Informe sobre la investigación matemática en España en el período 1990-1999

FOREWORD

The celebration of 2000 as World Mathematical Year in Spain has led to an increasing degree of contact and collaboration between the various mathematical societies and has ecnouraged mathematicians to reflect together on the state of our science. In order to celebrate World Mathematical Year properly, the CEAMM2000 was founded in Spain in 1998 as a committee grouping all Spanish mathematical associations, along with such institutions as the Scientific Research Council (CSIC), the Royal Academy of Exact, Physical and Natural Sciences, and the Ministry of Education and Culture[1]. The activities undertaken by this Committee included the drafting of a report to provide an overview of the production of mathematical literature in Spain in the area of research.

After one year's work we are proud to complete that task and submit this report, in which we present the most notable aspects of scientific mathematical literature in Spain in the 1990s.

Our first observation is that mathematical research in Spain has undergone extraordinary growth in recent years, both in terms of intensity and of quality and impact. The change has been spectacular, paralleling the country's overall development, which has been particularly significant in the field of mathematics. Spain has gone from having only a few mathematicians involved in research to a large number of suitably funded mathematical researchers, with specialists in almost all branches of mathematics, including those on the leading edge.

This study's aim is to provide precise and objective information in support of these observations. In the course of preparing this report, we encountered a number of difficulties that obliged us to make choices, many of them debatable, but nonetheless necessary if we were to complete the report.

The first of those choices centred on the definition of what we considered mathematical literature. Since we wished to avoid to the greatest extent possible any subjective positions, we took as our definition of mathematics article any article figuring in the "MathSciNet" database of the AMS (American Mathematical Society). On this basis, we selected Spanish production to include all documents in which any of the authors have Spain or any Spanish institution in the "Institution" field of that database. We should like to apologise to all those who have done or are now doing research at centres in other countries. In this way, we created what might be called the sample space of our study, which contains a total of 11,813 documents dating from throughout the decade and that went from representing 1.7% of world-wide production of mathematical literature in 1990 to 3.2% in 1999. Our account also gives some information that may be of interest as to the distribution of these works on the basis of the MSC (Mathematics Subject Classification) codes and the relative weight of those codes on the worldwide level.

For the quality study, we cross-referenced and screened this database following the list of journals in the classification of the ISI[2] by impact ratings, i.e. we refined the

[1]Spanish World Mathematical Year Committee, CEAMM2000. http://dulcinea.uc3m.es/ceamm

[2] ISI: Institute for Scientific Information. This Institute carries out bibliometric studies of world-wide scientific literature in all fields. It draws up a list of journals with the greatest impact, i.e. the SCI: Scientific Citation Index.

aforementioned database and kept only those documents published in one of the journals figuring in the ISI. We are aware that this is not always a reliable indicator of the impact or quality of an article and that excellent works are sometimes published in journals that do not figure on these lists, but it is an objective evaluation parameter that is becoming increasingly widespread, and to the extent that world-wide production is very considerable, we believe that it fulfils the objective of an index of quality. Lastly, in view of the large number of articles appearing in borderline areas, particularly physics, that distorted figures considerably, we carried out a manual screening by experts of the documents appearing in those areas to the extent that this was feasible. The result of this process was a second database of what we could call "quality documents", comprising 6,220 articles and accounting for 52.65% of the quantitative database , which has served as the basis for the rest of the study covered by our report. In comparison with the total literature included in the ISI, Spain's contribution went from 1.7% in 1990 to 3.9% in 1999. This upward trend has continued, and ISI figures for this year show that proportion now standing at 4.18%.

In order to bring this information more clearly into relationship with the reality of Spain, we attempted to catalogue the headings of the AMS classification in the different areas of knowledge specified in the Universities Law, a task that was not always easy, owing to the large number of borderline areas. This categorisation is the fruit of our efforts (with the appropriate consultation) and we are therefore fully responsible for any errors, and above all, it must be taken with the reservation that it is based on our own personal judgement. It is also true that researchers carrying out their work in specific areas of the AMS classification may in fact pertain to other areas of knowledge, and this must be taken into account in the interpretation of the comparative tables on literature and number of individuals pertaining to different areas of knowledge.

This report shows that Spain's production of mathematical literature places it among the top ten countries world-wide. Nevertheless, it remains for us to achieve the appropriate recognition of this fact in different international circles, although it is clear that progress has also been made in this respect. We recently learned that the Executive Committee of the IMU has proposed Madrid to host the International Mathematics Congress in 2006, with that nomination subject to approval at the IMU's General Assembly in Beijing in August 2002. This proposal is no doubt linked to the growing recognition referred to above. We trust that, if the candidature is in fact approved, this event will serve as additional stimulus for mathematical research. There are also many other signs of the good health of research in this country. In fact, while there is much room for improvement, it is increasingly common to find Spanish researchers named as guest speakers and members of scientific committees at high-level conferences and meetings and on the editorial boards of leading international publications. In this connection, we should also point out that a number of Spanish journals are now included on the ISI's lists (Revista Matemática Iberoamericana, Text) in commendable positions.

In spite of all this, as has been commented upon in numerous forums and meetings held in connection with World Mathematical Year 2000, mathematical research in this country still faces several problems. In the first place, the deficiencies of our school system, at both the primary and secondary levels, often make it difficult to transmit knowledge and interest in mathematics, even to the most enthusiastic students. In

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This constitutes the most objective and most widely-used reference in science and technology world-wide. Web site: http://www.isinet.com/

addition, we are aware of the difficulties affecting degree programmes in mathematics, with a decreasing number of students, in spite of the growing relevance of mathematical knowledge in the technological world and the good employment prospects for people holding degrees in mathematics. Furthermore, our university system's inability to incorporate the young researchers who have completed their training in recent years has contributed to an "ageing" of the population of researchers that could threaten the continuity of the upward trend observed in this report and mentioned above. Lastly, it is a well-known fact that the organisation, conditions and means that Spanish researchers encounter in their centres are not always the most appropriate for carrying out energetic, high quality research activities. It goes without saying that younger researchers face often insurmountable obstacles to a research career under reasonable conditions in surroundings where their work can be appropriately evaluated, valued and encouraged. These issues form a part of the concerns felt by all researchers and are even the object of legislative initiatives. We trust that, by working together, we will not only succeed in maintaining this level of research but also improve it and acquire the tools and structures that it requires, so that within ten years we will have created a situation that is even more encouraging.

It has not been an easy task to prepare this report, and it would have been altogether impossible if not for the excellent work done by Gema Villacián, whose collaboration was made possible by a special grant from the Office of the State Secretary for Education, Universities, Research and Development. We should also like to thank the CINDOC, the CSIC and the Complutensian University of Madrid for allowing us to use their facilities and the MathSciNet and ISI databases.

As mentioned above, this work would not have been possible without Gema's invaluable assistance. Of course, ultimate responsibility for any omissions in this Report lies solely with the authors.

Madrid, May 2001.

Carlos Andradas and Enrique Zuazua, Complutensian University of Madrid

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1. INTRODUCTION

The original idea for this work arose in connection with the initiative of application for promotion of Spain as a member of the International Mathematical Union from level 3

to level 4, with one of the prerequisites for that promotion being the demonstration that it is justified by the importance of our mathematical literature. This led to the idea of carrying out a study of the progression of the number of publications in the recent past. There is a generally held conviction among mathematicians that Spain's production of mathematical literature has ostensibly improved in recent years, but we had to put this conviction to the test on the basis of hard facts. In addition, just as important as demonstrating growth was the need to determine whether this growth was sustained over time and whether it was occurring equally in all areas of mathematics, and to detect any deviations that might occur and examine the quality of our literature and the patterns of collaboration, etc.

We soon realised that if we wished to make a study that would not be a mere quantitative analysis of publications, but would also include an analysis of the quality of those publications and be of use in drawing up a map of the current situation of mathematical research by autonomous communities, universities, areas of knowledge, etc., this would require specific dedication and infrastructure. Fortunately, the forthcoming celebration of World Mathematical Year allowed us to submit an application for a special grant from the Ministry for preparing the Report, the results of which are set forth on these pages.

Our overall aim was the following: to extract from the AMS's MathSciNet database all the entries for the period 1990-1999 corresponding to Spanish researchers and use them to compile a database of Spain's mathematical literature during that decade. Using this database, we would then compile a sub-base containing the documents included in the database of the ISI (Institute for Science Information), which would constitute the database used for the different quality analyses, always within the parameters of the index of impact drawn up by that Institute, those parameters of course being debatable but at the same time in increasingly widespread use. Why the period 1990-1999? First of all, because our aim was to make a study that would be sufficiently recent to provide information on the current situation in Spain, i.e. after a number of years of participation in international research forums. At the same time, the delay in publication of articles and their subsequent entry in the MathSci database made it necessary to use 1999 as the cut-off date for the study, so that the information for that year would be reasonably reliable. We should point out that, if we estimate an average delay of 18 months between when a piece of work is initially submitted by its author until its publication in a journal, we are in fact looking at research carried out between 1988 and 1998.

The structure of this Report is as follows: Section 2 contains a technical explanation of the methodology applied: databases used, structure of those databases, fields and indicators used, processing of information, etc. Section 2 also includes the Mathematics Subject Classification (MSC) and its adaptation to our areas of knowledge. Section 3 presents the results of the general database of Spanish mathematical literature, i.e. the information taken from the MathSciNet, both overall and broken down by MSC codes, and the percentage comparison of the weight of each category in total literature. We believe that this piece of information provides an initial overview of the distribution of our mathematical literature and of the areas that are either over- or underrepresented in comparison with the world average. We can say that Spain's production of mathematical literature went from 1.7% of the world total in 1990 to 3.2% in 1999.

Section 4 presents the "quality" database, i.e. the sub-base of the foregoing database containing all of the documents figuring in the former that have been published in journals included on the ISI's list for calculating the index of impact and referred to in this Report as ISI journals. This is the database used in the rest of the Report. One initial indicator of quality is the relative size of this sub-base in comparison with the initial database: 62.80%, while on the world-wide level the ISI sub-base represents only 52.88% of the MathSci database. We also present comparative data on mathematical literature and the situation of mathematics in Spain's overall scientific literature and that of other countries in our milieu. It is worth noting that, at present in Spain, mathematics is the scientific discipline that ranks third on the national level in respect of world-wide contribution, surpassed only by France, a country with a longstanding mathematical tradition.

Section 5 presents a study of the production of mathematical literature and its progression broken down by autonomous communities, universities and research centres, areas of knowledge and MSC codes, with a comparative breakdown of literature by the number of faculty and by every 10,000 inhabitants. At first glance, results show a ratio of 2 ISI articles per lecturer for the whole decade, a percentage that could certainly be improved upon, particularly if we take into account that only tenured lecturers are counted, meaning that in the foregoing ratio all production of mathematical literature by untenured lecturers and scholarship holders is attributed to them.

Section 6 presents a more detailed study of the "quality" of research, showing its distribution by quartiles within the classification of journals in accordance with the index of impact. This distribution is also carried out by university and area of knowledge. In addition, information is given on the mathematical journals with the highest volume of Spanish publications, and these are assigned to the corresponding quartile. Lastly, Section 7 presents a study of the pattern of collaboration or co-authorship in works in the area of mathematics, showing that there is a growing trend to joint authorship of articles, which has possibly been encouraged by the use of the Internet.

In short, we believe that this Report contains a great deal of information that could be highly useful for mapping the distribution of research in Spain, its deficiencies and its strongest groups and areas. On the other hand, it demonstrates the healthy state of mathematics in Spain as a whole, a situation that provides us with strong arguments to back demands and negotiations with our authorities for a more favourable treatment of mathematics at all levels of education. Nevertheless, it also shows that we have a long way to go before all university lecturers become involved in research as a normal activity. Lastly, the database that we have created will be a useful resource for further, more detailed studies.

2. METHODOLOGY

The first difficulty that we encountered in carrying out this study was the definition of what we considered to be a mathematics article. We decided to consider all articles figuring in the MathSciNet database mathematics articles, and so proceeded to identify all documents signed by authors at any Spanish institution and published during the period 1990-1999. On the basis of these documents, we carried out a second selection, retaining only documents published in journals that were included in the SCI or SSCI databases during the period 1990-1999. This second selection was made to allow us to work with the bibliometric indicator "impact factor". The final stage consisted of a manual screening of the database to eliminate articles that fit the initial definition, i.e. ones that appeared in the MathSci database, but that were in borderline areas (mainly physics) and whose content clearly placed them outside what mathematicians consider to be mathematics.

2.1. Sources of data

The study used as its primary source of information the interdisciplinary MathSci database, which includes reviews of one million articles from mathematical journals and their applications, and gives the contents of the reference journals "Mathematical Reviews" and "Current Mathematical Publications", published by the AMS. It deals basically with classical mathematics (algebra, geometry, topology, mathematical analysis, etc.), statistics, mechanics, informatics, quantum theory, relativity, astronomy, astrophysics and geophysics. The data was taken from three disks of the CD-ROM version, corresponding to the periods 1988-1992, 1993-1997 and 1998-2001 (February). Although data was taken from the disk containing literature up to February 2001, bearing in mind the delay between the publication of an article and its entry in the database, subsequent disks might contain articles corresponding to the period covered by the study, particularly the final year, 1999, which could slightly alter the results presented here.
The following is an example of a standard register in the MathSci database with its main fields:

- **No. of Inst.:**1
- **No. of Authors:** 4
- **Title:** On the use of divergence statistics to make inferences about three habitats.
- **Publication Year:** 1995
- **Journal:** Kybernetes [Kybernetes.-The-International-Journal-of-Systems-and- Cybernetics] 24 (1995), no. 1, 2, 44-54.
- **Type of Document:** Journal
- **ISSN:** 0368-492X
- **Authors:** Esteban,-M.-D., (E-MADC)
  Pardo,-J.-A. [Pardo-Llorente,-Julio- Angel], (E-MADC)
  Pardo,-M.-C. [Pardo,-Maria-del-Carmen], (E-MADC)
  Vicente,-M.-L. [Vicente-Hernanz,-Ma.-Lina], (E-MADC)
- **Institutions:** (E-MADC), Department of Mathematics, Universidad Complutense de Madrid, 28040 Madrid, Spain
- **MSC:** 62B10, 62B, 62

The interdisciplinary databases Science Citation Index and Social Sciences Citation Index include over 5,000 journals, most of them in English. The journals figuring in the ISI databases are the most representative of international scientific activity. The Science

Citation Index includes 3,500 journals on science and technology covering over 150 disciplines, while the Social Sciences Citation Index includes 1,700 journals covering over 50 disciplines.
One drawback of the ISI databases is their linguistic and geographical bias in favour of journals published in English, and the resulting preponderance of those published in the US and the UK.

2.2. Search strategy

Mathematical literature in Spain was obtained by selecting all documents in the MathSci database with the word "Spain" in the "Institution" field and corresponding to any year between 1990 and 1999 in the "Publication Year" field.

2.3. Type of document

Of the five types of document included in the MathSci database: "journal", "journal-translation", "book", "book proceedings" and "proceedings-paper", we selected only those of the "journal" type, corresponding to articles. This choice was based on the fact that, in addition, this is the type of document included in the ISI database.

2.4. MSC subject classification and areas of knowledge

The subject classification used is the one provided by the MathSci database in the "Primary Classification Codes" field corresponding to the "Mathematics Subject Classification 1991". The MSC classification was updated as of 2000, and although this update should not, in theory, affect our study, it was used in classification of under 0.05% of the documents. The new classification has not given rise to any substantial changes at the level of our work, the most significant change being the creation of three new codes: numbers 37, 74 and 91, which appear in italics in the following list.

To correlate articles with areas of knowledge, each MSC code has been assigned to one or more areas of knowledge. This assignment was made by the people responsible for the Report, with the suitable consultation in case of serious doubt. In any event, we chose always to assign each MSC code to all areas of knowledge to which they could naturally pertain. This means that documents with a particular MSC code are counted in each of the areas to which that code is assigned, and therefore the tables for areas of knowledge show totals that are higher than the actual total of documents.

@The following table shows the MSC classification translated into Spanish along with its assignment to areas of knowledge. The Appendix gives the original MSC classification (in English).@

MSC classification by areas of knowledge:

00	General	All
01	History and biography	All
03	Mathematical logic and foundations	Algebra, computer science and AI
04	Set theory	Algebra
05	Combinatorics	Algebra, statistics and OR
06	Lattices, ordered algebraic structures	Algebra
08	General mathematical systems	All
11	Number theory	Algebra
12	Field theory and polynomials	Algebra
13	Commutative rings and algebra	Algebra
14	Algebraic geometry	Algebra, Geometry and Topology
15	Linear algebra and multilinear algebra, matrix theory	Algebra
16	Associative rings and algebras	Algebra
17	Nonassociative rings and algebras	Algebra
18	Category theory, homological algebra	Algebra
19	K-theory	Algebra, Geometry and Topology
20	Group theory and generalisations	Algebra
22	Topological groups, Lie groups	Algebra, Geometry and Topology
26	Real functions	Mathematical analysis
28	Measure and integration	Mathematical analysis
30	Functions of a complex variable	Mathematical analysis
31	Potential theory	Mathematical analysis. Applied Mathematics
32	Several complex variables and analytical spaces	Mathematical analysis, geometry and topology
33	Special functions	Mathematical analysis
34	Ordinary differential equations	Mathematical analysis. Applied Mathematics
35	Partial differential equations	Applied mathematics
37	*Dynamical systems and ergodic theory*	*Applied mathematics, Geometry and Topology, Mathematical analysis*
39	Finite differences and functional equations	Mathematical analysis. Applied Mathematics
40	Sequences, series, summability	Mathematical analysis. Applied Mathematics
41	Approximation and expansion	Applied mathematics
42	Fourier analysis	Mathematical analysis. Applied Mathematics
43	Abstract harmonic analysis	Mathematical analysis
44	Integral transforms, operational calculus	Applied mathematics
45	Integral equations	Mathematical analysis, Applied Mathematics, Geometry and Topology
46	Functional analysis	Mathematical analysis
47	Operator theory	Mathematical analysis. Applied Mathematics
49	Calculus of variations, optimization	Applied mathematics, Geometry and Topology
51	Geometry	Algebra, Geometry and Topology
52	Convex and discrete geometry	Algebra, Geometry and Topology, Applied mathematics
53	Differential geometry	Geometry and topology
54	General topology	Geometry and topology
55	Algebraic topology	Algebra, Geometry and Topology
57	Manifolds and cell complexes	Geometry and topology
58	Global analysis, analysis on manifolds	Mathematical analysis, Applied mathematics, Geometry and Topology
60	Probability theory and stochastic processes	Statistics and OR, mathematical analysis Applied mathematics
62	Statistics	Statistics and OR
65	Numerical analysis	Applied mathematics
68	Computer science	Computer science and AI
70	Mechanics of particles and systems	Geometry and topology, Applied mathematics
73	Mechanics of solids	Geometry and topology, Applied mathematics
74	*Mechanics of deformable solids*	*Geometry and topology, Applied mathematics*
76	Fluid mechanics	Applied mathematics

78	Optics, electromagnetic theory	Applied mathematics
80	Classical thermodynamics, heat transfer	Applied mathematics
81	Quantum theory	Geometry and topology, Applied mathematics
82	Statistical mechanics, structure of matter	Geometry and Topology, Applied mathematics, Statistics and OR
83	Relativity and gravitational theory	Geometry and topology, Applied mathematics
85	Astronomy and astrophysics	Geometry and topology, Applied mathematics
86	Geophysics	Applied mathematics
90	Economics, operations research, programming, games	Statistics and OR
91	*Game theory, economics, social sciences and behavioural sciences*	*Statistics and OR*
92	Biology and other natural sciences, behavioural sciences	Applied mathematics
93	Systems theory, control	Applied mathematics
94	Information and communication, circuits	Applied mathematics, Computer science and AI

To determine the number of researchers, we used the sources provided by the Universities Board and therefore we have only taken into account information referring to permanent faculty (university and college professors and lecturers) in the areas of knowledge related to mathematics. "Mathematical analysis", "Computer science and Artificial intelligence", "Geometry and Topology", "Applied mathematics" and "Statistics and Operations research".
Of course, this means that we have not counted untenured faculty, to whom we apologise for the omission, but it would have been extremely difficult to obtain reliable information on them.

