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“SUB-FIELD NORMALIZATION IN THE MULTIPLICATIVE CASE: AVERAGE-BASED CITATION INDICATORS”

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Abstract

This paper investigates the citation impact of three large geographical areas –the U.S., the European Union (EU), and the rest of the world (RW)– at different aggregation levels. The difficulty is that 42% of the 3.6 million articles in our Thomson Scientific dataset are assigned to several sub-fields among a set of 219 Web of Science categories. We follow a multiplicative approach in which every article is wholly counted as many times as it appears at each aggregation level. We compute the crown indicator and the Mean Normalized Citation Score (*MNCS*) using for the first time sub-field normalization procedures for the multiplicative case. We also compute a third indicator that does not correct for differences in citation practices across sub-fields. It is found that: (1) No geographical area is systematically favored (or penalized) by any of the two normalized indicators. (2) According to the *MNCS*, only in six out of 80 disciplines –but in none of 20 fields– is the EU ahead of the U.S. In contrast, the normalized U.S./EU gap is greater than 20% in 44 disciplines, 13 fields, and for all sciences as a whole. The dominance of the EU over the RW is even greater. (3) The U.S. appears to devote relatively more –and the RW less– publication effort to sub-fields with a high mean citation rate, which explains why the U.S./EU and EU/RW gaps for all sciences as a whole increase by 4.5 and 5.6 percentage points in the un-normalized case. The results with a fractional approach are very similar indeed.

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I. INTRODUCTION

This paper is a contribution to the vast literature on the evaluation of the citation performance of research units at different aggregate levels. Of course, any exercise of this type must confront a number of methodological decisions that are often controversial. In order to analyze the consequences of some of them, we shall take many others as *a priori* given to us. For example, we assume that we are given a hierarchical Map of Science that distinguishes between several aggregation levels, say between scientific sub-fields, disciplines, and fields from the lowest to the highest aggregation level. Each category at any aggregate level is assumed to belong to only one item at the next level, so that each sub-field belongs to a single discipline, and each discipline to a single field. All fields together constitute the all-sciences aggregate level.

In the second place, among the many possible indicators for the evaluation of the citation performance of research unit, we use average-based indicators. It is generally accepted that for evaluations at the level of broad, aggregate scientific categories it is crucial that one carefully controls for wide differences in citation practices at the lowest level of aggregation. As is well known, for average-based indicators there are two main mechanisms in contention: the *crown indicator*, previously recommended by the Center for Science and Technological Studies (CWTS) at Leiden University (De Bruin *et al.*, 1993, and Moed *et al.*, 1995), and an alternative mechanism sometimes referred to as the *item-oriented field-normalized citation score average* (Lunberg, 2007), or as the *mean normalized citation score*.

It might be argued that the debate between the crown indicator and the MNCS has been solved in favor of the second. After all, as indicated in Waltman *et al.* (2011) the CWTS is currently moving towards a new crown indicator that relies on the second mechanism (for a clear rendition of the issues, as well as for relevant references and a evaluation of the debate involving the two mechanisms, see Larivière and Gingras, 2011). Nevertheless, we believe that it is still of interest to empirically compare the performance of the two indicators in other scenarios. In particular, this paper compares average-based indicators in a new dimension, namely, the

evaluation of a geographical area's performance across sub-fields, disciplines, and fields.¹ On the other hand, we use as a convenient reference a third average-based indicator that, contrary to the previous ones, does not correct for differences in mean citation rates (MCRs hereafter) across sub-fields. In this way, we can evaluate the consequences of completely ignoring sub-field normalization.

The main difficulty we confront in this paper is that individual publications in the periodical literature are often assigned to sub-fields via the journal in which they have been published. Many journals are assigned to a single sub-field, but many others are assigned to two, three, or more sub-fields. This is an important problem. For example, in the dataset used in this paper, where sub-fields are identified with the 219 Web of Science (WoS hereafter) categories distinguished by Thomson Scientific, 42% of the 3.6 million articles published in 1998-2002 are assigned to two or more, up to a maximum of six sub-fields.

There are two ways to deal with this situation. The first follows a *fractional* strategy, according to which each publication is fractioned into as many equal pieces as necessary, with each piece assigned to a corresponding sub-field. The second procedure follows a *multiplicative* strategy according to which each paper is wholly counted as many times as necessary in the several sub-fields to which it is assigned; in this way, the space of articles is expanded as much as necessary beyond the initial size. When publications are assigned to several sub-fields, the usual way to compile the crown indicator and the mean normalized citation score (*MNCS* hereafter) follows a fractional strategy (see *inter alia* Waltman *et al.*, 2011a).² In this paper, we apply for the first time the ideas of Herranz and Ruiz-Castillo (2011a) about sub-field normalization in the multiplicative case to the evaluation of research units using the crown and the *MNCS* indicators.

From the empirical point of view, this paper complements previous contributions that study aggregation and normalization issues with average-based citation indicators for different types of

¹ In the words of Larivière and Gingras (2011, p. 393), “*Only scarce empirical evidence has been provided so far on the differences between the results obtained by these two averaging methods and protagonists agree that more empirical analysis would be welcome to clarify and finally settle the situation.*”

² Larivière and Gingras (2011) use a journal classification that assigns each journal to a single sub-field, avoiding the need for a multiplicative (or a fractional) strategy.

research units (see Van Raan *et al.*, 2010, Opthof and Leydesdorff, 2010, Waltman *et al.*, 2011b, and Larivière and Gingras, 2011). In our case, we partition the world into three large geographical areas: the U.S., the EU, namely, the 15 countries forming the European Union before the 2004 accession, and any other country of the rest of the world (RW hereafter). On the other hand, between the 219 sub-fields and the all-sciences case we distinguish between 80 disciplines, and 20 fields. These choices deserve four comments.

Firstly, so far we have implicitly assumed that each paper has been written by one or more authors belonging to the same research unit. However, in an international context we must confront the problem raised by cooperation between research units. Formally, this problem is identical to the one generated when a journal is assigned to several sub-fields: what should be done with papers written by authors belonging to two or more research units? Although this old issue admits different solutions (see *inter alia* Anderson *et al.*, 1988, and Aksnes *et al.*, 2012 for a discussion), in this paper we side with many other authors in following a multiplicative strategy at all aggregation levels that is analogous to the one already described for the treatment of multiple assignment publications at the sub-field level (see the influential contributions by May, 1997, and King, 2004, as well as the references in Section II in Albarrán *et al.*, 2010). Aksnes *et al.* (2012), however, have recently provided strong arguments in favor of using fractionalised rather than whole counts.

Secondly, the papers already mentioned usually compare the crown indicator and the *MNCS* for the evaluation of different types of research units: individual researchers, research groups, universities, countries, or journals. The analogous task in this paper is the evaluation of three large geographical areas at several aggregate levels. In particular, the comparison of the relative performance of the U.S. and the EU is an important empirical issue in view of the so-called “European Paradox”, popularized in the *First European Report on Science and Technology Indicators* (EC, 1994), according to which Europe plays a leading world role in terms of scientific excellence but lacks the entrepreneurial capacity of the U.S. to transform it into innovation, growth, and jobs. This paradox is based exclusively on a mere counting of the number of publications. As

soon as one takes into account the citation impact that these publications achieve, Albarrán *et al.* (2010, 2011a, 2011b) *inter alia* provide ample evidence against this view, and in favor of a dramatic dominance of the U.S. over the EU (and the RW). However, these papers work at the level of 22 broad, heterogeneous fields also distinguished by Thomson Scientific. Instead, Herranz and Ruiz-Castillo (2011b) study this issue for the 219 sub-fields identified with the WoS categories using different types of indicators. The present paper studies this important issue at different aggregate levels using average-based indicators.

Thirdly, previous results indicate that the similarity of the citation characteristics of articles published in journals assigned to one or several sub-fields guarantees that choosing the fractional or the multiplicative strategies may not lead to a radically different picture in practical applications. However, these results refer to citation distributions for entire scientific fields (Herranz and Ruiz-Castillo, 2011a), and citation distributions for the U.S., the EU, and the RW but only at the sub-field level (Herranz and Ruiz-Castillo, 2011b), or their evaluation using high- and low-impact indicators (Herranz and Ruiz-Castillo, 2011c). Therefore, the comparison of the two strategies for the evaluation of research units at different aggregate levels using average-based indicators is still an open question. The paper will first focus on the multiplicative case. Afterwards, we study the robustness of the results to those obtained under the alternative approach.

The rest of the paper is organized into four Sections and a statistical Appendix. Section II presents the original dataset, the aggregation scheme, and some descriptive statistics for citation distributions at all aggregate levels according to the multiplicative strategy. Section III introduces the three average-based indicators. Section IV includes the empirical results at the discipline, the field, and the all-sciences levels. Descriptive statistics and other individual information are relegated to the Appendix. Section V offers some concluding comments, discusses the robustness of the results using the multiplicative approach, and includes some suggestions for extensions.

II. DATA, DESCRIPTIVE STATISTICS, AND AVERAGE-BASED INDICATORS

II.1. The Original Dataset and the Geographical Extended Count

Since we wish to address a homogeneous population, in this paper only research articles or, simply, articles are studied. We begin with a large sample acquired from Thomson Scientific, consisting of more than 3,6 million articles published in 1998-2002, as well as more than 28 million citations these fields receive using a five-year citation window for each one. Thus, the original dataset is a citation distribution $\mathbf{c} = \{c_l\}$ consisting of N distinct articles, indexed by $l = 1, \dots, N$, where c_l is the number of citations received by article l .

In this paper, the world is partitioned into three geographical areas, indexed by $k = \text{U.S.}, \text{EU}, \text{RW}$. Articles are assigned to geographical areas according to the institutional affiliation of their authors on the basis of what had been indicated in the by-line of the publications. In every internationally co-authored article a whole count is credited to each contributing area. For every article l , let g^l be the number of geographical areas with authors in the by-line of the publication. Only domestic articles, or articles exclusively authored by one or more scientists affiliated to research centers either in the U.S., the EU or the RW alone, are counted once, in which case $g^l = 1$. Otherwise, g^l can be equal to 2 or 3. In this way we arrive at what we call the *geographical extended count*, whose total number of articles is equal to $G = \sum_l g^l$. As long as $g^l > 1$ for some l , we have that $G > N$.

II. 2. The Multiplicative Strategy In the Geographical Extended Count

As indicated in the Introduction, in the original dataset there are only about two million articles assigned to a single sub-field, while the multiple assigned articles represent about 42% of the total. To describe the multiplicative strategy it suffices to consider two aggregate levels: sub-fields and disciplines. Therefore, assume that there are S sub-fields, indexed by $s = 1, \dots, S$, D disciplines with $D < S$, indexed by $d = 1, \dots, D$, as well as a rule that indicates the unique discipline to which each sub-field belongs. Each article l in the geographical extended count is written by one or more authors that work in one or more geographical areas. Thus, for any article l written by one or more authors in area k , let X_l^k be the non-empty set of sub-fields to which article l is assigned. The cardinal of this set, $x_l^k = |X_l^k|$, is the number of elements in the set. Since in our dataset articles

can be assigned at most to six sub-fields, we have that $x_l^k \in [1, 6]$ for all l , and all k . In the first step in the multiplicative strategy each article is wholly counted as many times as necessary in the several sub-fields to which it is assigned. Thus, if an article l is assigned to three sub-fields, so that $x_l^k = 3$ for some k , it should be independently counted three times, once in each of the sub-fields in question, without altering the original number of citations in each case. Consequently, the total number of articles at this level, N_{SF} , is greater than G .

Let N_s^k be the number of distinct articles, indexed by $i = 1, \dots, N_s^k$, which are assigned to sub-field s and have at least one author working in area k . Then, $\mathbf{c}_s^k = \{c_{si}^k\}$ is the citation distribution of area k in sub-field s , where c_{si}^k is the number of citations received by article i , and $c_{si}^k = c_l$ for some article l in the original distribution. The corresponding double extended sub-field distribution, \mathbf{c}_s , is the union of these distributions for all k , namely, $\mathbf{c}_s = \cup_k \mathbf{c}_s^k$. The total number of articles in sub-field s is $N_s = \sum_k N_s^k$. In turn, the *double extended sub-field count*, **S-FC**, is simply the union of all double extended sub-field distributions, i. e. $\mathbf{S-FC} = \cup_s \mathbf{c}_s$. The total number of articles in area k is $N^k = \sum_s N_s^k$, while the total number of articles in the double extended sub-field count is $N_{SF} = \sum_k N^k = \sum_s N_s$. As long as $x_l^k > 1$ for some l and k , $N_{SF} > G$. For later reference, denote by M_s^k the MCR of area k in sub-field s , and by M_s the MCR of sub-field s . These magnitudes are defined as follows:

$$M_s^k = \sum_i c_{si}^k / N_s^k, \quad (1)$$

and
$$M_s = (\sum_k \sum_i c_{si}^k) / N_s = \sum_k (N_s^k / N_s) M_s^k.$$

In turn, for any article l written by one or more authors in area k , let Y_l^k be the non-empty set of disciplines to which article l is assigned, and let $y_l^k = |Y_l^k|$ be the cardinal of this set. Of course, $y_l^k \leq x_l^k$ for all l , and all k . In the second step in the multiplicative strategy each article is wholly counted as many times as necessary in the several disciplines to which it is assigned. Thus, if in the previous example with $x_l^k = 3$ for some l and some k , the first two sub-fields belong to one discipline whereas the third belongs to another discipline, so that $y_l^k = 2$, then at the discipline level

article l needs to be counted only twice. Consequently, the total number of articles at this level, N_D , is also greater than G but smaller than N_{SF} .

Let N_d^k be the number of distinct articles in discipline d that have at least one author working in area k , and denote by $\mathbf{c}_d^k = \{c_{dj}^k\}$ with $j = 1, \dots, N_d^k$ the citation distribution of area k in discipline d , where c_{dj}^k is the number of citations received by article j , and $c_{dj}^k = c_l$ for some l in the original distribution. The corresponding double extended discipline distribution, \mathbf{c}_d , is the union of these distributions for all k , namely, $\mathbf{c}_d = \cup_k \mathbf{c}_d^k$. The total number of articles in discipline d is $N_d = \sum_k N_d^k$. In turn, the *double extended discipline count*, \mathbf{DC} , is simply the union of all double extended sub-field distributions, i. e. $\mathbf{DC} = \cup_d \mathbf{c}_d$. The total number of articles in the double extended discipline count is $N_D = \sum_d \sum_k N_d^k = \sum_d N_d$. As long as $y_l^k > 1$ for some l and k , $N_D > G$. On the other hand, since $D < S$ and no multiplication of an article is necessary whenever two or more sub-fields belong to the same discipline, $y_l^k < x_l^k$ for some l and k . This ensures that $N_D < N_{SF}$. However, in what follows we will assume that, for all d , there is some area k and some l with $d \in Y_l^k$ and $y_l^k < x_l^k$, so that $\mathbf{c}_d^k \neq \cup_{s=d} \mathbf{c}_s^k$, and $N_d^k < \sum_{s=d} N_s^k$. Therefore, for any d , $N_d < \sum_{s=d} N_s$ and, of course, $N_D < N_{SF}$. Denote by M_d^k the MCR of area k in discipline d , and by M_d the MCR of sub-field s and discipline d , which are defined by

$$M_d^k = \sum_j c_{dj}^k / N_d^k. \quad (2)$$

$$M_d = (\sum_k \sum_j c_{dj}^k) / N_d = \sum_k (N_d^k / N_d) M_d^k.$$

Since $N_D < N_{SF}$, so that the link between the two levels is broken, a discipline's MCR will not be equal to the weighted sum of its sub-fields MCRs with weights equal to the proportion that each sub-field represents in the total number of discipline papers. That is to say,

$$M_d^k \neq \sum_{s=d} \alpha_s^k M_s^k,$$

and

$$M_d \neq \sum_{s=d} \alpha_s M_s, \quad (3)$$

where $\alpha_s^k = N_s^k/N_d^k$, $\alpha_s = N_s/N_d$, and the means M_s^k , M_d^k , M_s , and M_d are defined in equations (1) and (2).

II.3. Aggregation Scheme and Descriptive Statistics

The number of distinct articles in the original dataset is $N = 3,648,524$, while the number of articles in the geographically extended count is $G = 4,142,281$, a total which is 13.5% larger than N . As indicated in the Introduction, in this paper sub-fields are identified with the 219 WoS categories. There is no generally agreed-upon Map of Science or aggregation scheme that allows us to climb from the sub-field up to other aggregate levels. Among the many alternatives, Albarrán *et al.* (2011c) borrow from the schemes recommended by Tijssen and van Leeuwen (2003) and Glänzel and Schubert (2003) with the aim of maximizing the possibility that a power law represents the upper tail of each of the corresponding citation distributions. The resulting scheme consists of 80 disciplines, and 19 fields (The existence of a power law cannot be rejected in 59 of 80 disciplines and 16 of 19 fields, accounting for 71.8% and 75.5% of all articles in the respective extended samples). For our purposes, we separate Computer Sciences from Engineering to work with a total of 20 fields. Table A in the Appendix present the information about the number of articles, and the MCR at all aggregate levels.³ For convenience, sub-fields, disciplines, and fields are grouped into four very broad grand-fields that include Life Sciences, Physical Sciences, Other Natural Sciences, and Social Sciences.

Three points should be noted. Firstly, as expected, the size of the double extended counts decreases as we move upwards in the aggregation scale: the number of articles for sub-fields, disciplines, and fields are $N_{SF} = 6,512,031$, $N_D = 6,107,509$, and $N_F = 5,538,760$, totals which are 57.7%, 47.4%, and 33.7% greater than G . Secondly, publication practices across sub-fields are known to be very different. In some research areas authors publishing one article per year would be among the most productive, while in other instances authors –either alone or as members of a research team– are expected to publish several papers per year. On the other hand, since the WoS categories are not designed at all to equalize the number of articles published over a given period of

³ It is not claimed that this scheme provides an accurate representation of the structure of science. It is rather a convenient simplification for the presentation of information at the sub-field level in this paper.

time, distribution sizes are expected to differ greatly. In particular, in our dataset mean sizes (and standard deviations) are 29,735 (33,826) for sub-fields, 76,344 (51,021) for disciplines, and 276,938 (185,742) for fields. Thirdly, given the differences in citation practices across sub-fields, MCRs vary widely. For example, the mean (and standard deviation) are 6.1 (3.7) for sub-fields, 7 (3.9) for disciplines, and 7 (3.6) for fields. At the field level, for example, the maximum MCR is reached in Biosciences and Clinical Medicine I (Internal Medicine) with 15.4 and 13.2 citations, respectively, while the minimum is in Mathematics and Social Sciences, General with three citations each.

