

High correlation is not the whole story: a cautionary note on the use of simple metrics to determine QR allocations

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1. Introduction

There has been much discussion recently on the topic of replacing the RAE by a metric-based system to determine QR allocations to UK universities. See, for example, Section 4 of the recently published report “Science and Innovation Investment Framework 2004-14: Next Steps” (henceforth, SIIF). For example, SIIF shows that the correlation between UK HE institutions’ annual QR income and total income from all other sources has varied between 0.97 and 0.99 over a five-year period to 2004/05. This short note points out that even with correlations as large as this, using a metric-based system to determine QR allocations can have a very large effect on individual institutions, and can differentially affect sub-groups of institutions of a particular character.

The analyses on which these conclusions are based are both simple and very preliminary. In particular: 1) we have only been able to use institution-level data although it is widely believed, and acknowledged in SIIF, that different measures of research quality are appropriate for different areas of research; 2) we have made no attempt systematically to classify HE institutions into sub-groups, but do use one sub-group, the 94 Group, to support our interpretation of our results.

2. Data source

We have used HESA data for two successive years, 2002/03 and 2003/04, which we downloaded from the HESA web-site:

Table R1, <http://www.hesa.ac.uk/pi/0304/research.htm>

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These data are very similar to those used in Section 4 of SIIF, although they cover only two years rather than five. The data include, for each institution, the following variables: number of PhDs awarded; income from research grants and contracts; QR allocation. To allow direct comparison between the two years, we merged the Manchester and UMIST data for 2002/03, and removed a few institutions which did not feature in both years. This left us with data on 166 institutions.

3. Data analysis

We used simple graphical displays and linear regression models to investigate how well grant income and/or number of PhD’s awarded can predict actual QR allocations.

The four panels of Figure 1 shows scatterplots of institutional QR against grant income and against PhD numbers for each of 2003/03 and 2003/04, together with the fitted linear relationships. As noted in SIIF, the relationship between QR and grant income is consistent over the two years, and shows a very strong correlation between the two variables (0.979 in 2002/03, 0.980 in 2003/04). However, the same can be said of the relationship between QR and PhD numbers (0.92 in 2003/03, 0.960 in 2003/04). But the consequences of using each of the two regressions as the basis for re-allocating QR are materially different. For example, were grant income to be used, every member of the 94 Group would see a drop in their QR income. This may reflect the fact that universities in this group are generally research-led, but relatively small and with generally smaller proportions of their research activity in science, engineering and medicine