2.5. Institutions

To determine which institutions have contributed to the production of a document, we referred to the "Institution" field in the MathSci database, which includes the place of work of each of the authors signing the document. This information allows us to examine the productivity of institutions and the mathematical collaboration between them.

We should point out that this information is not standardised and that it sometimes refers to departments, sometimes to faculties and sometimes to universities. Given the existing differences in organisation between universities in respect of faculties and departments, in the detailed studies we chose to take the distinction no farther than the level of universities.

For the study of mathematical activity by institutions overall, centres are grouped into the following institutional categories: University, Scientific Research Council (CSIC), joint CSIC-university centres, and other centres. As the database contains references to only two centres not connected with any university or the CSIC, we decided to leave in the data on each of those centres

2.6. Authors

The study of authors signing a document was carried out on the basis of the "Author" field of the MathSci database, which includes the name (normally shown as a given name and one surname) and the place of work of each of the authors of the document.

2.7. Assignment of documents

For this study we used the complete count system, in which each complete document is assigned to each one of its authors and therefore to each of the institutions signing the document. We chose this method over a fractional count of documents in which each document written by more than one author is divided by the number of authors, and over a count by first author, since in the field of mathematics the authors of a document are, as a rule, listed in alphabetical order. The complete count system allows us to quantify the participation of different institutions in articles, it provides a more accurate picture than a count by first author, and its reliability has been repeatedly confirmed. The drawback presented by this method is the multiplication of the number of documents in the counts, giving totals that are higher than the actual number of documents.

2.8. Data processing

The information taken from the MathSci database was loaded into a relational database. This database consists of a series of data files:

- Documents
- Institutions
- Authors
- MSC classification
- SCI journals

2.9. Bibliometric indicators

a) Impact factor (IF)

As an indicator of visibility or dissemination of research results, we have used the impact factor of the journals where they are published, as given in the Journal Citation Reports for the years included in the period 1990-1999. A journal's impact factor is represented by the average number of citations per article within a certain period. Thus, the impact factor of journal X for 1998 is calculated by dividing the number of citations in 1998 by the source journals of the SCI, SSCI and A&HCI (Arts and Humanities Citation Index) of articles published in journal X in 1996 and 1997, divided by the total number of citable items published by journal X in those two years.

A journal's impact factor is used as an indirect measure of its quality, but in fact does no more than evaluate its impact or influence on the scientific community. Although the impact factor's validity as an indicator of visibility is widely accepted, its use has certain limitations that must be taken into account. For example, calculation of the impact factor is based solely on citations made in the very short term, to the detriment particularly of areas with a slower progression and of journals that fail to publish articles on the planned dates. Furthermore, impact factors for different subjects cannot be compared, since they depend, among other aspects, on the size of the scientific community, its publishing habits, and the nature of the field as basic or applied. This means that the impact factor must be dealt with separately for each discipline.

In this study, we use the IF as the "expected impact factor" of all documents published in the same journal, i.e. considering that all articles in a journal have the same probability of being cited.

b) Index of activity

The index of activity is an indicator of the degree of activity in a specific subject by a centre or geographic area, specifying whether that activity is greater or lesser than the national average.
This index is calculated as the ratio between the percentage of production by a centre or geographical area in connection with a given subject and the percentage represented by that subject in national production.

c) Standardised position

The impossibility of comparing impact factors for journals in different ISI disciplines makes it necessary to use a different measurement that does allow such comparison. The standardised position is calculated as the complement to 1 of the ratio obtained through division of the journal's position within the ISI discipline by the total number of journals in that discipline. In this study, where a journal belongs to more than one ISI discipline, we decided to take into account only the highest standardised position.

d) Collaboration

In the study on collaboration, we can distinguish between a number of different types: when the "Institution" field shows a foreign address, the collaboration is considered *international* and when more than one Spanish institution is shown, the document is considered to be the result of *national collaboration*. Within this latter category, we distinguish between two types: *external national* collaboration, when collaboration is between different Spanish research centres, and *internal national* collaboration, when it is between different departments of the same centre. In the case of universities, external collaboration refers to collaboration between different faculties and internal collaboration refers to collaboration between departments. In the case of CSIC centres, external collaboration refers to collaboration between different CSIC centres, while there are no instances of internal collaboration, since this information is not available in the database.
Where there has been both national and international collaboration on an article, it is counted for both types of collaboration.

e) Index of co-authorship

This is an indicator of collaboration between authors and is calculated as the average number of authors contributing to a document.

3. MATHSCI DATABASE

Mathematical literature in the MathSci database

Table 3.1 shows the articles figuring in the MathSci database in recent decades. Data for Spain and the European Union are available only from the 1980s onwards. These data, like all of the other results presented in this section, were obtained from the on-line version of the MathSci database.

Decade	Spain	EU	World-wide
1940-1949			32595
1950-1959			73863
1960-1969			135347
1970-1979			279882
1980-1989	3334	45922	349463
1990-1999	11504	104231	481105
Total	**14839**	**150190**	**1352255**

Table 3.1. Mathematical literature in MathSci by decades

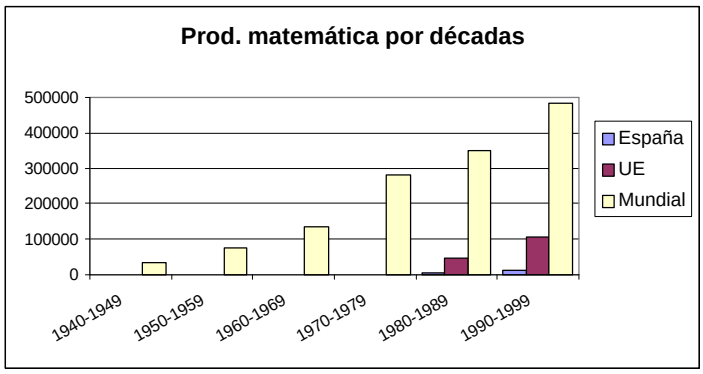

Figure 3.1. Mathematical literature in MathSci by decades

Distribution of mathematical literature during the period 1990-1999 in the MathSci database

Table 3.2 shows the types of mathematical literature for the period 1900-1999 figuring in the MathSci database. Both in Spanish production of mathematical literature and that of the European Union and world-wide production, there is a clear predominance of the article, labelled "journal" in the database, as the most frequently used type of document, accounting for 78% of Spanish production, 79% of EU production, and 78% of world-wide production. The next most frequent type is the proceedings-paper, making up 19% of Spanish and EU production and 15% of world-wide production. Translations of articles and book-proceedings represent a very small portion of production, as is the case with books, which account for 4% of world-wide production, 2% of production in the EU and 1% of Spanish production.

Spain's production of mathematical literature in the 1990s accounted for 10.6% of the European Union's production and 2.3% of world-wide production of mathematical literature.

Type of document	Spain	EU	World-wide	% Spain Compared with EU	% Spain Compared with world-wide prod.
Journal	11813	110106	494330	10,7%	2,4%
Proceedings-paper	2862	26978	99341	10,6%	2,9%
Book	118	2532	22701	4,7%	0,5%
Journal-translation	36	365	27032	9,9%	0,1%
Book-proceedings	2	46	9332	4,3%	0,0%
Total	**14831**	**140027**	**652736**	**10,6%**	**2,3%**

Table 3.2. Types of mathematical literature produced in 1990-1999 according to MathSci

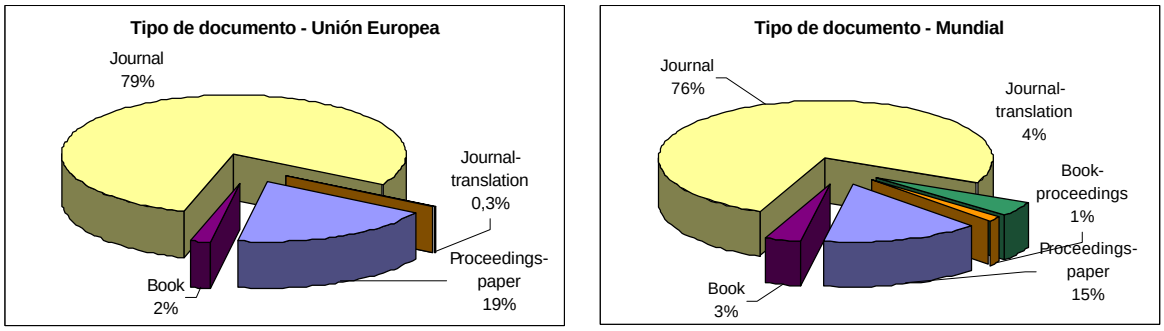

Figure 3.2. Types of document in the EU Graph 3.3. Types of document world-wide

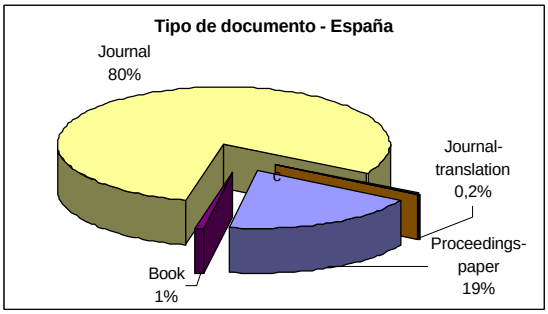

Figure 3.4. Types of document in Spain

Since the type of document dealt with in this study is the article, we will compare its progression over the past decade both in the MathSci database and, in the following Section, in the ISI database.

Comparison of world-wide and Spanish production of mathematical literature during the period 1990-1999 corresponding to articles figuring in the MathSci database

Table 3.3 compares the yearly progression of world-wide and Spanish production of mathematical literature during the period 1990-1999 in the MathSci database. The discrepancy between the totals shown in this table and in Table 3.2 is due to articles figuring with a multiple publication date (e.g. 1992-1993) in the MathSci database, which are counted twice in Table 3.3.

Both world-wide and in the European Union and Spain, the 1990s were characterised by an increase in the production of mathematical literature figuring in the MathSci database. The real increase in this production of mathematical literature between 1990 and 1999 was 27% world-wide, 58% in the European Union and 133% in Spain. The yearly increase also shows that Spanish production grew faster than production in the rest of the world.

The decreases recorded in production for 1993 and 1998, both world-wide and in Spain are puzzling, and may be due in part to the high levels of growth recording for the preceding years. Nevertheless, in our study we have detected the duplication of some documents in the MathSci database, for 1992 and 1997, to be precise, meaning that the high levels of growth for those years might be slightly inflated as a result. If we look at the progression of the percentage of world-wide production represented by Spanish production, we note that this percentage grew throughout the decade, from 1.7% in 1990 to 3.2% in 1999. The same occurs if we look at the EU, where Spain's production in the last decade went from 8.9% of the total in 1990 to 13.0% in 1999.

The figures for the most recent years, particularly 1999, may vary slightly on the basis of incorporation of data from future disks.

	Spain		**EU**		**World-wide**		**Relative %**	
Year	**No. doc.**	**Increase**	**No. doc.**	**Increase**	**No. doc.**	**Increase**	**Spain - world-wide**	**Spain - EU**
1990	690		7795		40116		**1,7%**	**8,9%**
1991	919	*33,2%*	9954	*27,7%*	47073	*17,3%*	**2,0%**	**9,2%**
1992	1167	*27,0%*	11854	*19,1%*	54078	*14,9%*	**2,2%**	**9,8%**
1993	926	*-20,7%*	8655	*-27,0%*	41576	*-23,1%*	**2,2%**	**10,7%**
1994	901	*-2,7%*	9363	*8,2%*	43620	*4,9%*	**2,1%**	**9,6%**
1995	1097	*21,8%*	10321	*10,2%*	46853	*7,4%*	**2,3%**	**10,6%**
1996	1323	*20,6%*	12585	*21,9%*	56121	*19,8%*	**2,4%**	**10,5%**
1997	1776	*34,2%*	15925	*26,5%*	65653	*17,0%*	**2,7%**	**11,2%**
1998	1428	*-19,6%*	11986	*-24,7%*	50508	*-23,1%*	**2,8%**	**11,9%**
1999	1610	*12,7%*	12344	*3,0%*	50885	*0,7%*	**3,2%**	**13,0%**
Total	**11837**		**110782**		**496483**		**2,4%**	**10,7%**

Note: Increases calculated in comparison with the preceding year

Table 3.3. Comparison of production of mathematical literature in 1990-1999 according to MathSci

The following graph shows a comparison of yearly production of mathematical literature. In order to standardise value ranges and make them comparable, the graphs for Spain and the EU have been multiplied by the ratio of total world-wide documents to total respective documents for Spain and the EU.

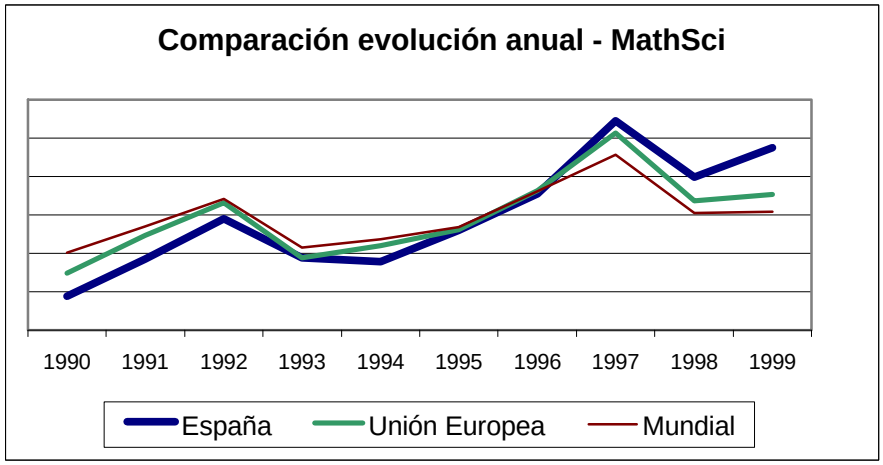

Figure 3.5. Progression of the number documents in the MathSci database

Distribution of MathSci production by MSC classification, showing the index of activity for Spain

Table 3.4 shows Spanish and world-wide production for the decade 1990-1999 classified by its principal MSC code, and the percentage of total production for the code. The final column shows the index of activity for Spain, calculated as the ratio between the percentage of Spanish production in the area and the world-wide percentage for the same area. An index of activity higher than one indicates activity at a level higher than the world average for the area.

Readers will note that we are working here with the actual total of 11,813 articles corresponding to Spanish production in the MathSci database for the decade 1990-1999 and the 494,330 articles corresponding to world-wide production, as shown in Table 3.2. The minor discrepancies with the totals shown in the table are due to the fact that some documents do not include any information in the MSC field and therefore could not be catalogued.

Percentages for Spain in respect of total production are observed to be much higher than world-wide percentages for the following codes:

44: Integral transfers, operational calculus
46: Functional analysis
04: Set theory
53: Differential geometry
42: Fourier analysis

In these categories, the percentage of Spanish production in the world-wide total is much higher than the average percentage of Spanish production in world-wide production for the whole decade, which, as we have seen, amounted to 2.4% (Table 3.3).

On the other hand, Spain's contribution to the following areas was minimal:

51: Geometry (general)
11: Number theory
05: Combinatorics

This information should be taken with the appropriate reservations, since, for example, many Spanish publications in the area of Number Theory are classified in the area of Algebraic Geometry, and, similarly, Geometry publications are generally found in more specific categories. Information relating to new subjects in the MSC classification is not taken into account, since it is not representative.

MSC Code	Publications in the period 1990-1999	Percentage of total	Publications in Spain	Percentage of Spanish activity	Percentage of code	Index of activity
00	1174	0.2	37	0.3	3.15	**1.32**
01	6915	1.4	129	1.1	1.87	0.78
03	11012	2.2	280	2.4	2.54	**1.06**
04	986	0.2	53	0.4	5.38	**2.24**
05	19418	3.9	128	1.1	0.66	0.28
06	3369	0.7	30	0.3	0.89	0.37
08	982	0.2	9	0.1	0.92	0.38
11	16214	3.3	127	1.1	0.78	0.33
12	1202	0.2	37	0.3	3.08	**1.29**
13	3599	0.7	141	1.2	3.92	**1.64**
14	6732	1.4	228	1.9	3.39	**1.41**
15	4955	1.0	88	0.7	1.78	0.74
16	7490	1.5	237	2.0	3.16	**1.32**
17	4719	1.0	224	1.9	4.75	**1.98**
18	1332	0.3	53	0.4	3.98	**1.66**
19	603	0.1	7	0.1	1.16	0.48
20	11812	2.4	249	2.1	2.11	0.88
22	3060	0.6	29	0.2	0.95	0.40
26	3747	0.8	37	0.3	0.99	0.41
28	3430	0.7	104	0.9	3.03	**1.27**
30	7554	1.5	138	1.2	1.83	0.76
31	1292	0.3	21	0.2	1.63	0.68
32	5600	1.1	135	1.1	2.41	**1.01**
33	3441	0.7	120	1.0	3.49	**1.46**
34	15826	3.2	326	2.8	2.06	0.86
35	25191	5.1	587	5.0	2.33	0.97
37*	*1525*	*0.3*	*82*	*0.7*	*5.38*	*2.25*
39	2797	0.6	63	0.5	2.25	0.94
41	5236	1.1	140	1.2	2.67	**1.12**
42	4926	1.0	249	2.1	5.05	**2.11**
43	1114	0.2	9	0.1	0.81	0.34
44	931	0.2	90	0.8	9.67	**4.04**
45	1693	0.3	23	0.2	1.36	0.57
46	12639	2.6	1082	9.2	8.56	**3.57**
47	11758	2.4	262	2.2	2.23	0.93
49	6382	1.3	88	0.7	1.38	0.58
51	3322	0.7	10	0.1	0.30	0.13
52	3618	0.7	45	0.4	1.24	0.52
53	10330	2.1	529	4.5	5.12	**2.14**
54	8583	1.7	228	1.9	2.66	**1.11**
55	2575	0.5	119	1.0	4.62	**1.93**
57	5427	1.1	96	0.8	1.77	0.74
58	18537	3.8	583	4.9	3.15	**1.31**
60	19036	3.9	273	2.3	1.43	0.60
62	27034	5.5	644	5.5	2.38	0.99
65	23848	4.8	499	4.2	2.09	0.87
68	18825	3.8	259	2.2	1.38	0.57
70	3552	0.7	152	1.3	4.28	**1.79**
73	8401	1.7	133	1.1	1.58	0.66
74*	*1043*	*0.2*	*23*	*0.2*	*2.21*	*0.92*
76	12985	2.6	189	1.6	1.46	0.61
78	2494	0.5	38	0.3	1.52	0.64
80	1312	0.3	18	0.2	1.37	0.57
81	29527	6.0	840	7.1	2.84	**1.19**
82	9999	2.0	160	1.4	1.60	0.67
83	11605	2.4	378	3.2	3.26	**1.36**

85	416	0.1	9	0.1	2.16	0.90
86	1133	0.2	12	0.1	1.06	0.44
90	21311	4.3	499	4.2	2.34	0.98
91*	*1037*	*0.2*	*67*	*0.6*	*6.46*	*2.70*
92	4372	0.9	64	0.5	1.46	0.61
93	17166	3.5	233	2.0	1.36	0.57
94	5065	1.0	69	0.6	1.36	0.57
Total	**493209**		**11811**			

* From MSC 2000

Table 3.4. Distribution of MathSci production according to the MSC

4. DATABASE

In this Section we present information on Spanish production of mathematical literature for the decade appearing in the ISI database. The source for this information was SCISearch, the on-line version of the SCI database.

4.1 Comparison of world-wide and Spanish production of mathematical literature for the period 1990-1999, corresponding to articles in the ISI database

Table 4.1 compares the yearly progression of world-wide and Spanish production of mathematical literature for the period 1990-1999 in the ISI database. We have taken into account the documents figuring in the ISI database for the years 1990-1999 corresponding to the ISI mathematics disciplines: "mathematical methods, biology and medicine", "mathematical methods, physical science", "mathematical methods, social sciences", "mathematics", "mathematics and statistics", "applied mathematics", "general mathematics", "miscellaneous mathematics", "pure mathematics", "mathematics, statistics & probability", "mathematical physics", "mathematical psychology", "social sciences, mathematical methods" and "statistics & probability". We estimate that 10% of the documents for the final year might be unaccounted for owing to the time elapsed between the publishing date and when the information is compiled.

