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ORIGINAL ARTICLE

United Kingdom's contribution to European research output in biomedical sciences: 2008–2017

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Abstract

Background: On 31 January 2020, the United Kingdom (UK) formally left the European Union (EU). Only a short transition period, until 31 December 2020, is available to negotiate collaborations for research in biomedical sciences and health care. Within the European scientific community, two opinions are common: 1) Brexit is an opportunity to obtain more funding at the expense of the departing British; and 2) UK colleagues should continue to collaborate in EU scientific efforts, including Horizon Europe and Erasmus+. To provide evidence for more informed negotiations, we sought to determine the contribution of the UK to EU's research in biomedical sciences.

Methods: We performed a macro level scientometric analysis to estimate the contribution of the UK and EU member states, including those associated with EU-funding (EU+) namely Albania, Armenia, Bosnia-Herzegovina, Faroe Islands, Georgia, Iceland, Israel, Macedonia, Moldova, Montenegro, Norway, Serbia, Switzerland, Tunisia, Turkey, and Ukraine, to preclinical, clinical and health sciences. We searched the Web of Science database to count the total number of scientific publications and the top 1% most cited publications in the world between 2008 and 2017, calculated the performance efficiency by dividing the top 1% by the total number, and calculated the odds ratios to create a ranking of performance efficiency. We then compared the contribution of the UK to all the EU+ -based publications and the top 1% to the contributions of the ten EU member states with the largest biomedical research output and also compared the respective contributions to EU+ publications that resulted from collaborations with other regions in the world.

Results: We found 2,991,016 biomedical publications from EU+ during 2008–2017, of which 19,019 (0.64%) were in the world's top 1% of the most cited publications. The UK produced 665,467 (22.3%) of these publications and had over two and a half times more top 1% most cited publications than the EU+ (odds ratio 2.79, 95% CI 2.71–2.88, $p< 0.001$). The UK's share in the EU+ co-publications with regions outside Europe ranged between 23.0% for the Arab League and 50.6% for Australia and New Zealand and its share of the top 1% ranged between 48.6% for the USA and Canada and 70.7% for the African Union.

Conclusions: The UK contributed far more highly cited publications than the rest of the EU+ states and strongly contributed to European collaborations with the rest of the world during 2008–2017. This suggests that if the UK ceases to participate in EU scientific collaborations as a result of Brexit, the quantity and quality of EU's research in biomedical sciences will be adversely affected.

Keywords: Biomedical research in EU, Brexit, research collaborations, quantifying research contributions

Introduction

On 31 January 2020, the United Kingdom (UK) left the European Union (EU). However, a transition phase will last until 31 December 2020 during which the future relationship between the UK and the EU will be negotiated. The borders of Northern Ireland and trading relationships are the main topics of the ongoing negotiations; the future of collaborations in biomedical sciences and health care has received little attention. UK Prime Minister Johnson promised a substantial investment (over £18 billion, or approximately €22.6 billion within 5 years) in health and life sciences and, if the assumptions about a boosted post-Brexit economy quickly become a reality, even more.[1] The UK government appears to have allocated £800 million (about €920 million) to a future new research agency, but the size of the investments in biomedical research is not known.[2]

The implications of the UK leaving the EU will be significant for both parties in many ways, including scientific research and collaboration. The UK has been the most successful country in obtaining Horizon 2020 grants, receiving €1.3 billion (about £1.1 billion) annually on average,[2] and one in five European Research Council winners is working in the UK.[4,5] For the call for proposals on Health, demographic change, and well-being under the Horizon 2020 theme Societal Challenges, this translates to 15% of the theme's budget for UK institutions.[6] Closing access to EU funding might result in potentially inadequate funding of UK research. An example in which a number of these things converge is the withdrawal of UK colleagues from European Reference Networks (ERNs). The 24 thematic ERNs are the infrastructure for pan-European collaboration on about 6000 complex or rare diseases severely affecting 30 million people in the EU. The networks connect centres of expertise in specific diseases, health care providers, patients, and laboratories in EU member states to share knowledge and infrastructure and to improve the care and access to care for these patients. The UK's contribution to this infrastructure is substantial: in the UK, 35 hospitals and 129 health care providers are responsible for approximately

23% of the total patients in the 24 ERNs. However, after the coordinators' meeting on 25 June 2018, all six coordinatorships of the ERNs by UK colleagues were transferred to their partners on the Continent, although UK health care providers continue to be involved in 23 of the 24 networks.[7] Continuation of the participation depends on the outcome of Brexit negotiations during the transition period: UK participation might end after a hard or otherwise poorly negotiated Brexit.[8] Support from the Continent to keep UK colleagues in the ERNs is mixed, because some groups may see Brexit as an opportunity for increased funding for groups from countries remaining in the EU.