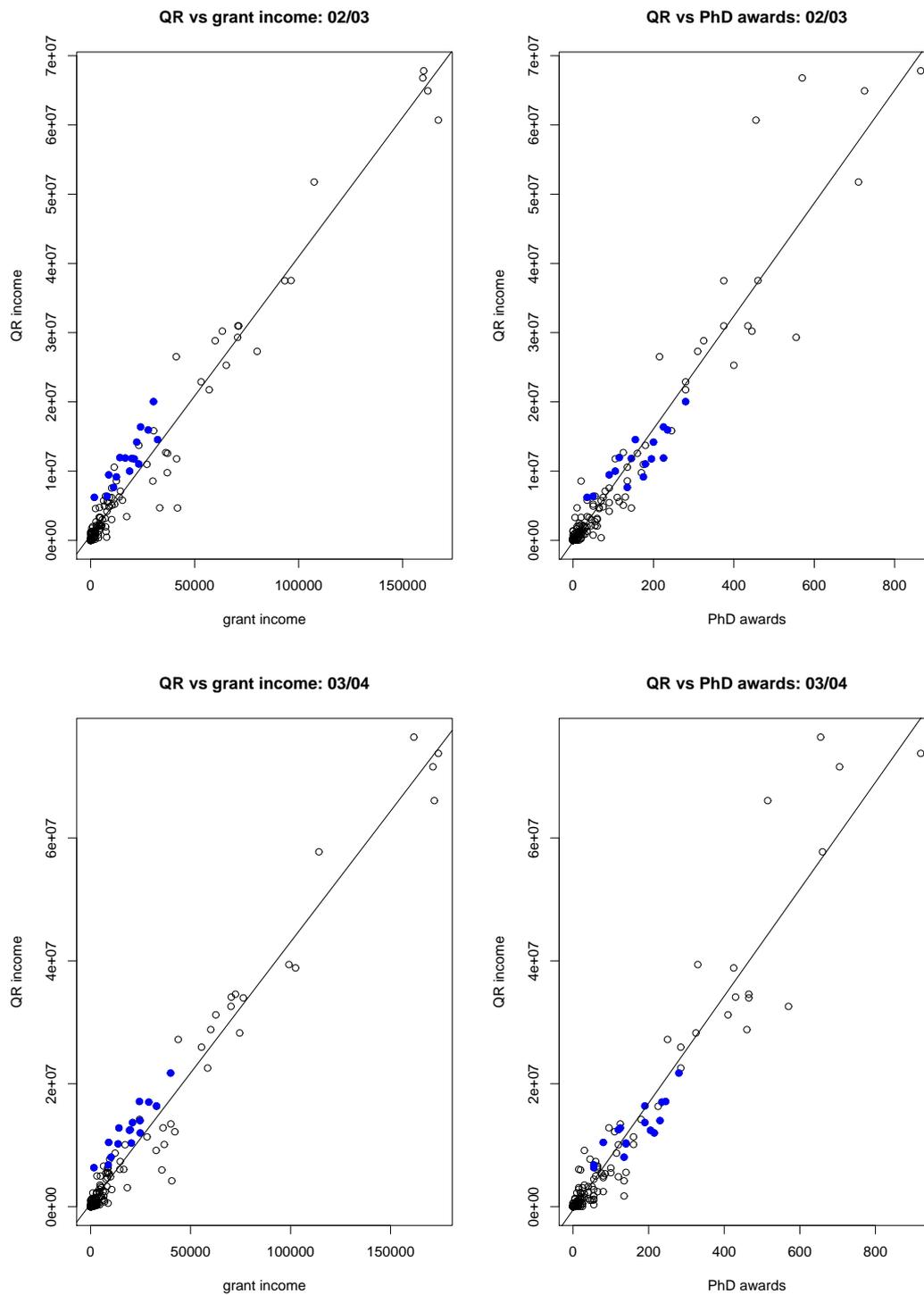


Figure 1: Institutional QR against grant income or PhD numbers, for years 2002/03 and 2003/04. 94 Group universities are shown as filled blue circles, others as open circles. Lines are fitted linear regressions.

than, for example, most of the bigger Russell Group universities. In contrast, using PhD numbers the 94 Group as a whole would not be disadvantaged - some within the group would gain, others would lose.