Table B in the Appendix includes the geographical areas' publication effort at all aggregate levels. For sub-fields, for example, the correlation coefficients between them are the following: between the U.S and the EU it is 0.92, while between the RW and the U.S. and the RW and the EU they are 0.81 and 0.93. This means, of course, that there is little difference in the way all areas allocate their publication effort at the lowest aggregation level. For disciplines, the correlation coefficients are 0.86, 0.67, and 0.90, which shows somewhat larger differences.

Finally, Table C in the Appendix include the geographical areas' publication shares for disciplines and fields (the information for sub-fields can be found in Table B in Appendix I in Herranz and Ruiz-Castillo, 2011b). It should be noted that the share of all articles is approximately 29%, 33% and 38% for the U.S., the EU, and the RW, respectively. More importantly for the discussion of the European Paradox in Section IV, the EU has more articles than the U.S. in 54 out of 80 disciplines, and 15 out of 20 fields. These 54 disciplines are allocated as follows over grand-fields: 17 out of 28 in Life Sciences, 17 out of 17 in Physical Sciences, 20 out of 26 in Other Natural Sciences, including three out of four Residual Sub-fields⁴, and none out of nine Social Sciences.

III. AVERAGE-BASED INDICATORS

III. 1. Additional Notation

⁴ These are sub-fields whose presence distorts the appearance of a power law among the group of sub-fields to which in principle they belong. See Albarrán *et al.* (2011c) for details.

In order to introduce the sub-field normalized average-based indicators at the discipline level, we need to introduce some more notations. Recall that, for any k and l , X_l^k and Y_l^k are the sets of sub-fields and disciplines to which article l is assigned. Next, for any $d \in Y_l^k$, let $X_{ld}^k \subseteq X_l^k$ be the non-empty set of sub-fields in X_l^k that belong to discipline d , and let $x_{ld}^k = |X_{ld}^k|$ be the number of sub-fields in X_{ld}^k . Finally, for any s and any k , let $\mathbf{c}^{k,s} = \{v_{si}^k c_{si}^k\}$ be a new sub-field distribution for area k where

$$v_{si}^k = 1/x_{ld}^k \text{ for all } s \in X_{ld}^k.$$

Similarly, the new sub-field distribution \mathbf{c}'_s is the union of these distributions over all geographical areas, namely, $\mathbf{c}'_s = \cup_k \mathbf{c}^{k,s}$. Let $N^{k,s} = \sum_i v_{si}^k$ be the possibly fractional number of articles in the new sub-field distribution $\mathbf{c}^{k,s}$, let $N'_s = \sum_k N^{k,s}$ be the number of articles in the new sub-field s , and define the new MCRs, $M^{k,s}$ and M'_s , by

$$M^{k,s} = (\sum_i v_{si}^k c_{si}^k) / (\sum_i v_{si}^k). \quad (3)$$

$$M'_s = (\sum_k \sum_i v_{si}^k c_{si}^k) / N'_s = \sum_k (N^{k,s} / N'_s) M^{k,s}. \quad (4)$$

As in Herranz and Ruiz-Castillo (2011a), it can be shown that the number of articles and citations in the union of the new sub-field distributions, $\cup_{s \in d} \mathbf{c}^{k,s}$, coincides with N_d^k and γ_d^k , respectively. That is to say, $N_d^k = \sum_{s \in d} N^{k,s}$, and $\gamma_d^k = \sum_{s \in d} \sum_i v_{si}^k c_{si}^k$. Therefore, we have:

$$\begin{aligned} M_d^k &= \gamma_d^k / N_d^k = (\sum_{s \in d} \sum_i v_{si}^k c_{si}^k) / (\sum_{s \in d} \sum_i v_{si}^k) \\ &= (\sum_{s \in d} [N^{k,s} [\sum_i v_{si}^k c_{si}^k / N^{k,s}]]) / (\sum_{s \in d} \sum_i v_{si}^k) = \sum_{s \in d} (N^{k,s} / N_d^k) M^{k,s}. \end{aligned} \quad (5)$$

At the aggregate level,

$$\begin{aligned} M_d &= \gamma_d / N_d = (\sum_k \gamma_d^k) / (\sum_k N_d^k) = (\sum_k \sum_{s \in d} \sum_i v_{si}^k c_{si}^k) / N_d = \sum_k (N_d^k / N_d) M_d^k \\ &= \sum_k (N_d^k / N_d) \sum_{s \in d} (N^{k,s} / N_d^k) M^{k,s} = \sum_{s \in d} \sum_k (N^{k,s} / N_d) M^{k,s} \\ &= \sum_{s \in d} (N'_s / N_d) \sum_k (N^{k,s} / N'_s) M^{k,s} = \sum_{s \in d} (N'_s / N_d) M'_s. \end{aligned} \quad (6)$$

By comparing expressions (1) and (3), and (2) and (4), it should be clear that the difference between the multiplicative strategy at the sub-field and the discipline level amounts to a question of

weighting. In the first case, the N_s^k distinct articles of area k in sub-field s receive a weight equal to one, while in the second case an article l in the original distribution belonging to a new sub-field s and discipline d is weighted by the inverse of the number of sub-fields belonging to discipline d , namely, by $v_{si}^k = (1/x_{ld}^k)$. Then, the MCRs at the discipline level in expressions (5) and (6) are seen to be equal to the weighted sum of the new sub-fields MCRs, with weights equal to the proportion that the number of articles in each new sub-field represents in the total number of articles in the discipline. Note also that, eventually, when we reach the maximum aggregation level the weighting system in the multiplicative strategy coincides with the one in the fractional strategy.

III. 2. Sub-field Normalized Aggregate Indicators

From this point, sub-field normalization proceeds as follows. Let $e_{si}^k, i = 1, \dots, N_s^k$, denote the expected number of citations of article i published by area k in sub-field s . At the discipline level, consider the following two well-known indicators. Firstly, the so-called *crown indicator* for geographical area k , C_d^k , is the ratio $CPP^k/FCSm^k$ where CPP^k and $FCSm^k$ stand for, respectively, the area's MCR and the mean sub-field citation score. Therefore, C_d^k is defined as

$$C_d^k = CPP^k/FCSm^k = (\sum_{s=d} \sum_i v_{si}^k c_{si}^k / N_d^k) / (\sum_{s=d} \sum_i v_{si}^k e_{si}^k / N_d^k), \quad (9)$$

an analogue to equation (1) in Waltman *et al.* (2011a). The rationale is that the articles of a geographical area are seen as a single integrated *oeuvre* rather than as a number of independent works. Since the distribution of citations over the individual articles is not considered important, normalization is performed at the level of the area's *oeuvre* as a whole rather than at the level of the area's individual publications. This is why this procedure has been called the *ratio of averages* by Larivière and Gingras (2011). Secondly, the *mean normalized citation score*, $MNCS_d^k$, is defined as

$$MNCS_d^k = (1/N_d^k) [\sum_{s=d} \sum_i (v_{si}^k c_{si}^k / e_{si}^k)], \quad (10)$$

an analogue to equation (2) in Waltman *et al.* (2011a). The $MNCS_d^k$ indicator first performs normalization at the level of individual articles, and then obtains the average of the normalized articles. This is why this procedure has been called the *average of ratios* by Larivière and Gingras

(2011). The idea is that once the number of citations received by an article has been normalized for differences among sub-fields, all articles should be treated equally.

In this situation, it is natural to take e_{si}^k equal to the sub-field's MCR, M'_s , for all $i = 1, \dots, N_s^k$. In this case

$$\begin{aligned} C_d^k &= (\sum_{s=d} \sum_i v_{si}^k c_{si}^k) / (\sum_{s=d} \sum_i v_{si}^k M'_s) = (\sum_{s=d} \sum_i v_{si}^k c_{si}^k) / \sum_{s=d} N_s^{k'} M'_s = \\ &= (\sum_{s=d} \sum_i v_{si}^k c_{si}^k / N_d^k) / (\sum_{s=d} (N_s^{k'} / N_d^k) M'_s) = M_d^k / M^{k\#}_d, \end{aligned} \quad (11)$$

where M_d^k is area k 's MCR at the discipline level, defined in equation (1), and

$$M^{k\#}_d = \sum_{s=d} \beta_s^k M'_s$$

is the MCR that unit k would obtain at the discipline level if each of its publications in a given sub-field s were to receive M'_s citations, that is, if $c_{si}^k = M'_s$ for all $i = 1, \dots, N_s^k$. Similarly, we have

$$MNCS_d^k = (1/N_d^k) (\sum_{s=d} \sum_i (v_{si}^k c_{is}^k / M'_s)). \quad (12)$$

Of course, when we apply formulas (11) and (12) to all areas we obtain:

$$\begin{aligned} C_d &= (\sum_k \sum_{s=d} \sum_i v_{si}^k c_{si}^k) / (\sum_k \sum_{s=d} \sum_i M'_s) = (\sum_k \sum_{s=d} \sum_i v_{si}^k c_{si}^k) / (\sum_k \sum_{s=d} N_s^{k'} M'_s) \\ &= (\sum_k \sum_{s=d} \sum_i v_{si}^k c_{si}^k) / (\sum_k \sum_{s=d} \sum_i v_{si}^k c_{si}^k) = 1, \end{aligned}$$

and

$$MNCS_d = (1/N_d) [\sum_k \sum_{s=d} \sum_i (v_{si}^k c_{is}^k / M'_s)] = (1/N_d) (\sum_{s=d} N_s') = 1.$$

Thus, whenever C_d^k or $MNCS_s^k$ is above (below) one it means that the articles in area k have received, on average, more (fewer) citations than the world as a whole.

III. 3. A New Type of Un-normalized Indicator

It might be argued that it is not obvious why we should evaluate a research unit's *oeuvre* independently of the differences between its publication effort across sub-fields, $N_s^{k'} / N_d^k$, and the world publication effort, N'_s / N_d . This is exactly what is done in C_d^k in equation (9) where the normalization process is tailored to the geographical area publication effort, as well as in $MNCS_d^k$ in equation (10) where all sub-fields count the same regardless of their relative importance at the world level. Alternatively, we can take $e_{si}^k = M_d$ for all i and all s in d ; normalize each article at the

discipline level, so that c_{si}^k/M_d , and define the MCR over all articles published by unit k . In this case we have a new indicator, A_d^k , defined as

$$A_d^k = (1/N_d^k) (\sum_{s=d} \sum_i (c_{si}^k/M_d)) = M_d^k/M_d. \quad (13)$$

This indicator can also be seen as the result of normalization at the level of the research unit's *oeuvre* as a whole, where the expected number of citations of the *oeuvre* is taken to be the aggregate world MCR, M_d , in which case

$$A_d^k = (\sum_{s=d} \sum_i c_{si}^k) / (\sum_{s=d} \sum_i M_d) = (\sum_{s=d} \sum_i c_{si}^k) / N_d^k M_d = M_d^k/M_d.$$

Finally, note that if we were to take the discipline as a homogeneous sub-field, then both C_d^k and $MNCS_d^k$ would coincide and be equal to A_d^k . This provides a third interpretation of indicator A_d^k : it is the natural measure to take when the discipline is taken as homogeneous. This shows that A_d^k does not correct for differences across sub-fields.

Remark 1. Note that at the sub-field level both C_s^k and $MNCS_s^k$ would coincide and be equal to $A_s^{k'} = M_s^{k'}/M'_s$. It is easy to establish that the relationship between the C_d^k and $MNCS_d^k$ indicators at the discipline level and the one just defined, $A_s^{k'}$, is the following:

$$MNCS_d^k = \sum_s \beta_s^k A_s^{k'},$$

and

$$C_d^k = \sum_s b_s^k A_s^{k'}, \text{ where } b_s^k = (\beta_s^k M'_s) / \sum_s \beta_s^k M'_s, \quad (14)$$

with $\sum_s b_s^k = 1$. Therefore, in the calculation of C_d^k articles from sub-fields with a high M'_s are weighted more (see equation 14), while in $MNCS_d^k$ articles from all sub-fields are treated equally.

Remark 2. Recall that $C_d^k = M_d^k/M^{k\#}_d$, where $M^{k\#}_d$ is the MCR that area k would obtain at the discipline level if each of its publications in a given sub-field s were to receive M'_s citations, that is, if $c_{si}^k = M'_s$ for all $i = 1, \dots, N_s^k$. If we define $C^{k\#}_d = M^{k\#}_d/M_d$, then we have

$$C_d^k C^{k\#}_d = A_d^k. \quad (15)$$

Therefore, A_d^k penalizes (rewards) area k when $C^{k\#}_d < 1$ ($C^{k\#}_d > 1$), that is, when the area's expected MCR is smaller (greater) than the world MCR at the discipline level. This will be the case whenever

area k 's publication shares in sub-fields with high MCR are smaller than the world publication shares in these sub-fields. Another interpretation is that A_d^k can be broken down in a useful way into two components, C_d^k and $C_d^{k\#}$. For any pair k and v of research units we have

$$A_d^k / A_d^v = M_d^k / M_d^v = (C_d^k / C_d^v)(M_d^{k\#} / M_d^{v\#}).$$

IV. EMPIRICAL RESULTS

IV. 1. Methodological Issues

This Sub-section studies two methodological issues: the comparison between the two normalized indicators, and the impact of sub-field normalization relative to the un-normalized indicator.

1. The first question that needs investigating is whether any geographical area is systematically favored (or penalized) by any of the two normalized indicators. If the answer is positive, in the comparison between areas we need to distinguish between the two of them. Otherwise, no distinction will be necessary. The relevant information for fields and the all sciences case is in Table 1, and for disciplines in Table D in the Appendix.

Table 1 around here

(i) It is well known that the crown indicator weights more heavily articles published in sub-fields with higher MCRs while the *MNCS* weights equally articles from all sub-fields (see Waltman *et al.*, 2011a, and Herranz and Ruiz-Castillo, 2011d). Assume that an area k systematically publishes more articles in those sub-fields. To be sure that this implies that C^k is greater than $MNCS^k$, it is still needed that area k does relatively well in these sub-fields with high MCR. In the all-sciences case, what we find is that C^{US} is slightly (1.3%) greater than $MNCS^{US}$, while the opposite is the case for the EU and the RW (where C^k is 2.1% and 1.6% smaller than $MNCS^k$). This is consistent with the fact that there is little difference in the way all areas allocate their publication effort at the lowest aggregation level (see Section II.3).

(ii) At the field level, C and $MNCS$ differ in only 18 categories because Space Science and the Multidisciplinary field are single sub-field categories. Qualitatively, the geographical areas behave again somewhat differently: $C^{US} > MNCS^{US}$ in 11 out of 18 fields, while this is the case for only four fields in the EU and the RW. However, quantitative differences are always of a small order of magnitude: the largest eight differences among a total of 54 cases for the three geographical areas are in absolute value between 2% and 3.8%.

(iii) Finally, there can only be differences between the two indicators in 59 out of 80 disciplines because the remaining 21 cases are single sub-field disciplines. Qualitatively, the three areas now behave rather similarly: $C^k > MNCS^k$ in 34 out of 59 cases for the U.S., 29 for the RW, and 21 for the EU. Again, only in a handful of cases –in 14 out of 177 possibilities– are differences in absolute value larger than 2%.

In brief, for most purposes using the crown or the $MNCS$ indicator at the field or the discipline level does not make much of a difference in any of the three geographical areas. This is consistent with the findings in other scenarios. Consequently, taking into account the advantages that have been advocated in the literature in favor of the $MNCS$ (see *inter alia* Opthof and Leydesdorff, 2010, Waltman *et al.*, 2011b, and Larivière and Gingras, 2011), in the sequel we will restrict ourselves to using this indicator.

2. The consequences of aggregation with or without sub-field normalization, that is, with or without correcting for differences in MCRs across sub-fields is an important methodological question. Within any geographical area k and at any aggregate level, the greater the area's proportion of articles in sub-fields with a high MCR, the stronger the tendency for A^k to be greater than $MNCS^k$ is expected to be. This tendency will be strengthened by a concentration of the area's more highly cited articles in those sub-fields.

In the important all-sciences case, it is observed that $A^k > MNCS^k$ for both $k = \text{U.S.}, \text{EU}$, but not for RW (see the last row in Table 1). Since this effect is stronger in the U.S. than in the EU, the normalized U.S./EU gap according to the $MNCS$ is observed to be smaller than according to A .

Normalization, therefore, brings the U.S. and the EU closer together. On the other hand, since $MNCS^{RW} > A^{RW}$ and $MNCS^{EU} < A^{EU}$, the normalized RW/EU gap is greater than the un-normalized one. This means that, as before, normalization brings the RW and the EU closer together. In both cases, the difference is certainly non-negligible. Before normalization, the U.S./EU gap is 1.292, meaning that the U.S. MCR is 29.2% greater than that of the EU. After normalization, this figure decreases to 24.7%. In the RW versus the EU case, before normalization the gap is 0.717, meaning that the RW mean is 28.3% smaller than that of the EU, while after normalization this figure decreases to 22.7%.

The comparison of normalized and un-normalized indicators at other aggregate levels can be attempted with the information for fields and disciplines presented in Table 1 and in Table D in the Appendix. However, we are primarily interested in the consequences of normalization for the U.S./EU and RW/EU gaps. The relevant information for fields is in Table 2 and that for disciplines is in Table E in the Appendix. Of course, the sign of the differences ($MNCS^{US} - A^{US}$) and ($MNCS^{EU} - A^{EU}$) determines the sign of the difference between the normalized and the un-normalized U.S./EU gaps in columns 1 and 5 in Table 2. A summary of possible cases appears in Table 3. This information deserves two comments.

Tables 2 and 3 around here

Firstly, in a majority of cases –12 out of 18 fields, and 32 out of 59 disciplines– the normalized US/EU gap is smaller than the un-normalized one. In nine fields and 21 disciplines this is a necessary consequence of the fact that $MNCS^{US} < A^{US}$ while $MNCS^{EU} > A^{EU}$. Nevertheless, it should be emphasized that in six fields and 27 disciplines the US/EU gap is greater when we measure it with the $MNCS$ than when we do it with the A indicator that disregards differences across the constituent sub-fields.