Taken together, Brexit looks like a political accident that will mainly affect the UK, but it will also have implications for European research. However, the extent of contribution to EU research by UK colleagues is unknown. We therefore sought to determine the contribution of UK scientists to EU research in quantitative terms to support the negotiations during the transition period with hard evidence.

Methods

Database

We extracted data from the Web of Science the same way as described by Asubiaro and Badmus[9] for African countries for a single research area; however, our work encompassed not one research area but several, namely preclinical, clinical, and health sciences within the larger domain of biomedical sciences, and we looked for the total number of publications and the world's top 1% most cited publications each year for the decade 2008–2017.

The details of how we searched the Web of Science are given in online Supplement 1.

Indicators

We calculated the indicators for EU member states including those associated with EU funding (EU+), because many important publications during the decade under study were based on FP6, FP7, and Horizon2020 funding, with and without the UK and for the UK separately. Specifically, we counted the total number of publications, the top 1% of the most cited publications, and the number of publications resulting from collaboration with other regions of the world. We calculated the performance efficiency by dividing the top 1% by the total number of publications. Next, we calculated odds ratios and confidence intervals (and *p* values) to create top-ten rankings: position of the country in total output, in the top 1% most cited publications, position in terms of collaboration with other regions of the world, and position in terms of publications based on EU-funded research. In each ranking, separate columns were assigned to the contributions of the UK (Tables 1 to 3). The share of a country in the publications from EU+ as a whole was calculated as a percentage (both total or top 1% most cited publications of the country divided by the total or top 1% most cited publications of the EU+ without this specific country, multiplied by 100).

Analysis for Tables 1 and 2 was performed on 4 February 2020; analysis for supplemental Table 1 was performed on 11 February 2020.

Results

From 1 January 2008 to 31 December 2017, we found 2,991,016 biomedical publications of institutes in the UK and EU+ in the Web of Science, of which 19,019 belonged to the world's top 1% most cited publications (in the field of research in the year of publication). This corresponds to a performance efficiency of 0.6%.

Table 1. UK and top ten EU countries ranked by number of publications and share in top 1% most cited publications in preclinical, clinical, and health sciences: 2008–2017.

	Publications				Publications with other EU+ countries		EU+ share of total country output		Country's share of total EU+ output		Publications with UK		UK share of total output	
Country	Total	Top 1% most cited	OR[a]	(95% CI)	Total	Top 1% most cited	Total	Top 1% most cited	Total	Top 1% most cited	Total	Top 1% most cited	Total	Top 1% most cited
EU+	2,991,016	19019	reference											
UK	665,467	8412	2.79	(2.71–2.88)	184,633	5097	27.7%	60.6%	22.2%	44.2%				
GERMANY	503,532	5195	1.87	(1.81–1.93)	154,429	3828	30.7%	73.7%	16.8%	27.3%	48,372	2234	9.6%	43.0%
ITALY	377,622	3812	1.74	(1.68–1.81)	103,889	3010	27.5%	79.0%	12.6%	20.0%	38,826	1869	10.3%	49.0%
FRANCE	315,874	3971	2.25	(2.17–2.33)	95,550	3037	30.2%	76.5%	10.6%	20.9%	34,700	1904	11.0%	47.9%
SPAIN	252,692	2656	1.77	(1.70–1.84)	65,125	2137	25.8%	80.5%	8.4%	14.0%	25,710	1360	10.2%	51.2%
NETHERLANDS	238,402	3708	2.82	(2.72–2.93)	91,709	2772	38.5%	74.8%	8.0%	19.5%	36,232	1799	15.2%	48.5%
SWEDEN	128,007	1913	2.52	(2.41–2.65)	56,479	1592	44.1%	83.2%	4.3%	10.1%	20,372	1054	15.9%	55.1%
BELGIUM	115,152	2049	3.05	(2.91–3.20)	56,912	1738	49.4%	84.8%	3.8%	10.8%	18,724	1066	16.3%	52.0%
DENMARK	92,074	1580	2.88	(2.74–3.04)	38,596	1236	41.9%	78.2%	3.1%	8.3%	15,011	842	16.3%	53.3%
POLAND	80,709	838	1.67	(1.56–1.79)	20,579	766	25.5%	91.4%	2.7%	4.4%	7559	496	9.4%	59.2%
AUSTRIA	80,458	1131	2.31	(2.17–2.45)	38,544	991	47.9%	87.6%	2.7%	5.9%	9473	587	11.8%	51.9%

