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Higher Education Authority

Research collaboration in Ireland's HE system: a bibliometric study

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Introduction

The client and this study

Earlier in 2009, Forfás and the Higher Education Authority (HEA) commissioned a report on research activity in Ireland.

The report contained an analysis developed across four main themes:

1. International Comparative Performance of the Irish research base at overall system, broad subject and finer disciplinary levels.
2. Institutional Comparative Research Performance in Ireland and Northern Ireland.
3. Research Collaboration internationally and within the island of Ireland.
4. Impact Profiles® describing the distribution of citation impact underpinning Ireland's average relative performance.

The current report has been commissioned by the HEA and provides further development of theme 3, on collaboration, with a specific focus on collaboration between Higher Education Institutions (HEIs) within Ireland.

The analysts

Evidence Ltd, a business within Thomson Reuters, has carried out the analyses and produced this report. It has considerable experience in related work for a number of jurisdictions and has ready data and appropriate and tested methodology to address the HEA's requirements. It is currently producing reports of a similar nature for several research agencies in the UK and in Singapore.

Evidence specialises in research performance analysis and interpretation. It has extensive experience with and databases on research inputs, activity and outputs relating to research both globally and particularly for the European research base. It has also developed innovative analytical approaches for benchmarking international, national and institutional research impact.

Evidence works for government departments and agencies and for universities and other research-based organisations. *Evidence* staff have experience in research institutes, HE research management and administration, national policy development and both private sector and charitable research organisations.

Collaboration

Earlier co-authorship analyses for Ireland considered data for the ten-year period 1998-2007 and showed:

- Rapidly rising collaboration profiles
- Very good links with the USA
- Potentially strong links within Europe, varying between institutions and therefore likely built on specific initiatives
- A need to foster links with China and perhaps other targets in Asia
- A relatively poor level of collaboration within Ireland, with some notable exceptions
- Very little collaboration with Northern Ireland

The level of national inter-institutional collaboration determined in the earlier study appeared to be relatively small. Collaboration between Ireland and Northern Ireland is very low, with QUB linking to around just 1% of output for UCD and about 2% of output for TCD whereas collaboration between QUB and UU is over 10% of the latter's activity. That compares with collaboration between TCD and UCD of less than 3%. Given the spread of activity and inevitable demand for resources, these data suggest that there is much latent potential for collaboration.

The HEA asked *Evidence* to explore these data further in order to determine more details of the dynamics of collaboration by institution and field.

This report covers two main aspects of collaborative authorship:

Part I – Across the system

- A graph of total inter-HEI collaboration by year 1998-2007
- Matrices of inter-institutional co-authored papers broken down by
    - Early five years from 1998-2002 and
    - Recent five years 2003-2007

Part II –By subject area

Two elements for each main subject area covered in the earlier report:

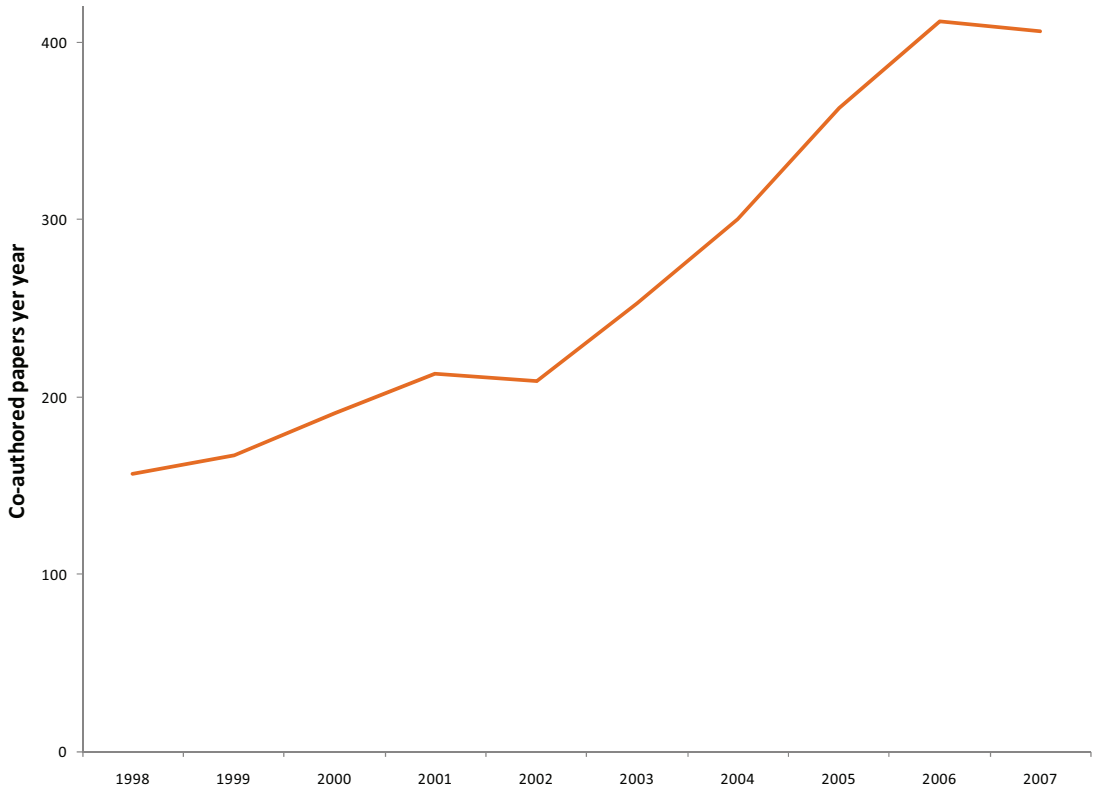
- A graph of papers within HE sector with two or more institutional addresses
- Matrix of papers by institution by year that have a co-author at another Ireland HEI

Across the system

The output of research publications has increased markedly for Ireland over the period studied. This is important for two reasons. First, all analyses must take into account the progressive volume change. For collaboration this means looking at co-authorship relative to total authored output. An absolute change may not be a relative change. Second, most research policy evaluation has historically considered stable systems and looked for specific changes within them. When an entire national system is expanding rapidly (as it has in the last decade for not only Ireland but also Brazil, China and India) then there are likely to be other data characteristics which are out of line with 'normal' expectations. Interpretation must therefore proceed with care.

Figure 1 shows that there has been a marked increase in intra-national co-authorship for Irish researchers from 2002, so the overall level of collaboration had more than doubled by 2006.

Figure 1. Total numbers of papers per year that carry addresses for authors at two or more HEIs in Ireland



Absolute increase in collaboration

Given the overall pattern in Figure 1, it is not surprising to find that the numbers of collaborative papers between pairs of Irish HEIs have generally increased between 1998-2002 and 2003-2007 (Table 1). In a very small number of instances there has been an absolute decrease (an example is DIT and QUB) but it is clear that, in the overwhelming majority of pair-wise combinations, the increased volume of institutional output has also captured increased institutional collaboration.

Table 1. Change in volume of research articles co-authored between HEIs in Ireland, where volume = (2003-2007) – (1998-2002)

	UCD	TCD	UCC	NUI Galway	DCU	UL	NUI M'nooth	RCSI	DIT	DIAS	Other	QUB	UU
UCD		75	52	22	28	25	57	37	3	14	11	36	25
TCD	75		53	38	41	1	20	26	4	6	14	10	16
UCC	52	53		24	22	26	6	2	19	0	37	7	-5
NUI Galway	22	38	24		7	8	18	-2	0	-1	6	1	5
DCU	28	41	22	7		9	12	3	9	8	17	4	-4
UL	25	1	26	8	9		0	1	5	1	16	-1	6
NUI Maynooth	57	20	6	18	12	0		-1	25	5	-2	7	1
RCSI	37	26	2	-2	3	1	-1		6	0	1	5	7
DIT	3	4	19	0	9	5	25	6		-1	1	-7	27
DIAS	14	6	0	-1	8	1	5	0	-1		-3	0	0
Other	19	14	41	14	18	16	-2	1	1	-3		8	5
QUB	36	10	7	1	4	-1	7	5	-7	0	8		114
UU	25	16	-5	5	-4	6	1	7	27	0	5	114	

Tables 2a and 2b on the next page show the patterns for the two five-year periods separately.