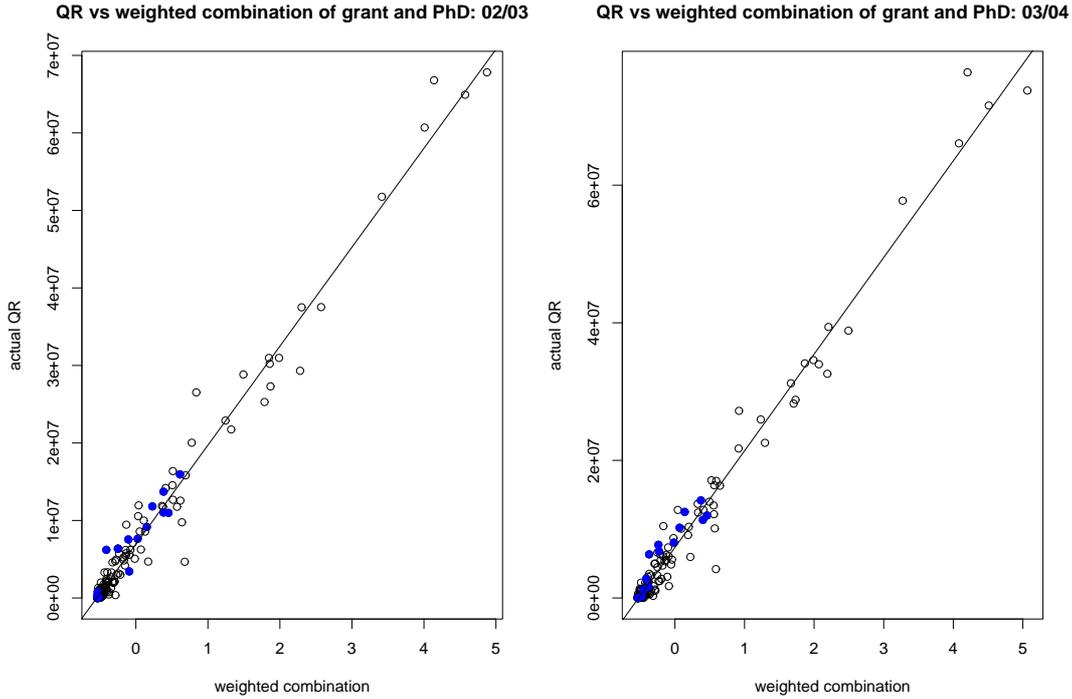


Figure 2: Institutional QR against optimally weighted linear combination of grant income and PhD numbers, for years 2002/03 and 2003/04. 94 Group universities are shown as filled circles, others as open circles. Lines are fitted multiple linear regressions.

A second, and more extreme example from the upper end of the QR income range is Imperial College, which has the fourth largest actual QR income in both years. Using grant income, Imperial would have gained approximately £7million, or 12% of its actual allocation in each of 2002/03 and 2003/04, but using PhD numbers it would have lost £23million (39%) in 2003/03 and £22million (33%) in 2003/04.

An obvious next question is whether using both grant income and PhD numbers in a multiple linear regression model would make any further material changes to the outcome. The optimum weighting of standardised grant income and PhD numbers turns out to be 0.63:0.37 in 2003/03 and 0.64:0.36 in 2003/04, again showing very strong consistency between the two years.

The two panels of Figure 2 show the relationship between QR income and the optimally weighted linear combination of standardised grant income and PhD numbers for each of the two years. Inevitably, the correlations are now even stronger (0.989 in both years), and the differences between actual and fitted QR allocations smaller, than for either of the single variable fits. Nevertheless, these differences can be large in absolute terms, varying between a £10million reduction and a £9million increase in 2003/03, and between an £11million reduction and a £10million increase in 2003/04.

Table 1 gives the differences between actual and metric-based QR allocations for each of the 166 institutions in each of the years 2002/03, using each of the three regression models.

A final comment is that the UK higher education sector now contains a very diverse set of institutions, both in size and in their degree of concentration on research activities. This alone is enough to induce very high correlations between institution-level QR allocations and simple predictors thereof. To illustrate the point, using both grant income and PhD numbers gives a predictor whose sector-wide correlation with

actual QR was 0.989 in both 2002/03 and 2003/04. However, suppose that we were to divide the sector into two groups, according to whether their actual QR allocations were less than or greater than £10million. Although the first group includes most of the institutions (132 out of 166 in 2002/03, 128 in 2003/04), the correlation between predicted and actual QR allocations within the group drops to 0.849 and 0.804 for 2002/03 and 2003/04, respectively. Remember also that a better measure than correlation is the squared correlation, R^2 , which here represents the proportion of the variability in QR allocations captured by the fitted regression; for example, in 2003/04, the multiple regression model captures 98% of the variability sector-wide, but only 65% within the large group of institutions earning less than £10million annual QR.