Secondly, fields are ordered in Table 3 according to the size of the difference between the gaps according to the two procedures. Because this gap difference is generally very small, we have only recorded the five greatest instances. Only for the field consisting of the Residual Sub-fields the

difference is greater than 10%, while for the next four cases it is between 4% and 10%. Similarly, only for four disciplines the gap difference is greater than 10%, while in the next 15 cases it is between 3% and 10%. Thus, the order of magnitude of the differences (in absolute value) between the normalized and the un-normalized gaps for fields and disciplines is generally small.

IV.2. Substantive Issues

Once the methodological issues have been discussed, it only remains to summarize the substantive results about the citation performance of the three geographical areas at all aggregate levels. In view of the results in the previous Sub-section, we will confine the analysis to the *MNCS* indicator, according to which in 71 out of 80 disciplines and in all fields the ranking of geographical areas is always: U.S., EU, and RW. The quantitative results for disciplines are summarized in Table 4, while the results for fields –recorded in Tables 1 and 2– are illustrated in Figures 1 and 2.

Table 4 and Figures 1 and 2 around here

For disciplines, the main message is that only in six out of 80 disciplines, representing 4% of all articles, is the EU ahead of the U.S. These include two disciplines among the Life Sciences (Experimental & Laboratory Medicine, and Other Clinical Medicine), one among the Physical Sciences (Applied Chemistry & Chemical Engineering), two among the Other Natural Sciences (Agricultural Science & Technology, and Pure & Applied Ecology), and one among the Social Sciences (Geography, Planning & Urban Studies). In contrast, in 55% of all disciplines the U.S./EU gap is greater than 20%, and in nine disciplines, representing about 11% of all articles, that gap is greater than 40%. On the other hand, only in two disciplines among the Life Sciences (Integrative & Complementary Medicine, and Rheumatology & Orthopedics) and one among the Social Sciences (Law & Criminology) –representing less than 2% of all articles– is the RW ahead of the EU, while in 50 out of 80 disciplines representing about 64% of all articles the EU/RW gap is greater than 20%.

According to the *MNCS*, the EU is about 10% above the world level in only three fields (Multidisciplinary; Agricultural & Environment; and Chemistry), and well below 10% in Economics & Business. The U.S. is well above 10% in all fields except Clinical Medicine III

(which includes Health and other minor Medical Sciences) and Social Sciences, General. The consequences for the U.S./EU gap are quite dramatic: the gap is (i) about 10% in three fields (Agriculture & Environment; Biology, Organismic and Supra-organismic levels; and Clinical Medicine III), (ii) between 10% and 20% in four fields (Engineering; Social Sciences, General; Mathematics; and Geosciences), and (iii) greater than 20% in the remaining 13 fields. The maximum gap, above 31%, is in Economics & Business, the Multidisciplinary category, Clinical Medicine I and II (Internal and Non-internal), and the Residual Sub-fields. The RW performance is between 10% and 20% below the EU in eight fields, and between 20% and 50% in the remaining 12 cases that represent about two thirds of all articles. The smallest gap is in Clinical Medicine I, II, and III, and Economics & Business. The largest gap is in the Multidisciplinary category, Chemistry, Physics, and Agriculture and Environment.

For all sciences as a whole, both the U.S. and the EU are above the world mean, but the U.S./EU gap is 24.7%. The RW/EU gap is 22.7%.

V. CONCLUSIONS AND EXTENSIONS

V.1. Conclusions

This paper has investigated the citation impact of three large geographical areas –the U.S., the EU, and the RW– at different aggregation levels when it is recognized that 42% of the 3.6 million articles in our dataset are assigned to several sub-fields among a set of 219 WoS categories. To deal with this problem, we have followed a multiplicative approach in which every article is wholly counted as many times as it appears at each aggregation level. Based in Herranz and Ruiz-Castillo (2011a), we have developed a novel sub-field normalization procedure consisting of two steps. Firstly, at each aggregate level a new set of sub-fields is defined. At the discipline level, for example, an article in the original distribution is weighted by the inverse of the number of sub-fields belonging to each discipline. Secondly, to control for wide differences in citation practices at the lowest level of aggregation, the procedure takes as a normalization factor the MCR of the new sub-field thus constructed.

The study has focused on the consequences of using different average-based indicators of citation impact. From a methodological point of view, the main conclusions are the following two:

1. Using the crown or the *MNCS* indicator gives rise to some differences in the measurement of citation impact in all areas, as well as in the measurement of the U.S./EU and the RW/EU gaps. However, in agreement with previous results in other empirical scenarios, these differences are of a small order of magnitude, generally below a few percentage points.

2. The U.S. appears to devote relatively more –and the RW relatively less– effort to sub-fields with a high MCR, which explains why normalization according to the *MNCS* implies that for all sciences as a whole the U.S./EU and the RW/EU gap decrease by 4.5 and 5.6 percentage points –a non-negligible difference. However, this is not the case within all categories at all other aggregate levels: there are instances in which both gaps are greater according to the normalized indicators. Since differences in both directions are in most cases of a small order of magnitude, we conclude that no geographical area is biased towards sub-fields with systematically higher or lower MCRs within most aggregate categories.

From a substantive point of view, geographical areas do not seem to specialize in these sub-fields where they enjoy a comparative advantage, namely, in these sub-fields where there is a large $A_s^k = M_s^k/M_s$ indicator. Forces explaining publication efforts are different from the ones explaining relative successes. In this scenario, the main conclusions are the following two:

1. Although the EU publishes more articles than the U.S. in 113 out of 219 sub-fields, Herranz and Ruiz-Castillo (2011b) reported the following findings: (i) the U.S. MCR is greater than that of the EU in 174 sub-fields, and (ii) the U.S./EU gap is greater than 20% or 40% in 105 and 31 sub-fields, respectively. In this paper, we have found that the EU publishes more articles than the U.S. in 54 out of 80 disciplines, and 15 out of 20 fields. However, according to the *MNCS* only in six out of 80 disciplines –but in no field at all– is the EU still ahead of the U.S. In contrast, the normalized U.S./EU gap according to the *MNCS* is greater than 20% in 44 out of 80 disciplines, 13 out of 20 fields, and for all sciences as a whole.

2. Likewise, although the RW is usually the area with more publications, it exhibits the worst citation performance in almost all cases. Consequently, the dominance of the EU over the RW is even more apparent: the EU/RW gap is greater than 20% in 50 out of 80 disciplines and 12 out of 20 fields, while it is equal to 21.5% in the all-sciences case.

V. 2. A Comparison of Results With the Fractional Approach

In our opinion, in regard to the problem of the multiple assignment of journals, and hence articles to sub-fields, there are reasons in favor of a multiplicative rather than a fractional strategy (see Herranz and Ruiz-Castillo, 2011a). However, we are aware that many practitioners would think differently depending, among other things, on the particular view one has about the criteria used in the assignment of journals to sub-fields. The less credit you attach to such criteria, the more you might be in favor of a fractional strategy. Therefore, it is important that this paper has established that there exists a sub-field normalization procedure for average-based indicators that is conceptually sound and empirically viable. Nevertheless, we may all agree that knowing the empirical consequences of following the two strategies is worthwhile investigating.

In Herranz and Ruiz-Castillo (2011a) we found that –in certain respects– the citation characteristics of articles coming from journals assigned to multiple sub-fields do not differ much from the rest. Thus, in spite of the wide differences in the mix between the two types of articles, MCRs for individual sub-fields according to the two strategies are not very different from each other. Furthermore, the MCR distributions according to the two strategies are highly correlated. Finally, normalized and un-normalized citation distributions according to either the multiplicative or the fractional strategies share the same skewed shape, and the measures of low-impact according to both strategies are very close to each other. However, it should be noted that excellence is not equally structured in all citation distributions. Although this structure is differently captured by our high-impact indicator under the two strategies in contention, the set of extreme citation distributions that behave very differently from the rest in the sense that they are characterized by a very high high-impact value essentially coincides under the multiplicative and the fractional strategies. In Herranz and Ruiz-Castillo (2011b) was found that the U.S./EU gap according to the MCR is strictly greater

according to the fractional strategy in 137 out of 219 sub-fields, or 63% of the total. However, gap differences are not very large: only in 20 cases –of which 17 reflect a worsening of the EU situation– this difference in absolute value is 10% greater than the U.S./EU gap under the multiplicative strategy. In turn, the U.S./EU gap according to our high-impact indicator changes by more than 10% when we take the fractional approach in only 17 disciplines and two fields (see Herranz and Ruiz-Castillo, 2011c).

In our case, the results are very similar (see Tables F and G in the Appendix to Herranz and Ruiz-Castillo, 2011d for disciplines and fields, respectively). Focusing on the U.S./EU gap, they can be summarized as follows. Firstly, the U.S./EU gap is greater or equal in the fractional approach in 56 out of 80 disciplines, and in 15 out of 20 fields. Secondly, differences between the two approaches are above 5% in only 10 disciplines and no field at all. Therefore, in line with previous results, we may conclude that the similarity of citation characteristics of articles published in journals assigned to one or several sub-fields guarantees that choosing one of the two strategies may lead to a very similar picture in practical applications.

V. 3. Extensions

Consider the distinction between domestic publications, whose authors belong to only one of the geographical areas distinguished in this paper, and international publications that involve cooperation between any two or the three of them. Contrary to what happens with articles published in journals assigned to one or several sub-fields, it is known that domestic and international publications are characterized by very different citation rates. Except for the cooperation between the EU and the RW, international co-authorship in our dataset is vastly successful (see Albarrán et al. 2011a). Therefore, following Aksnes *et al.*'s (2012) recommendation in favor of using fractionalized counts to calculate relative citation indicators at the national level, rather than using whole counts as we have done in this paper, might make a significant difference. As a matter of fact, the existing evidence about how the members of this partition fare in the 22 broad fields distinguished by Thomson Scientific indicates that, in each of the six fields in which the EU contributes to the overall high-impact levels above what could be expected from its publication share, the explanation of the

success lies in international publications. In turn, the RW domestic articles perform dramatically worse in every single field than those written in collaboration with the U.S., or with both the U.S. and the EU (see Section 4.4 in Albarrán et al. 2011a). Thus, it might be interesting to assess by how much the U.S./EU and RW/EU gaps according to the MNCS change in favor of the U.S., and against the RW as a consequence of adopting the fractional approach in this dimension.

On the other hand, the present analysis might be extended in rather obvious directions towards specific countries within the EU and the RW, and even individual research centers. It would be important to analyze domestic and internationally co-authored articles separately. In the European case, the latter should differentiate between intra-European cooperation and cooperation with the U.S. and the rest of the world.

Finally, as is well known, references made by articles in any sub-field give rise to a highly skewed distribution of citations received in which a large proportion of articles gets none or few citations while a small percentage of them account for a disproportionate amount of all citations (Schubert *et al.*, 1987, Seglen, 1992, Glänzel, 2007, Albarrán and Ruiz-Castillo, 2011, and Albarrán *et al.*, 2011c). An important consequence is that average-based indicators may not adequately summarize these distributions for which the upper and the lower part are typically very different. This leads to the idea of using two indicators to describe any citation distribution: a high- and a low-impact measure defined over the set of articles with citations below or above a critical citation level (see Albarrán *et al.*, 2011d, for a discussion of technical properties). While average-based measures are silent about the distributive characteristics on either side of the mean, the high- and low-impact measures used for the evaluation of the U.S., the EU, and the RW in Albarrán *et al.* (2011a) are sensitive to the citation inequality in the sense that an increase in the coefficient of variation increases both of them. Previous results for the partition studied in this paper are either restricted to the scenario in which articles are assigned to only one of the 22 broad fields distinguished by Thomson Scientific (Albarrán *et al.*, 2011a, b), or study the case at the lowest aggregation level in which sub-fields are identified with 219 WoS categories (Herranz and Ruiz-Castillo, 2011b). Herranz and Ruiz-Castillo (2011c) investigates how to apply this approach to higher aggregate levels, including

normalization procedures –as those developed in this paper– capable of correcting for differences in citation practices across sub-fields.

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Table 1. Average-based Indicators At Higher Aggregate Levels In the Double Extended Count

FIELDS	MNCS ^{US} (1)	MNCS ^{EU} (2)	MNCS ^{RW} (3)	C ^{US} (4)	C ^{EU} (5)	C ^{RW} (6)	A ^{US} (7)	A ^{EU} (8)	A ^{RW} (9)
1. BIOSCIENCES	1.270	0.991	0.744	1.278	0.977	0.741	1.299	0.974	0.731
2. BIOMEDICAL RESEARCH	1.248	1.020	0.778	1.256	1.018	0.773	1.265	1.011	0.773
3. CLINICAL MEDICINE I	1.276	0.933	0.795	1.283	0.932	0.786	1.289	0.930	0.785
4. CLINICAL MEDICINE II	1.235	0.930	0.815	1.238	0.932	0.811	1.232	0.943	0.803
5. CLINICAL MEDICINE III	1.084	0.992	0.853	1.113	0.974	0.833	1.075	0.991	0.870
6. NEUROS. AND BEHAVIORAL	1.180	0.943	0.782	1.208	0.946	0.772	1.126	0.987	0.816
7. CHEMISTRY	1.440	1.102	0.775	1.472	1.100	0.765	1.472	1.094	0.768
8. PHYSICS	1.365	1.077	0.781	1.385	1.071	0.775	1.380	1.080	0.772
9. SPACE SCIENCE	1.268	0.987	0.762	1.268	0.987	0.762	1.268	0.987	0.762
10. MATHEMATICS	1.241	1.051	0.802	1.239	1.041	0.797	1.298	1.043	0.771
11. COMPUTER SCIENCE	1.239	0.987	0.800	1.227	1.000	0.793	1.256	0.983	0.789
12. ENGINEERING	1.224	1.053	0.824	1.231	1.047	0.821	1.229	1.063	0.814
13. MATERIALS SCIENCE	1.336	1.061	0.851	1.325	1.023	0.864	1.398	1.065	0.827
14. GEOSCIENCE	1.223	1.030	0.797	1.221	1.028	0.793	1.228	1.052	0.774
15. AGRIC. AND ENVIRONMENT	1.184	1.091	0.803	1.188	1.064	0.811	1.224	1.080	0.785
16. BIOLOGY (ORG. & SUPRA.)	1.190	1.064	0.813	1.196	1.055	0.805	1.218	1.086	0.775
17. MULTIDICIPLINARY	1.665	1.232	0.626	1.665	1.232	0.626	1.665	1.232	0.626
18. RESIDUAL SUB-FIELDS	1.382	1.050	0.797	1.377	1.020	0.774	1.615	1.014	0.718
19. SOCIAL SCIENCES, GENERAL	1.113	0.950	0.771	1.111	0.951	0.771	1.112	0.960	0.762
20. ECONOMIC AND BUSSINESS	1.208	0.868	0.732	1.205	0.862	0.735	1.223	0.847	0.727
ALL FIELDS	1.271	1.018	0.785	1.305	1.012	0.786	1.324	1.025	0.735

Table 2. Comparison Between Geographical Areas At the Field and All-sciences Levels

	$\frac{MNCS^{US}}{MNCS^{EU}}$ (1)	$\frac{MNCS^{RW}}{MNCS^{EU}}$ (2)	$\frac{C^{US}}{C^{EU}}$ (3)	$\frac{C^{RW}}{C^{EU}}$ (4)	$\frac{A^{US}}{A^{EU}}$ (5)	$\frac{A^{RW}}{A^{EU}}$ (6)
1. BIOSCIENCES	1.281	0.751	1.308	0.758	1.334	0.750
2. BIOMEDICAL RESEARCH	1.223	0.763	1.234	0.759	1.251	0.765
3. CLINICAL MEDICINE I	1.367	0.851	1.376	0.843	1.386	0.844
4. CLINICAL MEDICINE II	1.328	0.877	1.328	0.871	1.307	0.852
5. CLINICAL MEDICINE III	1.093	0.860	1.142	0.855	1.085	0.879
6. NEUROS. AND BEHAVIORAL	1.251	0.829	1.277	0.816	1.141	0.827
7. CHEMISTRY	1.307	0.703	1.338	0.695	1.346	0.702
8. PHYSICS	1.268	0.726	1.293	0.724	1.277	0.715
9. SPACE SCIENCE	1.285	0.772	1.285	0.772	1.285	0.772
10. MATHEMATICS	1.181	0.763	1.189	0.765	1.245	0.739
11. COMPUTER SCIENCE	1.255	0.811	1.227	0.793	1.278	0.803
12. ENGINEERING	1.163	0.782	1.176	0.784	1.157	0.766
13. MATERIALS SCIENCE	1.258	0.802	1.295	0.844	1.312	0.777
14. GEOSCIENCE	1.187	0.773	1.188	0.772	1.167	0.735
15. AGRIC. AND ENVIRONMENT	1.086	0.736	1.116	0.762	1.134	0.727
16. BIOLOGY (ORG. & SUPRA.)	1.118	0.764	1.134	0.763	1.121	0.713
17. MULTIDISCIPLINARY	1.352	0.508	1.352	0.508	1.352	0.508
18. RESIDUAL SUB-FIELDS	1.316	0.759	1.350	0.758	1.593	0.708
19. SOCIAL SCIENCES, GENERAL	1.171	0.812	1.168	0.810	1.159	0.794
20. ECONOMIC AND BUSINESS	1.392	0.844	1.398	0.853	1.444	0.858
ALL SCIENCES	1.247	0.773	1.289	0.777	1.292	0.717

Table 3. A. Normalized *versus* Un-normalized U.S./EU Gaps At the Field Level

<u>NORMALIZED GAP < UN-NORMALIZED GAP.</u>				
	$MNCS^{US} < A^{US}$	Gap difference in %		
$MNCS^{EU} > A^{EU}$	1. Residual Sub-fields	(17.4%)		
	2. Mathematics	(5.1%)		
	5. Biosciences			
	6. Economics and Business			
	7. Chemistry			
	8. Biomedical Research			
	9. Computer Science			
	10. Clinical Medicine I (Internal)			
	11. Physics			
	$MNCS^{EU} < A^{EU}$	3. Agricultural and Environment	(4.3%)	
		4. Materials Science	(4.1%)	
12. Biology				
<u>NORMALIZED GAP > UN-NORMALIZED GAP.</u>				
	$MNCS^{US} < A^{US}$	$MNCS^{US} > A^{US}$		
$MNCS^{EU} < A^{EU}$	2. Geoscience		(9.6%)	
	6. Engineering			
$MNCS^{EU} > A^{EU}$		1. Neurosciences and Behavioral		
		3. Clinical Medicine II (Non-internal)		
		4. Social Sciences, General		
		5. Clinical Medicine III		

