth. *Journal of International Business Studies* **42:362-380**.

Geuna, A. and B.R. Martin. 2001. University research evaluation and funding: An international comparison, SPRU Electronic Working Paper Series, No. 71, University of Sussex, http://www.sussex.ac.uk/spru.

H.M. Treasury. 2007. The race to the top, A review of Government's Science and Innovation Policies, Lord Sainsbury of Turville, October 2007

Hansen, M.T. and J. Birkinshaw. 2007. The Innovation Value Chain. *Harvard Business Review* **June 121-130**.

Harrison, R.T. and C. Leitch. 2010. Voodoo Institution or Entrepreneurial University? Spin-off Companies, the Entrepreneurial System and Regional Development in the UK. *Regional Studies* **44:1241-1262**.

Hewitt-Dundas, N. 2012. Research intensity and knowledge transfer activity in UK universities. *Research Policy* 41.2:262-275.

Jarzabkowski, P. 2005. *Strategy as Practice: An activity-based approach*. London, UK: Sage.

Jordan, D. and E. O'Leary. 2007. Sources of innovation in Irish SMEs: Evidence from two Irish regions. In *British-Irish Regional Science Association Annual Conference*. Bangor.

Kandiko, C. and P. Blackmore. 2010. Creating a 21st Century Curriculum: The Kings-Warwick Project: Warwick University/Kings College.

Kauffeld-Monz, M. and M. Fritsch. 2013. Who Are the Knowledge Brokers in Regional Systems of Innovation? A Multi-Actor Network Analysis. *Regional Studies* **47:669-685**.

Konnola, T.; V. Brummer; and A. Salo. 2007. Diversity in foresight: Insights from the fostering of innovation ideas. *Technological Forecasting And Social Change* **74:608-626**.

Maringe, F. and S. Carter. 2007. International students' motivations for studying in UK HE. *The International Journal of Educational Management* **21:459-475**.

Mazzarol, T.; G.N. Soutar; and V. Thein. 2001. Critical success factors in

the marketing of an educational insititution: a comparison of institutional and student perspectives. *Journal of makreting in higher education* **10:39-57**.

McMahon, M. 1992. Higher Education in a World Market. An Historical Look at the Global Context of International Study. *Higher Education* **24:465-482**.

Miozzo, M. and L. Soete. 2001. Internationalization of services: a technological perspective. *Technological Forecasting and Social Science* **67:159-185.**

Muscio, A.; D. Quaglione; and G. Vallanti. 2015. University regulation and university-industry interaction: a performance analysis of Italian academic departments. *Industrial and Corporate Change* **24:1047-1079**.

Orr, D., Jaeger, M., Schwarzenberger, A., 2007. Performance-based funding as an instrument of competition in German higher education. Journal of Higher Education Policy and Management 29, 1, 3-23.

Ostergaard, C.R.; B. Timmermans; and K. Kristinsson. 2011. Does a different view create something new? The effect of employee diversity on innovation. *Research Policy* **40:500-509**.

Plewa, C.; V. Galan-Muros; and T. Davey. 2015. Engaging business in curriculum design and delivery: a higher education institution perspective. *Higher Education* **70:35-53**.

Roper, S. and S. Arvanitis. 2012. From knowledge to added value: A comparative, panel-data analysis of the innovation value chain in Irish and Swiss manufacturing firms. *Research Policy* **41:1093-1106**.

Roper, S. and J.H. Love. 2002. Innovation and Export Performance: Evidence from UK and German Manufacturing Plants. *Research Policy* **31:1087-1102**.

Schatzel, K.E.; R.J. Calantone; and C. Droge. 2001. Beyond the firm's initial declaration: Are preannouncements of new product introductions and withdrawals alike? *Journal of Product Innovation Management* **18:82-95**.

Sorlin, S., 2007. Funding diversity: Performance-based funding regimes as drivers of differentiation in higher education systems. Higher Education Policy 20, 413-40.

Trippl, M. 2011. Regional innovation systems and knowledge-sourcing activities in traditional industries-evidence from the Vienna food sector.

Environment and Planning A **43:1599-1616**.

Wakeling, P. and K. Jefferies. 2013. The effect of tuition fees on student mobility: the UK and Ireland as a natural experiment. *British Educational Research Journal* **39:491-513**.

Wilkins, S. and J. Huisman. 2011. Student Recruitment at International Branch Campuses: Can They Compete in the Global Market? *Journal of Studies in International Education* **15:299-316**.

Winkler, V.A. and R.B. Bouncken. 2011. How Does Cultural Diversity in Global Innovation Teams Affect the Innovation Process? *Emj-Engineering Management Journal* **23:24-35**.

Young, B.; N. Hewitt-Dundas; and S. Roper. 2008. Intellectual Property Management in Publicly Funded R&D Centres - A Comparison of University-based and Company-based Research Centres. *Technovation* **28:473-484**.

![ERC Enterprise Research Centre]

Centre Manager
Enterprise Research Centre
Warwick Business School
Coventry, CV4 7AL
Enquiries@enterpriseresearch.ac.uk

Centre Manager
Enterprise Research Centre
Aston Business School
Birmingham, B1 7ET
Enquiries@enterpriseresearch.ac.uk

www.enterpriseresearch.ac.uk