4. Conclusions

Our aim in this report has been to show some of the shortcomings in the kinds of simple metric-based systems for allocating QR funds which have been publicised in recent government communications, for example in SIIF. Our analyses are very preliminary in nature, are based on limited data, and should not be regarded as in any way authoritative. Nevertheless, we believe they support the following conclusions:

1. Principally because of the very wide range of variation in levels of research activity amongst UK higher education institutions, it is easy to find simple metric-based predictors of QR allocations which are very highly correlated with actual QR allocations. However, even a correlation of the order of 0.95 or more between metric-based and actual QR allocations can imply very substantial changes in QR for some institutions.
2. Any metric-based system for future QR allocations would need to be much more sophisticated than the simple approach presented here, or the even simpler analyses presented in SIIF, if it were to have any credibility within the HE sector.
3. A credible metric-based system would need to be based on much more detailed data than we have used. Minimally, research performance indicators would need to be both larger in number, and disaggregated to academic areas within institutions, so as to allow performance indicators to be combined in different ways for different academic areas.

Table 1. Changes between actual QR allocations and hypothetical metric-based allocations using either grant income (grant), number of PhD's awarded (PhD) or weighted linear combination (both). Figures are in thousands of pounds. A negative figure means that actual QR was lower than would have been allocated by the metric-based method, and conversely.

| | Institution | Change in QR 2002/03 | | | Change in QR 2003/04 | | |
|----|---------------------------------------|----------------------|--------|--------|----------------------|--------|--------|
| | | grant | PhD | both | grant | PhD | both |
| 1 | Anglia Polytechnic University | -1883 | -5109 | -2964 | -2094 | -3936 | -2633 |
| 2 | Aston University | 2306 | -331 | 1446 | 2416 | 300 | 1769 |
| 3 | Bath Spa University College | -547 | 477 | 62 | -383 | 657 | 222 |
| 4 | The University of Bath | 3131 | 223 | 1949 | 3624 | 2611 | 3194 |
| 5 | Birkbeck College | 2426 | 2510 | 2563 | 2574 | 2536 | 2658 |
| 6 | Birmingham College of Food, ... | -719 | 232 | -136 | -447 | 541 | 140 |
| 7 | The University of Birmingham | 147 | -15727 | -6748 | 2221 | -16462 | -5532 |