The initial analysis of this tables confirms the conclusion drawn in the preceding Section to the effect that Spanish production of mathematical literature grew much faster than world-wide production of mathematical literature during the last decade. While world-wide production showed moderate growth throughout the decade, Spanish production grew much faster (with the exception of 1994 and 1996, when, once again, we must take into account the effect of the exceptional growth recorded in the preceding years).

Spain's contribution to the ISI database went from 1.7% of world-wide production in 1990 to 3.9% in 1999, and has continued to grow, reaching 4.18%, according to the most recent ISI data for 2001.

	Spain		World-wide		Relative %
Year	**No. doc.**	**Increase**	**No. doc.**	**Increase**	**Spain - world-wide**
1990	339		20500		1.7%
1991	374	*10.3%*	21386	*4.3%*	1.7%
1992	459	*22.7%*	22081	*3.2%*	2.1%
1993	606	*32.0%*	23651	*7.1%*	2.6%
1994	627	*3.5%*	25126	*6.2%*	2.5%
1995	785	*25.2%*	26917	*7.1%*	2.9%
1996	835	*6.4%*	28133	*4.5%*	3.0%
1997	1010	*21.0%*	30278	*7.6%*	3.3%
1998	1128	*11.7%*	31457	*3.9%*	3.6%
1999	1256	*11.3%*	31883	*1.4%*	3.9%
Total	**7419**		**261412**		**2.8%**

Note: Increases calculated in comparison with the preceding year

Table 4.1. Comparison of production of mathematical literature in 1990-1999 according to ISI

The following graph compares the yearly progression of production of mathematical literature. As before, in order to allow comparison, the graph for Spain has been multiplied by the ratio of total documents world-wide to total documents for Spain.

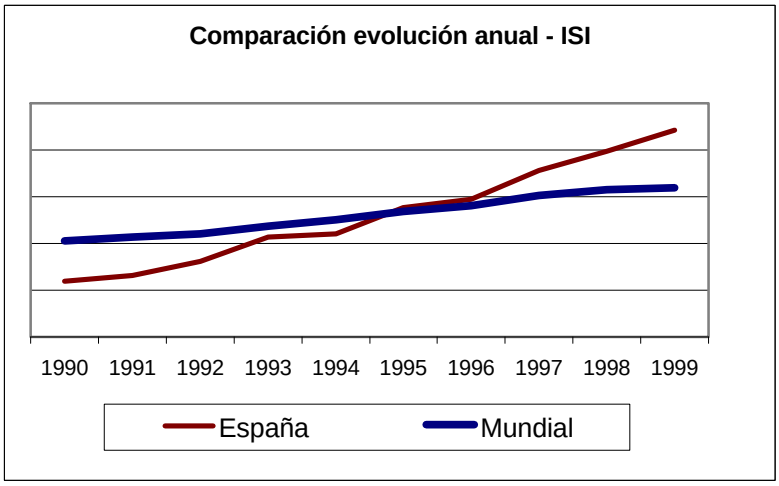

Figure 4.1. Progression of the number of documents in the ISI

4.2. Selection of articles for the study and their distribution in the period 1990-1999

In order to make more finely-focused studies of Spain's qualitative production, from the 11,813 works figuring in the Spanish MathSci database we selected those that also figure in the ISI database. We then eliminated a number of works whose publication was listed under headings that are not strictly mathematical within the classification used by the ISI and whose content was considered to be clearly non-mathematical by the experts consulted. This screening affected particularly articles on physics figuring in the MathSci database and therefore included in the 11,813 articles extracted from it.

The documents that were finally selected and that are the subject of this study are the 6,220 articles distributed throughout the decade as follows:

Year	No. art.	Increase
1990	330	
1991	388	17.6%
1992	448	15.5%
1993	520	16.1%
1994	524	0.8%
1995	644	22.9%
1996	672	4.3%
1997	828	23.2%
1998	883	6.6%
1999	983	11.3%
Total	**6220**	

Note: Increases calculated in comparison with the preceding year

Table 4.2. Spanish production of mathematical literature 1990-1999

Nevertheless, Section 6.5 also contains some data from the ISI database without subsequent screening and this data confirms the need for that screening.

We must bear in mind that the ISI database contains very few Spanish journals and that we are therefore working almost exclusively with Spanish mathematical literature published in foreign journals. During the period 1990-1999, no Spanish physics journal and only to Spanish mathematics journals appear in the ISI database: *Revista Matemática Iberoamericana* , which appeared in the database for the first time in 1998, and *Test*, in 1999. *Publicacions Matematiques*, published by UAB, appeared in 2000, and more are likely to appear in 2001. These facts point to the improved competitiveness of our publications, although it is well-known that, since the ISI is a private organisation, there are other factors (including potential profitability) that influence the decision to include a journal in its database.

4.3. Distribution of production of mathematical literature in the period 1990-1999

Graph 4.2 shows the progression of Spanish production during the period 1990-1999. Production of mathematical literature grew steadily and at a high rate after 1990. However, after 1993 that increase was not linear, but instead followed a roughly two-year cycle, being much lower in 1994, 1996 and 1998, and higher in 1995, 1997 and 1999.

In simpler terms, we can state that Spanish production grew by 300%, while world-wide production grew at less than half that rate.

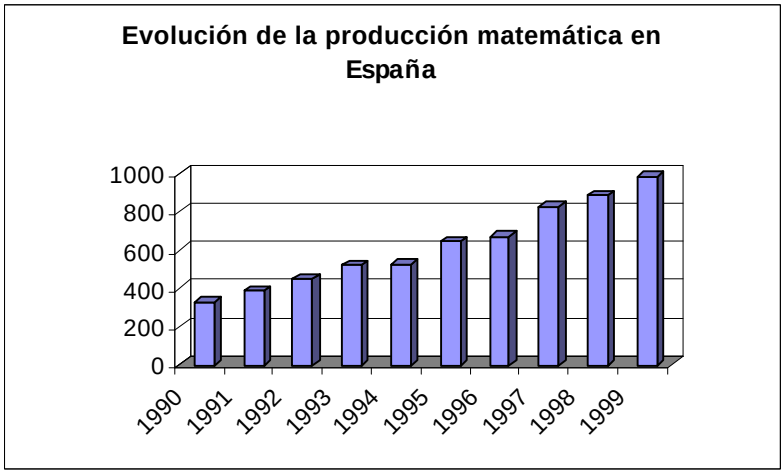

Figure 4.3. Progression of production of mathematical literature in Spain

4.4. Mathematical research in the context of Spanish research

Lastly, in order to provide an idea of the position of mathematical research in the context of all research carried out in Spain, and in order to compare that research with neighbouring countries, Table 4.3 shows the following three items:

a) the percentage of Spanish production of mathematical literature in respect of world-wide production as reported by the ISI;
b) the order in which the foregoing percentage situates mathematics within the 21 fields of science listed below; and
c) relative impact, i.e. deviation (as a percentage) from the average number of citations per article world-wide. For example, the -16 for Spain in this

column means that the average number of citations of Spanish articles is 16% lower than the world average, i.e. if the average number of citations of an article world-wide is 10 times, Spanish articles would be cited an average of 8.4 times.

The third-place ranking of mathematics in Spain means that there are only two disciplines (astrophysics and agrarian sciences) with a presence in world-wide production of literature greater than the 4.18% currently held by production of mathematical literature. The ISI lists the following 21 fields: space sciences, agrarian sciences, mathematics, microbiology, chemistry, plant and animal sciences, ecology and the environment, pharmacology, physics, biology and biochemistry, immunology, material sciences, neuroscience, molecular biology, clinical medicine, geological sciences, economics and business management, engineering, informatics, psychology and psychiatry and social sciences.

Data for Spain, Japan, France and the United States refer to the five-year period 1996-2000, while the remainder are for 1995-1999 and were extracted from the web site of the Philadelphia Institute for Scientific Information, ISI.

We note that in Spain mathematical research ranks third in the country's total production of scientific literature (in spite of the fact that the resources dedicated to mathematical research cannot compare with those dedicated to other disciplines), although the average number of citations per article is much lower than the world average. Only in France does mathematical research rank higher in national production, holding first place, but we must bear in mind France's extraordinary tradition in mathematics. Spain is followed by Germany and Italy, while other countries rank much lower. Smaller countries, such as Denmark, Belgium and Norway, have production with a greater relative impact: the average number of citations per article is much higher than the world average.

Country	%	Order	Relative impact
Spain	4.18%	3rd	-16
Germany	9.88%	4th	2
Australia	2.78%	12th	15
Belgium	1.24%	11th	46
Denmark	0.79%	15th	52
United States	35.43%	15th	29
Francia	12.25%	1st	2
Holland	1.79%	21st	14
Italy	4.80%	6th	-2
Japan	5.26%	16th	-21
Norway	0.49%	16th	35
United Kingdom	6.72%	21st	26
Sweden	1.30%	20th	-2
Switzerland	1.25%	16th	31

Table 4.3. World-wide comparison of mathematical research

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5. STUDY OF PRODUCTION OF MATHEMATICAL LITERATURE

All of the results given below are based on the analysis of the 6,220 articles finally selected.

5.1. Overall information by autonomous communities

Distribution of production of mathematical literature in Spain by autonomous communities

Analysis of Spanish production of mathematical literature by autonomous communities as shown in Table 5.1 in absolute figures reveals the heavy concentration of research in Madrid and Catalonia. These two are followed by Andalusia and, at a certain distance, by Valencia, with these four autonomous communities accounting for almost 70% of Spanish production of mathematical literature.
This is clearly due to the heavy concentration of universities and faculty in these communities, particularly Madrid and Catalonia, making the figure for the proportion of articles per lecturer an important one. Thus, Aragon, which ranks fifth in respect of number of articles, is the autonomous community with the highest number of articles per lecturer, followed by Cantabria, while the four communities with the greatest production hold much lower positions, with Catalonia as the autonomous community that maintains the best ranking in this respect, as second in terms of production and third in terms of articles per lecturer.

The National University for Distance Education (UNED) is counted separately, since its production cannot be assigned to any particular autonomous community.

When using these figures, it must be taken into account that only tenured lecturers have been counted, as obtained from the Universities Board database for 2000. Thus, the autonomous communities with the highest degree of civil service presence may be at a disadvantage in connection with this ratio in comparison with those communities where there are more associate and assistant lecturers involved in research. It is also important to remember, particularly when analysing the data for autonomous communities with new universities, that publications can undergo substantial delays in appearing and that the attribution of a work to an autonomous community is based on the address given in the article, which, in most cases, is the address at the time the work is submitted rather than the time of its publication.

Another factor to take into account is the heterogeneity of the autonomous communities in terms of their number universities. Madrid, Catalonia and Andalusia have a large number of universities with widely varying levels of activity, and therefore some universities may "penalise" others when the overall figures for autonomous communities are averaged out, while Cantabria and La Rioja, for example, each have only one university and therefore the data for the autonomous community coincide with those for its university. Table 5.2 shows the universities covered in the study by autonomous communities.

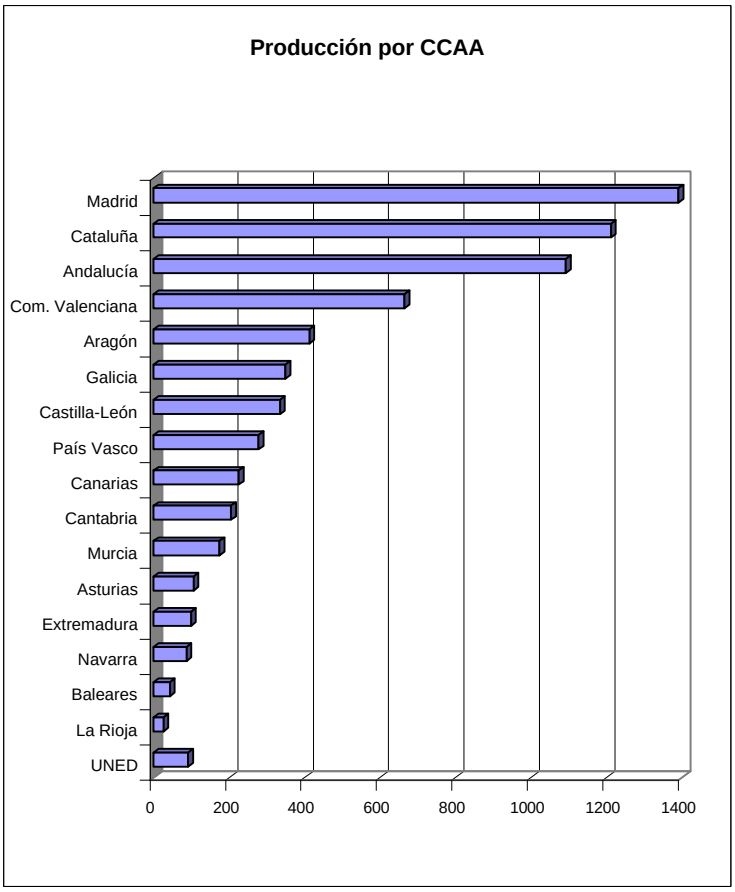


Figure 5.1. Production by autonomous communities

Autonomous communities	No. art.	%	No. of articles per lecturer
Aragon	413	6.6%	3.82
Cantabria	205	3.3%	3.66
Catalonia	1212	19.5%	3.16
Extremadura	99	1.6%	2.75
Murcia	174	2.8%	2.49
Navarre	87	1.4%	2.42
Madrid	1391	22.4%	2.39
Valencia	665	10.7%	2.25
Basque Country	278	4.5%	2.09
Andalusia	1092	17.6%	1.92
Castilla-León	335	5.4%	1.84
Canary Islands	225	3.6%	1.73
Galicia	349	5.6%	1.65
La Rioja	26	0.4%	1.18
Asturias	106	1.7%	1.05
Balearic Islands	43	0.7%	1.05
Actual total	**6220**		**2.22**

Table 5.1. Production of mathematical literature by autonomous communities

Table 5.2. Universities per autonomous community

- Andalusia
  - University of Almería
  - University of Cádiz
  - University of Córdoba
  - University of Granada
  - University of Jaén
  - University of Málaga
  - University of Seville
- Aragon
  - University of Saragossa
- Asturias
  - University of Oviedo
- Balearic Islands
  - University of the Balearic Islands
- Canary Islands
  - University of La Laguna
  - University of Las Palmas de Gran Canaria
- Cantabria
  - University of Cantabria
- Castilla-León
  - University of Burgos
  - University of Salamanca
  - University of Valladolid
- Castile-La Mancha
  - University of Castile-La Mancha
- Catalonia
  - Autonomous University of Barcelona
  - University of Barcelona
  - University of Lleida
  - James I University
  - Technical University of Catalonia
  - Pompeu Fabra University
- Valencia
  - University of Alacant
  - University of Valencia
  - Technical University of Valencia
- Extremadura
  - University of Extremadura
- Galicia
  - University of La Coruña
  - University of Santiago de Compostela
  - University of Vigo
- La Rioja
  - University of La Rioja
- Madrid
  - Autonomous University of Madrid
  - Charles III University of Madrid
  - Complutensian University of Madrid
  - University of Alcalá de Henares
  - Technical University of Madrid
- Murcia
  - University of Murcia
- Navarre
  - University of Navarre
  - Public University of Navarre
- Basque Country
  - University of the Basque Country

Progression of production of mathematical literature by autonomous communities and years

Table 5.3 shows the progression of production by autonomous communities and the increase recorded, based on the first two-year period studied, or failing that, the first two-year period in which the autonomous community produced any publications.

The autonomous communities with the largest production of mathematical literature, particularly Madrid and Catalonia, show below-average growth. This, then, indicates a trend to decentralisation of research. Asturias and Murcia are the autonomous communities with the fastest growth in production of mathematical literature, followed by Andalusia, Navarre and the Canary Islands. The huge increase shown for La Rioja is not representative, since it occurs in a single two-year period and consists of one single article in its first year of production of mathematical literature. Even so, its rapid growth is outstanding. The Basque Country is the autonomous community with the lowest rate of growth in its production.

	90-91	**92-93**	**94-95**	**96-97**	**98-99**	**Total**	**Increase**
Madrid	166	242	268	337	378	1391	128%
Catalonia	159	187	233	287	346	1212	118%
Andalusia	93	134	196	276	393	1092	323%
Valencia	83	99	132	154	197	665	137%
Aragon	56	80	91	85	101	413	80%
Galicia	36	49	56	84	124	349	244%
Castilla-León	49	54	59	72	101	335	106%
Basque Country	50	43	50	58	77	278	54%
Canary Islands	16	24	44	70	71	225	344%
Cantabria	23	38	38	55	51	205	122%
Murcia	19	23	35	37	60	174	216%
Asturias	5	12	21	33	35	106	600%
Extremadura	11	19	18	21	30	99	173%
Navarre		10	16	27	34	87	240%
Balearic Islands	4	9	5	14	11	43	175%
La Rioja				1	25	26	2400%
UNED	*8*	*12*	*19*	*34*	*19*	*92*	*138%*
Actual total	718	968	1168	1500	1866	6220	198%

Table 5.3. Progression of production of mathematical literature by autonomous communities

The following graph shows the progression of the five autonomous communities with the greatest production during the decade, those with over 400 articles.

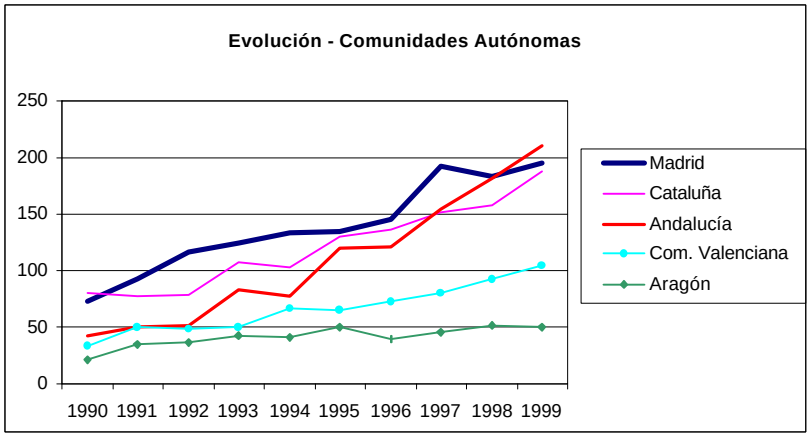


Figure 5.2. Progression of production by autonomous communities

5.2. General figures by institutional sectors

Distribution of production of mathematical literature in Spain by institutional sectors

Table 5.4 shows production of mathematical literature by institutional sectors. Percentages refer to the participation of the different sectors in the production of mathematical literature. Where different institutional sectors have collaborated on a single work, for example universities and the CSIC, that work is attributed to both sectors. This means that totals amount to more than the 6,220 actual documents and the sum of percentages is over 100.

Universities comprise the most productive sector and account for almost all Spanish production, i.e. 98.6%, while the CSIC accounts for only 2.3%. Joint university-CSIC centres contribute 0.1% of production. Only two other centres figure as contributors to production of mathematical literature in Spain: the Institute of Catalan Studies (IEC) and the Bank of Spain, the latter with only two documents in the course of the decade. It is worth noting the total absence of the private sector from the production of mathematical literature in Spain, a clear indication of the lack of integration of mathematics in R&D in the world of business and the scant or non-existent interest of the private enterprise in this area of research.

Sector	No. art.	%
Universities	6133	98.6%
CSIC	144	2.3%
IEC*	19	0.3%
Joint CSIC-Universities	4	0.1%
Bank of Spain	2	0.0%
Actual total	6220	

IEC*: Institute of Catalan Studies

Table 5.4. Production by sectors

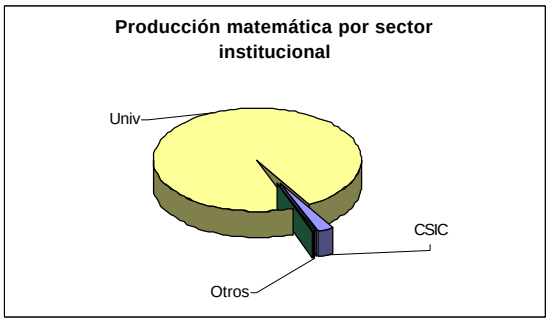


Figure 5.3. Production by institutional sectors

Yearly progression of production of mathematical literature in Spain by institutional sectors

Table 5.5 shows the progression of production of scientific literature in the two most productive sectors: universities and CSIC, and the increase recorded in this production.