Tables 2a and 2b. Actual numbers of collaborative papers in each five-year period

1998-2002	UCD	TCD	UCC	NUI Galway	DCU	UL	NUI M'nooth	RCSI	DIT	DIAS	Other	QUB	UU
UCD	2861	75	30	47	41	6	22	24	30	14	41	25	16
TCD	75	2553	19	9	39	13	16	59	54	5	9	63	20
UCC	30	19	2158	9	10	13	6	11	1	0	19	18	21
NUI Galway	47	9	9	1065	5	6	7	8	2	2	30	15	3
DCU	41	39	10	5	783	3	9	3	15	4	7	30	5
UL	6	13	13	6	3	524	0	0	0	0	14	7	0
NUI Maynooth	22	16	6	7	9	0	430	1	7	33	9	11	4
RCSI	24	59	11	8	3	0	1	429	20	0	0	9	0
DIT	30	54	1	2	15	0	7	20	284	2	9	11	1
DIAS	14	5	0	2	4	0	33	0	2	225	4	1	0
Other	47	9	19	34	7	14	9	0	9	4	309	6	2
QUB	25	63	18	15	30	7	11	9	11	1	6	4531	154
UU	16	20	21	3	5	0	4	0	1	0	2	154	1630
2003-2007													
UCD	4510	150	82	69	69	31	79	61	33	28	52	61	41
TCD	150	3904	72	47	80	14	36	85	58	11	23	73	36
UCC	82	72	3217	33	32	39	12	13	20	0	56	25	16
NUI Galway	69	47	33	1692	12	14	25	6	2	1	36	16	8
DCU	69	80	32	12	1345	12	21	6	24	12	24	34	1
UL	31	14	39	14	12	1125	0	1	5	1	30	6	6
NUI Maynooth	79	36	12	25	21	0	842	0	32	38	7	18	5
RCSI	61	85	13	6	6	1	0	655	26	0	1	14	7
DIT	33	58	20	2	24	5	32	26	495	1	10	4	28
DIAS	28	11	0	1	12	1	38	0	1	343	1	1	0
Other	66	23	60	48	25	30	7	1	10	1	587	14	7
QUB	61	73	25	16	34	6	18	14	4	1	14	5370	268
UU	41	36	16	8	1	6	5	7	28	0	7	268	2136

Relative change in collaboration

The change in output between the two periods means that the change in collaborative volume should be contextualised in terms of the background volume growth. This is done by looking at the level of co-authorship in terms of the institution's overall publication activity. Note that where two HEIs have very different outputs the level of mutual co-authorship will be a different share of each HEIs total. This means that whereas the absolute level of collaboration (Table 1) is a symmetrical table, the relative level of collaboration (Table 3) is non-symmetrical.

Table 3. Change in percentage share of publications that are collaborative with another institution