Table 3. B. Normalized *versus* Un-normalized US/EU Gaps At the Discipline Level

<u>NORMALIZED GAP < UN-NORMALIZED GAP:</u>		
	$MNCS^{US} < A^{US}$	
$MNCS^{EU} > A^{EU}$	21	
$MNCS^{EU} < A^{EU}$	11	
Total		32
<u>NORMALIZED GAP > UN-NORMALIZED GAP:</u>		
	$MNCS^{US} < A^{US}$	$MNCS^{US} > A^{US}$
$MNCS^{EU} < A^{EU}$	1	24
$MNCS^{EU} > A^{EU}$		2
Total		27

Table 4. Comparison Between Geographical Areas At the Discipline Level According to the MNCS Indicator

Number of Disciplines in which: (4)	U. S. versus EU U.S				TOTAL (5) = (1) +
	EU Ahead (1)	< 20% (2)	U.S. Ahead: ≥ 20% (3)	Total (4) = (2) + (3)	
	1. Life Sciences	2	6	20	
2. Physical Sciences	1	4	12	16	17
3. Other Natural Sciences	2	17	7	24	26
4. NATURAL SCIENCES = 1 + 2 + 3	5	27	39	66	71
5. Social Sciences = 4 + 5	1	3	5	8	9
ALL SCIENCES	6	30	44	74	80

Number of Disciplines in which: (4)	RW versus EU U.S				TOTAL (5) = (1) +
	RW Ahead (1)	< 20% (2)	EU Ahead: ≥ 20% (3)	Total (4) = (2) + (3)	
	1. Life Sciences	2	15	11	
2. Physical Sciences	0	3	14	17	17
3. Other Natural Sciences	0	3	23	26	26
4. NATURAL SCIENCES = 1 + 2 + 3	2	21	48	69	71
5. Social Sciences = 4 + 5	1	3	5	8	9
ALL SCIENCES	3	24	53	77	80

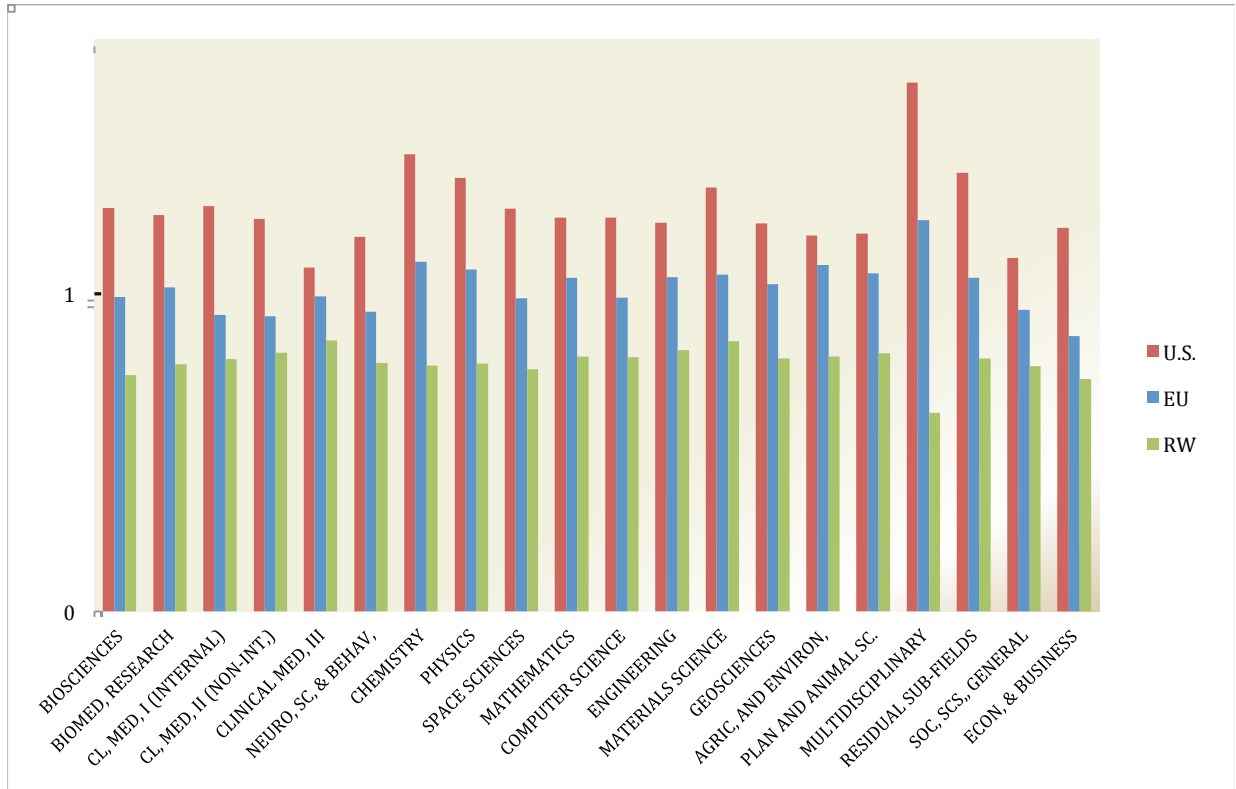


Figure 1. Mean Normalized Citation Score Indicators At the Field Level For the Three Geographical Areas ($MNCSt$). Articles Published In 1998-2002 With a Five-Year Citation Window

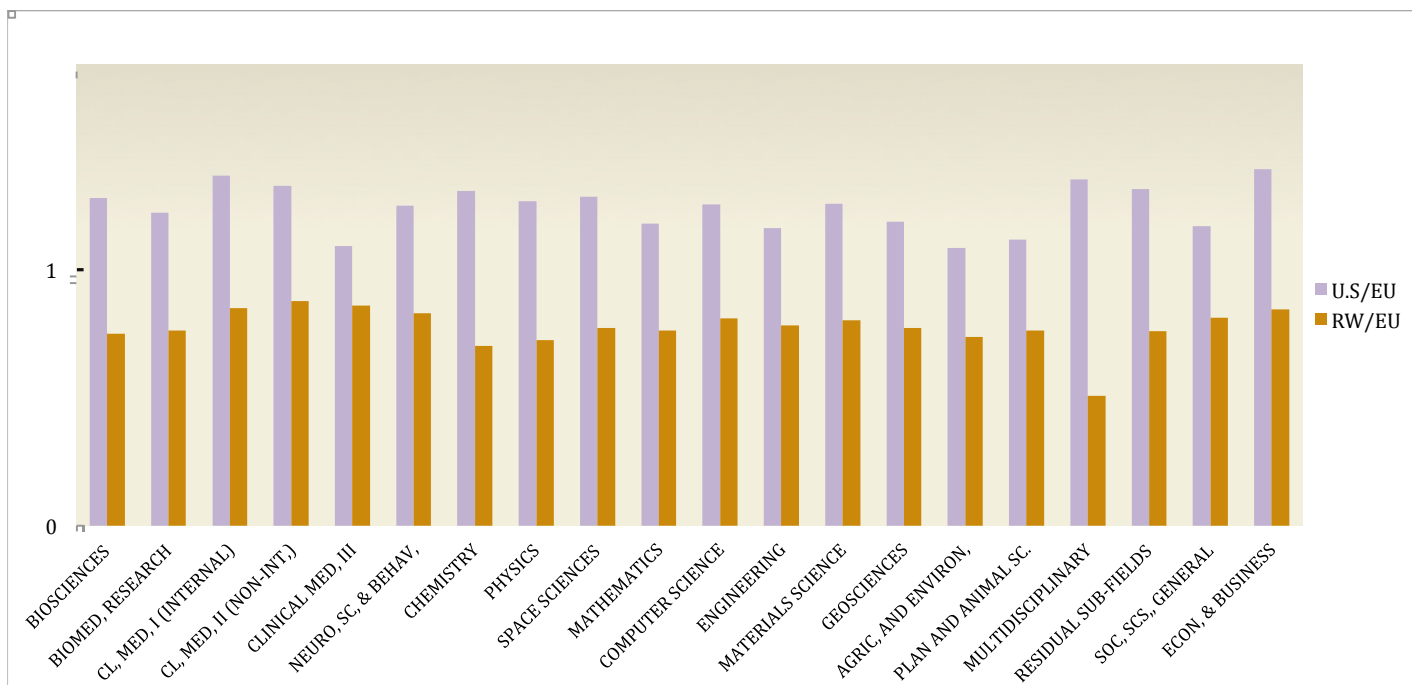


Figure 2. U.S./EU and RW/EU Gaps According To the Mean Normalized Citation Score Indicators At the Field Level. Articles Published In 1998-2002 With a Five-Year Citation Window

APPENDIX

Table A. Number of Articles and Mean Citation Rates In the Double Extended Counts For Sub-fields, Disciplines, and Fields

	SUB-FIELDS			DISCIPLINES			FIELDS		
	Number Of Articles	%	MCR	Number Of Articles	%	MCR	Number Of Articles	%	MCR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A. LIFE SCIENCES									
I. BIOSCIENCES									
							429,332	7.8	15.4
D1. Multidisciplinary Biology				42,034	0.69	9.5			
1. BIOLOGY	28,017	0.43	7.9						
2. BIOLOGY, MISCELLANEOUS	475	0.01	3.6						
3. EVOLUTIONARY BIOLOGY	13,542	0.21	12.9						
D2. Biochemistry, Biophysics, Mol. Biology				287,797	4.71	16.0			
4. BIOCHEMICAL RESEARCH METHODS	37,350	0.57	9.5						
5. BIOCHEMISTRY & MOLECULAR BIOLOGY	248,933	3.82	17						
6. BIOPHYSICS	56,436	0.87	11.1						
D3 = 7. Cell Biology	97,545	1.5	22.5	97,545	1.60	22.5			
D4. Genetics & Development Biology				91,943	1.51	16.7			
8. GENETICS & HEREDITY	74,782	1.15	16.9						
9. DEVELOPMENTAL BIOLOGY	19,590	0.3	20.2						
II. BIOMEDICAL RESEARCH									
							317,909	5.7	8.8
D5. Anatomy & Pathology				39,021	0.64	8.9			
10. PATHOLOGY	32,518	0.5	9.6						
11. ANATOMY & MORPHOLOGY	6,756	0.1	5.8						
D6. Biomaterials & Bioengineering				91,185	1.49	8.9			
12. ENGINEERING, BIOMEDICAL	21,597	0.33	6.9						
13. BIOTECH. & APPLIED MICROBIOLOGY	69,781	1.07	9.5						
D7. Experimental & Laboratory Medicine				15,423	0.25	6.4			
14. MEDICAL LABORATORY TECHNOLOGY	10,927	0.17	6.4						
15. MICROSCOPY	4,496	0.07	6.3						
D8 Pharmacology & Toxicology				136,684	2.24	8.1			
16. PHARMACOLOGY & PHARMACY	111,320	1.71	8.3						
17. TOXICOLOGY	34,066	0.52	7.3						
D9 = 18. Physiology	49,225	0.76	10.7	49,225	0.81	10.7			
III. CLINICAL MEDICINE I (INTERNAL)									
							509,541	9.2	13.2
D10. Cardiovascular & Respiratory Medicine				79,780	1.31	12.2			
19. CARDIAC & CARDIOVASCULAR SYSTEMS	60,300	0.93	12.2						
20. RESPIRATORY SYSTEM	30,928	0.47	10.5						
D11 = 21. Endocrinology & Metabolism	55,583	0.85	13.3	55,583	0.91	13.3			
D12. General & Internal Medicine				149,527	2.45	11.9			
22. ANESTHESIOLOGY	18,037	0.28	7						
23. CRITICAL CARE MEDICINE	14,301	0.22	11.4						
24. EMERGENCY MEDICINE	6,864	0.11	4.1						
25. GASTROENTEROLOGY & HEPATOLOGY	37,885	0.58	11.2						

26. MEDICINE, GENERAL & INTERNAL	66,266	1.02	15.1			
27. TROPICAL MEDICINE	9,193	0.14	5.7			
D13. Hematology & Oncology				131,133	2.15	16.1
28. HEMATOLOGY	47,323	0.73	17.5			
29. ONCOLOGY	91,359	1.4	14.8			
D14. Immunology				115,554	1.89	13.8
30. ALLERGY	9,706	0.15	9.2			
31. IMMUNOLOGY	94,351	1.45	14.9			
32. INFECTIOUS DISEASES	37,806	0.58	12.3			
IV. CLIN. MED. II (NON-INTERNAL)						549,174 9.9 8.3
D15. Age & Gender Related Medicine				59,716	0.98	7.4
33. GERIATRICS & GERONTOLOGY	10,141	0.16	8.2			
34. OBSTETRICS & GYNECOLOGY	34,907	0.54	6.9			
35. ANDROLOGY	1,605	0.02	5.7			
36. REPRODUCTIVE BIOLOGY	18,956	0.29	9.7			
37. GERONTOLOGY	7,334	0.11	7.4			
D16 = 38. Dentistry, Oral Surgery	23,294	0.36	5.5	23,294	0.38	5.5
D17. Dermatology & Urogenital System				59,102	0.97	8.3
39. DERMATOLOGY	22,848	0.35	6.2			
40. UROLOGY & NEPHROLOGY	36,254	0.56	9.6			
D18. Ophthalmology & Otorhinolaryngology				47,410	0.78	6.1
41. OTORHINOLARYNGOLOGY	18,492	0.28	4.4			
42. OPHTHALMOLOGY	28,918	0.44	7.2			
D19 = 43 Integrative & Complementary Medicine	2,633	0.04	4.4	2,633	0.04	4.4
D20. Psychiatry & Neurology				110,370	1.81	10.1
44. CLINICAL NEUROLOGY	73,322	1.13	9.8			
45. PSYCHIATRY	47,038	0.72	9.9			
D21 = 46. Radiology, Nuclear Med. & Imaging	58,950	0.91	7.9	58,950	0.97	7.9
D22. Rheumatology & Orthopedics				55,519	0.91	7.1
47. ORTHOPEDICS	25,624	0.39	5.9			
48. RHEUMATOLOGY	11,821	0.18	11.5			
49. SPORT SCIENCES	22,548	0.35	6			
D23. Surgery				155,182	2.54	9.1
50. SURGERY	109,354	1.68	6.5			
51. TRANSPLANTATION	22,663	0.35	7			
P52. ERIPHERAL VASCULAR DISEASE	40,847	0.63	16.4			
D24 = 53. Pediatrics	45,506	0.7	5.9	45,506	0.75	5.9
V. CL. MED. III (HEALTH & OTHER SCS.)						114,753 2.1 5.9
D25. Health Sciences				105,469	1.73	6.2
54. HEALTH CARE SCIENCES & SERVICES	15,058	0.23	5.9			
55. HEALTH POLICY & SERVICES	9,388	0.14	6.3			
56. MEDICINE, LEGAL	4,565	0.07	4.5			
57. NURSING	9,105	0.14	3			
58. PUBLIC, ENVIRON. & OCCUP. HEALTH	56,693	0.87	7.4			
59. REHABILITATION	14,513	0.22	4.3			
60. SUBSTANCE ABUSE	8,382	0.13	7.6			
D26. Other Clinical Medicine				15,378	0.25	3.5
61. EDUCATION, SCIENTIFIC DISCIPLINES	8,371	0.13	2.9			
62. MEDICAL INFORMATICS	7,007	0.11	4.3			

VI. NEUROSCIENCE & BEHAVIOR				231,219	4.2	10.2
D27. Neurosciences & Psychopharmacology				129,562	2.12	13.4
63. NEUROIMAGING	6,826	0.1	10.9			
64. NEUROSCIENCES	125,782	1.93	13.6			
D28. Psychology & Behavioral Sciences				113,029	1.85	6.5
65. BEHAVIORAL SCIENCES	16,450	0.25	8.9			
66. PSYCHOLOGY, BIOLOGICAL	4,429	0.07	7.5			
67. PSYCHOLOGY	17,977	0.28	7.9			
68. PSYCHOLOGY, APPLIED	8,732	0.13	4.7			
69. PSYCHOLOGY, CLINICAL	18,978	0.29	7.5			
70. PSYCHOLOGY, DEVELOPMENTAL	10,994	0.17	7.8			
71. PSYCHOLOGY, EDUCATIONAL	5,601	0.09	5.2			
72. SYCHOLOGY, EXPERIMENTAL	17,565	0.27	7.6			
73. PSYCHOLOGY, MATHEMATICAL	1,930	0.03	5.1			
74. PSYCHOLOGY, MULTIDISCIPLINARY	19,785	0.3	4.9			
75. PSYCHOLOGY, PSYCHOANALYSIS	2,504	0.04	2.7			
76. PSYCHOLOGY, SOCIAL	10,717	0.16	6.3			
77. SOCIAL SCIENCES, BIOMEDICAL	6,669	0.1	5.4			
B. PHYSICAL SCIENCES						
VII. CHEMISTRY				580,050	10.5	7.3
D29 = 78. Chemistry, Multidisciplinary				107,816	1.66	8.9
D30. Analytical, Inorganic & Nuclear Chemistry				125,780	2.06	7.3
79. CHEMISTRY, INORGANIC & NUCLEAR	55,337	0.85	6.7			
80. CHEMISTRY, ANALYTICAL	73,439	1.13	7.5			
D31. Applied Chemistry & Chemical Engineering				95,175	1.56	4.7
81. CHEMISTRY, APPLIED	37,068	0.57	5.6			
82. ENGINEERING, CHEMICAL	64,146	0.99	4.3			
D32. Organic & Medicinal Chemistry ,				105,557	1.73	7.8
83. CHEMISTRY, MEDICINAL	27,721	0.43	7.5			
84. CHEMISTRY, ORGANIC	84,274	1.29	7.9			
D33. Physical Chemistry				165,622	2.71	7.8
85. CHEMISTRY, PHYSICAL	143,582	2.2	7.8			
86. ELECTROCHEMISTRY	22,040	0.34	7.6			
D34 = 87. Polymer Science				61,649	1.01	6.2
VIII. PHYSICS				610,826	11.0	7.1
D35. Multidisciplinary Physics				136,906	2.24	8.4
88. PHYSICS, MULTIDISCIPLINARY	101,780	1.56	9.3			
89. SPECTROSCOPY	35,126	0.54	5.8			
D36. Applied Physics				208,980	3.42	5.7
90. ACOUSTICS	15,991	0.25	4			
91. OPTICS	61,373	0.94	5.6			
92. PHYSICS, APPLIED	143,531	2.2	5.8			
D37 = 93. Physics, Atomic, Molecular & Chemical				74,351	1.22	8.6
D38 = 94. Thermodynamics (Classical Physics)				19,276	0.32	3.5
D39 = 95. Physics, Mathematical				41,061	0.67	5.9
D40. Particle & Nuclear Physics				74,155	1.21	8.8
96. PHYSICS, NUCLEAR	33,146	0.51	5.6			
97. PHYSICS, PARTICLES & FIELDS	50,532	0.78	10			