Both the CSIC and universities show growth in their production, although at a faster rate in the case of the CSIC, owing to the low level of production at the start of the decade.

	90-91	92-93	94-95	96-97	98-99	Total	Increase
Universities	714	950	1154	1474	1841	6133	158%
CSIC	5	21	25	48	45	144	800%

Note: Increases are calculated in respect of the first two-year period, or failing that, in respect of the first two-year period with publication.

Table 5.5. Progression of production of mathematical production by universities and the CSIC

The following graph shows the progression of the two most productive institutional sectors. As before, the graph for the CSIC has been multiplied by 6133/144 to allow comparison.

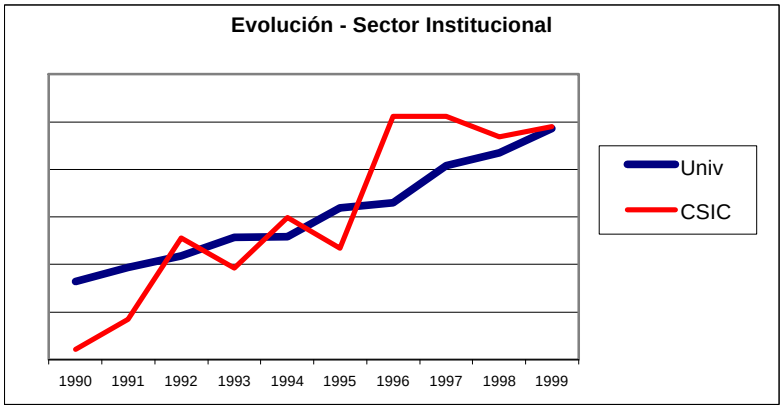


Figure 5.4. Progression of production by institutional sectors.

5.3. General figures by research centres

Following is the production by centres in the two most important institutional sectors: universities and the CSIC, and by joint university-CSIC centres.
The category of university centre includes all Spanish universities.

Distribution of production of mathematical literature in Spain by universities

Table 5.6 shows the distribution of mathematical production at different Spanish universities, which, as already mentioned, constitute the main sector of mathematical research in Spain. The table shows only those universities that produced mathematical literature during the period of the study. The percentages shown in the table refer to the percentage represented by production at the university in comparison with the total number of documents studied.

Analysis of production of mathematical literature by universities shows the substantial differences existing between them. The Complutensian University of Madrid makes the largest contribution to mathematical research (11.4% of total production), followed at a

distance by the University of Granada and the Technical University of Catalonia (8.8% and 7.1%, respectively). The universities of Burgos, Navarre, Las Palmas, Jaén and Lleida are those with the smallest production of mathematical literature, with a percentage of under 0.15% of the total.

The table shows a comparative breakdown of production by each university centre by the number of lecturers and the ratio of documents per lecturer is calculated for the ten years covered by the study. The University of Barcelona and the Autonomous University of Madrid are outstanding for their high proportion of documents per lecturer. The University of Barcelona ranks fourth in terms of the total number of documents and leads production in terms of the number of documents per lecturer. The Complutensian University of Madrid ranks first in terms of the total number of documents but only fifth in terms of the number of documents per lecturer.

University	No. art.	%	No. of lecturers	No. of articles per lecturer
University of Barcelona	425	6.8%	78	5.45
Autonomous University of Madrid	299	4.8%	56	5.34
Autonomous University of Barcelona	381	6.1%	78	4.88
University of La Laguna	220	3.5%	56	3.93
Complutensian University of Madrid	709	11.4%	184	3.85
University of Zaragoza	413	6.6%	108	3.82
University Cantabria	205	3.3%	56	3.66
University of Valencia (General Studies)	313	5.0%	89	3.52
Pompeu Fabra University	14	0.2%	4	3.50
University of Granada	549	8.8%	160	3.43
University of Santiago de Compostela	286	4.6%	92	3.11
University Extremadura	99	1.6%	36	2.75
University Murcia	174	2.8%	70	2.49
Charles III University of Madrid	93	1.5%	38	2.45
Public University of Navarre	86	1.4%	36	2.39
UNED	92	1.5%	41	2.24
University of Malaga	153	2.5%	70	2.19
University of Alacant	107	1.7%	49	2.18
Technical University of Catalonia	442	7.1%	211	2.09
Technical University of Valencia	253	4.1%	121	2.09
University of the Basque Country	278	4.5%	133	2.09
University of Valladolid	254	4.1%	123	2.07
University of Salamanca	81	1.3%	42	1.93
University of Seville	335	5.4%	178	1.88
University of Almería	47	0.8%	32	1.47
James I University of Castelló	46	0.7%	36	1.28
University of La Rioja	26	0.4%	22	1.18
University of Vigo	67	1.1%	57	1.18
University of Oviedo	106	1.7%	101	1.05
University of the Balearic Islands	43	0.7%	41	1.05
Technical University of Madrid	274	4.4%	279	0.98
University of Lleida	9	0.1%	12	0.75
University of Córdoba	33	0.5%	47	0.70
University of Alcalá de Henares	18	0.3%	26	0.69
University of La Coruña	25	0.4%	63	0.40
University of Cádiz	18	0.3%	59	0.31
University of Jaén	7	0.1%	24	0.29
University of Las Palmas de Gran Canaria	5	0.1%	74	0.07

University of Burgos	1	0.0%	17	0.06
University of Navarre	1	0.0%		
Actual total	6133		3124	

Table 5.6. Production of mathematical literature by universities

Progression of production of mathematical literature in Spain by universities and years.

Table 5.7 shows the progression and growth of production of mathematical literature at universities during the decade. In order to make the table easier to read, the data have been grouped by two-year periods.

It is interesting to note that the universities with the highest ratio of articles per lecturer are among those with the lowest rate of growth of production. This could be due to two factors: in the first place, these centres had taken a "modern" approach to research and publication since the beginning of the decade, while the other centres gradually entered the field of research activities and the dynamics of publication as the decade progressed. Secondly, the staff at these centres has varied little, meaning that the number or "actual" researchers there remained constant throughout the decade.

The high rates of growth recorded at some new universities indicates the effort that these newer and smaller centres are making to carry out substantial production of mathematical literature. The University of Córdoba, James I University and Autonomous University of Madrid are those that have shown the slowest growth.

Centre	90-91	92-93	94-95	96-97	98-99	Total
Complutensian U. of Madrid.	82	128	144	163	192	709
U. of Granada	51	67	116	140	175	549
Technical U. of Catalonia	41	65	74	125	137	442
U. of Barcelona	70	80	94	83	98	425
U. of Zaragoza	56	80	91	85	101	413
Autonomous U. of Barcelona	54	62	84	86	95	381
U. of Seville	32	42	48	92	121	335
U. of Valencia	38	58	70	78	69	313
Autonomous U. of Madrid	53	57	64	66	59	299
U. of Santiago de Compostela	36	49	56	63	82	286
U. of the Basque Country	50	43	50	58	77	278
Technical U. of Madrid	28	57	57	62	70	274
U. of Valladolid	34	41	48	53	78	254
Technical U. of Valencia	44	44	50	49	66	253
U. of La Laguna	16	24	44	68	68	220
U. of Cantabria	23	38	38	55	51	205
U. of Murcia	19	23	35	37	60	174
U. of Málaga	8	22	30	36	57	153
U. of Alacant	4	4	18	32	49	107
U. of Oviedo	5	12	21	33	35	106
U. of Extremadura	11	19	18	21	30	99
Charles III U. of Madrid			1	32	60	93
UNED	8	12	19	34	19	92
Public U. of Navarre		10	16	27	33	86
U. of Salamanca	15	13	11	18	24	81
U. of Vigo				20	47	67
U. of Almería				8	39	47
James I U.				15	31	46
U. of the Balearic Islands	4	9	5	14	11	43

U. of Córdoba	4	6	5	8	10	33
U. of La Rioja				1	25	26
U. of La Coruña				7	18	25
U. of Alcalá de Henares	2	4	0	4	8	18
U. of Cádiz	1	1	0	7	9	18
Pompeu Fabra U.				1	13	14
U. of Lleida					9	9
U. of Jaén				1	6	7
U. of Las Palmas de G.C.				2	3	5
U. of Burgos				1	0	1
U. of Navarre					1	1
Total	714	950	1154	1474	1841	6133

Note: Increases are calculated in respect of the first two-year period, or failing that, in respect of the first two-year period with publication.

Table 5.7. Progression of production of mathematical literature by universities

The following graph shows the progression of the five university centres with the highest production during the decade.

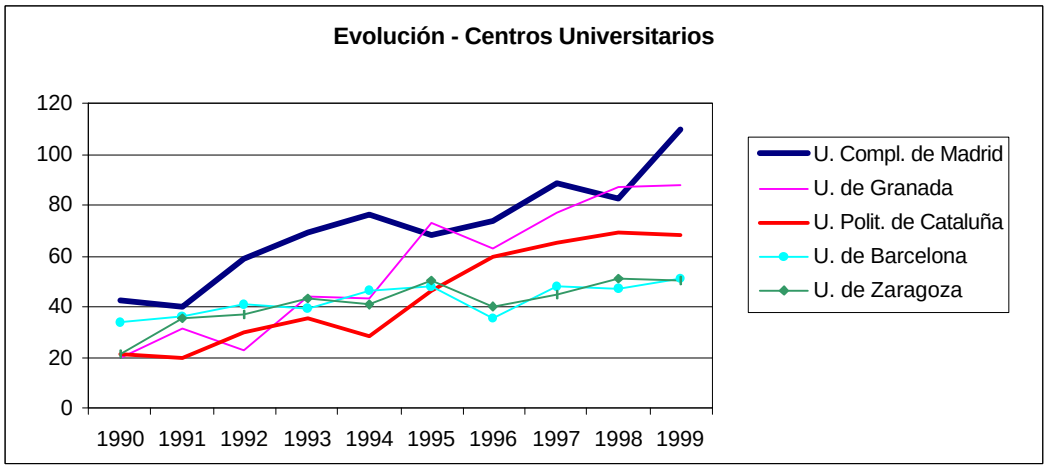


Figure 5.5. Progression of production by university centres

Distribution of production of mathematical literature in Spain by CSIC centres and joint CSIC-university centres

Table 5.8 shows the distribution of production of mathematical literature between the different CSIC centres and joint CSIC-university centres (shown in the table with an asterisk), giving the percentage that their production represents of the total number of documents studied.

Centre	No. art.	% of total production
Miguel A. Catalán Physics Centre (CFMAC)	93	1.5%
L. Torres Quevedo Physics Technology Centre (CETEF)	21	0.3%
Economics Analysis Institute (IAE)	17	0.3%
Madrid Institute of Materials Science (ICMM)	7	0.1%
Artificial Intelligence Research Institute (IIIA)	6	0.1%
Astrophysical Institute of Andalusia (IAA)	1	0.0%
Earth Sciences Institute of Andalusia (IACT) (*)	2	0.0%
Space Studies Institute of Catalonia (IEEC)(*)	1	0.0%
Robotics and Informatics Institute (IRII) (*)	1	0.0%

Total	148

Table 5.8. Production of mathematical literature by CSIC centres and joint centres

The CSIC centre with the greatest production was the Miguel A. Catalán Physics Centre, which is formed by three institutes: the Structure of Matter Institute, the Basic Physics and Mathematics Institute and the Daza de Valdés Optics Institute. Therefore, most of the mathematical research by the CSIC is done at the Basic Physics and Mathematics Institute, which has a small but very active group of mathematicians (three researchers) and whose production accounts for 80% of the CSIC's total production of mathematical literature. There is also a mathematics researcher at the Applied Physics Institute of the L. Torres Quevedo Physics Technology Centre.

The last three centres shown in the table are joint centres, none of which is strictly involved in mathematics. The Earth Sciences Institute of Andalusia changed its name during the decade and was previously called the Mediterranean Institute of Andalusia.

The following table and graphics show the progression by the Miguel A. Catalán Physics Centre:

Centre	90-91	92-93	94-95	96-97	98-99	Total	Increase
M.A. Catalán Physics Centre	3	16	16	36	22	93	200%

Table 5.9. Progression of production of mathematical literature by the Miguel A. Catalán Physics Centre

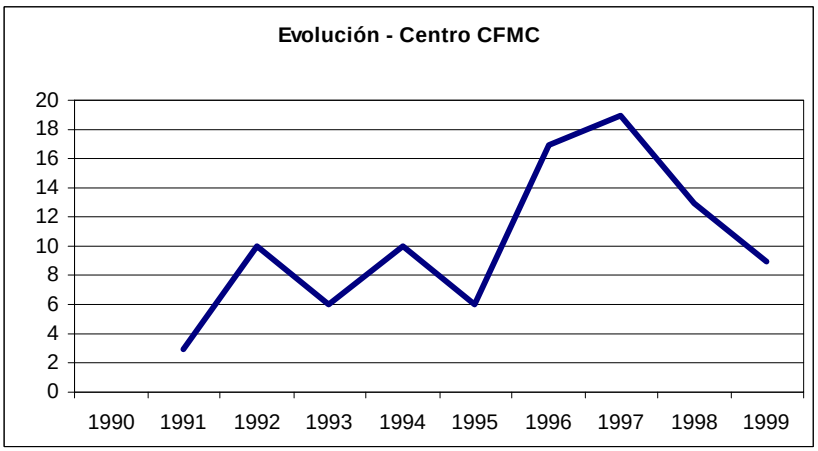


Figure 5.6. Progression of production by the M.A. Catalán Physics Centre

5.4. General figures by MSC classification

Table 5.10 shows the distribution of production by the MSC 1991 classification and including the three new subjects added to MSC 2000, in descending order by the number of documents in each subject, also showing the percentage of total production.

Over 50% of Spanish research is centred on 9 of the 61 subjects included in MSC 1991, while almost 90% is centred on 35 of those subjects. As seen in the table, the most

productive subject in mathematical research in terms of the total number of documents is that of *Functional analysis* (no. 46), followed by *Partial differential equations* (no. 35) and *Numerical analysis* (no. 65).

MSC	MSC 1991	No. art.	%	cumulative %
46	Functional analysis	561	9.0%	9.0%
35	Partial differential equations	377	6.1%	15.1%
65	Numerical analysis	377	6.1%	21.1%
62	Statistics	357	5.7%	26.9%
90	Economics, operations research, programming, games	317	5.1%	32.0%
58	Global analysis, analysis on manifolds	312	5.0%	37.0%
53	Differential geometry	274	4.4%	41.4%
34	Ordinary differential equations	182	2.9%	44.3%
68	Computer science	181	2.9%	47.2%
20	Group theory and generalisations	180	2.9%	50.1%
14	Algebraic geometry	167	2.7%	52.8%
16	Associative rings and algebras	167	2.7%	55.5%
42	Fourier analysis	158	2.5%	58.0%
60	Probability theory and stochastic processes	156	2.5%	60.5%
93	Systems theory, control	155	2.5%	63.0%
76	Fluid mechanics	141	2.3%	65.3%
17	Nonassociative rings and algebras	135	2.2%	67.5%
47	Operator theory	121	1.9%	69.4%
54	General topology	107	1.7%	71.1%
13	Commutative rings and algebra	103	1.7%	72.8%
32	Several complex variables and analytic spaces	94	1.5%	74.3%
73	Solid mechanics	94	1.5%	75.8%
70	Mechanics of particles and systems	92	1.5%	77.3%
03	Mathematical logic and foundations	88	1.4%	78.7%
05	Combinatorics	88	1.4%	80.1%
30	Functions of a complex variable	82	1.3%	81.4%
81	Quantum theory	82	1.3%	82.8%
41	Approximation and expansion	81	1.3%	84.1%
55	Algebraic topology	73	1.2%	85.2%
11	Number theory	71	1.1%	86.4%
82	Statistical mechanics, structure of matter	68	1.1%	87.5%
33	Special functions	61	1.0%	88.5%
15	Linear and multilinear algebra, matrix theory	60	1.0%	89.4%
28	Measure and integration	48	0.8%	90.2%
49	Calculus of variations, optimization	46	0.7%	90.9%
94	Information and communication, circuits	45	0.7%	91.7%
57	Manifolds and cell complexes	44	0.7%	92.4%
92	Biology and other natural sciences, behavioural sciences	41	0.7%	93.0%
83	Relativity and gravitational theory	38	0.6%	93.6%
04	Set theory	36	0.6%	94.2%
37*	Dynamic systems and ergodic theory	34	0.5%	94.8%
91*	Game theory, economics, social and behavioural sciences	32	0.5%	95.3%
18	Category theory, homological algebra	31	0.5%	95.8%
52	Convex and discrete geometry	28	0.5%	96.2%
12	Field theory and polynomials	25	0.4%	96.6%
26	Real functions	23	0.4%	97.0%
78	Optics, electromagnetic theory	23	0.4%	97.4%
01	History and biography	21	0.3%	97.7%
22	Topological groups, Lie groups	17	0.3%	98.0%
39	Finite differences and functional equations	17	0.3%	98.2%
44	Integral transforms, operational calculus	17	0.3%	98.5%
74*	Mechanics of deformable solids	14	0.2%	98.7%

06	Order, lattices, ordered algebraic structures	13	0.2%	99.0%
31	Potential theory	13	0.2%	99.2%
45	Integral equations	13	0.2%	99.4%
80	Classical thermodynamics, heat transfer	10	0.2%	99.5%
86	Geophysics	8	0.1%	99.7%
43	Abstract harmonic analysis	6	0.1%	99.8%
19	K-theory	5	0.1%	99.8%
85	Astronomy and astrophysics	4	0.1%	99.9%
51	Geometry	3	0.0%	100.0%
08	General mathematical systems	2	0.0%	100.0%
00	General	1	0.0%	100.0%
	Total	6220		

* From MSC 2000

Table 5.10. Production of mathematical literature by MSC classification

Progression of production of mathematical literature in Spain by MSC classification and years.

Table 5.11 shows the progression of production of mathematical literature by MSC classification and the increases recorded during the decade for each subject.

Taking the MSC codes with over 100 articles in the course of the decade, there were particularly notable increases in the publication of articles on subjects in the areas of Statistics (no. 62), Numerical analysis (no. 65), Differential geometry (no. 53) and Computer science (no. 68).

MSC	90-91	92-93	94-95	96-97	98-99	Total	Increase
46	80	97	117	119	148	561	85%
35	48	81	75	93	80	377	67%
65	40	53	67	81	136	377	240%
62	30	41	64	96	126	357	320%
90	33	41	64	81	98	317	197%
58	34	65	69	88	56	312	65%
53	27	33	48	75	91	274	237%
34	21	19	23	53	66	182	214%
68	18	30	27	47	59	181	228%
20	29	28	40	37	46	180	59%
14	25	20	28	43	51	167	104%
16	24	29	33	35	46	167	92%
42	16	32	30	31	49	158	206%
60	19	25	28	39	45	156	137%
93	16	23	33	36	47	155	194%
76	11	12	39	33	46	141	318%
17	14	27	33	30	31	135	121%
47	17	21	12	29	42	121	147%
54	14	18	9	29	37	107	164%
13	12	16	27	24	24	103	100%
32	9	14	20	28	23	94	156%
73	10	13	26	21	24	94	140%
70	12	12	21	23	24	92	100%
03	7	20	13	18	30	88	329%
05	7	9	10	30	32	88	357%
30	11	14	21	21	15	82	36%
81	16	13	15	17	21	82	31%
41	4	12	12	30	23	81	475%

55	9	15	11	17	21	73	133%
11	13	13	13	9	23	71	77%
82	15	10	14	10	19	68	27%
33	5	3	9	16	28	61	460%
15	10	9	12	14	15	60	50%
28	3	9	12	13	11	48	267%
49	6	14	8	10	8	46	33%
94	3	12	7	8	15	45	400%
57	5	10	11	8	10	44	100%
92	8	1	5	13	14	41	75%
83	5	10	5	7	11	38	120%
04	5	9	7	12	3	36	-40%
37*				1	33	34	3200%
91*					32	32	
18	3	2	9	4	13	31	333%
52	2	2	3	11	10	28	400%
12	6	4	6	4	5	25	-17%
26	1	1	4	8	9	23	800%
78			4	8	11	23	175%
01	3	6	2	5	5	21	67%
22	1	2	3	4	7	17	600%
39	3	2	3	4	5	17	67%
44	1	3	1	8	4	17	300%
74*					14	14	
06	1	0	0	3	9	13	800%
31		3	2	4	4	13	33%
45	2	2	3	3	3	13	50%
80		4	3	2	1	10	-75%
86		2	1	2	3	8	50%
43	1	0	2	2	1	6	0%
19		1	1	3	0	5	-100%
85	3	0	0	0	1	4	-67%
51			2	0	1	3	-50%
08			1	0	1	2	0%
00		1	0	0	0	1	-100%
Total	718	968	1168	1500	1866	6220	

Note: Increases are calculated in respect of the first two-year period, or failing that, in respect of the first two-year period with publication.