	UCD	TCD	UCC	NUI Galway	DCU	UL	NUI M'nooth	RCSI	DIT	DIAS	Other	QUB	Ulster	Gain, out of 12
UCD		0.7	0.8	-0.1	0.1	0.5	1.0	0.5	-0.3	0.1	-0.3	0.5	0.3	9
TCD	0.9		1.1	0.9	0.5	-0.2	0.3	-0.1	-0.6	0.1	0.2	-0.6	0.1	8
UCC	1.2	1.4		0.6	0.5	0.6	0.1	-0.1	0.6	0.0	0.9	-0.1	-0.5	8
NUI Galway	-0.3	1.9	1.1		0.2	0.3	0.8	-0.4	-0.1	-0.1	-0.7	-0.5	0.2	6
DCU	-0.1	1.0	1.1	0.3		0.5	0.4	0.1	-0.1	0.4	0.9	-1.3	-0.6	8
UL	1.6	-1.2	1.0	0.1	0.5		0.0	0.1	0.4	0.1	0.0	-0.8	0.5	8
NUI Maynooth	4.3	0.6	0.0	1.3	0.4	0.0		-0.2	2.2	-3.2	-1.3	-0.4	-0.3	6
RCSI	3.7	-0.8	-0.6	-0.9	0.2	0.2	-0.2		-0.7	0.0	0.2	0.0	1.1	6
DIT	-3.9	-7.3	3.7	-0.3	-0.4	1.0	4.0	-1.8		-0.5	-1.1	-3.1	5.3	4
DIAS	1.9	1.0	0.0	-0.6	1.7	0.3	-3.6	0.0	-0.6		-1.5	-0.2	0.0	4
Other	-4.0	1.0	4.1	-2.8	2.0	0.6	-1.7	0.2	-1.2	-1.1		0.4	0.5	7
QUB	0.6	0.0	0.1	0.0	0.0	0.0	0.1	0.1	-0.2	0.0	0.1		1.6	6
UU	0.9	0.5	-0.5	0.2	-0.3	0.3	0.0	0.3	1.2	0.0	0.2	3.1		8

In Tables 3, 4a and 4b, the institution for which co-authorship share is displayed is shown along each row, while the collaborating institution is shown in the table columns. For example, University College Cork (UCC) collaborates with NUI Galway. There has been a 0.6% increase in the share of UCC's publications that have a co-author from NUI Galway. The same set of publications represent a 1.1% increase in share of NUI Galway's publications that have a co-author from UCC.

Changes are highlighted: cells coloured red indicate an increase in relative collaboration. The column on the right of the table shows the number out of 12 possible pair-wise collaborations where relative co-authorship has increased. This is usually more than half of the total possibilities, and the values of gains in relative volume appear also to outweigh the reductions. There are more gains in the upper-left of the table (interactions between larger institutions) than elsewhere, so response has been focussed where research is also intensive.

Tables 4a and 4b. Share (%) of institutional papers that are collaborative with another institution, by five-year period