| 8 | Bishop Grosseteste College | -737 | 232 | -148 | -457 | 541 | 134 |
| 9 | Bolton Institute of Higher Education | -735 | 474 | -61 | -490 | 332 | 27 |
| 10 | The Arts Institute at Bournemouth | -719 | 232 | -136 | -447 | 541 | 140 |
| 11 | Bournemouth University | -967 | 278 | -295 | -918 | -409 | -536 |
| 12 | The University of Bradford | 1333 | -1670 | 274 | 1325 | -2642 | -70 |
| 13 | The University of Brighton | 871 | 1915 | 1430 | 1067 | 1446 | 1363 |
| 14 | The University of Bristol | 4007 | 2553 | 2824 | 4083 | -3915 | 453 |
| 15 | Brunel University | 1825 | -2542 | 230 | 2136 | -1878 | 725 |
| 16 | Buckinghamshire Chilterns ... | -1072 | -1069 | -878 | -580 | -715 | -421 |
| 17 | The University of Cambridge | 2633 | -2514 | -1379 | -781 | -5737 | -4746 |
| 18 | Institute of Cancer Research | -4207 | 7156 | -27 | -5277 | 7073 | -848 |
| 19 | Canterbury Christ Church... | -888 | 15 | -336 | -925 | -1155 | -812 |
| 20 | University of Central England... | -551 | -428 | -315 | -1118 | 296 | -411 |
| 21 | The University of Central Lancashire | -778 | -497 | -486 | -757 | -408 | -445 |
| 22 | Central School of Speech and Drama | -719 | 232 | -136 | -447 | 541 | 140 |
| 23 | University College Chester | -741 | -455 | -419 | -593 | 156 | -101 |
| 24 | University College Chichester | -637 | 412 | -19 | -511 | 586 | 115 |
| 25 | City University | 1557 | 1095 | 1503 | 729 | 218 | 649 |
| 26 | Coventry University | -704 | -1335 | -761 | -1042 | -1222 | -926 |
| 27 | Courtauld Institute of Art | 448 | 175 | 559 | 567 | 251 | 664 |
| 28 | Cranfield University | -12868 | -6929 | -10946 | -13554 | -7006 | -11414 |
| 29 | Cumbria Institute of the Arts | -719 | 232 | -136 | -447 | 541 | 140 |
| 30 | Dartington College of Arts | -588 | 370 | -2 | -364 | 632 | 227 |
| 31 | De Montfort University | 311 | -2922 | -829 | -631 | -514 | -480 |
| 32 | University of Derby | -769 | -1166 | -715 | -975 | -1599 | -1012 |
| 33 | University of Durham | 4069 | -2999 | 1172 | 4155 | -2891 | 1330 |
| 34 | The University of East Anglia | 975 | -3429 | -831 | 964 | -6178 | -1840 |
| 35 | The University of East London | 38 | 376 | 364 | 51 | -44 | 210 |
| 36 | Edge Hill College of Higher Education | -751 | -538 | -455 | -520 | 129 | -63 |
| 37 | Institute of Education | -176 | 1370 | 474 | -619 | 944 | -10 |
| 38 | The University of Essex | 2472 | -3138 | 371 | 3230 | -3155 | 905 |
| 39 | The University of Exeter | 3436 | -4887 | 269 | 3893 | -1429 | 1922 |
| 40 | Falmouth College of Arts | -607 | 362 | -17 | -427 | 129 | -2 |