* From MSC 2000

Table 5.11. Progression of production of mathematical literature by MSC

The following graphic shows the yearly progression (1990-1999) of the five MSC subjects with greatest production during the decade. Particularly noteworthy is the rapid and constant growth in the area of Numerical analysis (no. 65).

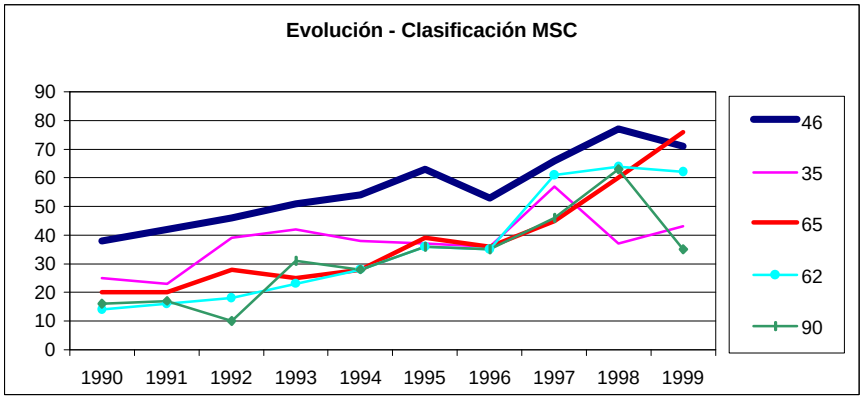


Figure 5.7. Progression of production by MSC classification

Most productive centres in MSC subjects with the greatest production

Table 5.12 shows the centres producing the most work in each of the five MSC codes with greatest production during the period 1990-1999. The last column shows the percentage of the total number of documents corresponding to the centre in question. Thus, we see that the Complutensian University of Madrid produced 35% of all Spanish articles in the category "Partial differential equations" during the decade.

Centre	No. art.	%
46 - Functional analysis		
Complutensian University of Madrid	84	13.1%
University of Granada	78	12.1%
Technical University of Valencia	72	11.2%
University of Seville	69	10.7%
University of Valencia	59	9.2%
35 - Partial differential equations		
Complutensian University of Madrid	146	35.0%
Autonomous University of Madrid	91	21.8%
University of the Basque Country	35	8.4%
University of Granada	23	5.5%
Technical University of Madrid	18	4.3%
65 - Numerical analysis		
University of Saragossa	81	19.6%
University of Valladolid	73	17.7%
Technical University of Valencia	42	10.2%
University of Málaga	28	6.8%
University of Alacant	23	5.6%
62 - Statistics		
Complutensian University of Madrid	80	18.1%
University of Barcelona	39	8.8%
University of Granada	36	8.1%
Technical University of Madrid	36	8.1%
University of Cantabria	34	7.7%
90 - Economics, operations research, programming, games		
University of Alacant	52	14.4%
Autonomous University of Barcelona	45	12.5%
University of Seville	27	7.5%
Complutensian University of Madrid	21	5.8%
University of Saragossa	21	5.8%

Table 5.12. Most productive centres in subjects with the greatest production

MSC subjects most studied in the five centres with the greatest production

Table 5.13 shows the MSC codes for the subjects most frequently researched at the five Spanish centres with the greatest production. The last column shows the percentage represented by the code in the centre's total production. Thus, 20.6% of the production of mathematical literature by the Complutensian University was in the area of Partial differential equations.

Although it is not shown in the table, owing to its low level of production, it is worth noting that production by the CSIC, which is in fact production by the Basic Physics and Mathematics Institute, is centred in two MSC subjects: 36.6% is classed as "Differential geometry" (no. 53) and 34.4% as "Global analysis, analysis in manifolds" (no. 58).

MSC subject	No. art.	%
Complutensian University of Madrid		
Partial differential equations	146	20.6%
Functional analysis	84	11.8%
Statistics	80	11.3%
Algebraic geometry	43	6.1%
Global analysis, analysis on manifolds	37	5.2%
University of Granada		
Differential geometry	108	19.7%
Functional analysis	78	14.2%
Statistics	36	6.6%
Ordinary differential equations	27	4.9%
Associative rings and algebras	26	4.7%
Technical University of Catalonia		
Computer science	81	18.3%
Combinatorics	74	16.7%
Global analysis, analysis on manifolds	35	7.9%
Fluid mechanics	25	5.7%
Solid mechanics	25	5.7%
University of Barcelona		
Probability theory and stochastic processes	57	13.4%
Global analysis, analysis on manifolds	49	11.5%
Algebraic geometry	48	11.3%
Statistics	39	9.2%
Commutative rings and algebra	29	6.8%
University of Saragossa		
Numerical analysis	81	19.6%
Nonassociative rings and algebras	60	14.5%
Global analysis, analysis on manifolds	26	6.3%
Approximation and expansion	25	6.1%
Group theory and generalisations	23	5.6%

Table 5.13. Subjects with the greatest production at the most productive centres

5.5. General figures by areas of knowledge

Distribution of production of mathematical literature by areas of knowledge

Table 5.14 shows the distribution of production of mathematical literature by areas of knowledge in which the articles covered by this study can be classified. The area with the largest number of publications is that of "Applied Mathematics", which accounts for 43.8% of total production. This is also the area with the largest number of faculty, and we therefore present a comparative breakdown of production by the number of tenured lecturers in the area. Taking into account the ratio of articles per lecturer, Geometry and Topology is the most productive area, followed at a distance by Algebra. Once again, we must point out that most MSC codes are assigned to more than one area of knowledge and therefore the total number of articles is higher than the 6,220 documents actually figuring in the database and the sum of percentages is over 100.

Area of knowledge	No. art.	%	No. of lecturers	No. of articles per lecturer

Geometry and topology	1585	25.5%	169	9.38
Algebra	1314	21.1%	205	6.41
Mathematical analysis	1871	30.1%	322	5.81
Applied mathematics	2723	43.8%	1334	2.04
Statistics and OR	1010	16.2%	705	1.43
Computer science and AI	338	5.4%	389	0.87
Actual total	6220			

Table 5.14. Production of mathematical literature by areas of knowledge

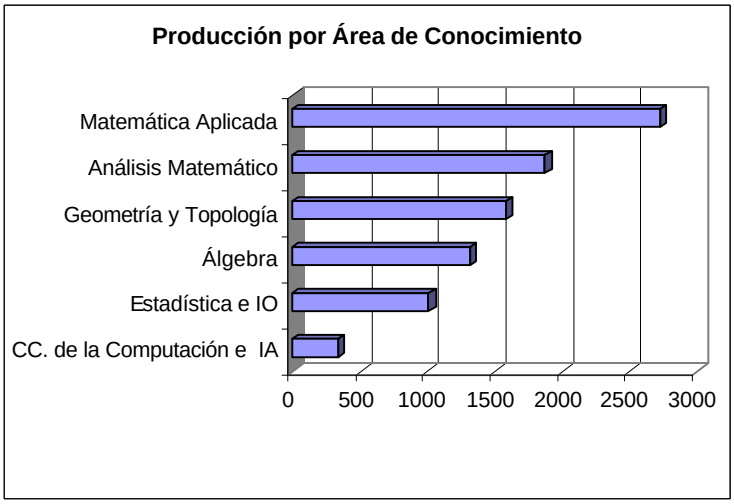


Figure 5.8. Production by areas of knowledge

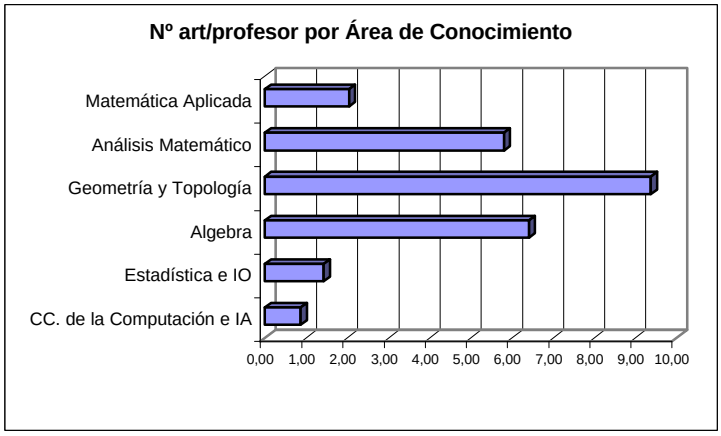


Figure 5.9. Ratio of articles per lecturer

Progression of production of mathematical literature by areas of knowledge

Table 5.15 shows the progression and growth of production of mathematical literature by areas of knowledge. Graph 5.10 shows the yearly progression of production in the different areas of knowledge.

	90-91	92-93	94-95	96-97	98-99	Total	Increase
Applied mathematics	315	453	512	669	774	2723	146%
Mathematical analysis	225	314	358	463	511	1871	127%

	90-91	92-93	94-95	96-97	98-99	Total	Increase
Geometry and topology	198	261	300	402	424	1585	114%
Algebra	171	213	254	303	373	1314	118%
Statistics and OR	107	133	183	261	326	1010	205%
Computer science and AI	31	69	50	78	110	338	255%
Actual total	718	968	1168	1500	1866	6220	

Note: Increases are calculated in respect of the first two-year period, or failing that, in respect of the first two-year period with publication.

Table 5.15. Progression of production by areas of knowledge

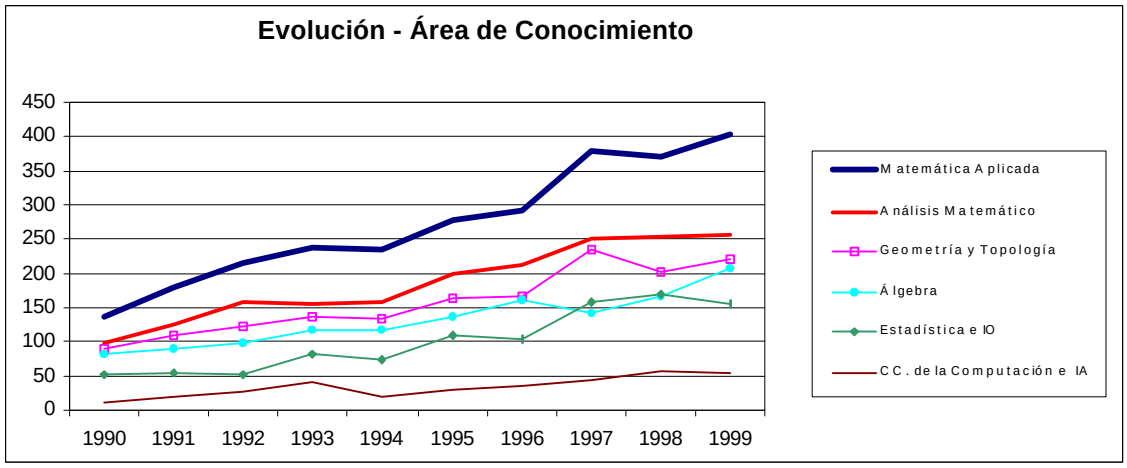


Figure 5.10. Progression of production by areas of knowledge

5.6. Comparative breakdown of mathematical production

Comparative breakdown of production of mathematical literature by autonomous communities by the number of inhabitants.

Table 5.16 shows a comparative breakdown of Spanish production of mathematical literature by the number of inhabitants of the autonomous communities. Population figures refer to 1 January 1998 and were taken from the National Statistical Institute's web page. The last column of the table shows the ratio of production of mathematical literature to inhabitants for the autonomous community, giving the number of documents produced during the decade for each 10,000 inhabitants. Data in the table is shown in descending order by this figure.

The presentation of general results in respect of production of mathematical literature by autonomous communities shows that Madrid and Catalonia account for the bulk of production, but also that Aragon and Cantabria are the autonomous communities with the highest number of articles per lecturer. If we take into account Table 5.16, we see that these two autonomous communities also have the highest proportion of articles per 10,000 inhabitants.

The autonomous communities of Madrid and Catalonia, which account for over 40% of Spain's production of mathematical literature, rank third and fourth, respectively, if we take into account the number of documents produced per 10, inhabitants, while the most productive autonomous communities in terms of capacity per inhabitant are Aragon and

Cantabria. Navarre, which was seen to be one of the least productive autonomous communities, ranks sixth in terms of production per inhabitant. It is also interesting to note that Andalusia, which ranks third in terms of the number of documents published, is not a particularly productive autonomous community in terms of production per number of inhabitants.

Autonomous communities	No. art.	%	No. of articles/10,000 inhabitants
Cantabria	205	3.3%	3.89
Aragon	413	6.6%	3.49
Madrid	1391	22.4%	2.73
Catalonia	1212	19.5%	1.97
Valencia	665	10.7%	1.65
Navarre	87	1.4%	1.64
Murcia	174	2.8%	1.56
Andalusia	1092	17.6%	1.51
Canary Islands	225	3.6%	1.38
Castilla-León	335	5.4%	1.35
Basque Country	278	4.5%	1.32
Galicia	349	5.6%	1.28
La Rioja	26	0.4%	0.99
Asturias	106	1.7%	0.98
Extremadura	99	1.6%	0.93
Balearic Islands	43	0.7%	0.54
Actual total	6220		

Table 5.16. Production of mathematical literature by autonomous communities per no. of inhabitants

University lecturers in mathematics per 10,000 inhabitants and autonomous communities.

Table 5.17 shows the ratio of faculty to each 10,000 inhabitants, and we note that Madrid and Cantabria are the autonomous communities with the highest proportion. There are substantial differences between autonomous communities in the number of lecturers per 10,000 inhabitants, which is most likely due to historical reasons.

Autonomous communities	No. of lecturers (2000)	Population	Lecturers/10,000 inhabitants
Madrid	583	5,091,336	1.15
Cantabria	56	527,137	1.06
Asturias	101	1,081,834	0.93
Aragon	108	1,183,234	0.91
La Rioja	22	263.644	0.83
Canary Islands	130	1,630,015	0.80
Andalusia	570	7,236,459	0.79
Galicia	212	2,724,544	0.78
Valencia	295	4,023,441	0.73
Castilla-León	182	2,484,603	0.73
Navarre	36	530,819	0.68
Basque Country	133	2,098,628	0.63
Murcia	70	1,115,068	0.63
Catalonia	383	6,147,610	0.62
Balearic Islands	41	796,483	0.51
Extremadura	36	1,069,419	0.34

Table 5.17. Proportion of lecturers in mathematics to each 10,000 inhabitants

6. STUDY OF QUALITY OF RESEARCH

For the purpose of evaluating the quality of research, in addition to the quantitative analysis carried out, it was necessary to use bibliometric indicators based on the number of citations of the works published in order to make comparisons. In evaluating the results provided by bibliometric indicators, we must take into account the limitations of such indicators, as mentioned in the Methodology section of this study.

6.1. Distribution of production by quartiles

The ISI database classifies journals by discipline on the basis of their subject matter and ranks the journals within each discipline on the basis of their impact factor. This ranking allows us to classify journals by quartiles. Table 6.1 shows the distribution of production of mathematical literature by the quartiles into which the journals that have published Spanish articles have been classified, in accordance with the most recent version of Journal Citation Reports (JCR 1999).

Quartile	No. journals	No. articles
1	107	16%
2	105	23%
3	110	36%
4	91	26%

Table 6.1. Distribution of Spanish production by quartiles

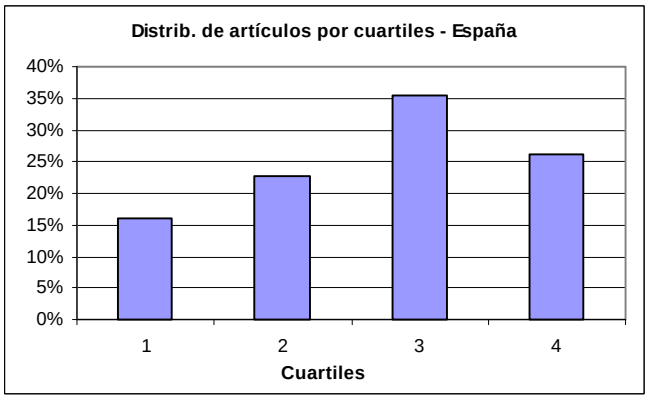


Figure 6.1. Distribution of Spanish production by quartiles

For the purpose of comparing the distribution of Spanish production by quartiles with world-wide distribution, we took the distribution of articles figuring in the MathSci database for the last decade appearing in the journals in the respective quartiles of the ISI. Table 6.2 shows the resulting distribution of mathematical literature.

This table shows that the distribution for Spain is shifted towards the third quartile much more markedly than world-wide distribution, in detriment of the number of works appearing in the first quartile. The percentages in the second and fourth quartile are similar for Spain and the rest of the world. Approximately 39% of articles were

published in journals with a higher than average impact factor. World-wide, this proportion is 44%.

Quartile	No. journals	No. articles
1	107	22%
2	105	22%
3	110	29%
4	91	27%

Table 6.2. Distribution of world-wide production by quartiles

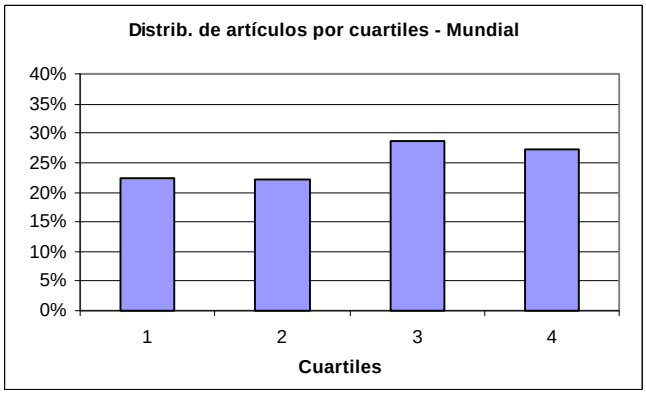


Figure 6.2. Distribution of world-wide production by quartiles

Progression of distribution by quartiles

Table 6.3 shows the progression of distribution by quartiles of production of mathematical literature. This distribution has not varied significantly over the past decade, although in absolute terms the number publications in quality journals has increased, as mentioned earlier.

	90-91	92-93	94-95	96-97	98-99
Quartile 1	17%	16%	16%	16%	15%
Quartile 2	22%	23%	25%	23%	21%
Quartile 3	34%	37%	35%	34%	37%
Quartile 4	27%	24%	25%	27%	26%

Table 6.3. Progression of distribution by quartiles

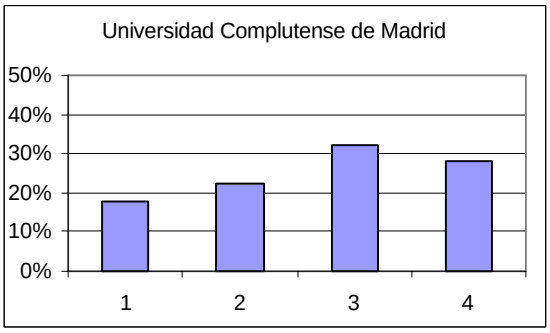
Distribution by quartiles of production at CSIC and university centres

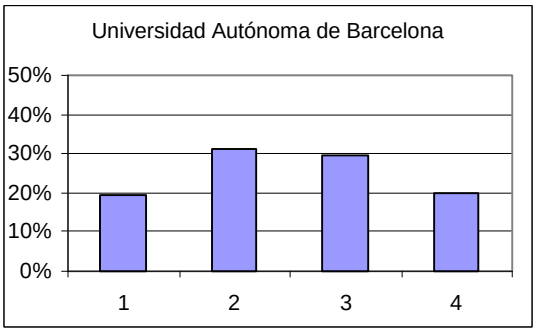
Table 6.4 shows the distribution of production by each university centre and the Miguel Catalán Institute, by the quartiles in which the journals where the articles were published are situated. Data in the table is shown in descending order of the figures for production at each centre. Percentages are shown in bold-face for the centres where production in the first quartile is higher than the national average. Graphs are also shown for the centres with the greatest production.