[a]Odds ratio of the top 1% most cited publications of a country relative to those of EU+ (reference); $p < .0001$.
Source Web of Science; data retrieved on 4 February 2020

The UK institutions contributed the most, with 665,467 publications, of which 8412 were in the top 1% most cited publications. The UK occupied the 4th position within the EU, with more than two and a half times the publications from EU+ (odds ratio 2.79, 95% confidence interval (CI) 2.71–2.88, p <0.0001; Table 1). Overall, the EU+ without the UK contributed 10,607 of the top 1% most cited publications, with a performance efficiency of 0.5%. The share of the UK in the output from EU+ countries was 22.2% and that in the top 1% of the most cited publications was 44.2% (Table 1).

The UK also led in collaborating with other more productive EU member states: 9.4%–16.3% of all publications from the ten most productive members were from research based on collaboration with the UK, and 43.0%–59.2% of the top publications from the individual countries were in collaboration with scientists affiliated to British institutions (Table 1). These ten countries and the UK together contributed 79.7% of the biomedical scientific publications from EU+.

Germany, second only to the UK in the total number of publications, contributed 16.8% of the total publications and 27.3% of the top 1% most cited publications, and was followed, in that order, by Italy and France, accounting for, respectively 12.6% and 10.6% of the total publications and 20.0% and 20.9% of the top 1% most cited publications.

Publications from Belgium, Denmark, and the Netherlands featured significantly more often than those from the UK in the top 1% most cited publications (relative to the EU+, the odds ratio was 3.07 for Belgium (95% CI 2.93–3.22), 2.90 for Denmark (95% CI 2.76–3.06); and 2.84 for the Netherlands (95% CI 2.74–2.94). The p value in each case was <0.001 (including those directly comparing the four highest-ranked EU member states).

Since the EU+ region collaborates actively with other regions in the world, we investigated the contribution of the UK and EU+ to the total and top 1% most cited publications resulting from collaborations with institutions outside Europe (Table 2). The UK's share in the total EU+ co-publications with regions outside Europe ranged from 23.0% with the Arab League to 50.6% with Australia-New Zealand and that in the top 1% from 48.6% with USA-Canada to 70.7% with the African Union (Table 2).

The above pattern remained more or less unchanged in the analyses restricted to publications arising from EU-funded research. The UK's share was exceptionally high, being 25.1% in the total output and 44.2% in the top 1% and ranged from 31.5% to 55.3% in total publications and from 53.4%–76.2% in the top 1% in terms of output from collaborative research (Table 3).

Discussion

Biomedical research institutions from the UK were key contributors to the EU+ research output, the UK being among the top four countries collaboration with which increases the chances of research papers from such collaborations being highly cited. The UK plays a substantial part in EU+ research collaborations and is less of an island than its geography may suggest when it comes to collaborating with the Continent and other regions of the world.

The UK's share in EU collaborations with other regions in the world (Table 2) is even larger than its share in EU publications as a whole. These collaborations with other regions in the world reflect the extensive international network of UK universities. The UK government's Science and Innovation Network is based in 31 countries, supporting international collaboration of UK companies and researchers. We believe the possibility to use funding from the UK's research councils—Research Councils UK (RCUK) is the strategic partnership of the UK's seven research councils—for overseas collaborations, especially when setting them up, is a significant advantage, even when the budget is restricted to the UK partner, because the funding sources (EC-funded or national) available to universities from the Continent are too limited to set up such collaborations.