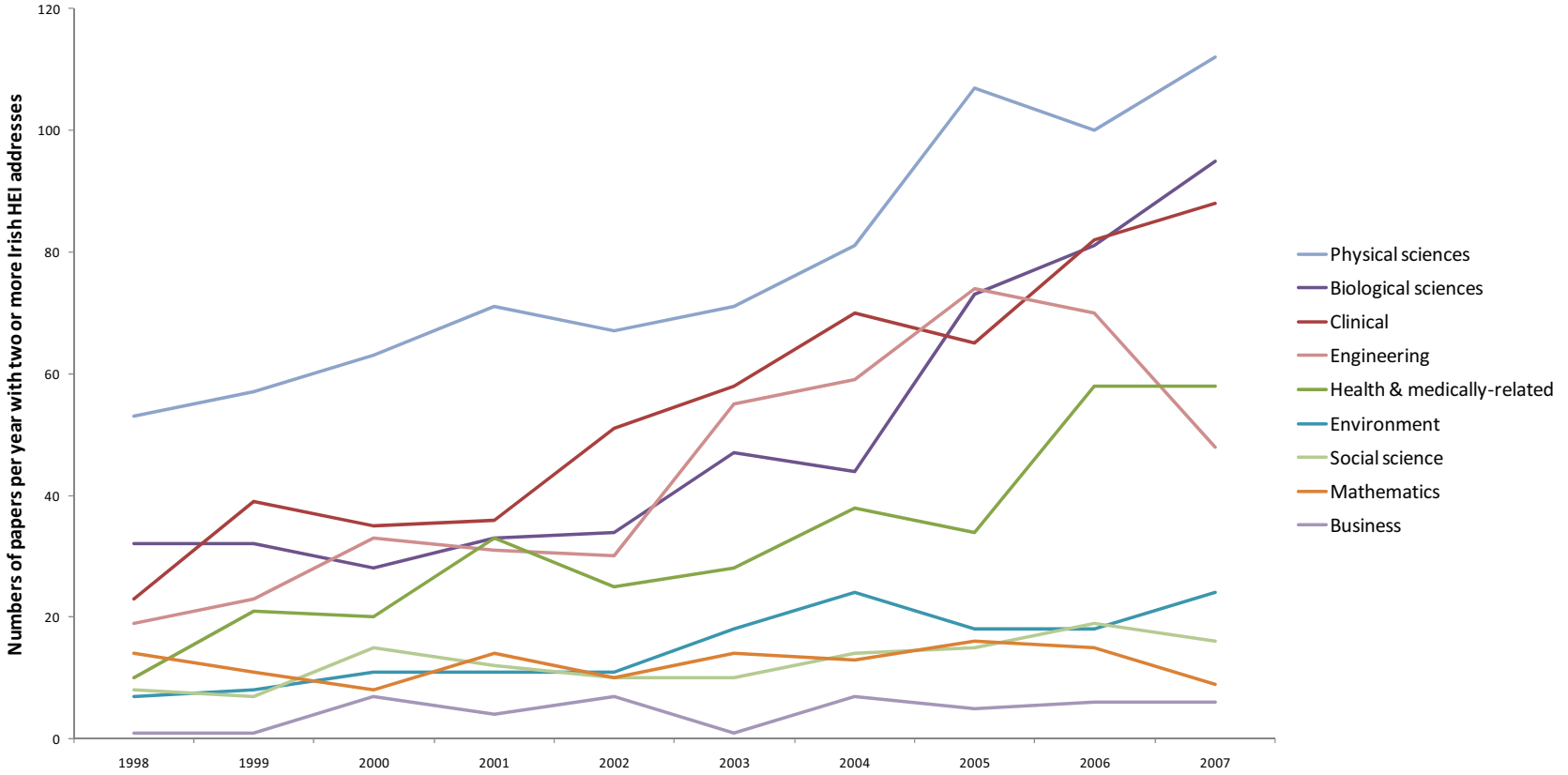
1998-2002	UCD	TCD	UCC	NUI Galway	DCU	UL	NUI M'nooth	RCSI	DIT	DIAS	Other	QUB	UU
UCD		2.6	1.0	1.6	1.4	0.2	0.8	0.8	1.0	0.5	1.4	0.9	0.6
TCD	2.9		0.7	0.4	1.5	0.5	0.6	2.3	2.1	0.2	0.4	2.5	0.8
UCC	1.4	0.9		0.4	0.5	0.6	0.3	0.5	0.0	0.0	0.9	0.8	1.0
NUI Galway	4.4	0.8	0.8		0.5	0.6	0.7	0.8	0.2	0.2	2.8	1.4	0.3
DCU	5.2	5.0	1.3	0.6		0.4	1.1	0.4	1.9	0.5	0.9	3.8	0.6
UL	1.1	2.5	2.5	1.1	0.6		0.0	0.0	0.0	0.0	2.7	1.3	0.0
NUI Maynooth	5.1	3.7	1.4	1.6	2.1	0.0		0.2	1.6	7.7	2.1	2.6	0.9
RCSI	5.6	13.8	2.6	1.9	0.7	0.0	0.2		4.7	0.0	0.0	2.1	0.0
DIT	10.6	19.0	0.4	0.7	5.3	0.0	2.5	7.0		0.7	3.2	3.9	0.4
DIAS	6.2	2.2	0.0	0.9	1.8	0.0	14.7	0.0	0.9		1.8	0.4	0.0
Other	15.2	2.9	6.1	11.0	2.3	4.5	2.9	0.0	2.9	1.3		1.9	0.6
QUB	0.6	1.4	0.4	0.3	0.7	0.2	0.2	0.2	0.2	0.0	0.1		3.4
UU	1.0	1.2	1.3	0.2	0.3	0.0	0.2	0.0	0.1	0.0	0.1	9.4	
2003-2007													
UCD		3.3	1.8	1.5	1.5	0.7	1.8	1.4	0.7	0.6	1.2	1.4	0.9
TCD	3.8		1.8	1.2	2.0	0.4	0.9	2.2	1.5	0.3	0.6	1.9	0.9
UCC	2.5	2.2		1.0	1.0	1.2	0.4	0.4	0.6	0.0	1.7	0.8	0.5
NUI Galway	4.1	2.8	2.0		0.7	0.8	1.5	0.4	0.1	0.1	2.1	0.9	0.5
DCU	5.1	5.9	2.4	0.9		0.9	1.6	0.4	1.8	0.9	1.8	2.5	0.1
UL	2.8	1.2	3.5	1.2	1.1		0.0	0.1	0.4	0.1	2.7	0.5	0.5
NUI Maynooth	9.4	4.3	1.4	3.0	2.5	0.0		0.0	3.8	4.5	0.8	2.1	0.6
RCSI	9.3	13.0	2.0	0.9	0.9	0.2	0.0		4.0	0.0	0.2	2.1	1.1
DIT	6.7	11.7	4.0	0.4	4.8	1.0	6.5	5.3		0.2	2.0	0.8	5.7
DIAS	8.2	3.2	0.0	0.3	3.5	0.3	11.1	0.0	0.3		0.3	0.3	0.0
Other	11.2	3.9	10.2	8.2	4.3	5.1	1.2	0.2	1.7	0.2		2.4	1.2
QUB	1.1	1.4	0.5	0.3	0.6	0.1	0.3	0.3	0.1	0.0	0.3		5.0
UU	1.9	1.7	0.7	0.4	0.0	0.3	0.2	0.3	1.3	0.0	0.3	12.5	