D41. Physics of Solids, Fluids & Plasmas				160,097	2.62	6.0			
98. PHYSICS, CONDENSED MATTER	130,377	2	5.7						
99. PHYSICS OF SOLIDS, FLUIDS & PLASMAS	29,720	0.46	7.3						
IX. SPACE SCIENCES							82,073	1.5	12.5
D42 = 100. Astronomy & Astrophysics ,	82,073	1.26	12.5	82,073	1.34	12.5			
X. MATHEMATICS							163,098	2.9	3.0
D43. Applied Mathematics				106,187	1.74	3.5			
101. MATHEMATICS, APPLIED	61,964	0.95	2.8						
102. STATISTICS & PROBABILITY	27,188	0.42	4.7						
103. MATHEMATICS, INTERDISC. APPL.	19,976	0.31	4.2						
104. SOCIAL SCIENCES, MATH. METHODS	6,078	0.09	4.3						
D44 = 105. Pure Mathematics	76,078	1.17	2.1	76,078	1.25	2.1			
XI. COMPUTER SCIENCE							132,264	2.4	3.5
D45. Computer Science & Information Tech.				132,264	2.17	3.5			
106. COMP. SC., ARTIFICIAL INTELLIGENCE	26,462	0.41	4						
107. COMPUTER SCIENCE, CYBERNETICS	4,865	0.07	2.7						
108. COMP. SC., HARDWARE & ARCHITECTURE	14,163	0.22	3.2						
109. COMP. SC., INFORMATION SYSTEMS	22,925	0.35	3.5						
110. COMP. SC., INTERDIS. APPLICATIONS	30,920	0.47	4.8						
111. COMP. SC., SOFTWARE ENGINEERING	19,570	0.3	2.8						
112. COMP. SC., THEORY & METHODS	37,783	0.58	2.5						
113. MATHEMATICAL & COMPUT. BIOLOGY	8,621	0.13	9						
C. OTHER NATURAL SCIENCES									
XII. ENGINEERING							392,455	7.1	3.5
D46. Electrical & Electronic Engineering				135,308	2.22	3.6			
114. ENG., ELECTRICAL & ELECTRONIC	131,115	2.01	3.6						
115. TELECOMMUNICATIONS	21,591	0.33	2.9						
D47. Civil Engineering				49,282	0.81	4.2			
116. ONSTRUCTION & BUILDING TECH.	9,010	0.14	2.4						
117. ENGINEERING, CIVIL	23,183	0.36	2.4						
118. ENGINEERING, ENVIRONMENTAL	22,096	0.34	6.6						
119. ENGINEERING, MARINE	417	0.01	1						
120. TRANSPORTATION SC. & TECHNOLOGY	6,365	0.1	1.5						
D48. Mechanical Engineering				99,768	1.63	3.1			
121. ENGINEERING, INDUSTRIAL	13,858	0.21	2.2						
122. ENGINEERING, MANUFACTURING	14,516	0.22	2.4						
123. ENGINEERING, MECHANICAL	40,995	0.63	2.9						
124. MECHANICS	48,002	0.74	3.8						
125. ROBOTICS	3,231	0.05	2.6						
D49. Instruments & Instrumentation				48,605	0.80	4.1			
126. INSTRUMENTS & INSTRUMENTATION	43,348	0.67	3.9						
127. IMAGING SC. & PHOTOGRAPHIC TECH.	5,449	0.08	5.6						
D50. Fuel & Energy				69,897	1.14	3.4			
128. ENERGY & FUELS	26,298	0.4	3.5						
129. NUCLEAR SCIENCE & TECHNOLOGY	42,406	0.65	3.4						
130. ENGINEERING, PETROLEUM	6,974	0.11	1.2						
D51. Other Engineering				60,713	0.99	3.0			

131. AUTOMATION & CONTROL SYSTEMS	18,140	0.28	3			
132. ENGINEERING, MULTIDISCIPLINARY	22,062	0.34	2.8			
133. ERGONOMICS	3,299	0.05	3.3			
134. OPERATIONS RES. & MANAG. SCIENCE	20,897	0.32	2.8			
XIII. MATERIALS SCIENCE					138,254	2.5 4.3
D52. Materials Science				138,254	2.26	4.3
135. MATERIALS SCIENCE, BIOMATERIALS	7,382	0.11	9.6			
136. MATERIALS SCIENCE, CERAMICS	21,255	0.33	3.5			
137. MAT. SC., CHARAC. & TESTING	6,606	0.1	1.5			
138. MAT. SC., COATINGS & FILMS	24,592	0.38	5.5			
139. MATERIALS SCIENCE, COMPOSITES	10,368	0.16	2.5			
140. MATERIALS SCIENCE, PAPER & WOOD	6,577	0.1	2			
141. MATERIALS SCIENCE, TEXTILES	4,923	0.08	2			
142. METALLURGY & METALL. ENGIN.	42,534	0.65	3.5			
143. NANOSCIENCE & NANOTECHNOLOGY	22,069	0.34	5.8			
XIV. GEOSCIENCES					137,187	2.5 6.6
D53. Geosciences & Technology				64,682	1.06	6.6
144. GEOCHEMISTRY & GEOPHYSICS	32,728	0.5	7.6			
145. GEOGRAPHY, PHYSICAL	10,440	0.16	6.9			
146. GEOLOGY	9,447	0.15	6.1			
147. ENGINEERING, GEOLOGICAL	5,253	0.08	2.7			
148. PALEONTOLOGY	8,039	0.12	4.9			
149. REMOTE SENSING	5,869	0.09	5.6			
D54. Hydrology & Oceanography				24,878	0.41	7.2
150. OCEANOGRAPHY	22,387	0.34	7.7			
151. ENGINEERING, OCEAN	3,725	0.06	2.9			
D55 Meteo., Atmosph., Aero., Sc. & Tech.				42,560	0.70	6.7
152. METEOROLOGY & ATMOSPH. SCS.	33,043	0.51	8.2			
153. ENGINEERING, AEROSPACE	12,910	0.2	1.8			
D56. Mineralogy & Petrology				14,782	0.24	4.7
154. MINERALOGY	9,038	0.14	5.5			
155. MINING & MINERAL PROCESSING	7,333	0.11	3.1			
XV. AGRICULT. & ENVIRONMENT					235,573	4.3 5.6
D57. Agricultural Science & Technology				46,943	0.77	4.5
156. AGRICULTURAL ENGINEERING	4,880	0.07	3.3			
157. AGRICULTURE, MULTIDISCIPLINARY	15,859	0.24	4.8			
158. AGRONOMY	26,490	0.41	4.5			
D58. Plant & Soil Science & Tech,				22,045	0.36	5.7
159. LIMNOLOGY	6,362	0.1	7.2			
160. SOIL SCIENCE	15,683	0.24	5.1			
D59. Environmental Science & Technology				91,032	1.49	6.2
161. BIODIVERSITY CONSERVATION	7,186	0.11	6.5			
162. ENVIRONMENTAL SCIENCES	78,593	1.21	6.7			
163. ENVIRONMENTAL STUDIES	10,681	0.16	3.6			
D60. Food & Animal Science & Technology				98,654	1.62	5.6
164. FOOD SCIENCE & TECHNOLOGY	46,497	0.71	5.1			
165. NUTRITION & DIETETICS	23,879	0.37	8.5			
166. AGRIC., DAIRY & ANIMAL SCIENCE	23,741	0.36	3.8			

167. HORTICULTURE	11,415	0.18	4.8			
XVI. BIOLOGY (ORGANISMIC AND SUPRAORG. LEVEL)				404,113	7.3	7.3
D61. Animal Sciences				65,071	1.07	5.0
168. ORNITHOLOGY	4,902	0.08	4.2			
169. ZOOLOGY	38,570	0.59	5.6			
170. ENTOMOLOGY	21,639	0.33	4			
D62. Aquatic Sciences ,				73,019	1.20	5.3
171. WATER RESOURCES	28,222	0.43	4.4			
172. FISHERIES	17,207	0.26	5.3			
173. MARINE & FRESHWATER BIOLOGY	37,027	0.57	6.1			
D63. Microbiology				100,770	1.65	11.5
174. MICROBIOLOGY	63,814	0.98	11.2			
175. PARASITOLOGY	13,268	0.2	6.2			
176. VIROLOGY	24,543	0.38	15.1			
D64. Plant Sciences				91,487	1.50	7.0
177. FORESTRY	12,289	0.19	5.4			
178. MYCOLOGY	6,973	0.11	5.3			
179. PLANT SCIENCES	73,854	1.13	7.5			
D65 = 180. Pure and Applied Ecology	46,672	0.72	8.6	46,672	0.76	8.6
D66 = 181. VETERINARY SCIENCES	54,380	0.84	3.8	54,380	0.89	3.8
XVII. MULTIDISCIPLINARY						
D67 = 182. MULTIDISCIPLINARY SCIENCES	27,961	0.43	3.2	27,961	0.46	3.2
XVIII. RESIDUAL SUB-FIELDS						
D68 = 183. MATERIALS SCIENCE, MULT.	153,666	2.36	4.9	153,666	2.52	4.9
D69 = 184. CRYSTALLOGRAPHY	32,344	0.5	4.4	32,344	0.53	4.4
D70 = 185. GEOSCIENCES, MULT.	54,564	0.84	5.6	54,564	0.89	5.6
D71 = 186. MED., RES. & EXPERIMENTAL	48,413	0.74	14.7	48,413	0.79	14.7
D.SOCIALSCIENCES						
XIX. SOCIAL SCIENCES, GENERAL				129,000	2.3	3.0
D72. Law & Criminology				12,480	0.20	3.5
187. CRIMINOLOGY & PENOLOGY	3,259	0.05	3.5			
188. LAW	9,714	0.15	3.4			
D73. Political Science & Public Administration				15,769	0.26	2.4
P189. OLITICAL SCIENCE	12,582	0.19	2.4			
P190. UBLIC ADMINISTRATION	3,595	0.06	2.5			
D74. Sociology & Other Social Studies				28,575	0.47	3.0
191. ETHNIC STUDIES	817	0.01	1.9			
192. FAMILY STUDIES	5,268	0.08	4.2			
193. SOCIAL ISSUES	4,257	0.07	2.6			
194. SOCIAL WORK	4,956	0.08	2.7			
195. SOCIOLOGY	12,668	0.19	3			
196. WOMEN'S STUDIES	3,757	0.06	2.8			
D75. Education				18,810	0.31	2.6
197. EDUCATION & EDUCATIONAL RES.	15,755	0.24	2.4			
198. EDUCATION, SPECIAL	3,055	0.05	3.7			

D76. Geography, Planning & Urban				20,550	0.34	3.2			
199. AREA STUDIES	3,491	0.05	1.4						
200. GEOGRAPHY	5,876	0.09	4.3						
201. PLANNING & DEVELOPMENT	6,403	0.1	3.1						
202. TRANSPORTATION	2,100	0.03	3.5						
2003 URBAN STUDIES	4,856	0.07	3.1						
D77. Ethics				3,948	0.06	2.5			
204. ETHICS	3,667	0.06	2.4						
205. MEDICAL ETHICS	972	0.01	3.8						
D78. Other Social Sciences				44,619	0.73	3.0			
206. ANTHROPOLOGY	6,884	0.11	3.2						
207. COMMUNICATION	5,052	0.08	3						
208. DEMOGRAPHY	2,364	0.04	4.2						
209. HISTORY OF SOCIAL SCIENCES	1,346	0.02	1.4						
210. INFORMATION SC. & LIBRARY SC.	9,167	0.14	2.9						
211. INTERNATIONAL RELATIONS	6,460	0.1	2.3						
212. LINGUISTICS	6,031	0.09	4.3						
213. SOCIAL SCIENCES, INTERD.	8,996	0.14	2.4						
XX. ECONOMICS & BUSINESS							65,360	1.2	3.9
D79. Economics				42,067	0.69	3.6			
214. AGRICULTURAL ECONOMICS & POLICY	2,034	0.03	2.6						
215. ECONOMICS	40,420	0.62	3.6						
216. INDUSTRIAL RELATIONS & LABOR	2,197	0.03	3.3						
D80. Business & Management				28,360	0.46	4.6			
217. BUSINESS	10,516	0.16	5.1						
218. BUSINESS, FINANCE	6,982	0.11	4.9						
219. MANAGEMENT	14,854	0.23	4.7						
ALL CATEGORIES	6,512,031	100	8	6,107,509	100.0	-	5,538,760	100.0	-

Table B. Publication Effort By Geographical Areas In the Double Extended Counts For Sub-fields, Disciplines, and Fields

	SUB-FIELDS			DISCIPLINES			FIELDS		
	U.S. RW	EU Articles	RW %	U.S. MCR	EU	RW	U.S.	EU	
	(1) (9)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
I. BIOSCIENCES							8.9	7.8	6.8
D1. Multidisciplinary Biology				0.75	0.67	0.66			
1. BIOLOGY	0.43	0.41	0.45						
2. BIOLOGY, MISCELLANEOUS	0.01	0.01	0.01						
3. EVOLUTIONARY BIOLOGY	0.25	0.22	0.17						
D2. Biochemistry, Biophysics, Mol. Biology				5.39	4.75	4.17			
4. BIOCHEMICAL RESEARCH METHODS	0.58	0.67	0.49						
5. BIOCHEMISTRY & MOLECULAR BIOLOGY	4.42	3.77	3.41						
6. BIOPHYSICS	0.83	0.87	0.89						
D3 = 7. Cell Biology	1.85	1.52	1.21	1.99	1.62	1.28			
D4. Genetics & Development Biology				1.84	1.58	1.19			
8. GENETICS & HEREDITY	1.36	1.23	0.92						
9. DEVELOPMENTAL BIOLOGY	0.42	0.29	0.22						
II. BIOMEDICAL RESEARCH							6.0	5.9	5.5
D5. Anatomy & Pathology				0.65	0.70	0.58			
10. PATHOLOGY	0.52	0.54	0.45						
11. ANATOMY & MORPHOLOGY	0.09	0.13	0.1						
D6. Biomaterials & Bioengineering				1.40	1.58	1.49			
12. ENGINEERING, BIOMEDICAL	0.35	0.38	0.27						
13. BIOTECH. & APPLIED MICROBIOLOGY	0.95	1.1	1.14						
D7. Experimental & Laboratory Medicine				0.29	0.27	0.21			
14. MEDICAL LABORATORY TECHNOLOGY	0.21	0.17	0.13						
15. MICROSCOPY	0.06	0.08	0.07						
D8 Pharmacology & Toxicology				2.25	2.23	2.24			
16. PHARMACOLOGY & PHARMACY	1.62	1.74	1.75						
17. TOXICOLOGY	0.64	0.48	0.47						
D9 = 18. Physiology	1.01	0.66	0.64	1.09	0.70	0.68			
III. CLINICAL MEDICINE I (INTERNAL)							10.1	10.6	7.3
D10. Cardiovascular & Respiratory Medicine				1.58	1.48	0.95			
19. CARDIAC & CARDIOVASCULAR SYSTEMS	1.11	1.05	0.68						
20. RESPIRATORY SYSTEM	0.56	0.55	0.35						
D11 = 21. Endocrinology & Metabolism	0.92	1.02	0.66	0.99	1.09	0.70			
D12. General & Internal Medicine				2.38	2.82	2.18			
22. ANESTHESIOLOGY	0.24	0.4	0.2						
23. CRITICAL CARE MEDICINE	0.25	0.27	0.15						
24. EMERGENCY MEDICINE	0.19	0.11	0.04						
25. GASTROENTEROLOGY & HEPATOLOGY	0.49	0.71	0.55						
26. MEDICINE, GENERAL & INTERNAL	0.99	1.15	0.92						

27. TROPICAL MEDICINE	0.06	0.11	0.23			
D13. Hematology & Oncology				2.50	2.44	1.63
28. HEMATOLOGY	0.81	0.9	0.51			
29. ONCOLOGY	1.63	1.54	1.12			
D14. Immunology				2.21	2.12	1.46
30. ALLERGY	0.12	0.23	0.11			
31. IMMUNOLOGY	1.74	1.55	1.14			
32. INFECTIOUS DISEASES	0.75	0.64	0.4			
IV. CL. MEDICINE II (NON-INTERNAL)						11.6 11. 7.6
D15. Age & Gender Related Medicine				1.17	1.07	0.76
33. GERIATRICS & GERONTOLOGY	0.24	0.16	0.09			
34. OBSTETRICS & GYNECOLOGY	0.56	0.65	0.42			
35. ANDROLOGY	0.02	0.02	0.03			
36. REPRODUCTIVE BIOLOGY	0.26	0.35	0.26			
37. GERONTOLOGY	0.23	0.08	0.05			
D16 = 38. Dentistry, Oral Surgery	0.36	0.38	0.33	0.39	0.41	0.36
D17. Dermatology & Urogenital System				1.02	1.20	0.73
39. DERMATOLOGY	0.33	0.48	0.26			
40. UROLOGY & NEPHROLOGY	0.62	0.65	0.43			
D18. Ophthalmology & Otorhinolaryngology				0.98	0.82	0.59
41. OTORHINOLARYNGOLOGY	0.36	0.32	0.2			
42. OPHTHALMOLOGY	0.55	0.45	0.36			
D19 = 43 Integrative & Complementary Medicine	0.03	0.03	0.06	0.03	0.03	0.06
D20. Psychiatry & Neurology				2.15	2.08	1.32
44. CLINICAL NEUROLOGY	1.17	1.35	0.9			
45. PSYCHIATRY	0.95	0.81	0.47			
D21 = 46. Radiology, Nuclear Med. & Imaging	1.05	1.06	0.67	1.13	1.12	0.71
D22. Rheumatology & Orthopedics				1.22	0.97	0.62
47. ORTHOPEDICS	0.55	0.41	0.26			
48. RHEUMATOLOGY	0.15	0.26	0.14			
49. SPORT SCIENCES	0.54	0.31	0.23			
D23. Surgery				2.92	2.77	2.06
50. SURGERY	1.93	1.77	1.41			
51. TRANSPLANTATION	0.35	0.41	0.29			
P52. ERIPHERAL VASCULAR DISEASE	0.75	0.73	0.44			
D24 = 53. Pediatrics	0.85	0.72	0.57	0.92	0.76	0.60
V. CL. MED. III (HEALTH & OTHER SCS.)						3.4 1.7 1.4
D25. Health Sciences				2.79	1.45	1.16
54. HEALTH CARE SCIENCES & SERVICES	0.41	0.2	0.12			
55. HEALTH POLICY & SERVICES	0.34	0.07	0.06			
56. MEDICINE, LEGAL	0.08	0.08	0.05			
57. NURSING	0.28	0.1	0.06			
58. PUBLIC, ENVIRON. & OCCUP. HEALTH	1.21	0.78	0.69			
59. REHABILITATION	0.42	0.16	0.12			
60. SUBSTANCE ABUSE	0.26	0.09	0.06			
D26. Other Clinical Medicine				0.44	0.21	0.14
61. EDUCATION, SCIENTIFIC DISCIPLINES	0.27	0.07	0.07			
62. MEDICAL INFORMATICS	0.14	0.13	0.07			