Although the presence of co-authors affiliated to UK institutes does not mean that the research would not have been realised without the UK contribution nor that the quality would have been lower, our results emphasize a fair role for the UK and indicate that science on the Continent might, at least temporarily, suffer from reduced access to high-quality

Table 2. Publications from EU+ and UK in collaboration with other regions of the world in preclinical, clinical, and health sciences 2008–2017

Publications:	EU+		EU+ without UK		UK		UK versus EU+ without UK		UK share	
Region	Total	Top 1% most cited	Total	Top 1% most cited	Total	Top 1% most cited	OR[a]	95% Confidence Interval	Total	Top 1% most cited
Total	2,991,016	19,019	2,325,549	10,607	665,467	8412	2.79	2.71–2.88	22.2%	44.2%
USA-CAN	391,310	9143	277,391	4701	113,919	4442	2.35	2.26–2.46	29.1%	48.6%
AUS-NZL	74,966	2556	37,037	829	37,929	1727	2.08	1.92–2.27	50.6%	67.6%
UNASUR[b]	43,457	1128	31,884	445	11,573	683	4.43	3.92–5.00	26.6%	60.5%
AFRICAN UNION	57,773	752	39,377	220	18,396	532	5.03	4.53–6.21	31.8%	70.7%
ASEAN[c]	22,192	599	12,214	219	9978	380	2.17	1.83–2.57	45.0%	63.4%
FAR EAST	66,617	1843	43,101	775	23,516	1068	2.60	2.37–2.85	35.3%	57.9%
SAARC[d]	18,980	523	10,156	168	8824	355	2.49	2.07–3.00	46.5%	67.9%
ARAB LEAGUE	33,988	389	26,172	141	7816	248	6.05	4.91–7.45	23.0%	63.8%

[a]Odds ratio of the top 1% most cited publications of the UK relative to the EU+; p <0.0001. [b]Union of South American Nations [c]Association of South East Asian Nations [d]South Asian Association for Regional Cooperation

Source Web of Science; data retrieved on 4 February 2020

Table 3. Publications from EU+ and UK based on EU-funded research and in collaboration with other regions of the world in preclinical, clinical, and health sciences: 2008–2017.

Publications of:	EU+		EU+ without UK		UK		UK versus EU+ without UK		UK share	
Region	Total	Top 1% most cited	Total	Top 1% most cited	Total	Top 1% most cited	OR[a]	95% Confidence Interval	Total	Top 1% most cited
Total	75,436	1863	55,997	1038	19,428	824	2.35	2.14–2.57	25.8%	44.2%
USA-CAN	13,363	747	8568	348	4794	399	2.14	1.85–2.49	35.9%	53.4%
AUS-NZL	2694	189	1203	47	1491	142	2.59	1.84–3.63	55.3%	75.1%
UNASUR[b]	1972	96	1351	34	621	62	4.30	2.80–6.60	31.5%	64.6%
AFRICAN UNION	2332	84	1215	20	1117	64	3.63	2.18–6.04	47.9%	76.2%
ASEAN[c]	992	42	456	10	536	32	2.83	1.38–5.83*	54.0%	76.2%
FAR EAST	2531	152	1570	49	961	103	3.73	2.63–5.29	38.0%	67.8%
SAARC[d]	665	52	379	15	286	37	3.61	1.94–6.71	43.0%	71.2%
ARAB LEAGUE	905	52	545	14	360	38	4.48	2.39–8.39	39.8%	73.1%

*p = .005; all other ORs, p <.0001
[a]odds ratio of the top 1% most cited publications of the UK relative to the EU+
[b]Union of South American Nations [c]Association of South East Asian Nations [d]South Asian Association for Regional Cooperation
Source Web of Science; data retrieved on 11 February 2020

collaboration involving the UK and countries outside the EU+ after 31 December 2020.

After the Brexit transition period, European science without UK participation might result in top continental scientists receiving more EU funding. However, a more probable outcome is that the money will go to those who failed to obtain funding before Brexit, which may lower the quality of EU-funded research. It is difficult to predict what will happen after the transition period. The UK might experience difficulties in retaining top scientists, especially those not from the UK, and the EU might, for instance, open its research programmes to participation from non-EU countries.

Recently, higher education and research organisations from the UK and the EU have asked their national governments and the European Commission to agree on continued collaboration by keeping the UK associated with Horizon Europe and Erasmus+.[10] The biomedical sciences account for roughly half of all science, and this study provides concrete evidence that collaboration between the UK and EU+ in the biomedical disciplines is essential.