Subject-level analyses

Collaboration has been analysed but is not reported for arts and humanities (see below). The data were explored to establish the number of papers by main subject area that had two or more co-authors from Irish HEIs. The following figure shows that overall collaboration has increased progressively in most areas of natural sciences and technology, though not in environmental sciences, but has changed little in mathematics and in social and economic sciences.

There seems to be an aberrant outcome for engineering after 2005 which is not explicable within the data-set which accords with the 2007 dip in Figure 1.

Figure 2. Numbers of Ireland papers analysed by main subject area where there are co-authors from two or more HE institutions



By subject and institution

When the data are disaggregated by institution, subject and year then the numbers of collaborative publications become rather small for many universities. It is then difficult to determine whether year-to-year variations are due to random fluctuations in small numbers or to real trends in activity. The following tables therefore refer only to those institutions where the absolute volume has been consistently substantive throughout the period, but this does not mean that there has not been growth in collaboration elsewhere in the system.

The tables are arranged by subject, with only select institutions shown. There are no data reported here for social sciences or business studies. This is because the numbers of collaborative publications by institution in these subject areas are small for all institutions (see Figure 2) and provide little real information. Numbers of collaborations were so small for arts & humanities that no analysis has been pursued. The numbers are also small for environmental sciences but the trend is clearer.

Tables 5a to 5g. Numbers of publications each institution co-authors with other Irish HEIs, by year and subject area

Subject area		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Clinical sciences	UCD	6	10	6	7	14	24	34	22	37	38
	TCD	13	11	17	16	18	25	20	23	33	24
	UCC	3	3	4	5	6	3	7	6	11	9
	NUI Galway	1	7	3		2	3	3	11	13	12
	NUI Maynooth		2	3	2	4	7	7	9	9	11
	RCSI	6	16	13	10	11	10	5	17	27	21
	QUB	9	15	14	15	18	19	31	25	17	28
	UU	7	14	10	14	22	19	27	20	15	22
Health and medically-related	UCD		7	6	5	2	5	13	16	20	22
	TCD	6	8	6	12	7	11	14	10	23	17
	UCC		2	4	7	14		2	5	5	9
	NUI Galway	1	1		2		3	5	2	13	10
	DCU			1	2			2	1	8	6
	QUB	5	6	5	10	5	10	8	9	15	19
	UU	3	9	8	14	20	11	10	15	19	18
Biological sciences	UCD	16	11	11	20	16	18	20	26	39	45
	TCD	3	10	12	11	8	14	9	23	23	23
	UCC	11	6	2	6	11	13	16	20	23	35