Table1. Continued.

| | Institution | Change in QR 2002/03 | | | Change in QR 2003/04 | | |
|----|--|----------------------|-------|-------|----------------------|--------|-------|
| | | grant | PhD | both | grant | PhD | both |
| 41 | University of Gloucestershire | -127 | -138 | 77 | -339 | -316 | -126 |
| 42 | Goldsmiths College | 4761 | 3583 | 4499 | 5170 | 2094 | 4205 |
| 43 | The University of Greenwich | -1701 | -275 | -1036 | -2297 | -2756 | -2345 |
| 44 | Harper Adams University College | -827 | 313 | -177 | -599 | -288 | -273 |
| 45 | University of Hertfordshire | -240 | -2602 | -989 | -717 | -539 | -491 |
| 46 | The University of Huddersfield | -122 | -1327 | -394 | 59 | -1637 | -389 |
| 47 | The University of Hull | 197 | -4900 | -1697 | 157 | -5038 | -1717 |
| 48 | Imperial College of Science... | -7316 | 23808 | 2562 | -7613 | 21813 | 1394 |
| 49 | The University of Keele | 528 | -1052 | 11 | 663 | -1708 | -127 |
| 50 | The University of Kent | 1677 | -3564 | -239 | 901 | -1503 | 86 |
| 51 | Kent Institute of Art and Design | -617 | 346 | -29 | -473 | 546 | 125 |
| 52 | King's College London | -807 | 7142 | 1167 | -3326 | 11225 | 1047 |
| 53 | Kingston University | -288 | 573 | 236 | -567 | -460 | -338 |
| 54 | The University of Lancaster | 4454 | -6236 | 314 | 3678 | -4872 | 415 |
| 55 | Leeds Metropolitan University | -865 | 92 | -308 | -1172 | -102 | -584 |
| 56 | The University of Leeds | 1750 | -4280 | -1351 | 3252 | -5340 | -732 |
| 57 | The University of Leicester | -3039 | -258 | -2268 | -3068 | 5096 | -261 |
| 58 | The University of Lincoln | -736 | 413 | -83 | -672 | 139 | -159 |
| 59 | Liverpool Hope University College | -663 | 321 | -68 | -414 | 184 | 25 |
| 60 | Liverpool John Moores University | -220 | 869 | 355 | -1538 | -9474 | -4399 |
| 61 | The University of Liverpool | -1926 | -868 | -2100 | -2827 | -1701 | -2966 |
| 62 | London Business School | 911 | 3119 | 1921 | 307 | 2322 | 1208 |
| 63 | University of London (Institutes...) | -1462 | -23 | -722 | -1338 | -199 | -726 |
| 64 | London Metropolitan University | -772 | -3097 | -1480 | -1566 | -137 | -854 |
| 65 | London South Bank University | -774 | 1130 | 115 | -712 | -3156 | -1459 |
| 66 | London School of Economics... | 5551 | 2796 | 4508 | 6303 | 2465 | 4885 |
| 67 | London School of Hygiene... | -9404 | 4107 | -4442 | -9668 | 4763 | -4493 |
| 68 | Loughborough University | -650 | -3069 | -1746 | -1137 | -2032 | -1635 |
| 69 | University of Luton | -989 | 137 | -358 | -966 | -189 | -479 |
| 70 | University of Manchester | 7777 | -5927 | 1203 | 8646 | 866 | 4412 |
| 71 | Manchester Metropolitan University | -380 | -1498 | -693 | -1131 | -2677 | -1595 |
| 72 | Middlesex University | 816 | -460 | 533 | -2 | -2343 | -686 |
| 73 | The University of Newcastle-upon-Tyne | 785 | 276 | 61 | 1869 | 1696 | 1281 |
| 74 | Newman College of HE | -719 | 232 | -136 | -447 | 541 | 140 |
| 75 | University College Northampton | -773 | -289 | -382 | -496 | 324 | 20 |
| 76 | Northern School of Contemporary Dance | -719 | 232 | -136 | -447 | 541 | 140 |
| 77 | University of Northumbria at Newcastle | -2444 | 274 | -1283 | -2661 | 29 | -1527 |
| 78 | Norwich School of Art and Design | -715 | 236 | -131 | -458 | 543 | 134 |
| 79 | The Nottingham Trent University | 917 | -1579 | 135 | 582 | -593 | 314 |
| 80 | The University of Nottingham | -1682 | -7114 | -4473 | 2757 | -10668 | -2882 |
| 81 | Open University | -31 | -4124 | -1587 | 1609 | -6064 | -1175 |
| 82 | Oxford Brookes University | -637 | -2117 | -1062 | -879 | -2525 | -1351 |

Table1. Continued.