We argue that Brexit should not be a reason for excluding UK researchers from such European consortia as the ERNs. Most of the UK scientists voted against Brexit[11] and protested against it in March 2019.[12] Moreover, our results suggest that science on the continent of Europe is stronger for the participation by UK researchers. From a clinical viewpoint, continued collaboration as before will ensure early access to innovations for patients throughout Europe and the UK. If we cannot keep biomedical research out of the political consequences of Brexit, the weakest people, those with diseases that offer limited options for treatment, will suffer the most, probably on both sides of the new border.

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Author contributions

EJGS initiated the study with initial data and performed the final statistics; TLRT analysed the Web of Science data summarised in the tables; both together discussed the data and wrote the manuscript.

Supplement 1: Web of Science search queries

We used the following Web of Science search queries:
WC = (allergy or andrology or anesthesiology or cardiac & cardiovascular systems or dentistry, oral surgery & medicine or dermatology or emergency medicine or endocrinology & metabolism or gastroenterology & hepatology or geriatrics & gerontology or health care sciences services or hematology or infectious diseases or medicine, legal or medical ethics or medical informatics or medical laboratory technology or medicine, general internal or neurosciences or clinical neurology or nursing or nutrition & dietetics or obstetrics & gynaecology or oncology or ophthalmology or orthopedics or otorhinolaryngology or pathology or pediatrics or peripheral vascular disease or pharmacology & pharmacy or psychiatry or public, environmental & occupational health or radiology, nuclear medicine & medical imaging or rehabilitation or respiratory systems or rheumatology or sport sciences or surgery or toxicology or transplantation or tropical medicine or urology & nephrology) which are the same topics as described in the *Times Higher Education* (THE) 2016 ranking for preclinical, clinical and health sciences [https://www.timeshighereducation.com/world-university-rankings/2016/subject-ranking/clinical-pre-clinical-health-0#!/page/0/length/25/sort_by/rank/sort_order/asc/cols/stats] replacing THE's "Clinical, pre-clinical and health – other topics" by the topics andrology, emergency medicine and peripheral vascular disease.

We used PY = (2008–2017) for the period analysed and for countries we used the following codes:

a) CU = (Austria OR Belgium OR Bulgaria OR Croatia OR Cyprus OR Czech Republic OR Denmark OR Estonia OR Finland OR France OR Germany OR Greece OR Hungary OR Ireland OR Italy OR Latvia OR Lithuania OR Luxembourg OR Malta OR Netherlands OR Poland OR Portugal OR Romania OR Slovakia OR Slovenia OR Spain OR Sweden OR UK OR United Kingdom OR England or Scotland or Wales or North Ireland OR Albania OR Armenia OR Bosnia Herzeg OR Faroe Islands OR Georgia OR Iceland OR Israel OR Macedonia OR Moldova OR Montenegro OR Norway OR Serbia OR Switzerland OR Tunisia OR Turkey OR Ukraine OR Yugoslavia)

b) CU = (England or Scotland or Wales or Northern Ireland or UK or United Kingdom)

c) CU = (Austria OR Belgium OR Bulgaria OR Croatia OR Cyprus OR Czech Republic OR Denmark OR Estonia OR Finland OR France OR Germany OR Greece OR Hungary OR Ireland OR Italy OR Latvia OR Lithuania OR Luxembourg OR Malta OR Netherlands OR Poland OR Portugal OR Romania OR Slovakia OR Slovenia OR Spain OR Sweden OR Albania OR Armenia OR Bosnia Herzeg OR Faroe Islands OR Georgia OR Iceland OR Israel OR Macedonia OR Moldova OR Montenegro OR Norway OR Serbia OR Switzerland OR Tunisia OR Turkey OR Ukraine OR Yugoslavia)

d) CU = (Germany); d1) CU = (as listed under a without "OR Germany")

e) CU = (Italy); e1) CU = (as listed under a without "OR Italy")

f) CU = (France); f1) CU = (as listed under a without "OR France")

g) CU = (Spain); g1) CU = (as listed under a without "OR Spain")

h) CU = (Netherlands); h1) CU = (as listed under a without "OR Netherlands")

i) CU = (Sweden); i1) CU = (as listed under a without "OR Sweden")

j) CU = (Belgium); j1) CU = (as listed under a without "OR Belgium")

k) CU = (Denmark); k1) CU = (as listed under a without "OR Denmark")

l) CU = (Poland); l1) CU = (as listed under a without "OR Poland")

m) CU = (Austria); m1) CU = (as listed under a without "OR Austria")