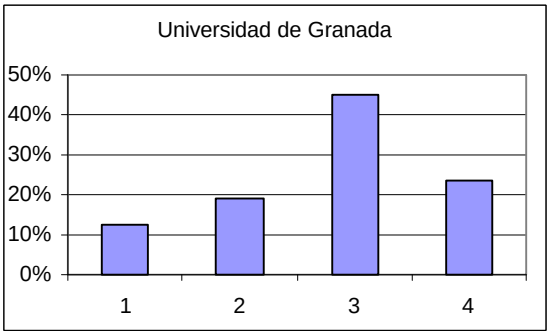
The universities whose production is of the highest quality (bearing in mind the limitations mentioned in connection with the concept of quality based on the index of impact) are the Autonomous University of Madrid, the University of Valladolid and the University of Salamanca.

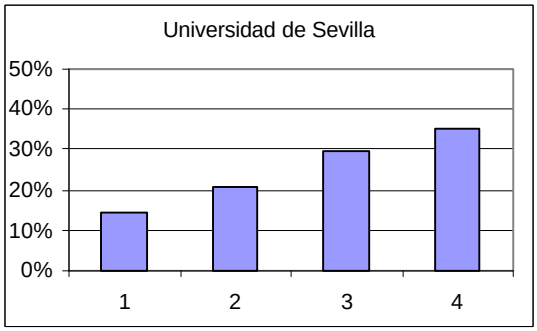
Centre	Quartile 1	Quartile 2	Quartile 3	Quartile 4
Complutensian University of Madrid	**18%**	22%	32%	28%
University of Granada	13%	19%	45%	24%
Technical University of Catalonia	**19%**	18%	40%	24%
University of Barcelona	**21%**	30%	29%	20%
University of Saragossa	13%	25%	41%	22%
Autonomous University of Barcelona	**19%**	31%	30%	20%
University of Seville	14%	21%	30%	35%
University of Valencia	10%	25%	33%	32%
Autonomous University of Madrid	**31%**	25%	26%	18%
University of Santiago de Compostela	**17%**	20%	37%	27%
University of the Basque Country	**18%**	24%	36%	21%
Technical University of Madrid	12%	24%	36%	28%
University of Valladolid	**29%**	21%	34%	17%
Technical University of Valencia	6%	8%	33%	53%
University of La Laguna	12%	14%	47%	27%
University of Cantabria	15%	20%	36%	29%
University of Murcia	7%	24%	44%	26%
University of Málaga	7%	22%	39%	32%
University of Alacant	**21%**	15%	31%	33%
University of Oviedo	11%	28%	36%	25%
University of Extremadura	7%	34%	21%	37%
Charles III University of Madrid	**17%**	29%	41%	12%
Miguel A. Catalán Physics Centre	10%	30%	39%	22%
UNED	9%	27%	41%	23%
Public University of Navarre	5%	19%	56%	21%
University of Salamanca	**28%**	30%	25%	18%
University of Vigo	9%	13%	60%	18%
University of Almería	9%	15%	64%	13%
James I University	9%	24%	20%	48%
University of the Balearic Islands	**26%**	23%	42%	9%
University of Córdoba	6%	9%	42%	42%
University of La Rioja	8%	23%	19%	50%
University of La Coruña	12%	16%	40%	32%
University of Alcalá de Henares	0%	33%	33%	33%
University of Cádiz	**22%**	44%	22%	11%
Pompeu Fabra University	**29%**	36%	29%	7%
University of Lleida	11%	0%	44%	44%
University of Jaén	14%	14%	43%	29%
University of Las Palmas de Gran Canaria	20%	0%	20%	60%
University of Navarre	0%	0%	0%	100%
University of Burgos	0%	0%	0%	100%
Spain	**16%**	**23%**	**36%**	**26%**

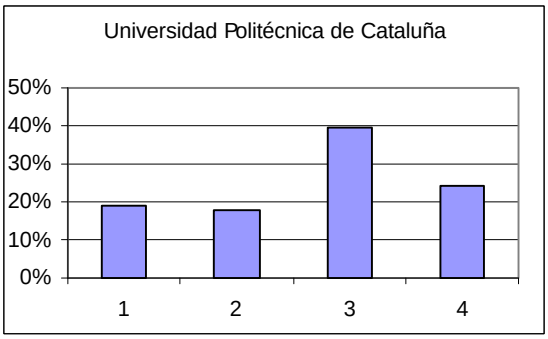
Table 6.4. Distribution by quartiles of university production

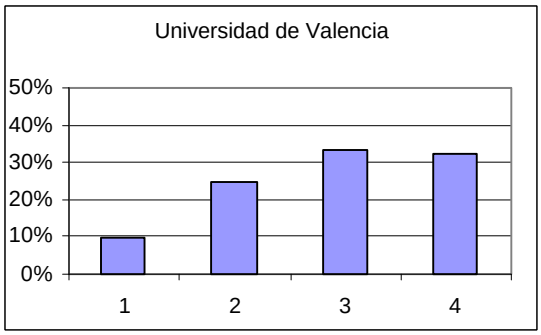


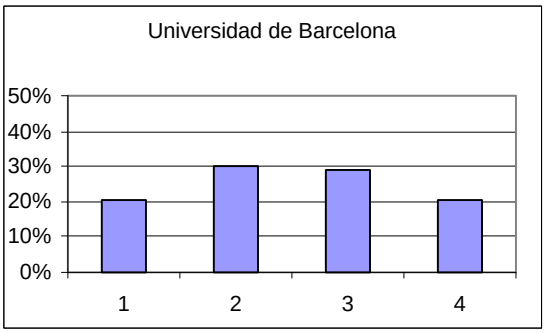


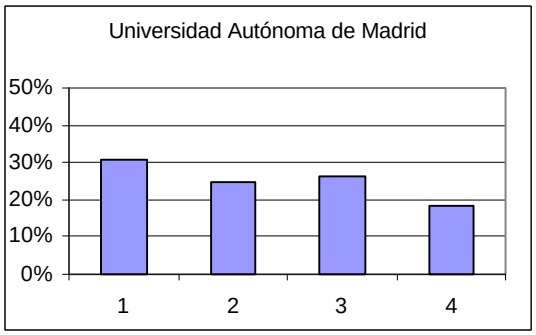


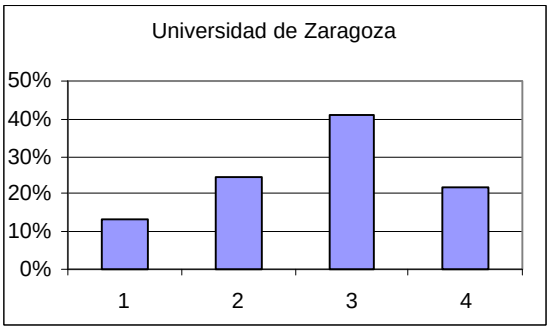


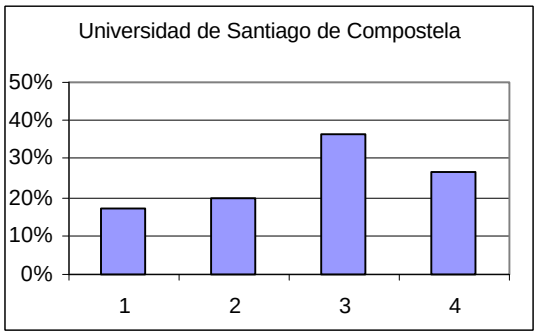












Figures 6.3.-6.12. Distribution by quartiles of university production

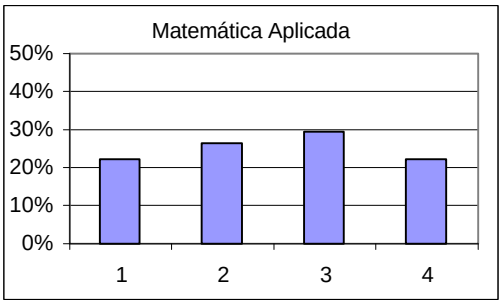
Distribution by quartiles of production by areas of knowledge

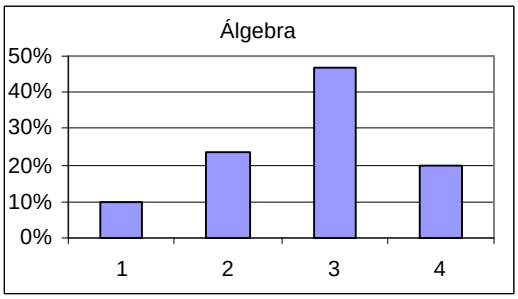
Table 6.5 shows the distribution of production by areas of knowledge for the quartiles in which journals where the articles were published are situated. Data in the table is shown in descending order of the figures for production in each area. Percentages are highlighted for the areas where production in the first quartile is higher than the national average and graphs are shown for the distribution by quartiles of each of those areas.

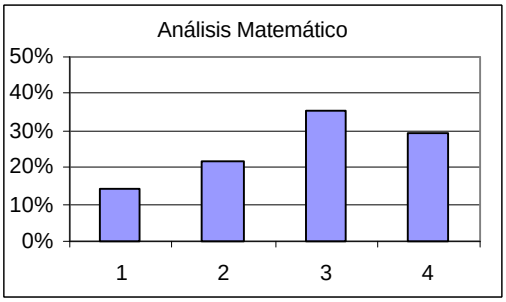
The areas of knowledge in which articles are published in journals with a higher index of impact are Applied Mathematics and Geometry and Topology.

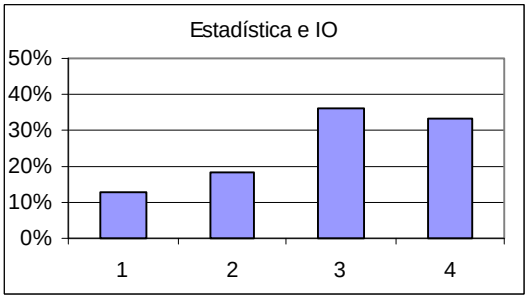
Centre	Quartile 1	Quartile 2	Quartile 3	Quartile 4
Applied mathematics	**22%**	26%	30%	22%
Mathematical analysis	14%	22%	35%	29%
Geometry and topology	**21%**	26%	28%	25%
Algebra	10%	24%	47%	20%
Statistics and OR	13%	18%	36%	33%
Computer Science and AI	15%	10%	47%	28%
Spain	**16%**	**23%**	**36%**	**26%**

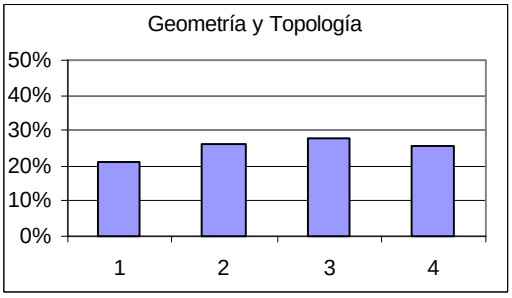
Table 6.5. Distribution by quartiles of production by areas of knowledge

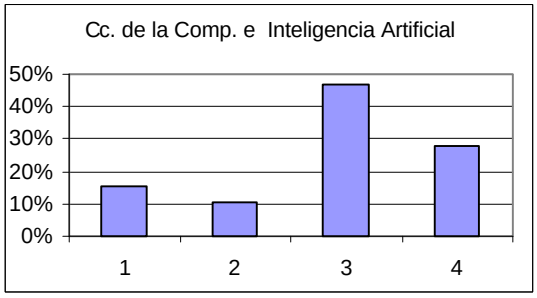












Figures 6.13.-6.18. Distribution by quartiles of production by areas of knowledge

Once again, the results shown in these tables must be interpreted with certain reservations. For example, Table 6.6 shows that a large portion of articles in the area of Algebra are published in the journals Communications in Algebra and Journal of Pure and Applied Algebra, which, being specialised journals and the number of algebraists being relatively small, are situated in Quartile 3 under the heading of Mathematics, although they are high quality journals in their field.

6.3. ISI journals with the largest number of documents published, with average impact factor and quartile

The following tables show the different ISI categories for the fifty journals in the preceding table, along with the average impact factor for the journal over the last ten years. Along with this information, the quartile where the journal is situated within its field is also shown. We have compiled data on the distribution by quartiles of articles included under the headings of Mathematics, Applied Mathematics and Statistics. It is curious to note that distribution by quartiles for these last two areas does not coincide with the distribution given in the preceding section, most probably owing to the articles in those areas published in journals included under other headings, mainly Mathematics.

Mathematics

Journal	No. art.	IF	Quartile
Proceedings of the American Mathematical Society	206	0.280	4
Communications in Algebra	199	0.283	3
Comptes Rendus de l'Academie des Sciences I. Mathematique	186	0.325	3
Journal of Mathematical Analysis and Applications	178	0.325	3
Journal of Algebra	158	0.422	2
Archiv der Mathematik	111	0.238	4
Nonlinear Analysis	108	0.330	3
Journal of Pure and Applied Algebra	94	0.378	3
Studia Mathematica	82	0.314	3
Journal of Differential Equations	76	0.687	1
Transactions of the American Mathematical Society	68	0.545	1
Manuscripta Mathematica	62	0.278	4
Bulletin of the Australian Mathematical Society	58	0.194	4
Mathematical Proceedings of the Cambridge Philosophical Society	54	0.402	2
Journal of Approximation Theory	52	0.392	1
Mathematische Nachrichten	51	0.250	3
Acta Mathematica Hungarica	50	0.141	4
Israel Journal of Mathematics	49	0.352	2
The Journal of the London Mathematical Society	49	0.404	2
Pacific Journal of Mathematics	44	0.371	2
The Rocky Mountain Journal of Mathematics	42	0.174	4
Mathematische Zeitschrift	41	0.432	2
Discrete Mathematics	40	0.224	3
Topology and its Applications	40	0.252	4
Journal of Functional Analysis	39	0.785	1
Proceedings of the Royal Society of Edinburgh A. Mathematics	38	0.410	3
Glasgow Mathematical Journal	34	0.258	3
Mathematische Annalen	34	0.574	1
Universitatis Debreceniensis	32	0.088	4
Geometriae Dedicata	30	0.272	3

Table 6.6. "Mathematics"

Quartile	No. articles
1	16%
2	23%
3	36%
4	26%

Table 6.7. Distribution by quartiles: Mathematics

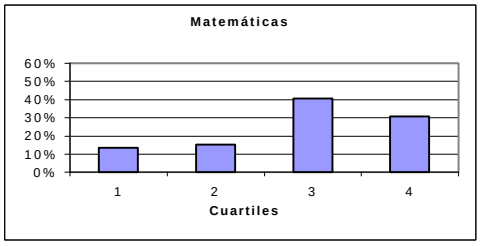


Figure 6.19. Distribution by quartiles

Mathematics, applied

Journal	No. art.	IF	Quartile
Proceedings of the American Mathematical Society	206	0,280	4
Journal of Mathematical Analysis and Applications	178	0,325	3
Journal of Computational and Applied Mathematics	139	0,373	3
Nonlinear Analysis	108	0,330	4
Linear Algebra and its Applications	104	0,372	3
Fuzzy Sets and Systems	102	0,489	3
Journal of Pure and Applied Algebra	94	0,378	3
Applied Mathematics and Computation	62	0,241	4
Computers and Mathematics with Applications	51	0,296	4
Applied Mathematics Letters	47	0,338	3
Topology and its Applications	40	0,252	4
Internat. J. of Bifurcation and Chaos in Applied Sci. and Engineering	38	0,794	2
Proceedings of the Royal Society of Edinburgh A. Mathematics	38	0,410	3
Applied Numerical Mathematics	37	0,493	2
Numerical Algorithms	33	0,454	3
SIAM Journal on Mathematical Analysis	30	0,701	1

Table 6.8. "Applied Mathematics"

Quartile	No. articles
1	2%
2	6%
3	56%
4	36%

Table 6.9. Distribution by quartiles: Applied mathematics

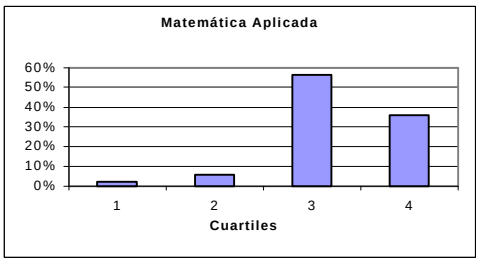


Figure 6.20. Distribution by quartiles

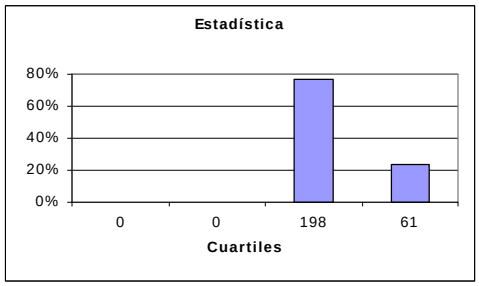
Statistics & Probability

Journal	No. art.	IF	Quartile
Fuzzy Sets and Systems	102	0.489	3
Communications in Statistics. Theory and Methods	61	0.158	4
Statistics and Probability Letters	60	0.253	3
Journal of Statistical Planning and Inference	36	0.278	3

Table 6.10. "Statistics and probability"

Quartile	No. articles
1	0%
2	0%
3	76%
4	24%

Table 6.11 Distribution by quartiles: Statistics and probability



Graph 6.21: Distribution by quartiles.

Astronomy & Astrophysics

Journal	No. art.	IF	Quartile
Celestial Mechanics and Dynamical Astronomy	41	0.420	4

Table 6.12. "Astronomy & Astrophysics"

Physics

Journal	No. art.	IF	Quartile
Journal of Physics A. Mathematical and General	61	1.799	2

Table 6.13. "Physics"

Physics, mathematical

Journal	No. art.	IF	Quartile
Journal of Physics A. Mathematical and General	61	1.799	2
Journal of Mathematical Physics	41	0.947	3

Table 6.14. "Mathematical Physics"

Computer Science, Theory & Methods

Journal	No. art.	IF	Quartile
Fuzzy Sets and Systems	102	0.489	3
Theoretical Computer Science	30	0.394	3

Table 6.15. "Computer Science, Theory & Methods"

Computer Science, Interdisciplinary Applications

Journal	No. art.	IF	Quartile
Computers and Mathematics with Applications	51	0.296	4
Computer Methods in Applied Mechanics and Engineering	30	0.864	1

Table 6.16. "Computer Science, Interdisciplinary Applications"

Computer Science, Information Systems

Journal	No. art.	IF	Quartile
Information Processing Letters	32	0.269	4

Table 6.17. "Computer Science, Information Systems"

Mathematics, miscellaneous

Journal	No. art.	IF	Quartile
Mathematical Social Sciences	30	0.328	4

Table 6.18. "Mathematics, miscellaneous"

Engineering, mechanical

Journal	No. art.	IF	Quartile
Computer Methods in Applied Mechanics and Engineering	30	0.864	1

Table 6.19. "Engineering, mechanical"

Mechanics

Journal	No. art.	IF	Quartile
Computer Methods in Applied Mechanics and Engineering	30	0.864	1

Table 6.20. "Mechanics"

Multidisciplinary Sciences

Journal	No. art.	IF	Quartile
International J. of Bifurcation and Chaos in Applied Scie. and Engineering	38	0.794	2

Table 6.21. "Interdisciplinary sciences"

6.4 Journals with the best standardised position and number of documents published in these journals

Table 6.22 shows the fifty journals with the largest number of documents, ordered by standardised position and indicating the number of documents published in each journal. The Appendix contains a similar table of the fifty journals with the best standardised positions without taking into account the number of documents published in them. As might be expected, this second table contains hardly any of the journals shown in Table 6.24, since only a very few Spanish articles are published in these journals. This coincides with the observation made earlier to the effect that much

remains to be done in connection with improving the quality of Spanish production or at least publishing in more prestigious journals.

We repeat that the standardised positions of journals allow us to compare journals in different ISI disciplines, which is not possible solely on the basis of the impact factor.