| | Institution | Change in QR 2002/03 | | | Change in QR 2003/04 | | |
|-----|--|----------------------|-------|-------|----------------------|-------|-------|
| | | grant | PhD | both | grant | PhD | both |
| 83 | The University of Oxford | -1066 | 6014 | -390 | -1814 | 10787 | 867 |
| 84 | The University of Plymouth | -13 | -1664 | -513 | -709 | -3973 | -1807 |
| 85 | The University of Portsmouth | 676 | 266 | 668 | 704 | 330 | 712 |
| 86 | Queen Mary and Westfield College | -2600 | 2707 | -843 | -4089 | 3118 | -1694 |
| 87 | Ravensbourne College of Design... | -719 | 232 | -136 | -447 | 541 | 140 |
| 88 | The University of Reading | 5969 | -1751 | 2871 | 6244 | -3666 | 2402 |
| 89 | Roehampton University | 71 | 859 | 583 | -43 | 398 | 328 |
| 90 | Rose Bruford College | -719 | 232 | -136 | -447 | 541 | 140 |
| 91 | Royal Academy of Music | -400 | 551 | 183 | -201 | 787 | 386 |
| 92 | Royal Agricultural College | -710 | 284 | -112 | -467 | 541 | 128 |
| 93 | Royal College of Art | 834 | 1405 | 1256 | 1306 | 1907 | 1733 |
| 94 | Royal College of Music | -557 | 461 | 50 | -313 | 736 | 295 |
| 95 | The Royal College of Nursing | -1002 | 232 | -319 | -664 | 541 | -2 |
| 96 | Royal Holloway and Bedford New College | 5220 | 2345 | 4205 | 6136 | 4028 | 5437 |
| 97 | Royal Northern College of Music | -552 | 399 | 32 | -307 | 682 | 281 |
| 98 | The Royal Veterinary College | 2 | 1455 | 719 | 523 | 2054 | 1257 |
| 99 | St George's Hospital Medical School | -4281 | 802 | -2347 | -5192 | 1447 | -2721 |
| 100 | College of St Mark and St John | -712 | 259 | -121 | -431 | 558 | 157 |
| 101 | St Martin's College | -674 | -527 | -401 | -444 | 119 | -17 |
| 102 | St Mary's College | -647 | 341 | -51 | -419 | 173 | 18 |
| 103 | The University of Salford | 2494 | 244 | 1756 | 1776 | -521 | 1026 |
| 104 | School of Oriental and African Studies | 2908 | -487 | 1782 | 3195 | -1426 | 1628 |
| 105 | The School of Pharmacy | -308 | 191 | 46 | -59 | 1134 | 545 |
| 106 | Sheffield Hallam University | -1802 | -435 | -1200 | -2192 | -1466 | -1844 |
| 107 | The University of Sheffield | 4002 | -5857 | -471 | 3682 | -2763 | 534 |
| 108 | Southampton Institute | -828 | -960 | -667 | -556 | 111 | -93 |
| 109 | The University of Southampton | 1578 | 607 | 423 | 983 | -5942 | -2426 |
| 110 | Staffordshire University | -1377 | -988 | -1062 | -1703 | -1134 | -1328 |
| 111 | The University of Sunderland | -982 | 1614 | 179 | -1346 | 304 | -557 |
| 112 | Surrey Institute of Art and Design... | -700 | 377 | -73 | -518 | 554 | 98 |
| 113 | The University of Surrey | 4524 | -1903 | 1951 | 3009 | -5471 | -298 |
| 114 | The University of Sussex | 2582 | -3914 | -1 | 4288 | -2303 | 1743 |
| 115 | The University of Teesside | -978 | -184 | -478 | -788 | -126 | -341 |
| 116 | Thames Valley University | -739 | -140 | -293 | -617 | 550 | 32 |
| 117 | Trinity and All Saints College | -682 | 269 | -98 | -414 | 574 | 173 |
| 118 | Trinity College of Music | -771 | 232 | -169 | -459 | 541 | 133 |
| 119 | University College London | 1773 | 20523 | 6983 | 7074 | 19963 | 9990 |
| 120 | The University of Warwick | 7138 | -2577 | 3184 | 4236 | -2087 | 1538 |
| 121 | University of the West of England... | -536 | -1339 | -696 | -1689 | -3022 | -2052 |
| 122 | The University of Westminster | -789 | 1121 | 88 | -1101 | 439 | -377 |
| 123 | Wimbledon School of Art | -3 | 991 | 595 | 95 | 1122 | 696 |
| 124 | University College Winchester | -549 | -350 | -258 | -342 | 236 | 91 |

Table1. Continued.