Subject area		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Biological sciences	NUI Galway	8	9	6	3	5	3	5	2	4	9
	DCU	6	4	4	5		3	5	6	6	6
	UL		3		4	6	9	1	10	6	7
	NUI Maynooth		2	4	2	3	5	9	10	9	11
	QUB	10	8	6	7	8	14	11	16	10	25
	UU	3	2	1	2	4	7	7	10	12	13
Environment	UCD	3	1	6	3	3	5	6	2	8	11
	TCD			1		2	4	8	3	4	9
	UCC	3	4	1	1	3	3	7	8	7	10
	NUI Galway	1	3	2	3	5	2	4	5	2	6
	QUB	3	3	4	7	2	6	4	6	3	4
	UU	1		4	6	1	6	4	2	2	2
Mathematics	UCD	6	4	2	3	2	2	5	6	4	5
	TCD	3	1	3	4	3	7	2	5		2
	QUB	1	4	2	2		2		3	2	1
	UU			1		1	1		2	1	
Physical sciences	UCD	21	21	19	17	22	12	22	27	15	24
	TCD	10	22	23	32	24	25	27	36	37	35
	UCC	4		3	5	8	8	8	19	18	27
	DCU	18	15	12	20	23	17	20	32	23	38
	NUI Maynooth	6	14	14	13	6	13	11	13	19	19
	DIT	5	11	22	22	12	16	13	17	26	20
	DIAS	6	8	8	6	9	9	10	17	12	19
	QUB	21	14	12	17	16	19	18	22	13	15
	UU	2	3	1	3	2	4	6	11	12	8

Subject area		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Engineering	UCD	3	10	10	11	10	12	22	25	18	14
	TCD	8	8	12	8	11	17	15	18	15	16
	UCC	3	2	6	2	4	9	6	12	18	15
	DCU	8	1	2	2	7	7	15	13	10	18
	UL	3	2	6	6	6	5	10	20	5	4
	NUI Maynooth				1	2	9	3	11	9	3
	DIT	2	1	4	9	1	5	3	4	12	4
	QUB	5	8	7	10	8	13	17	19	14	4
	UU		6	5	5	3	10	18	13	19	6

The data in this Table confirm at a more detailed level the overall impression in Figure 1 and the by-subject analysis in Figure 2. Collaboration between HEIs in Ireland is increasing and this increase is in some instances very marked. It is by no means a universal pattern, however, and it is impacting on a small group of larger and more intensive institutions much more significantly than it is elsewhere in the system.

It is also variable across subjects. The data for Social and Humanities subjects are universally sparse on collaboration, while the data for mathematics (included above) show low numbers and no clear trajectory.

The pivotal year for increasing collaboration is generally 2002, but some rise in collaboration is seen before this while in environmental sciences it is generally rather more recent.

The pattern in Engineering is extremely unusual and needs explanation from elsewhere. It will be noted that collaboration drops for almost every institution in the last year, with the notable exception of DCU. In a number of instances there is also a fall between 2005 and 2006. This change in trajectory suggests a system factor rather than any institutional issue; note also that the phenomenon extends – perhaps even more markedly - to QUB and UU.

Comparison with QUB and UU may throw further light on the significance of particular years and subject areas for the universities in Ireland. Physical sciences is an area of substantial and growing collaboration, but for UCD and QUB there is no significant change in level of collaboration over the period, so this is not a uniform pattern but may be one stimulated by a change in the Ireland system. Clinical sciences produce an equivocal result. Health & medically related subjects, however, show a more similar growth change in both Ireland and in QUB/UU suggesting that this may have been a supra-national shift in working patterns leading to the growth of links across neighbouring jurisdictions in the health area.

These are first impressions. No doubt additional conclusions and hypotheses will be reached as these data and analyses are studied reflectively.