VI. NEURO, SCIENCE & BEHAVIOR							6.1	3.9	2.9
D27. Neurosciences & Psychopharmacology				2.56	2.22	1.71			
63. NEUROIMAGING	0.12	0.13	0.07						
64. NEUROSCIENCES	2.32	2.02	1.56						
D28. Psychology & Behavioral Sciences				3.21	1.55	1.08			
65. BEHAVIORAL SCIENCES	0.35	0.26	0.17						
66. PSYCHOLOGY, BIOLOGICAL	0.11	0.06	0.04						
67. PSYCHOLOGY	0.43	0.28	0.16						
68. PSYCHOLOGY, APPLIED	0.29	0.08	0.06						
69. PSYCHOLOGY, CLINICAL	0.61	0.21	0.12						
70. PSYCHOLOGY, DEVELOPMENTAL	0.35	0.11	0.08						
71. PSYCHOLOGY, EDUCATIONAL	0.17	0.05	0.05						
72. SYCHOLOGY, EXPERIMENTAL	0.4	0.28	0.16						
73. PSYCHOLOGY, MATHEMATICAL	0.06	0.02	0.02						
74. PSYCHOLOGY, MULTIDISCIPLINARY	0.51	0.23	0.21						
75. PSYCHOLOGY, PSYCHOANALYSIS	0.07	0.05	0.01						
76. PSYCHOLOGY, SOCIAL	0.31	0.12	0.09						
77. SOCIAL SCIENCES, BIOMEDICAL	0.13	0.08	0.09						
VII. CHEMISTRY							6.7	10.	13.
D29 = 78. Chemistry, Multidisciplinary	1.02	1.21	2.52	1.10	1.29	2.67			
D30. Analytical, Inorganic & Nuclear Chemistry				1.28	2.34	2.41			
79. CHEMISTRY, INORGANIC & NUCLEAR	0.46	1.01	1.01						
80. CHEMISTRY, ANALYTICAL	0.75	1.22	1.34						
D31. Applied Chemistry & Chemical Engineering				1.02	1.50	2.01			
81. CHEMISTRY, APPLIED	0.33	0.56	0.76						
82. ENGINEERING, CHEMICAL	0.66	0.93	1.28						
D32. Organic & Medicinal Chemistry ,				1.23	1.77	2.07			
83. CHEMISTRY, MEDICINAL	0.37	0.37	0.51						
84. CHEMISTRY, ORGANIC	0.9	1.39	1.52						
D33. Physical Chemistry				1.65	2.84	3.40			
85. CHEMISTRY, PHYSICAL	1.35	2.37	2.72						
86. ELECTROCHEMISTRY	0.19	0.31	0.48						
D34 = 87. Polymer Science	0.52	0.82	1.38	0.56	0.87	1.46			
VIII. PHYSICS							8.1	10.	13.
D35. Multidisciplinary Physics				1.43	2.19	2.90			
88. PHYSICS, MULTIDISCIPLINARY	0.92	1.49	2.11						
89. SPECTROSCOPY	0.41	0.57	0.62						
D36. Applied Physics				2.66	3.02	4.33			
90. ACOUSTICS	0.25	0.25	0.24						
91. OPTICS	0.75	0.91	1.12						
92. PHYSICS, APPLIED	1.59	1.88	2.95						
D37 = 93. Physics, Atomic, Molecular & Chemical	0.93	1.28	1.19	1.00	1.36	1.26			
D38 = 94. Thermodynamics (Classical Physics)	0.24	0.25	0.38	0.26	0.27	0.40			
D39 = 95. Physics, Mathematical	0.46	0.69	0.71	0.49	0.74	0.75			
D40. Particle & Nuclear Physics				0.92	1.34	1.34			
96. PHYSICS, NUCLEAR	0.32	0.53	0.63						
97. PHYSICS, PARTICLES & FIELDS	0.6	0.85	0.85						
D41. Physics of Solids, Fluids & Plasmas				1.67	2.82	3.17			
98. PHYSICS, CONDENSED MATTER	1.11	2.18	2.54						

99. PHYSICS OF SOLIDS, FLUIDS & PLASMAS	0.44	0.48	0.45						
IX. SPACE SCIENCES							1.6	1.6	1.3
D42 = 100. Astronomy & Astrophysics	1.36	1.35	1.11	1.46	1.44	1.18			
X. MATHEMATICS							2.7	3.0	3.1
D43. Applied Mathematics				1.64	1.80	1.76			
101. MATHEMATICS, APPLIED	0.77	0.98	1.06						
102. STATISTICS & PROBABILITY	0.48	0.41	0.37						
103. MATHEMATICS, INTERDISC. APPL.	0.29	0.34	0.3						
104. SOCIAL SCIENCES, MATH. METHODS	0.13	0.11	0.06						
D44 = 105. Pure Mathematics	0.94	1.16	1.35	1.01	1.23	1.43			
XI. COMPUTER SCIENCE							2.5	2.5	2.2
D45. Computer Science & Information Tech.				2.31	2.27	1.96			
106. COMP. SC., ARTIFICIAL INTELLIGENCE	0.37	0.45	0.4						
107. COMPUTER SCIENCE, CYBERNETICS	0.06	0.07	0.09						
108. COMP. SC., HARDWARE & ARCHITECTURE	0.3	0.15	0.21						
109. COMP. SC., INFORMATION SYSTEMS	0.44	0.29	0.34						
110. COMP. SC., INTERDIS. APPLICATIONS	0.51	0.47	0.45						
111. COMP. SC., SOFTWARE ENGINEERING	0.38	0.27	0.27						
112. COMP. SC., THEORY & METHODS	0.54	0.72	0.49						
113. MATHEMATICAL & COMPUT. BIOLOGY	0.18	0.13	0.1						
XII. ENGINEERING							6.7	6.3	8.0
D46. Electrical & Electronic Engineering				2.27	1.85	2.49			
114. ENG., ELECTRICAL & ELECTRONIC	2.03	1.67	2.29						
115. TELECOMMUNICATIONS	0.36	0.26	0.37						
D47. Civil Engineering				0.93	0.70	0.81			
116. ONSTRUCTION & BUILDING TECH.	0.13	0.13	0.15						
117. ENGINEERING, CIVIL	0.43	0.27	0.38						
118. ENGINEERING, ENVIRONMENTAL	0.38	0.33	0.32						
119. ENGINEERING, MARINE	0.01	0.01	0.01						
120. TRANSPORTATION SC. & TECHNOLOGY	0.16	0.06	0.08						
D48. Mechanical Engineering				1.53	1.41	1.90			
121. ENGINEERING, INDUSTRIAL	0.23	0.16	0.25						
122. ENGINEERING, MANUFACTURING	0.19	0.17	0.29						
123. ENGINEERING, MECHANICAL	0.6	0.5	0.76						
124. MECHANICS	0.61	0.71	0.86						
125. ROBOTICS	0.05	0.05	0.06						
D49. Instruments & Instrumentation				0.65	0.82	0.88			
126. INSTRUMENTS & INSTRUMENTATION	0.52	0.7	0.75						
127. IMAGING SC. & PHOTOGRAPHIC TECH.	0.09	0.08	0.08						
D50. Fuel & Energy				0.83	1.10	1.42			
128. ENERGY & FUELS	0.32	0.34	0.52						
129. NUCLEAR SCIENCE & TECHNOLOGY	0.42	0.69	0.8						
130. ENGINEERING, PETROLEUM	0.13	0.06	0.13						
D51. Other Engineering				0.99	0.91	1.07			
131. UTOMATION & CONTROL SYSTEMS	0.23	0.27	0.32						
132. ENGINEERING, MULTIDISCIPLINARY	0.34	0.28	0.38						
133. ERGONOMICS	0.06	0.06	0.04						

134. OPERATIONS RES. & MANAG. SCIENCE	0.35	0.3	0.32						
XIII. MATERIALS SCIENCE							1.6	2.2	3.4
D52. Materials Science				1.41	2.03	3.10			
135. MATERIALS SCIENCE, BIOMATERIALS	0.1	0.13	0.11						
136. MATERIALS SCIENCE, CERAMICS	0.14	0.3	0.49						
137. MAT. SC., CHARAC. & TESTING	0.07	0.08	0.14						
138. MAT. SC., COATINGS & FILMS	0.25	0.37	0.48						
139. MATERIALS SCIENCE, COMPOSITES	0.11	0.14	0.21						
140. MATERIALS SCIENCE, PAPER & WOOD	0.08	0.1	0.11						
141. MATERIALS SCIENCE, TEXTILES	0.05	0.05	0.12						
142. METALLURGY & METALL. ENGIN.	0.3	0.49	1.06						
143. NANOSCIENCE & NANOTECHNOLOGY	0.29	0.34	0.37						
XIV. GEOSCIENCES							2.6	2.5	2.4
D53. Geosciences & Technology				0.99	1.11	1.07			
144. GEOCHEMISTRY & GEOPHYSICS	0.49	0.53	0.49						
145. GEOGRAPHY, PHYSICAL	0.14	0.18	0.15						
146. GEOLOGY	0.13	0.15	0.16						
147. ENGINEERING, GEOLOGICAL	0.07	0.07	0.1						
148. PALEONTOLOGY	0.09	0.15	0.13						
149. REMOTE SENSING	0.11	0.09	0.08						
D54. Hydrology & Oceanography				0.42	0.40	0.40			
150. OCEANOGRAPHY	0.34	0.35	0.34						
151. ENGINEERING, OCEAN	0.08	0.04	0.06						
D55. Meteo., Atmosph., Aero., Sc. & Tech.				0.92	0.63	0.59			
152. METEOROLOGY & ATMOSPH. SCS.	0.63	0.48	0.44						
153. ENGINEERING, AEROSPACE	0.27	0.16	0.18						
D56. Mineralogy & Petrology				0.16	0.23	0.31			
154. MINERALOGY	0.09	0.16	0.16						
155. MINING & MINERAL PROCESSING	0.08	0.08	0.17						
XV. AGRIC. AND ENVIRONMENT							4.0	4.2	4.5
D57. Agricultural Science & Technology				0.61	0.70	0.95			
156. AGRICULTURAL ENGINEERING	0.09	0.06	0.07						
157. AGRICULTURE, MULTIDISCIPLINARY	0.12	0.26	0.32						
158. AGRONOMY	0.35	0.34	0.5						
D58. Plant & Soil Science & Tech,				0.35	0.36	0.37			
159. LIMNOLOGY	0.13	0.08	0.08						
160. SOIL SCIENCE	0.19	0.25	0.27						
D59. Environmental Science & Technology				1.63	1.50	1.38			
161. BIODIVERSITY CONSERVATION	0.15	0.09	0.1						
162. ENVIRONMENTAL SCIENCES	1.26	1.22	1.15						
163. ENVIRONMENTAL STUDIES	0.21	0.18	0.12						
D60. Food & Animal Science & Technology				1.37	1.69	1.74			
164. FOOD SCIENCE & TECHNOLOGY	0.5	0.82	0.79						
165. NUTRITION & DIETETICS	0.4	0.41	0.31						
166. AGRIC., DAIRY & ANIMAL SCIENCE	0.3	0.33	0.45						
167. HORTICULTURE	0.17	0.15	0.2						
XVI. BIOLOGY							7.0	7.3	7.5

D61. Animal Sciences				1.24	0.89	1.08			
168. ORNITHOLOGY	0.09	0.07	0.06						
169. ZOOLOGY	0.64	0.52	0.62						
170. ENTOMOLOGY	0.42	0.24	0.34						
D62. Aquatic Sciences ,				1.06	1.21	1.29			
171. WATER RESOURCES	0.39	0.44	0.46						
172. FISHERIES	0.22	0.2	0.35						
173. MARINE & FRESHWATER BIOLOGY	0.47	0.64	0.59						
D63. Microbiology				1.61	1.89	1.48			
174. MICROBIOLOGY	0.88	1.19	0.88						
175. PARASITOLOGY	0.14	0.2	0.26						
176. VIROLOGY	0.49	0.41	0.27						
D64. Plant Sciences				1.16	1.50	1.75			
177. FORESTRY	0.2	0.19	0.17						
178. MYCOLOGY	0.07	0.12	0.12						
179. PLANT SCIENCES	0.82	1.13	1.38						
D65 = 180. Pure and Applied Ecology	0.87	0.66	0.65	0.93	0.70	0.69			
D66 = 181. VETERINARY SCIENCES	0.79	0.82	0.88	0.85	0.87	0.93			
XVII. MULTIDISCIPLINARY							0.4	0.4	0.7
D67 = 182. MULTIDISCIPLINARY SCIENCES	0.33	0.3	0.61	0.36	0.32	0.65			
XVIII. RESIDUAL SUB-FIELDS							3.8	5.0	6.4
D68 = 183. MATERIALS SCIENCE, MULT.	1.36	2.23	3.23	1.46	2.37	3.43			
D69 = 184. CRYSTALLOGRAPHY	0.22	0.52	0.69	0.24	0.55	0.73			
D70 = 185. GEOSCIENCES, MULT.	0.74	0.83	0.92	0.79	0.88	0.98			
D71 = 186. MED., RES. & EXPERIMENTAL	0.89	0.7	0.67	0.96	0.74	0.71			
XIX. SOCIAL SCIENCES, GENERAL							4.3	1.8	1.3
D72. Law & Criminology				0.52	0.10	0.06			
187. CRIMINOLOGY & PENOLOGY	0.08	0.05	0.03						
188. LAW	0.41	0.06	0.03						
D73. Political Science & Public Administration				0.47	0.22	0.14			
189. POLITICAL SCIENCE	0.35	0.16	0.1						
190. PUBLIC ADMINISTRATION	0.09	0.05	0.03						
D74. Sociology & Other Social Studies				0.91	0.30	0.27			
191. ETHNIC STUDIES	0.03	0.01	0						
192. FAMILY STUDIES	0.2	0.03	0.03						
193. SOCIAL ISSUES	0.12	0.05	0.04						
194. SOCIAL WORK	0.17	0.04	0.04						
195. SOCIOLOGY	0.31	0.15	0.14						
196. WOMEN'S STUDIES	0.13	0.03	0.03						
D75. Education				0.67	0.19	0.14			
197. EDUCATION & EDUCATIONAL RES.	0.5	0.15	0.12						
198. EDUCATION, SPECIAL	0.12	0.02	0.01						
D76. Geography, Planning & Urban				0.46	0.35	0.23			
199. AREA STUDIES	0.08	0.03	0.05						
200. GEOGRAPHY	0.1	0.13	0.06						
201. PLANNING & DEVELOPMENT	0.12	0.11	0.07						
202. TRANSPORTATION	0.05	0.03	0.03						
2003 URBAN STUDIES	0.13	0.06	0.04						

D77. Ethics				0.12	0.05	0.04			
204. ETHICS	0.11	0.03	0.04						
205. MEDICAL ETHICS	0.02	0.02	0.01						
D78. Other Social Sciences				1.30	0.59	0.42			
206. ANTHROPOLOGY	0.16	0.08	0.09						
207. COMMUNICATION	0.17	0.05	0.03						
208. DEMOGRAPHY	0.06	0.03	0.02						
209. HISTORY OF SOCIAL SCIENCES	0.03	0.02	0.01						
210. INFORMATION SC. & LIBRARY SC.	0.27	0.11	0.07						
211. INTERNATIONAL RELATIONS	0.15	0.1	0.06						
212. LINGUISTICS	0.17	0.07	0.05						
213. SOCIAL SCIENCES, INTERD.	0.25	0.11	0.07						
XX. ECONOMICS & BUSINESS							1.9	1.1	0.7
D79. Economics				1.06	0.67	0.42			
214. AGRICULTURAL ECONOMICS & POLICY	0.06	0.02	0.02						
215. ECONOMICS	0.93	0.62	0.38						
216. INDUSTRIAL RELATIONS & LABOR	0.07	0.02	0.02						
D80. Business & Management				0.87	0.36	0.25			
217. BUSINESS	0.33	0.1	0.08						
218. BUSINESS, FINANCE	0.24	0.06	0.04						
219. MANAGEMENT	0.35	0.22	0.14						
ALL CATEGORIES	100	100	100	100	100	100	100	100	100

Table C. Publication Shares By Geographical Areas In the Double Extended Counts For Disciplines, and Fields