Journal	Standardised Position	No. art.
Computer Methods in Applied Mechanics and Engineering	0.91	30
Journal of Functional Analysis	0.88	39
Journal of Differential Equations	0.86	76
Journal of Physics. A. Mathematical and General	0.80	61
Transactions of the American Mathematical Society	0.79	68
Journal of Approximation Theory	0.78	52
Fuzzy Sets and Systems	0.77	102
Mathematische Annalen	0.77	34
Applied Numerical Mathematics	0.74	37
SIAM Journal on Mathematical Analysis	0.73	30
Mathematische Zeitschrift	0.71	41
Int. Journal of Bifurcation and Chaos in Applied Sciences and Engineering	0.70	38
Israel Journal of Mathematics	0.68	49
Mathematical Proceedings of the Cambridge Philosophical Society	0.67	54
Journal of Algebra	0.66	158
Journal of Pure and Applied Algebra	0.66	94
Journal of Mathematical Analysis and Applications	0.59	178
The Journal of the London Mathematical Society Second Series	0.58	49
Pacific Journal of Mathematics	0.50	44
Proceedings of the Royal Society of Edinburgh. Section A. Mathematics	0.50	38
Glasgow Mathematical Journal	0.47	34
Discrete Mathematics	0.45	40
Proceedings of the American Mathematical Society	0.43	206
Applied Mathematics Letters. An International Journal of Rapid Publication	0.43	47
Numerical Algorithms	0.41	33
Geometriae Dedicata	0.41	30
Journal of Mathematical Physics	0.40	41
Mathematische Nachrichten	0.39	51
Studia Mathematica	0.39	82
Comptes Rendus de l'Academie des Sciences. Serie I. Mathematique	0.37	186
Linear Algebra and its Applications	0.36	104
Communications in Algebra	0.35	199
Non-linear Analysis. Theory, Methods and Applications	0.34	108
Computers and Mathematics with Applications. An International Journal	0.34	51
Journal of Computational and Applied Mathematics	0.33	139
Topology and its Applications	0.32	40
Theoretical Computer Science	0.32	30
Journal of Statistical Planning and Inference	0.30	36
Statistics and Probability Letters	0.28	60
Information Processing Letters	0.23	32
Manuscripta Mathematica	0.22	62
Archiv der Mathematik. Archives of Mathematics. Archives Mathematiques	0.21	111
Celestial Mechanics and Dynamical Astronomy	0.19	41
Applied Mathematics and Computation	0.18	62
Acta Mathematica Hungarica	0.17	50
Bulletin of the Australian Mathematical Society	0.16	58
The Rocky Mountain Journal of Mathematics	0.12	42
Mathematical Social Sciences	0.10	30
Universitatis Debreceniensis. Publicationes Mathematicae	0.10	32
Communications in Statistics. Theory and Methods	0.09	61

Table 6.22. Standardised position

6.5. Journals publishing the largest number of documents and their ISI discipline, not screened for borderline areas

Both in the Introduction to this Report and in the Methodology section, we commented that, the database used for this study was subjected to a manual screening to eliminate articles classified in borderline areas of mathematics where, although classified as mathematical literature by the AMS, many articles are not considered by mathematicians in general to be in that field.
These difficult to classify areas are the following: Physics, Mathematical Physics, Nuclear Physics, Particle Physics, areas related to Computers, Mechanics, Mechanical Engineering and Astronomy and Astrophysics.
Nevertheless, in order to present the data that would have been obtained without that screening, Table 6.23 shows the fifty journals with the greatest amount of literature, the number of articles published in them and the ISI discipline in which they are classed. We repeat that the database including all of the articles situated in borderline areas of mathematics would contain 7,419 articles.

Journal	No. art.	Discipline
Journal of Physics A. Mathematical and General	263	Physics. Physics, mathematical
Proceedings of the American Mathematical Society	206	Mathematics. Mathematics, applied
Communications in Algebra	199	Mathematics
Comptes Rendus Acad. Sciences I. Mathematique	186	Mathematics
Physics Letters B	179	Physics
Journal of Mathematical Analysis and Applications	178	Mathematics. Mathematics, applied
Journal of Mathematical Physics	175	Physics, mathematical
Nuclear Physics B	160	Physics, nuclear. Physics, particles & fields
Journal of Algebra	158	Mathematics
Journal of Computational and Applied Mathematics	137	Mathematics, applied
Classical and Quantum Gravity	119	Physics
Physical Review D	115	Physics, particles & fields
Archiv der Mathematik	111	Mathematics
Non-linear Analysis. Theory, Methods and Applications	107	Mathematics. Mathematics, applied
Physics Letters A	106	Physics
Linear Algebra and its Applications	104	Mathematics, applied
Fuzzy Sets and Systems	103	Computer Science, Theory & Methods. Mathematics, applied. Statistics & Probability
Journal of Pure and Applied Algebra	93	Mathematics. Mathematics, applied
Studia Mathematica	81	Mathematics
Journal of Differential Equations	76	Mathematics
Transactions of the American Mathematical Society	68	Mathematics
Applied Mathematics and Computation	62	Mathematics, applied
Manuscripta Mathematica	62	Mathematics
Communications in Statistics. Theory and Methods	61	Statistics & probability
Statistics and Probability Letters	60	Statistics & probability
Bulletin of the Australian Mathematical Society	58	Mathematics
Computers and Mathematics with Applications	54	Computer Science, Interdisciplinary Applications. Mathematics, applied
Math. Proceed. of the Cambridge Philosoph. Society	54	Mathematics
International J. of Modern Physics A. Particles and Fields. Gravitation. Cosmology. Nuclear Physics	52	Physics, nuclear. Physics, particles & fields
Journal of Approximation Theory	52	Mathematics
Mathematische Nachrichten	51	Mathematics
Acta Mathematica Hungarica	50	Mathematics

The Journal of the London Mathematical Society	49	Mathematics
Israel Journal of Mathematics	47	Mathematics
Modern Physics Letters A. Particles and Fields, Gravitation, Cosmology, Nuclear Physics	47	Physics, mathematical. Physics, nuclear. Physics, particles & fields
Pacific Journal of Mathematics	44	Mathematics
International Journal of Bifurcation and Chaos in Applied Sciences and Engineering	42	Mathematics, applied. Multidisciplinary Sciences
Journal of Geometry and Physics	42	Mathematics, applied. Physics, mathematical
The Rocky Mountain Journal of Mathematics	42	Mathematics
Celestial Mechanics and Dynamical Astronomy	41	Astronomy & Astrophysics
Mathematische Zeitschrift	41	Mathematics
Discrete Mathematics	40	Mathematics
Topology and its Applications	40	Mathematics. Mathematics, applied
Applied Mathematics Letters	39	Mathematics, applied
Journal of Functional Analysis	39	Mathematics
Applied Numerical Mathematics	37	Mathematics, applied
Proceedings of the Royal Society of Edinburgh A. Mathematics	37	Mathematics. Mathematics, applied
Journal of Statistical Planning and Inference	36	Statistics & probability
Computer Methods in Applied Mechanics and Engineering	35	Computer Science, Interdisciplinary Applications. Engineering, mechanical. Mechanics
General Relativity and Gravitation	35	Physics

Table 6.23. Journals with the greatest amount of literature and their ISI discipline

We observe that the number of articles appearing in the area of Physics is very extensive. It was precisely this observation and the fact that the great majority of the authors of these articles belong to Physics departments rather than Mathematics departments that led us to carry out the manual screening mentioned in the Introduction.

7. COLLABORATION IN MATHEMATICAL RESEARCH

Once again, the information presented in this section is based on the 6,220 articles contained in the Spanish ISI database.

Collaborations between authors - Authorship index

Co-authorship index

The co-authorship index is the average number of authors contributing to a document. This index, along with the average number of Spanish authors contributing to the document, is shown in Table 7.1. We note that, on the average, of the 2.16 authors signing an article, 1.7 are Spanish.

Average no. of authors per articles	2.16
Average no. of Spanish authors per article	1.70

Table 7.1. Co-authorship index

Progression of the co-authorship index

Table 7.2 shows the progression of the co-authorship index in Spanish production during the last decade. Figures show a slight but constant increase in collaboration in mathematical research. The average number of authors per article has increased by 18.2% in the last ten years, going from 1.91 to 2.25 authors per document.
Among exclusively Spanish authors, this increase is somewhat less pronounced, but there is also a trend to growth, going from 1.59 Spanish authors per article in 1990 to 1.8 in 1999. This sustained increase in collaboration is most likely due to a greater presence of Spanish researchers in international forums and the spread of the use of the Internet. We can state that the approach to work in the area of mathematics is changing, going from individual work to an increasing predominance of teamwork.

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**Increase**
Average no. of authors per article	1.91	2.02	2.04	2.06	2.06	2.21	2.17	2.21	2.27	2.25	18.2%
Average no. of Spanish authors per article	1.59	1.59	1.55	1.60	1.61	1.71	1.69	1.73	1.81	1.79	12.7%

Table 7.2. Progression of the co-authorship index

Single-author documents and progression

Of the 6,220 articles covered by this study, 1,506 were signed by a single author. Table 7.3 shows the progression of this type of article.

Although the absolute number of documents produced by single authors has grown, going from 115 documents in 1990 to 196 in 1999, if we take into account the growth of production the percentage of documents by a single author decreased during the decade, from 35% of production in 1990 to only 20% in 1999.

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**Increas**

											e
No. of single-author articles	115	110	128	144	138	132	152	204	187	196	70.4%

Table 7.3. Progression in production of single-author articles

Collaborations between institutions - Average number per article

Average no. of institutions per article

Table 7.4 shows the average number of institutions contributing to a document. Of the average number of 1.55 institutions per article, 1.19 are Spanish.

Average no. of institutions per article	1.55
Average no. of Spanish institutions per article	1.19

Table 7.4. Average no. of institutions per article

Progression of the average number of institutions per article

Table 7.5 shows the progression of the average number of institutions contributing to documents during the last decade.
Once again, we find a sustained increase in collaboration in mathematical research. The average number of institutions per article has increased by 15.7% in the last ten years, going from 1.36 in 1990 to 1.58 in 1999.
In addition, collaboration between Spanish institutions increased during the decade.

	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**Increase**
Average no. of institutions per article	1.36	1.52	1.50	1.53	1.54	1.54	1.54	1.61	1.58	1.58	15.7%
Average no. of Spanish institutions per article	1.11	1.15	1.13	1.18	1.18	1.18	1.18	1.22	1.22	1.22	10.3%

Table 7.5. Progression of the average no. of institutions per article

Rates of collaboration between institutions

Rates of national and international collaboration in the production of mathematical literature in Spain

Table 7.6 shows the figures for collaboration between institutions. We observe that most mathematical research, 55.9% to be precise, is carried out without collaboration between different institutions.
We should bear in mind that documents signed by various authors with the same address are not considered to constitute institutional collaboration. Thus, if an article is written by two lecturers from the same department, it is not considered to constitute collaboration.

	No. art.	**%**
No collaboration	3480	55.9%
National collaboration	1064	17.1%
Internal national collaboration	*235*	*3.8%*
External national collaboration	*875*	*14.1%*
International collaboration	1862	29.9%
Actual total	6220	

Table 7.6. Rates of collaboration

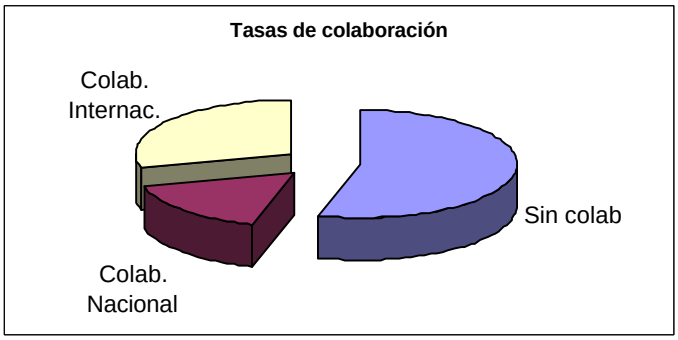


Figure 7.1. Types of collaboration

Yearly progression of mathematical collaboration

Table 7.7 shows the yearly progression of collaboration during the last decade and the increases recorded in different types of collaboration

There is a tendency to increased collaboration and rates of both national and international collaboration have grown much faster than the rate of works without collaboration.

	90-91	92-93	94-95	96-97	98-99	Total	Increase
No collaboration	443	567	651	814	1005	3480	127%
National collaboration	91	136	195	269	373	1064	310%
Internal collaboration	*17*	*25*	*43*	*63*	*87*	*235*	*412%*
External collaboration	*75*	*118*	*159*	*222*	*301*	*875*	*301%*
International collaboration	196	292	358	456	560	1862	186%
Actual total	718	968	1168	1500	1866	6220	

Note: Increases are calculated in respect of the first two-year period, or failing that, in respect of the first two-year period with publication

Table 7.7. Progression of mathematical collaboration

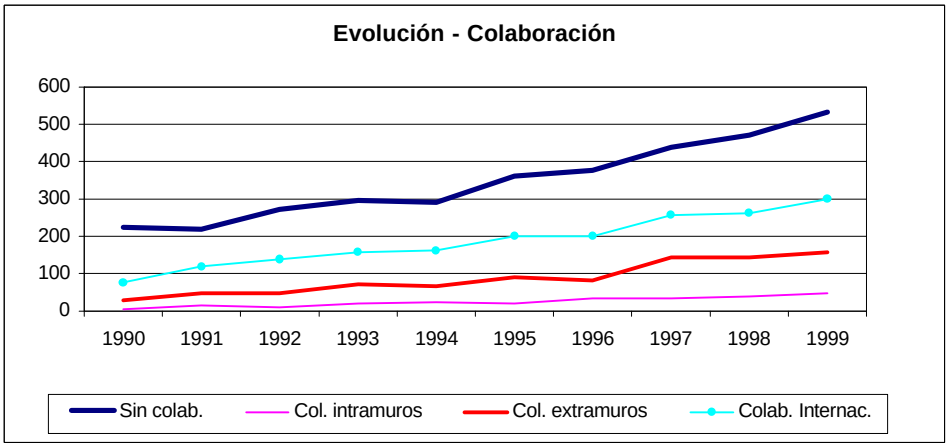


Figure 7.2. Progression of mathematical collaboration

Collaboration between autonomous communities

Table 7.8 shows collaboration between different autonomous communities. Each row represents an autonomous community and contains (rounded off) percentages for collaboration with the autonomous community for the corresponding column in respect of the total collaboration by the autonomous community of the row. The table is therefore not symmetrical but must instead be read by columns.
Overall, the table indicates that geographic factors play an important role in collaboration. This is probably due not so much to greater ease of movement and contact as to the fact that researchers in one autonomous community have likely been trained as part of a "parent" team in a neighbouring one. For example, the highest rates of collaboration are between the Balearic Islands and Catalonia, La Rioja and Aragon, and Navarre and Aragon. The Madrid autonomous community is the one that collaborates with the greatest number of others.

	And	Arag	Ast	Bale	Can	Cant	CL	Cat	Val	Ext	Gal	Rioj	Mad	Mur	Nav	PV
Andalusia		6	1		1		2	5	10	6	9		39	16		6
Aragon	6		9		6	1	2	3	5		2	6	16		31	13
Asturias	3	27				27	3	19			14		8			
Balearic Islands								78	22							
Canary Islands	2	11				8	6	2	2			2	62			8
Cantabria		1	14		7		29		7	4			26		7	3
Cast-León	3	3	2		7	33		3	15	5			25			5
Catalonia	6	3	7	7	1		2		3		10		54	2	1	6
Valencia	16	9		3	1	7	13	4		3	3		13	6	17	4
Extremad.	35					15	15		10				15	10		
Galicia	13	3	7					13	3				40	16	1	4
La Rioja		64			9								9		18	
Madrid	16	6	1		14	6	5	20	3	1	11	0		2	0	14
Murcia	39							4	9	4	26		11			7
Navarre		60				9		2	21	0	2	3	2			2
Basque Country	8	16			6	2	3	7	3	0	3		45	3	1	

Table 7.8. Collaboration between autonomous communities (percentage)

International collaboration

Spanish production of mathematical literature in international collaboration, by collaborating countries

Table 7.9 shows patterns of international collaboration in broad geographic areas. Percentages refer to the total for international collaboration.

Comparison of main collaboration combinations shows that Spanish researchers collaborate especially with the European Union; 16.1% of the total number of documents were written in collaboration with the EU and 9% with the US and Canada. The lowest rate of collaboration in mathematical research is with European countries that are not member states of the EU.

	No. art.	**%**

European Union	1003	53.9%
Rest of Europe	207	11.1%
US and Canada	562	30.2%
Latin America	184	9.9%
Other countries	262	14.1%
Actual total	1862	

Table 7.9. International collaboration

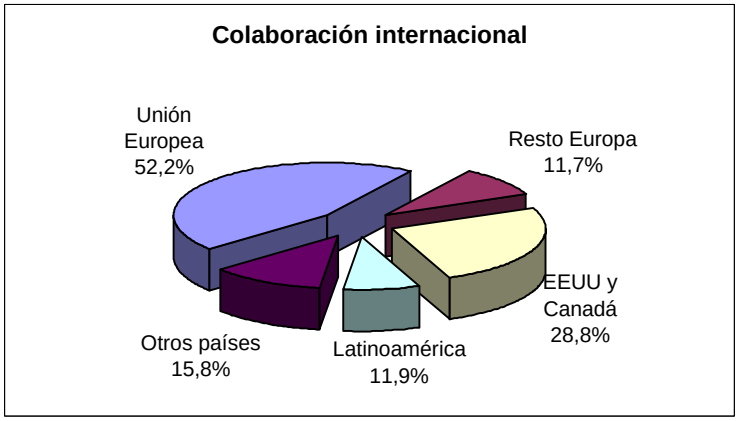


Figure 7.3. International collaboration

Tables 7.10, 7.11, 7.12, 7.13, and 7.14 show figures for international collaboration.
In respect of collaboration with the European Union, the highest rate of collaboration is with France (27.8% of collaboration with the EU), followed by Great Britain (14.3%) and Italy (13.9%). There is substantial collaboration with the US, which accounts for 8% of the total number of documents. Among Latin American countries, Brazil is the country that has the largest number of collaborations with Spain (58 documents), followed by Argentina (42 documents) and Mexico (38 documents). There is very little collaboration with Southeast Asian countries.

European Union member states	**No. art.**
Francia	279
Great Britain	143
Italy	139
Germany	135
Belgium	115
Holland	61
Portugal	31
Sweden	27
Finland	25
Austria	20
Ireland	13
Greece	9
Denmark	6
Total	1003

Table 7.10. Collaboration with the EU

US and Canada	**No. art.**

US	507
Canada	55
Total	562

Table 7.11. Collaboration with the EU and Canada

Rest of Europe	**No. art.**
Poland	61
Romania	33
Norway	30
Croatia	19
Bulgaria	16
Czech Republic	16
Hungary	10
Ukraine	7
Slovakia	4
Switzerland	4
Uzbekistan	3
Belarus	2
Estonia	1
Yugoslavia	1
Total	207

Table 7.12. Collaboration with the rest of Europe

Latin America	**No. art.**
Brazil	58
Argentina	42
Mexico	38
Venezuela	15
Chile	13
Uruguay	10
Cuba	5
Costa Rica	3
Total	184

Table 7.13. Collaboration with Latin America

Other countries	**No. art.**
Russia	73
Israel	36
People's Republic of China	33
Australia	23
Japan	17
New Zealand	12
Vietnam	11
Turkey	10
Morocco	8
India	7
Republic of Korea	7
South Africa	7
Georgia	4
Armenia	2
Lebanon	2
Singapore	2
Taiwan	2
USSR	2
Zimbabwe	2

Egypt	1
Iraq	1
Total	262

Table 7.14. Collaboration with the rest of the world

Pattern of collaboration by research centres

Table 7.15 shows patterns of collaboration by universities and the Miguel A. Catalán Physics Centre (which in fact corresponds to the mathematicians of the Basic Physics and Mathematics Institute), in descending order by volume of production of articles on mathematics. Percentages higher than the average for the category are shown in bold-face.

The universities of Málaga, Extremadura and Seville have the highest rates of "no collaboration", all much higher than the national average, followed by the University of La Rioja and University of Granada. The University of Burgos is not representative, since it published only one document. On the other hand, the universities with the lowest rate of "no collaboration" were the University of Alcalá de Henares and University of La Coruña. The University of Navarre is not representative, since it published only one document.

The highest rates of internal collaboration (interdepartmental collaboration) were recorded for the Technical University of Catalonia, University of Valladolid and University of Cantabria. On the other hand, the universities of Las Palmas Córdoba, Lleida and Alcalá de Henares had the highest rates of external (interfaculty) collaboration. Almost of all of these universities have a low level of production. Among those with the highest levels of production, the highest rates of external collaboration were recorded for the Technical University of Madrid and the University of Cantabria.