| | Institution | Change in QR 2002/03 | | | Change in QR 2003/04 | | |
|-----|--|----------------------|-------|-------|----------------------|-------|-------|
| | | grant | PhD | both | grant | PhD | both |
| 125 | The University of Wolverhampton | -916 | -669 | -636 | -1388 | -863 | -1015 |
| 126 | University College Worcester | -1036 | -106 | -474 | -815 | -303 | -419 |
| 127 | Writtle College | -728 | 232 | -141 | -451 | 541 | 138 |
| 128 | York St John College | -733 | -575 | -456 | -467 | 541 | 127 |
| 129 | The University of York | 856 | 2132 | 1113 | 1895 | 397 | 1107 |
| 130 | University of Wales, Aberystwyth | 1406 | 305 | 1057 | 2238 | 1225 | 1958 |
| 131 | University of Wales, Bangor | 2747 | 437 | 1931 | 3210 | 4355 | 3729 |
| 132 | Cardiff University | 9238 | 9215 | 8869 | 8084 | 5994 | 6929 |
| 133 | University of Wales Institute, Cardiff | 123 | 565 | 499 | 374 | 1283 | 920 |
| 134 | University of Glamorgan | 341 | 343 | 520 | 486 | 986 | 851 |
| 135 | The University of Wales, Lampeter | 226 | 484 | 538 | 566 | 377 | 707 |
| 136 | University of Wales College of Medicine | -1109 | 3161 | 540 | -1456 | 5303 | 1083 |
| 137 | The University of Wales, Newport | -295 | 305 | 152 | -115 | 568 | 354 |
| 138 | North-East Wales Institute of Higher Education | -654 | 27 | -179 | -476 | 306 | 27 |
| 139 | Royal Welsh College of Music and Drama | -719 | 232 | -136 | -447 | 541 | 140 |
| 140 | Swansea Institute of Higher Education | -654 | 309 | -66 | -395 | 622 | 202 |
| 141 | University of Wales, Swansea | 2865 | -2203 | 953 | 3030 | -762 | 1655 |
| 142 | Trinity College, Carmarthen | -702 | 249 | -118 | -429 | 559 | 158 |
| 143 | University of Wales Centre for Adv. Welsh... | -591 | 460 | 28 | -330 | 774 | 297 |
| 144 | The University of Aberdeen | -5789 | -3871 | -5349 | -6038 | -3268 | -5270 |
| 145 | University of AbertayDundee | -1149 | -216 | -600 | -623 | 142 | -140 |
| 146 | Bell College | -715 | 252 | -126 | -450 | 561 | 145 |
| 147 | The University of Dundee | -5597 | 3434 | -2476 | -6226 | 3149 | -3042 |
| 148 | Edinburgh College of Art | 165 | 731 | 600 | 397 | 609 | 689 |
| 149 | The University of Edinburgh | -1980 | 235 | -2259 | -5270 | 2417 | -3524 |
| 150 | Glasgow Caledonian University | 0 | -660 | -81 | 402 | 10 | 432 |
| 151 | Glasgow School of Art | 397 | 1533 | 1045 | 566 | 1453 | 1105 |
| 152 | The University of Glasgow | -5655 | 2241 | -3515 | -3959 | 524 | -3048 |
| 153 | Heriot-Watt University | 604 | 808 | 698 | 581 | 2667 | 1384 |
| 154 | Napier University | -212 | -431 | -110 | -48 | -167 | 90 |
| 155 | The University of Paisley | -697 | 75 | -205 | -382 | -70 | -69 |
| 156 | Queen Margaret Univ College, Edinburgh | -795 | 472 | -115 | -583 | 390 | -28 |
| 157 | The Robert Gordon University | -349 | -151 | -86 | -316 | 190 | 50 |
| 158 | Royal Scottish Academy of Music and Drama | -748 | 252 | -147 | -467 | 574 | 139 |
| 159 | The University of St Andrews | 1717 | 1658 | 1648 | 1198 | -1293 | 203 |
| 160 | The University of Stirling | 2761 | 2120 | 2630 | 3383 | 1487 | 2798 |
| 161 | The University of Strathclyde | 3662 | -738 | 1857 | 3308 | -932 | 1601 |
| 162 | UHI Millennium Institute | -3383 | 678 | -1708 | -3618 | 1093 | -1745 |
| 163 | The Queen's University of Belfast | 2894 | -3934 | 53 | 1822 | -2719 | -111 |
| 164 | St Mary's University College | -758 | 232 | -161 | -462 | 541 | 130 |
| 165 | Stranmillis University College | -756 | 232 | -160 | -724 | 541 | -41 |
| 166 | University of Ulster | 5264 | -223 | 3205 | 2267 | 167 | 1462 |