	DISCIPLINES				FIELDS			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>I. BIOSCIENCES</i>					33.3	32.8	33.9	100.0
D1. Multidisciplinary Biology	31.4	31.7	36.9	100.0				
D2. Bioch., Biophysics & Molecular Biology	33.1	32.8	34.0	100.0				
D3. Cell Biology	36.2	32.9	30.9	100.0				
D4. Genetics & Development Biology	35.3	34.3	30.4	100.0				
<i>II. BIOMEDICAL RESEARCH</i>					30.1	33.1	36.7	100.0
D5. Anatomy & Pathology	29.5	35.7	34.8	100.0				
D6. Biomaterials & Bioengineering	27.1	34.4	38.5	100.0				
D7. Experimental & Laboratory Medicine	32.8	34.9	32.3	100.0				
D8. Pharmacology & Toxicology	29.2	32.4	38.4	100.0				
D9. Physiology	39.0	28.5	32.5	100.0				
<i>III. CLINICAL MEDICINE I (INTERNAL)</i>					31.9	37.3	30.7	100.0
D10. Cardiovascular & Respiratory Medicine	35.1	36.9	27.9	100.0				
D11. Endocrinology & Metabolism	31.4	38.9	29.7	100.0				
D12. General & Internal Medicine	28.2	37.5	34.3	100.0				
D13. Hematology & Oncology	33.8	37.0	29.2	100.0				
D14. Immunology	33.8	36.5	29.7	100.0				
<i>IV. CL. MEDICINE II (NON-INTERNAL)</i>					34.0	36.6	29.5	100.0
D15. Age & Gender Related Medicine	34.6	35.6	29.8	100.0				
D16. Dentistry, Oral Surgery	29.5	34.7	35.8	100.0				
D17. Dermatology & Urogenital System	30.6	40.5	29.0	100.0				
D18. Ophthalmology & Otorhinolaryngology	36.5	34.3	29.2	100.0				
D19. Integrative & Complementary Medicine	21.3	26.2	52.4	100.0				
D20. Psychiatry & Neurology	34.4	37.4	28.2	100.0				
D21. Radiology & Nuclear Medicine	33.8	37.9	28.3	100.0				
D22. Rheumatology & Orthopedics	38.8	34.9	26.3	100.0				
D23. Surgery	33.3	35.5	31.2	100.0				
D24. Pediatrics	35.6	33.4	31.0	100.0				
<i>V. CL. MED. III (HEALTH & OTHER SCS.)</i>					47.3	27.2	25.5	100.0
D25. Health Sciences	46.8	27.4	25.7	100.0				
D26. Other Clinical Medicine	50.3	27.6	22.1	100.0				
<i>VI. NEURO, SCIENCE & BEHAVIOR</i>					42.3	30.7	27.0	100.0
D27. Neurosciences & Psychopharmacology	35.0	34.0	30.9	100.0				
D28. Psychology & Behavioral Sciences	50.3	27.2	22.5	100.0				
<i>VII. CHEMISTRY</i>					18.6	31.1	50.3	100.0
D29. Multidisciplinary Chemistry	18.1	23.7	58.2	100.0				

D30. Analytical, Inorganic & Nuclear Chem.	17.9	37.0	45.0	100.0				
D31. Applied Chemistry & Chemical Eng.	19.0	31.3	49.7	100.0				
D32. Organic & Medicinal Chemistry	20.6	33.3	46.0	100.0				
D33. Physical Chemistry	17.7	34.1	48.2	100.0				
D34. Polymer Science	16.2	28.0	55.8	100.0				
VIII. PHYSICS					21.2	32.2	46.6	100.0
D35. Multidisciplinary Physics	18.5	31.8	49.8	100.0				
D36. Applied Physics	22.5	28.8	48.7	100.0				
D37. Atomic, Molecular & Chemical Physics	23.9	36.3	39.8	100.0				
D38. Thermodynamics	24.0	27.4	48.6	100.0				
D39. Mathematical & Theoretical Physics	21.1	35.7	43.1	100.0				
D40. Particle & Nuclear Physics	21.9	35.8	42.3	100.0				
D41. Physics of Solids, Fluids & Plasmas	18.4	35.1	46.5	100.0				
IX. SPACE SCIENCES					31.5	34.8	33.7	100.0
D42. Astronomy & Astrophysics	31.5	34.8	33.7	100.0				
X. MATHEMATICS					26.1	33.5	40.3	100.0
D43. Applied Mathematics	27.4	33.7	38.9	100.0				
D44. Pure mathematics	23.5	32.2	44.3	100.0				
XI. COMPUTER SCIENCE					31.0	34.2	34.9	100.0
D45. Computer Science	31.0	34.2	34.9	100.0				
XII. ENGINEERING					27.5	28.8	43.7	100.0
D46. Electrical & Electronic Engineering	29.6	27.2	43.2	100.0				
D47. Civil Engineering	33.3	28.2	38.5	100.0				
D48. Mechanical Engineering	27.1	28.1	44.8	100.0				
D49. Instruments & Instrumentation	23.8	33.6	42.6	100.0				
D50. Fuel & Energy	21.0	31.3	47.7	100.0				
D51. Other Engineering	28.9	29.9	41.2	100.0				
XIII. MATERIALS SCIENCE					18.1	29.2	52.7	100.0
D52. Materials Science	18.1	29.2	52.7	100.0				
XIV. GEOSCIENCES					30.1	32.2	37.7	100.0
D53. Geosciences & Technology	27.0	34.2	38.8	100.0				
D54. Hydrology & Oceanography	30.0	32.0	37.9	100.0				
D55. Meteorology, Atmos., Aero. Sc. & Tech	38.1	29.3	32.6	100.0				
D56. Mineralogy & Petrology	19.3	31.3	49.4	100.0				
XV. AGRIC. AND ENVIRONMENT					27.4	32.1	40.5	100.0
D57. Agricultural Science & Technology	22.8	29.6	47.5	100.0				
D58. Plant & Soil Science & Technology	27.9	32.3	39.8	100.0				
D59. Environmental Science & Technology	31.7	32.8	35.5	100.0				
D60. Food & Animal Science & Technology	24.5	34.0	41.5	100.0				
XVI. BIOLOGY (ORGANISMIC AND SUPRAORGANISMIC LEVELS)					27.9	32.6	39.5	100.0
D61. Animal Sciences	33.7	27.3	39.0	100.0				

D62. Aquatic Sciences	25.7	32.9	41.4	100.0				
D63. Microbiology	28.2	37.3	34.5	100.0				
D64. Plant Sciences	22.4	32.7	44.9	100.0				
D65. Pure and Applied Ecology	35.4	30.0	34.6	100.0				
D66. Veterinary Sciences	27.8	31.9	40.2	100.0				
XVII. MULTIDISCIPLINARY					<i>22.7</i>	<i>22.7</i>	<i>54.5</i>	<i>100.0</i>
D67. Multidisciplinary	22.7	22.7	54.5	100.0				
XVIII. RESIDUAL SUB-FIELDS					<i>21.1</i>	<i>31.3</i>	<i>47.6</i>	<i>100.0</i>
D68. Materials Science, Multidisciplinary	16.9	30.7	52.4	100.0				
D69. Crystallography	12.9	34.1	53.0	100.0				
D70. Geosciences, Multidisciplinary	25.7	32.1	42.2	100.0				
D71. Medicine, Research & Experimental	35.0	30.5	34.4	100.0				
XIX. SOCIAL SCIENCES, GENERAL					<i>54.0</i>	<i>24.7</i>	<i>21.3</i>	<i>100.0</i>
D72. Law & Criminology	73.3	15.6	11.1	100.0				
D73. Political Science & Public Administration	52.2	27.4	20.4	100.0				
D74. Sociology & Other Social Studies	56.3	21.2	22.5	100.0				
D75. Education	62.6	19.8	17.6	100.0				
D76. Geography, Planning & Urban	39.8	33.6	26.5	100.0				
D77. Ethics	52.8	23.0	24.2	100.0				
D78. Other Social Sciences	51.5	26.5	22.0	100.0				
XX. ECONOMICS & BUSINESS					<i>47.8</i>	<i>29.6</i>	<i>22.5</i>	<i>100.0</i>
D79. Economics	44.8	31.8	23.4	100.0				
D80. Business & Management	54.5	25.0	20.4	100.0				
ALL CATEGORIES	29.0	32.6	38.5	100.0	<i>29.0</i>	<i>32.5</i>	<i>38.5</i>	<i>100.0</i>

Table D. Average-based Indicators At the Discipline Level

DISCIPLINES	MNCS ^{US}	MNCS ^{EU}	MNCS ^{RW}	C ^{US}	C ^{EU}	C ^{RW}	A ^{US}	A ^{EU}	A ^{RW}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
D1. Multidisciplinary Biology	1.177	1.165	0.708	1.173	1.133	0.726	1.197	1.147	0.706
D2. Bioch., Biophysics & Molecular Biology	1.276	0.985	0.746	1.284	0.981	0.737	1.303	0.971	0.733
D3. Cell Biology	1.302	0.927	0.725	1.302	0.927	0.725	1.302	0.927	0.725
D4. Genetics & Development Biology	1.226	0.962	0.781	1.226	0.961	0.780	1.229	0.959	0.779
D5. Anatomy & Pathology	1.278	1.008	0.757	1.272	1.009	0.757	1.288	1.000	0.755
D6. Biomaterials & Bioengineering	1.332	1.021	0.747	1.348	1.026	0.737	1.335	1.020	0.747
D7. Experimental & Laboratory Medicine	1.038	1.100	0.853	1.038	1.100	0.853	1.039	1.100	0.853
D8. Pharmacology & Toxicology	1.205	1.052	0.801	1.207	1.052	0.800	1.200	1.055	0.802
D9. Physiology	1.230	0.941	0.776	1.230	0.941	0.776	1.230	0.941	0.776
D10. Cardiovascular & Respiratory Medicine	1.203	0.941	0.822	1.207	0.940	0.820	1.207	0.939	0.820
D11. Endocrinology & Metabolism	1.229	0.942	0.834	1.229	0.942	0.834	1.229	0.942	0.834
D12. General & Internal Medicine	1.370	0.955	0.745	1.406	0.955	0.717	1.401	0.958	0.717
D13. Hematology & Oncology	1.264	0.905	0.815	1.262	0.908	0.813	1.260	0.914	0.809
D14. Immunology	1.238	0.926	0.820	1.241	0.928	0.813	1.251	0.914	0.820
D15. Age & Gender Related Medicine	1.139	0.977	0.865	1.139	0.978	0.867	1.126	0.980	0.877
D16. Dentistry, Oral Surgery	1.049	1.015	0.946	1.049	1.015	0.946	1.049	1.015	0.946
D17. Dermatology & Urogenital System	1.255	0.935	0.822	1.266	0.929	0.813	1.287	0.915	0.815
D18. Ophthalmology & Otorhinolaryngology	1.248	0.865	0.850	1.245	0.866	0.852	1.242	0.857	0.865
D19. Integrative & Complementary Medicine	0.978	0.936	1.041	0.978	0.936	1.041	0.978	0.936	1.041
D20. Psychiatry & Neurology	1.246	0.951	0.765	1.246	0.950	0.765	1.248	0.950	0.764
D21. Radiology & Nuclear Medicine	1.226	0.978	0.759	1.226	0.978	0.759	1.226	0.978	0.759
D22. Rheumatology & Orthopedics	1.130	0.912	0.925	1.138	0.923	0.919	1.064	0.977	0.936
D23. Surgery	1.270	0.940	0.781	1.254	0.937	0.793	1.267	0.955	0.767
D24. Pediatrics	1.319	0.861	0.783	1.319	0.861	0.783	1.319	0.861	0.783
D25. Health Sciences	1.090	0.986	0.851	1.116	0.972	0.832	1.085	0.983	0.864
D26. Other Clinical Medicine	1.023	1.061	0.870	1.030	1.054	0.863	0.988	1.125	0.871
D27. Neurosciences & Psychopharmacology	1.269	0.948	0.753	1.270	0.947	0.753	1.271	0.945	0.754
D28. Psychology & Behavioral Sciences	1.104	0.945	0.834	1.091	0.958	0.850	1.082	0.976	0.846
D29. Multidisciplinary Chemistry	1.914	1.216	0.627	1.914	1.216	0.627	1.914	1.216	0.627
D30. Analytical, Inorganic & Nuclear Chem.	1.339	1.055	0.820	1.340	1.054	0.819	1.347	1.052	0.819
D31. Applied Chemistry & Chemical Eng.	1.170	1.173	0.826	1.172	1.178	0.823	1.162	1.181	0.824
D32. Organic & Medicinal Chemistry	1.329	1.041	0.823	1.327	1.041	0.824	1.324	1.043	0.824
D33. Physical Chemistry	1.395	1.058	0.814	1.396	1.058	0.814	1.396	1.059	0.813
D34. Polymer Science	1.442	1.095	0.824	1.442	1.095	0.824	1.442	1.095	0.824
D35. Multidisciplinary Physics	1.614	1.119	0.696	1.654	1.119	0.691	1.621	1.109	0.700
D36. Applied Physics	1.321	1.084	0.802	1.326	1.083	0.803	1.316	1.078	0.808
D37. Atomic, Molecular & Chemical Physics	1.243	1.022	0.834	1.243	1.022	0.834	1.243	1.022	0.834

D38. Thermodynamics	1.249	1.034	0.858	1.249	1.034	0.858	1.249	1.034	0.858
D39. Mathematical & Theoretical Physics	1.237	1.088	0.811	1.237	1.088	0.811	1.237	1.088	0.811
D40. Particle & Nuclear Physics	1.317	1.012	0.826	1.328	0.999	0.824	1.361	1.004	0.810
D41. Physics of Solids, Fluids & Plasmas	1.307	1.093	0.808	1.295	1.092	0.809	1.328	1.091	0.801
D42. Astronomy & Astrophysics	1.268	0.987	0.762	1.268	0.987	0.762	1.268	0.987	0.762
D43. Applied Mathematics	1.238	1.037	0.800	1.236	1.032	0.794	1.285	1.029	0.774
D44. Pure Mathematics	1.228	1.091	0.812	1.228	1.091	0.812	1.228	1.091	0.812
D45. Computer Science	1.239	0.987	0.800	1.227	1.000	0.793	1.256	0.983	0.789
D46. Electrical & Electronic Engineering	1.309	1.002	0.787	1.306	1.003	0.789	1.303	1.004	0.790
D47. Civil Engineering	1.047	1.042	0.928	1.081	1.022	0.910	1.073	1.078	0.880
D48. Mechanical Engineering	1.256	1.041	0.819	1.281	1.039	0.808	1.254	1.062	0.807
D49. Instruments & Instrumentation	1.151	1.105	0.833	1.166	1.100	0.826	1.186	1.096	0.821
D50. Fuel & Energy	1.127	1.118	0.867	1.142	1.110	0.866	1.112	1.124	0.869
D51. Other Engineering	1.187	1.073	0.816	1.186	1.072	0.817	1.185	1.075	0.816
D52. Materials Science	1.336	1.061	0.851	1.325	1.023	0.864	1.398	1.065	0.827
D53. Geosciences & Technology	1.219	1.017	0.832	1.224	1.018	0.823	1.237	1.027	0.811
D54. Hydrology & Oceanography	1.238	1.063	0.759	1.247	1.057	0.762	1.213	1.080	0.764
D55. Meteorology, Atmos., Aero. Sc. & Tech	1.228	0.979	0.752	1.213	1.004	0.753	1.183	1.040	0.750
D56. Mineralogy & Petrology	1.222	1.173	0.803	1.232	1.123	0.821	1.205	1.205	0.790
D57. Agricultural Science & Technology	1.178	1.212	0.782	1.195	1.212	0.777	1.163	1.223	0.783
D58. Plant & Soil Science & Technology	1.124	1.116	0.819	1.121	1.102	0.826	1.176	1.084	0.808
D59. Environmental Science & Technology	1.147	1.012	0.857	1.158	1.005	0.858	1.144	1.003	0.869
D60. Food & Animal Science & Technology	1.235	1.105	0.775	1.226	1.076	0.785	1.299	1.095	0.746
D61. Animal Sciences	1.142	1.074	0.826	1.154	1.070	0.820	1.140	1.080	0.823
D62. Aquatic Sciences	1.090	1.047	0.907	1.087	1.047	0.908	1.081	1.061	0.901
D63. Microbiology	1.232	1.031	0.777	1.224	1.021	0.777	1.280	1.024	0.746
D64. Plant Sciences	1.268	1.109	0.787	1.278	1.113	0.783	1.261	1.110	0.790
D65. Pure and Applied Ecology	1.068	1.087	0.855	1.068	1.087	0.855	1.068	1.087	0.855
D66. Veterinary Sciences	1.213	1.081	0.788	1.213	1.081	0.788	1.213	1.081	0.788
D67. Multidisciplinary	1.665	1.232	0.626	1.665	1.232	0.626	1.665	1.232	0.626
D68. Materials Science, Multidisciplinary	1.449	1.060	0.821	1.449	1.060	0.821	1.449	1.060	0.821
D69. Crystallography	1.477	1.121	0.806	1.477	1.121	0.806	1.477	1.121	0.806
D70. Geosciences, Multidisciplinary	1.234	1.083	0.795	1.234	1.083	0.795	1.234	1.083	0.795
D71. Medicine, Research & Experimental	1.379	0.929	0.678	1.379	0.929	0.678	1.379	0.929	0.678
D72. Law & Criminology	1.111	0.583	0.854	1.113	0.582	0.856	1.107	0.592	0.869
D73. Political Science & Public Administration	1.180	0.906	0.664	1.180	0.906	0.665	1.180	0.906	0.665
D74. Sociology & Other Social Studies	1.153	0.951	0.664	1.156	0.936	0.664	1.167	0.917	0.661
D75. Education	1.033	1.028	0.850	1.026	1.046	0.853	1.040	1.025	0.827
D76. Geography, Planning & Urban	1.030	1.093	0.838	1.033	1.085	0.830	0.994	1.167	0.798
D77. Ethics	1.112	0.940	0.812	1.127	0.923	0.815	1.078	1.013	0.818
D78. Other Social Sciences	1.103	0.932	0.842	1.102	0.935	0.838	1.108	0.918	0.847

D79. Economics	1.224	0.891	0.719	1.228	0.888	0.718	1.223	0.893	0.718
D80. Business & Management	1.167	0.823	0.772	1.162	0.825	0.773	1.173	0.814	0.767