The highest rates of international collaboration were recorded for the Autonomous University of Madrid, Autonomous University of Barcelona, Charles III University of Madrid and University of the Balearic Islands. Pompeu Fabra University and the University of Lleida had high rates of international collaboration in spite of their low level of production. The Complutensian University of Madrid, the university with the highest level of production, had rates of "no collaboration" and of both types of national collaboration that were below the national average, but also had a high rate of international collaboration.

Centre	No collaboration	Internal	External	International
Complutensian University of Madrid	43.0%	2.5%	9.9%	**36.1%**
University of Granada	**63.9%**	**4.9%**	6.6%	19.3%
Technical University of Catalonia	51.4%	**7.0%**	10.2%	27.1%
University of Saragossa	50.4%	**5.1%**	**17.2%**	25.4%
University of Barcelona	45.4%	0.5%	10.4%	35.3%
Autonomous University of Barcelona	40.7%	0.5%	**15.0%**	**39.9%**
University of Seville	**66.3%**	5.7%	6.6%	18.8%
University of Valencia	52.7%	1.0%	13.4%	26.2%
Autonomous University of Madrid	43.8%	0.0%	7.4%	**44.1%**
University of Santiago de Compostela	50.3%	**5.2%**	11.5%	27.3%
University of the Basque Country	50.0%	3.2%	**15.1%**	23.4%
Technical University of Madrid	31.0%	**4.7%**	**26.6%**	28.5%

Technical University of Valencia	55.5%	**5.5%**	11.8%	23.6%
University of Valladolid	**56.1%**	**5.9%**	6.7%	25.3%
University of La Laguna	46.8%	**4.1%**	12.7%	**30.0%**
University of Cantabria	37.1%	**5.9%**	**22.0%**	**30.7%**
University of Murcia	52.9%	1.1%	9.8%	27.0%
University of Málaga	**69.3%**	**3.9%**	6.5%	14.4%
University of Alacant	53.3%	3.7%	6.5%	29.0%
University of Extremadura	**66.7%**	2.0%	13.1%	16.2%
University of Oviedo	52.8%	0.0%	**15.1%**	22.6%
Charles III University of Madrid	31.2%	1.1%	**20.4%**	**39.8%**
University of Salamanca	43.2%	3.7%	13.6%	**35.8%**
UNED	39.1%	0.0%	**18.5%**	26.1%
University of Vigo	31.3%	**4.5%**	**38.8%**	23.9%
Public University of Navarre	33.7%	3.5%	12.8%	18.6%
University of Almería	38.3%	0.0%	**25.5%**	**36.2%**
University of the Balearic Islands	44.2%	0.0%	14.0%	**39.5%**
James I University	45.7%	0.0%	**17.4%**	23.9%
University of Córdoba	36.4%	3.0%	**36.4%**	15.2%
University of La Rioja	**65.4%**	0.0%	**19.2%**	3.8%
University of La Coruña	20.0%	0.0%	**24.0%**	**32.0%**
University of Alcalá de Henares	16.7%	0.0%	**33.3%**	27.8%
Pompeu Fabra University	28.6%	0.0%	**21.4%**	**50.0%**
University of Cádiz	44.4%	0.0%	**16.7%**	5.6%
University of Lleida	33.3%	0.0%	**33.3%**	**44.4%**
University of Jaén	28.6%	0.0%	**42.9%**	0.0%
University of Las Palmas de Gran Canaria	40.0%	0.0%	**60.0%**	0.0%
University of Burgos	100.0%	0.0%	0.0%	0.0%
University of Navarre	0.0%	0.0%	0.0%	100.0%
Miguel A. Catalán Physics Centre Catalan	18.3%		**43.0%**	32.3%
Spain	**55.9%**	**3.8%**	**14.1%**	**29.9%**

Table 7.15. Pattern of collaboration by research centres

Pattern of collaboration by MSC classification

Pattern of collaboration in the 20 MSC subjects with greatest production

Table 7.16 shows the patterns of collaboration for the 20 MSC subjects with the greatest production during the last decade. Higher than average percentages are shown in bold-face.

There was a particularly high rate of international collaboration in subjects 16: Associative rings and algebras and 35: Partial differential equations.
In contrast, the subjects 13: Commutative rings and algebras, 65: Numerical analysis and 93: Systems theory, control, were those with the highest rate of "no collaboration", all of them at over 60%.
Subject 93: Systems theory, control, also showed a high rate of internal collaboration, as did 76: Fluid mechanics.
Lastly, subjects 53: Differential geometry, 58: Global analysis, analysis on manifolds, and 54: General topology, were those with the highest rates of external collaboration.

MSC	Subject	No collaboration	Internal	External	International

46	Functional analysis	**57.0%**	1.4%	13.3%	28.3%
65	Numerical analysis	**66.1%**	3.3%	9.3%	21.3%
35	Partial differential equations	49.9%	0.8%	9.4%	**39.9%**
62	Statistics	**56.2%**	2.6%	**19.3%**	21.9%
58	Global analysis, analysis on manifolds	37.8%	3.6%	**24.8%**	**33.8%**
90	Economics, operations research, programming, games	54.0%	**4.3%**	12.8%	29.0%
53	Differential geometry	52.9%	2.4%	**25.3%**	19.4%
68	Computer science	46.6%	3.1%	12.4%	**37.8%**
34	Ordinary differential equations	**59.8%**	**4.8%**	**14.8%**	20.6%
20	Group theory and generalisations	**60.9%**	0.5%	**16.3%**	22.3%
16	Associative rings and algebras	45.9%	2.9%	9.4%	**41.8%**
14	Algebraic geometry	**58.6%**	3.0%	6.5%	**32.0%**
42	Fourier analysis	44.4%	**4.3%**	**19.1%**	**32.1%**
93	Systems theory, control	**62.1%**	**9.3%**	6.2%	22.4%
60	Probability theory and stochastic processes	48.1%	2.5%	12.0%	**37.3%**
76	Fluid mechanics	50.7%	**7.6%**	4.9%	**36.8%**
17	Nonassociative rings and algebras	**56.8%**	1.4%	11.5%	**30.2%**
47	Operator theory	**60.3%**	1.7%	**14.9%**	23.1%
54	General topology	42.9%	**4.5%**	**24.1%**	28.6%
13	Commutative rings and algebra	**68.9%**	**4.9%**	2.9%	23.3%
	Spain	**55.9%**	**3.8%**	**14.1%**	**29.9%**

Table 7.16. Pattern of collaboration in subjects with greatest production

8. CONCLUSIONS

- Both world-wide and in Europe and Spain, the 1990s were characterised by an increase of the production of mathematical literature recorded in the MathSci database. Spanish production grew faster than world-wide production, going from 1.7% of world-wide production in 1990 to 3.2% in 1999. This situation is the same in the context of the EU, where Spanish production during the last decade went from 8.9% in 1990 to 13.0% in 1999 (cf. p. 20).

- The subject codes Integral transforms, operational calculus (no. 44), Functional analysis (no. 46), Set theory (no. 04), Differential geometry (no. 53) and Fourier analysis (no. 42) accounted for a much higher percentage of Spain's total production than the percentage for those subjects in world-wide production, i.e. we could be said to be over-represented in these subjects (cf. p. 21).

- Spanish production included in the ISI database has also grown much faster than world-wide production. Spain's contribution to this database went from 1.7% of world-wide production in 1990 (with 330 articles) to 3.9% in 1999 (with 983 articles), and has continued to grow, reaching 4.18% according to ISI figures for 2001. Simplifying things somewhat, we can say that Spanish production has increased by 300% while world-wide production has grown at under half that rate (pp. 24 and following).

- In comparison with other scientific disciplines, mathematics ranks third in Spain in respect of its contribution to world-wide production of literature (4.18%), after astrophysics and agrarian sciences. Nevertheless, the average number of citations per article is 16% lower than the world average (p. 27).

- The autonomous communities with the highest absolute figures for production of mathematical literature are Madrid, Catalonia and Andalusia, all three of them with over one thousand documents each in the ISI database during the decade, and between the three accounting for 60% of Spanish production. The substantial concentration of research in Madrid and Catalonia is patent. Nevertheless, if we look at production in terms of number of lecturers, the autonomous communities with the highest rates of articles per lecturer are Aragon, Cantabria and Catalonia, in that order (p. 29).

- The average number of ISI articles is 2.22, and if we take the total number of documents in the MathSci database, productivity amounted to 3.78 articles per lecturer for the decade. On the basis of a superficial examination of these figures, we can estimate that only 2/5 of the total of 3,124 lecturers in mathematics at universities are active in publishing articles regularly (cf. p. 29).

- Among institutional sectors, universities constitute the most productive sector, contributing to 98.6% of documents, while the CSIC contributes to only 2.3%. The private sector is almost totally absent from the production of mathematical literature in Spain, pointing up the scant or non-existent interest of private business in research and the absence of mathematics from R&D projects in the area of business (p. 32).

- Among universities, the Complutensian University of Madrid makes the greatest contribution to mathematical research (11.4% of total production) followed at a distance by the University of Granada and the Technical University of Catalonia (8.8% and 7.1%, respectively). The universities of Burgos, Navarre, Las Palmas, Jaén and Lleida are those with the least production of mathematical literature, with a percentage of under 0.15% of the total. A comparative breakdown of production by the number of faculty at each university shows that the universities with the highest ratio of documents to lecturers are the University of Barcelona, Autonomous University of Madrid and the Autonomous University of Barcelona (p. 34).

- At the CSIC, 80% of the total production of mathematical literature is concentrated at the Miguel A. Catalán Physics Centre (CFMAC), comprising just three researchers. It is interesting to note that the CSIC has no separate institute dedicated to mathematics, a situation not found in any other EU member state (cf. p. 36).

- Over 50% of Spanish research falls within the area of nine MSC codes, while almost 90% falls within 35 MSC codes. The three most productive codes in terms of the absolute number of documents are Functional analysis (no. 46), Partial differential equations (no. 35) and Numerical analysis (no. 65). The greatest increases in production during the decade were recorded in Statistics (no. 62), Numerical analysis (no. 65), Differential geometry (no. 53) and Computer sciences (no. 68) (cf. p. 38).

- Assignation of MSC codes to areas of knowledge shows that Applied Mathematics is the area of greatest productivity, with 43.8% of total production. This is also the area with the greatest number of lecturers, and therefore, taking into account the ratio of articles to lecturers, Geometry and Topology is the most productive area, followed at a distance by Algebra (p. 43).

- If we analyse the distribution of Spanish research by quartiles within the ISI classification by impact factor, we note that it is shifted much more heavily towards the third quartile than the world-wide distribution, in detriment to the number of works situated in the first quartile. Percentages for the second and fourth quartiles are similar for Spain and the rest of the world. Approximately 39% of articles are published in journals with an above average impact factor. This average world-wide is 44% (pp. 46 ff.). Furthermore, the distribution by quartiles showed no appreciable variation in the course of the decade (cf. pp. 46 ff.).

- This same displacement towards the third quartile is noted at most centres, although not to the same extent in all cases. The Autonomous University of Madrid, University of Valladolid, University of Salamanca and University of Barcelona are noteworthy for the quality of their research (percentage of articles in the first quartile) (cf. pp. 48 and 49).

- In terms of areas of knowledge, Applied Mathematics and Geometry and Topology had the largest number of publications in the upper quartiles, while Algebra and Computer Science were displaced heavily towards the third quartile (cf. pp. 50 ff.).

- In respect of patterns of collaboration, we can state that there is a growing number of articles signed by more than one author. We can reasonably surmise that electronic communication has had a significant influence on this phenomenon, which is substantially changing approaches to collaboration in the authorship of works in mathematics. Nevertheless, there is still evidence of strong influence by geographic factors in collaboration between different autonomous communities. In respect of international collaboration, this is most frequent with the US and other EU member states, and among the latter, the greatest degree of collaboration is with France (cf. pp. 58 ff.).

9. APPENDIX

MSC 2000 classification

00 General
01 History
03 Mathematical logic and foundations
04 Set theory
05 Combinatorics
06 Order, lattices, ordered algebraic structures
08 General mathematical systems
11 Number theory
12 Field theory and polynomials
13 Commutative rings and algebras
14 Algebraic geometry
15 Linear and multilinear algebra; matrix theory
16 Associative rings and algebras
17 Nonassociative rings and algebras
18 Category theory, homological algebra
19 K-theory
20 Group theory and generalizations
22 Topological groups, Lie algebras
26 Real functions
28 Measure and integration
30 Functions of a complex variable
31 Potential theory
32 Several complex variables and analytic spaces
33 Special functions
34 Ordinary differential equations
35 Partial differential equations
37 * *Dynamical systems and ergodic theory*
39 Finite differences and functional equations
40 Sequences, series, summability
41 Approximation and expansion
42 Fourier analysis
43 Abstract harmonic analysis
44 Integral transforms, operational calculus
45 Integral equations
46 Functional analysis
47 Operator theory
49 Calculus of variations and optimal control; optimization
51 Geometry
52 Convex sets and related geometric topics
53 Differential geometry
54 General topology
55 Algebraic topology
57 Manifolds and cell complexes
58 Overall analysis, analysis on manifolds
60 Probability theory and stochastic processes
62 Statistics
65 Numerical analysis
68 Computer science
70 Mechanics of particles and systems
73 Mechanics of solids
74 * *Mechanics of deformable solids*
76 Fluid mechanics
78 Optics, electromagnetic theory
80 Classical thermodynamics, heat transfer
81 Quantum theory
82 Statistical mechanics, structure of matter
83 Relativity and gravitational theory
85 Astronomy and astrophysics
86 Geophysics
90 Economics, operations research, programming, games
91 * *Game theory, economics, social and behavioural sciences*
92 Biology and behavioural sciences
93 Systems theory, control
94 Information and communication, circuits

* From MSC 2000

Journals with the largest number of documents published and their discipline

The table shows the fifty journals that have published most articles by Spanish authors and the number of articles published in each of them. Along with this information, the table also shows the ISI disciplines in which the journals are classified.

Journal	No. art.	Discipline
Proceedings of the American Mathematical Society	**206**	Mathematics. Mathematics, applied
Communications in Algebra	**199**	Mathematics
C. R. Academie des Sciences I. Mathematique	**186**	Mathematics
Journal of Mathematical Analysis and Applications	**178**	Mathematics. Mathematics, applied
Journal of Algebra	**158**	Mathematics
Journal of Computational and Applied Mathematics	**139**	Mathematics, applied
Archiv der Mathematik	**111**	Mathematics
Nonlinear Analysis	**108**	Mathematics. Mathematics, applied
Linear Algebra and its Applications	**104**	Mathematics, applied
Fuzzy Sets and Systems	**102**	Compurter Science, Theory & Methods. Mathematics, applied. Statistics & Probability
Journal of Pure and Applied Algebra	**94**	Mathematics. Mathematics, applied
Studia Mathematica	**82**	Mathematics
Journal of Differential Equations	**76**	Mathematics
Transactions of the American Mathematical Society	**68**	Mathematics
Applied Mathematics and Computation	**62**	Mathematics, applied
Manuscripta Mathematica	**62**	Mathematics
Communications in Statistics. Theory and Methods	**61**	Statistics & Probability
Journal of Physics. A. Mathematical and General	**61**	Physics. Physics, mathematical
Statistics and Probability Letters	**60**	Statistics & Probability
Bulletin of the Australian Mathematical Society	**58**	Mathematics
Math. Proceed.. Cambridge Philosophical Society	**54**	Mathematics
Journal of Approximation Theory	**52**	Mathematics
Computers and Mathematics with Applications	**51**	Computer Science, Interdisciplinary Applications. Mathematics, applied
Mathematische Nachrichten	**51**	Mathematics
Acta Mathematica Hungarica	**50**	Mathematics
Israel Journal of Mathematics	**49**	Mathematics
The Journal of the London Mathematical Society.	**49**	Mathematics
Applied Mathematics Letters	**47**	Mathematics, applied
Pacific Journal of Mathematics	**44**	Mathematics
The Rocky Mountain Journal of Mathematics	**42**	Mathematics
Celestial Mechanics and Dynamical Astronomy	**41**	Astronomy & Astrophysics
Journal of Mathematical Physics	**41**	Physics, mathematical
Mathematische Zeitschrift	**41**	Mathematics
Discrete Mathematics	**40**	Mathematics
Topology and its Applications	**40**	Mathematics. Mathematics, applied
Journal of Functional Analysis	**39**	Mathematics
Inter. J. of Bifurcat. and Chaos in App. Sci. and Engin	**38**	Mathematics, applied. Multidisciplinary Sciences
Proc. Royal Soc. of Edinburgh. Sect. A. Mathematics	**38**	Mathematics. Mathematics, applied
Applied Numerical Mathematics	**37**	Mathematics, applied
Journal of Statistical Planning and Inference	**36**	Statistics & Probability
Glasgow Mathematical Journal	**34**	Mathematics
Mathematische Annalen	**34**	Mathematics
Numerical Algorithms	**33**	Mathematics, applied
Information Processing Letters	**32**	Computer Science, Information Systems
Universitatis Debreceniensis	**32**	Mathematics
Computer Methods in Applied Mechanics and Engineering.	**30**	Computer Science, Interdisciplinary Applications. Engineering, Mechanical. Mechanics
Geometriae Dedicata	**30**	Mathematics
Mathematical Social Sciences	**30**	Mathematics, miscellaneous
SIAM Journal on Mathematical Analysis	**30**	Mathematics, applied
Theoretical Computer Science	**30**	Computer Science, Theory & Methods

Journals with the highest standardised positions and no. of documents published in them

The table shows the fifty journals with the highest standardised positions and the number of documents published in each journal. The journals' standardised positions allow us to compare journals in different ISI disciplines, a comparison that is not possible on the basis of the impact factor.

Journal	Standardised Position	No. art.
Annals of Mathematics. Second Series	0.99	3
Chaos. An Interdisciplinary Journal of Nonlinear Science	0.99	4
Memoirs of the American Mathematical Society	0.99	2
SIAM Journal on Optimization	0.99	4
IEEE Transactions on Image Processing	0.99	2
Journal of the Royal Statistical Society. Series B. Methodological	0.98	6
Operations Research	0.98	2
Acta Mathematica	0.98	3
Communications on Pure and Applied Mathematics	0.97	7
Journal of the American Mathematical Society	0.97	3
Econometrica. Journal of the Econometric Society	0.96	6
Mathematical Programming	0.96	7
American Mathematical Society. Bulletin. New Series	0.96	1
Biometrics. Journal of the International Biometric Society	0.96	1
Inventiones Mathematicae	0.95	8
Journal of the ACM	0.95	2
IEEE. Transactions on Information Theory	0.95	10
Constructive Approximation	0.94	11
International Journal for Numerical Methods in Engineering	0.94	19
Journal of Nonlinear Science	0.94	5
Mathematics of Operations Research	0.94	4
Numerical Linear Algebra with Applications	0.94	4
Journal of the American Statistical Association	0.94	14
SIAM Journal on Control and Optimization	0.94	15
Journal of Algebraic Combinatorics. An International Journal	0.93	1
Biometrika	0.93	7
Geometric and Functional Analysis	0.92	1
Artificial Intelligence	0.92	4
Advances in Mathematics	0.92	5
Computer Methods in Applied Mechanics and Engineering	0.91	30
Naval Research Logistics. An International Journal	0.91	6
The Annals of Statistics	0.91	15
SIAM Journal on Scientific Computing	0.91	12
Duke Mathematical Journal	0.90	19
Applied and Computational Harmonic Analysis	0.90	1
Journal de Mathematiques Pures et Appliquees. Neuvieme Serie	0.90	20
IEEE. Transactions on Software Engineering	0.90	1
Computer Physics Communications	0.89	6
Computational Geometry. Theory and Applications	0.89	4
SIAM Journal on Numerical Analysis	0.88	28
Annales Scientifiques de l'Ecole Normale Superieure. Quatrieme Serie	0.88	7
Journal of Overall Optimization	0.88	1
Inverse Problems	0.88	11
Archive for Rational Mechanics and Analysis	0.88	20
Journal of Functional Analysis	0.88	39
SIAM Review	0.87	8
Journal of Differential Geometry	0.87	6
Journal of Computational Physics	0.87	19
Journal of Differential Equations	0.86	76

Commentarii Mathematici Helvetici	0.86	14