For the African Union we used CU = (South Africa OR Egypt OR Nigeria OR Tunisia OR Morocco OR Kenya OR Uganda OR Tanzania OR Ghana OR Ethiopia OR Algeria OR Cameroon OR Malawi OR Senegal OR Zambia OR Burkina Faso OR Sudan OR Zimbabwe OR Mali OR Cote Ivoire OR Mozambique OR Benin OR Botswana OR Rwanda OR Congo OR Zaire OR Libya OR Gabon OR Madagascar OR Martinique OR Niger OR Togo OR Guinea Bissau OR Angola OR Mauritius OR Namibia OR Cent Afr Republ OR Swaziland OR Seychelles OR Lesotho OR Eritrea OR Chad OR Burundi OR Mauritania OR Djibouti OR Dem Rep Congo OR Somalia OR Equat Guinea OR Rep Congo)

For the Arab League we used CU = (Algeria OR Bahrain OR Comoros OR Djibouti OR Egypt OR Iraq OR Jordan OR Kuwait OR Lebanon OR Libya OR Mauritania OR Morocco OR Oman OR Palestine OR Qatar OR Saudi Arabia OR Somalia OR Sudan OR Syria OR Tunisia OR United Arab Emirates OR Yemen)

For the ASEAN we used CU = (Singapore OR Thailand OR Malaysia OR Indonesia OR Philippines OR Vietnam OR Cambodia OR Laos OR Brunei OR Myanmar), for the Far East we used CU = (Japan OR Peoples R China OR South Korea OR Taiwan OR North Korea OR Mongolia)

For SAARC we used CU = (Afganistan OR Bangladesh OR Bhutan OR India OR Maldives OR Nepal OR Pakistan OR Sri Lanka)

And for UNASUR we used CU = (Brazil OR Argentina OR Chile OR Colombia OR Peru OR Venezuela OR Uruguay OR Ecuador OR Bolivia OR Paraguay).

For funding agency, we used:

n) FO = (European Union or European Commission or EU or EC or European Community or European Community's seventh framework programme)

As search strings we used for data shown in Table 1:

For the row named "EU+" we used WC = (as indicated above) AND PY = (2008–2017) AND CU = (a), for the row named "UK" we used WC = (as indicated above) AND PY = (2008–2017) AND CU = (b) and we used WC = (as indicated above) AND PY = (2008–2017) AND CU=(b) AND CU = (c), and for the rows named after country d to m we used WC = (as indicated above) AND PY = (2008–2017) AND CU = (d or e or f or … m) or we used WC = (as indicated above) AND PY = (2008–2017) AND CU = (d or e or f or … m) AND CU = (d1 or e1 or f1 or … m1) or we used WC = (as indicated above) AND PY = (2008–2017) AND CU = (d or e or f or … m) AND CU = (b).

As search strings we used for data shown in Table 2:

Columns 2–3:WC = (as indicated above) AND PY = (2008–2017) AND CU = (a) AND CU = (world region as indicated above) for columns 4–5 we used WC = (as indicated above) AND PY = (2008–2017) AND CU = (c) NOT CU = (b) AND CU = (world region as indicated above) and for columns 6–7 we used WC = (as indicated above) AND PY = (2008–2017) AND CU = (b) AND CU = (world region as indicated above).

As search strings for data shown in supplemental Table 1 we used:

Columns 2–3 WC = (as indicated above) AND PY = (2008–2017) AND CU = (a) AND FO = (n) or WC = (as indicated above) AND PY = (2008–2017) AND CU = (a) AND FO = (n) AND CU = (world region as indicated above), for columns 4–5 we used WC = (as indicated above) AND PY = (2008–2017) AND CU = (c) NOT CU = (b) AND FO = (n) or WC = (as indicated above) AND PY = (2008–2017) AND CU = (c) NOT CU = (b) AND FO = (n) AND CU = (world region as indicated above), for columns 6–7 we used WC = (as indicated above) AND PY = (2008–2017) AND CU = (b) AND FO = (n) or WC = (as indicated above) AND PY = (2008–2017) AND CU = (b) AND FO = (n) AND CU = (world region as indicated above).