Table E. Gaps Between Geographical Areas At the Discipline Level

	$\frac{MNCS^{US}}{MNCS^{EU}}$	$\frac{MNCS^{RW}}{MNCS^{EU}}$	$\frac{C^{US}}{C^{EU}}$	$\frac{C^{RW}}{C^{EU}}$	$\frac{A^{US}}{A^{EU}}$	$\frac{A^{RW}}{A^{EU}}$
	(1)	(2)	(3)	(4)	(5)	(6)
D1. Multidisciplinary Biology	1.010	0.607	1.035	0.640	1.044	0.615
D2. Bioch., Biophysics & Molecular Biology	1.295	0.757	1.309	0.751	1.343	0.755
D3. Cell Biology	1.405	0.782	1.405	0.782	1.405	0.782
D4. Genetics & Development Biology	1.275	0.812	1.276	0.812	1.281	0.812
D5. Anatomy & Pathology	1.268	0.751	1.260	0.750	1.288	0.755
D6. Biomaterials & Bioengineering	1.305	0.732	1.313	0.719	1.309	0.732
D7. Experimental & Laboratory Medicine	0.943	0.775	0.944	0.776	0.945	0.775
D8. Pharmacology & Toxicology	1.145	0.761	1.148	0.760	1.138	0.760
D9. Physiology	1.307	0.825	1.307	0.825	1.307	0.825
D10. Cardiovascular & Respiratory Medicine	1.279	0.874	1.284	0.873	1.285	0.873
D11. Endocrinology & Metabolism	1.304	0.885	1.304	0.885	1.304	0.885
D12. General & Internal Medicine	1.434	0.780	1.473	0.751	1.463	0.748
D13. Hematology & Oncology	1.397	0.901	1.390	0.895	1.379	0.885
D14. Immunology	1.336	0.885	1.338	0.876	1.368	0.897
D15. Age & Gender Related Medicine	1.166	0.886	1.165	0.887	1.149	0.895
D16. Dentistry, Oral Surgery	1.033	0.932	1.033	0.932	1.033	0.932
D17. Dermatology & Urogenital System	1.343	0.879	1.363	0.875	1.407	0.891
D18. Ophthalmology & Otorhinolaryngology	1.443	0.982	1.437	0.984	1.449	1.009
D19. Integrative & Complementary Medicine	1.045	1.113	1.045	1.113	1.045	1.113
D20. Psychiatry & Neurology	1.310	0.805	1.311	0.805	1.314	0.804
D21. Radiology & Nuclear Medicine	1.253	0.776	1.253	0.776	1.253	0.776
D22. Rheumatology & Orthopedics	1.240	1.014	1.233	0.995	1.089	0.959
D23. Surgery	1.352	0.831	1.338	0.847	1.327	0.804
D24. Pediatrics	1.532	0.909	1.532	0.909	1.532	0.909
D25. Health Sciences	1.105	0.863	1.148	0.855	1.104	0.879
D26. Other Clinical Medicine	0.964	0.820	0.978	0.819	0.878	0.774
D27. Neurosciences & Psychopharmacology	1.339	0.795	1.341	0.795	1.345	0.798
D28. Psychology & Behavioral Sciences	1.169	0.883	1.140	0.887	1.109	0.867
D29. Multidisciplinary Chemistry	1.574	0.516	1.574	0.516	1.574	0.516
D30. Analytical, Inorganic & Nuclear Chem.	1.269	0.778	1.270	0.777	1.281	0.779
D31. Applied Chemistry & Chemical Eng.	0.997	0.704	0.995	0.699	0.984	0.697
D32. Organic & Medicinal Chemistry	1.277	0.791	1.275	0.792	1.270	0.790
D33. Physical Chemistry	1.318	0.769	1.319	0.769	1.319	0.768
D34. Polymer Science	1.317	0.753	1.317	0.753	1.317	0.753
D35. Multidisciplinary Physics	1.443	0.622	1.479	0.618	1.461	0.631
D36. Applied Physics	1.219	0.740	1.225	0.742	1.220	0.749
D37. Atomic, Molecular & Chemical Physics	1.216	0.816	1.216	0.816	1.216	0.816

D38. Thermodynamics	1.207	0.829	1.207	0.829	1.207	0.829
D39. Mathematical & Theoretical Physics	1.137	0.745	1.137	0.745	1.137	0.745
D40. Particle & Nuclear Physics	1.302	0.816	1.330	0.825	1.356	0.806
D41. Physics of Solids, Fluids & Plasmas	1.196	0.740	1.186	0.740	1.217	0.734
D42. Astronomy & Astrophysics	1.285	0.772	1.285	0.772	1.285	0.772
D43. Applied Mathematics	1.194	0.772	1.198	0.770	1.249	0.752
D44. Pure Mathematics	1.125	0.744	1.125	0.744	1.125	0.744
D45. Computer Science	1.255	0.811	1.227	0.793	1.278	0.803
D46. Electrical & Electronic Engineering	1.307	0.786	1.302	0.786	1.298	0.787
D47. Civil Engineering	1.005	0.891	1.058	0.890	0.995	0.816
D48. Mechanical Engineering	1.206	0.786	1.232	0.778	1.181	0.760
D49. Instruments & Instrumentation	1.041	0.754	1.060	0.751	1.082	0.749
D50. Fuel & Energy	1.009	0.775	1.029	0.781	0.989	0.773
D51. Other Engineering	1.106	0.761	1.107	0.762	1.102	0.759
D52. Materials Science	1.258	0.802	1.295	0.844	1.312	0.777
D53. Geosciences & Technology	1.199	0.818	1.202	0.809	1.204	0.789
D54. Hydrology & Oceanography	1.165	0.714	1.180	0.721	1.123	0.708
D55. Meteorology, Atmos., Aero. Sc. & Tech	1.254	0.768	1.209	0.750	1.137	0.721
D56. Mineralogy & Petrology	1.041	0.685	1.098	0.731	1.000	0.655
D57. Agricultural Science & Technology	0.972	0.645	0.986	0.641	0.950	0.640
D58. Plant & Soil Science & Technology	1.007	0.734	1.017	0.749	1.084	0.746
D59. Environmental Science & Technology	1.132	0.847	1.152	0.853	1.140	0.866
D60. Food & Animal Science & Technology	1.118	0.701	1.140	0.729	1.186	0.681
D61. Animal Sciences	1.063	0.769	1.079	0.766	1.056	0.762
D62. Aquatic Sciences	1.042	0.866	1.038	0.867	1.019	0.849
D63. Microbiology	1.195	0.754	1.198	0.761	1.250	0.729
D64. Plant Sciences	1.144	0.710	1.148	0.703	1.136	0.712
D65. Pure and Applied Ecology	0.982	0.786	0.982	0.786	0.982	0.786
D66. Veterinary Sciences	1.122	0.729	1.122	0.729	1.122	0.729
D67. Multidisciplinary	1.352	0.508	1.352	0.508	1.352	0.508
D68. Materials Science, Multidisciplinary	1.367	0.774	1.367	0.774	1.367	0.774
D69. Crystallography	1.317	0.718	1.317	0.718	1.317	0.718
D70. Geosciences, Multidisciplinary	1.139	0.734	1.139	0.734	1.139	0.734
D71. Medicine, Research & Experimental	1.485	0.730	1.485	0.730	1.485	0.730
D72. Law & Criminology	1.907	1.466	1.912	1.470	1.870	1.469
D73. Political Science & Public Administration	1.303	0.734	1.302	0.733	1.302	0.733
D74. Sociology & Other Social Studies	1.213	0.699	1.235	0.709	1.273	0.721
D75. Education	1.005	0.827	0.981	0.815	1.015	0.807
D76. Geography, Planning & Urban	0.943	0.767	0.952	0.765	0.851	0.684
D77. Ethics	1.184	0.864	1.221	0.883	1.065	0.807
D78. Other Social Sciences	1.184	0.903	1.179	0.896	1.207	0.923

D79. Economics	1.374	0.808	1.383	0.809	1.370	0.805
D80. Business & Management	1.417	0.937	1.410	0.937	1.441	0.942

Table F. U.S./EU and RW/EU Gaps According to Average-based Indicators in the Fractional Approach. The Discipline Level

	$\frac{MNCS^{US}}{MNCS^{EU}}$	$\frac{MNCS^{RW}}{MNCS^{EU}}$	$\frac{C^{US}}{C^{EU}}$	$\frac{C^{RW}}{C^{EU}}$	$\frac{I^{US}}{I^{EU}}$	$\frac{I^{RW}}{I^{EU}}$
	(1)	(2)	(3)	(4)	(5)	(6)
D1. Multidisciplinary Biology	1.002	0.525	1.031	0.562	1.044	0.615
D2. Bioch., Biophysics & Molecular Biology	1.278	0.772	1.289	0.769	1.343	0.755
D3. Cell Biology	1.411	0.755	1.411	0.755	1.405	0.782
D4. Genetics & Development Biology	1.266	0.789	1.267	0.791	1.281	0.812
D5. Anatomy & Pathology	1.323	0.790	1.321	0.793	1.288	0.755
D6. Biomaterials & Bioengineering	1.348	0.743	1.364	0.730	1.309	0.732
D7. Experimental & Laboratory Medicine	0.976	0.774	0.977	0.777	0.945	0.775
D8. Pharmacology & Toxicology	1.158	0.777	1.161	0.776	1.138	0.760
D9. Physiology	1.260	0.795	1.260	0.795	1.307	0.825
D10. Cardiovascular & Respiratory Medicine	1.250	0.866	1.250	0.866	1.285	0.873
D11. Endocrinology & Metabolism	1.303	0.893	1.303	0.893	1.304	0.885
D12. General & Internal Medicine	1.512	0.777	1.570	0.747	1.463	0.748
D13. Hematology & Oncology	1.428	0.884	1.426	0.882	1.379	0.885
D14. Immunology	1.307	0.920	1.307	0.910	1.368	0.897
D15. Age & Gender Related Medicine	1.192	0.896	1.188	0.898	1.149	0.895
D16. Dentistry, Oral Surgery	1.031	0.925	1.031	0.925	1.033	0.932
D17. Dermatology & Urogenital System	1.357	0.880	1.375	0.875	1.407	0.891
D18. Ophthalmology & Otorhinolaryngology	1.510	1.000	1.508	1.006	1.449	1.009
D19. Paramedicine	1.329	1.205	1.329	1.205	1.045	1.113
D20. Psychiatry & Neurology	1.404	0.826	1.405	0.827	1.314	0.804
D21. Radiology & Nuclear Medicine	1.255	0.800	1.255	0.800	1.253	0.776
D22. Rheumatology & Orthopedics	1.241	1.023	1.235	0.996	1.089	0.959
D23. Surgery	1.401	0.847	1.388	0.866	1.327	0.804
D24. Pediatrics	1.659	0.949	1.659	0.949	1.532	0.909
D25. Health Sciences	1.110	0.854	1.166	0.844	1.104	0.879
D26. Other Clinical Medicine	0.967	0.847	0.984	0.851	0.878	0.774
D27. Neurosciences & Psychopharmacology	1.374	0.800	1.376	0.800	1.345	0.798
D28. Psychology & Behavioral Sciences	1.213	0.881	1.169	0.885	1.109	0.867
D29. Multidisciplinary Chemistry	1.616	0.481	1.616	0.481	1.574	0.516
D30. Analytical, Inorganic & Nuclear Chem.	1.355	0.759	1.360	0.758	1.281	0.779
D31. Applied Chemistry & Chemical Eng.	0.998	0.676	0.995	0.669	0.984	0.697
D32. Organic & Medicinal Chemistry	1.249	0.782	1.250	0.780	1.270	0.790
D33. Physical Chemistry	1.331	0.737	1.333	0.737	1.319	0.768
D34. Polymer Science	1.327	0.719	1.327	0.719	1.317	0.753
D35. Multidisciplinary Physics	1.484	0.599	1.518	0.598	1.461	0.631
D36. Applied Physics	1.236	0.710	1.249	0.714	1.220	0.749

D37. Atomic, Molecular & Chemical Physics	1.195	0.820	1.195	0.820	1.216	0.816
D38. Thermodynamics	1.189	0.855	1.189	0.855	1.207	0.829
D39. Mathematical & Theoretical Physics	1.159	0.768	1.159	0.768	1.137	0.745
D40. Particle & Nuclear Physics	1.286	0.820	1.324	0.829	1.356	0.806
D41. Physics of Solids, Fluids & Plasmas	1.213	0.731	1.209	0.731	1.217	0.734
D42. Astronomy & Astrophysics	1.265	0.775	1.265	0.775	1.285	0.772
D43. Applied Mathematics	1.207	0.773	1.214	0.775	1.249	0.752
D44. Pure mathematics	1.141	0.740	1.141	0.740	1.125	0.744
D45. Computer Science	1.269	0.820	1.253	0.806	1.278	0.803
D46. Electrical & Electronic Engineering	1.340	0.766	1.336	0.767	1.298	0.787
D47. Civil Engineering	0.976	0.935	1.068	0.918	0.995	0.816
D48. Mechanical Engineering	1.193	0.786	1.219	0.781	1.181	0.760
D49. Instruments & Instrumentation	1.086	0.734	1.097	0.731	1.082	0.749
D50. Fuel & Energy	0.954	0.786	0.977	0.789	0.989	0.773
D51. Other Engineering	1.101	0.789	1.106	0.794	1.102	0.759
D52. Materials Science	1.271	0.779	1.304	0.824	1.312	0.777
D53. Geosciences & Technology	1.206	0.798	1.210	0.791	1.204	0.789
D54. Hydrology & Oceanography	1.158	0.702	1.188	0.702	1.123	0.708
D55. Meteorology, Atmos., Aero. Sc. & Tech	1.262	0.780	1.182	0.752	1.137	0.721
D56. Mineralogy & Petrology	1.093	0.720	1.178	0.782	1.000	0.655
D57. Agricultural Science & Technology	0.943	0.606	0.950	0.607	0.950	0.640
D58. Plant & Soil Science & Technology	1.046	0.689	1.052	0.701	1.084	0.746
D59. Environmental Science & Technology	1.109	0.829	1.126	0.834	1.140	0.866
D60. Food & Animal Science & Technology	1.138	0.680	1.175	0.710	1.186	0.681
D61. Animal Sciences	1.093	0.777	1.113	0.775	1.056	0.762
D62. Aquatic Sciences	1.072	0.878	1.073	0.880	1.019	0.849
D63. Microbiology	1.190	0.760	1.197	0.767	1.250	0.729
D64. Plant Sciences	1.125	0.707	1.126	0.699	1.136	0.712
D65. Pure and Applied Ecology	1.022	0.763	1.022	0.763	0.982	0.786
D66. Veterinary Sciences	1.173	0.721	1.173	0.721	1.122	0.729
D67. Multidisciplinary	1.382	0.483	1.382	0.483	1.352	0.508
D68. Materials Science, Multidisciplinary	1.367	0.782	1.367	0.782	1.367	0.774
D69. Crystallography	1.205	0.753	1.205	0.753	1.317	0.718
D70. Geosciences, Multidisciplinary	1.220	0.724	1.220	0.724	1.139	0.734
D71. Medicine, Research & Experimental	1.681	0.698	1.681	0.698	1.485	0.730
D72. Law & Criminology	1.946	1.358	1.946	1.358	1.870	1.469
D73. Political Science & Public Administration	1.397	0.754	1.397	0.754	1.302	0.733
D74. Sociology & Other Social Studies	1.342	0.644	1.365	0.645	1.273	0.721
D75. Education	1.050	0.853	1.035	0.847	1.015	0.807
D76. Geography, Planning & Urban	0.940	0.747	0.944	0.730	0.851	0.684
D77. Ethics	1.193	0.738	1.232	0.772	1.065	0.807

D78. Other Social Sciences	1.247	0.904	1.258	0.901	1.207	0.923
D79. Economics	1.445	0.785	1.455	0.786	1.370	0.805
D80. Business & Management	1.488	0.946	1.479	0.947	1.441	0.942

**Table G. U.S./EU and RW/EU Gaps According to Average-based Indicators in the Fractional Approach.
The Field Level**

	$\frac{MNC S^{US}}{MNC S^{EU}}$ (1)	$\frac{MNC S^{RW}}{MNC S^{EU}}$ (2)	$\frac{C^{US}}{C^{EU}}$ (3)	$\frac{C^{RW}}{C^{EU}}$ (4)	$\frac{I^{US}}{I^{EU}}$ (5)	$\frac{I^{RW}}{I^{EU}}$ (6)
1. BIOSCIENCES	1.272	0.749	1.299	0.761	1.334	0.750
2. BIOMEDICAL RESEARCH	1.221	0.772	1.232	0.771	1.251	0.765
3. CLINICAL MEDICINE I	1.381	0.852	1.396	0.844	1.386	0.844
4. CLINICAL MEDICINE II	1.348	0.889	1.350	0.884	1.307	0.852
5. CLINICAL MEDICINE III	1.097	0.853	1.157	0.844	1.085	0.879
6. NEUROS. AND BEHAVIORAL	1.280	0.833	1.300	0.819	1.141	0.827
7. CHEMISTRY	1.342	0.684	1.375	0.675	1.346	0.702
8. PHYSICS	1.278	0.711	1.305	0.709	1.277	0.715
9. SPACE SCIENCE	1.265	0.775	1.265	0.775	1.285	0.772
10. MATHEMATICS	1.174	0.757	1.186	0.762	1.245	0.739
11. COMPUTER SCIENCE	1.269	0.820	1.253	0.806	1.278	0.803
12 ENGINEERING	1.161	0.788	1.186	0.787	1.157	0.766
13. MATERIALS SCIENCES	1.271	0.779	1.304	0.824	1.312	0.777
14. GEOSCIENCE	1.199	0.773	1.190	0.767	1.167	0.735
15. AGRIC. AND ENVIRONMENT	1.086	0.708	1.120	0.737	1.134	0.727
16. PLANT AND ANIMAL SC.	1.123	0.764	1.137	0.763	1.121	0.713
17. MULTIDICPLINARY	1.382	0.483	1.382	0.483	1.352	0.508
18. RESIDUAL SUB-FIELDS	1.359	0.761	1.433	0.753	1.593	0.708
19. SOCIAL SCIENCES, GENERAL	1.216	0.803	1.223	0.797	1.159	0.794
20. ECONOMIC AND BUSSINESS	1.448	0.837	1.450	0.849	1.444	0.858
A. LIFE SCIENCES	1.301	0.828	1.326	0.816	1.294	0.815
B. PHYSICAL SCIENCES	1.276	0.716	1.307	0.707	1.283	0.723
C. OTHER NATURAL SCIENCES	1.176	0.755	1.202	0.760	1.226	0.696
D. SOCIAL SCIENCES	1.291	0.816	1.316	0.821	1.258	0.814