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Jean-Michel Salaün, Thierry Lafouge, Chérifa Boukacem

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Demand for scientific articles and citations

An example from the Institut de l'information scientifique et technique (France)

Jean-Michel Salaün, Gres1, salaun@enssib.fr
Thierry Lafouge, Recodoc2, lafouge@enssib.fr
Cherifa Boukacem, Gres1, cboukace@enssib.fr

Abstract

The patterns that appear in exchanges between researchers, scientific journal publications and the demand for scientific articles often intersect, but the logic behind each type of activity is not necessarily the same. Analyses of requests for scientific articles from document suppliers may help to interpret current developments in electronic publishing.

This study of article requests to the Institut de l'information scientifique et technique (INIST) shows that, in France, document supply customers fall into three main categories : business, academic libraries and public research organisations, in descending order. Demand focuses mainly on medicine, pharmacology, biology and chemistry, and the distribution of articles is entirely in accordance with the laws of bibliometrics.

A further comparative analysis shows a high reciprocal correlation (except in the physical sciences) between the 50 journals most frequently requested from INIST, and the 50 most frequently cited journals according to ISI (Institute for Scientific Information). The titles which did not appear in either one list or the other show that the most frequently cited physics journals are not necessarily requested from the document supplier, and that, conversely, some frequently requested journals are not often cited. It may therefore be assumed that a trade in electronic articles is likely to develop quite rapidly in disciplines which are common to both lists, although this would focus on reputed titles only, but that a different pattern of electronic document exchange would emerge for scientific literature in other disciplines.

1Cresi, Enssib, 17,21 Bvd du 11 novembre 1918, 69623 Villeurbanne Cedex France.

2Recodoc, Université Claude Bernard Lyon 1 bat 721, 43 Bvd du 11 novembre 1918, 69622 Villeurbanne cedex France.

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Jean-Michel Salaün, Gres3, salaun@enssib.fr
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Introduction

Published communications between researchers⁵ appear to follow a linear pattern which may be summarised as follows : author-article-journal-collection-article-reader. The link between the publishers of scientific journals and the libraries providing access to their collections reflects the commercial aspects of the process. However, this linear pattern actually masks a number of parallel processes and more complex circuits.

Document exchanges simultaneously involve several overlapping issues, processes and patterns of logic, although these intersect only at specific points in the chain :

- the dynamics of scientific research are expressed in practice through research programmes, which need funding, through laboratory activities, which have to be managed, and through the careers of individual researchers. As W. D. Garvey (GAR79) showed some twenty years ago, communication between researchers is essential in maintaining these dynamic processes, and this is occurring today through the use of electronic networks by researchers. (CRA96). Articles published in journals still play an essential part, not so much as a means for disseminating knowledge (since scientific communication often uses faster, informal channels that vary with each discipline) as to achieve the recognition of knowledge. Being published means, first of all, recognition from one's peers, and secondly, becoming a reference for colleagues. The impact of an article, a researcher, a laboratory or a journal is often assessed in terms of the number of citations it receives in scientific publications, however arguable this criterion may be.
- The situation differs from standard publication processes in that scientific authors are not paid for the writing they actually do for journals, while readers do not pay for access to the documents (since journal subscriptions are paid for by their institutions). The financial exchanges supporting research activities - which sometimes involve very high stakes - occur in a separate context. This characteristic feature has been a basis for arguing (HAR97) that publishing is not only an activity which runs parallel to communication between researchers, but that it may even have a parasitic role which could easily be short-circuited today through electronic networks.

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⁵This study was made as part of a research programme of which full details are available on the Web site. See : économie du document - _circulation des articles scientifiques.
<http://www.enssib.fr/eco-doc>

- The publishing process involves obtaining and selecting manuscripts, editing by an editorial board, assembling the articles in journals published on a regular basis, the purchase of journals through subscriptions taken out by libraries or document centres, and their incorporation into collections, which includes inserting their references into bibliographic tools to make them available to reader communities. In this particular chain of activities, libraries act as customers, while publishers (often through a subscription agency) act as suppliers. Any financial transactions are conducted on a standard commercial basis.

The steep — and highly controversial — rise in journal subscription prices is a symptom of the emerging crisis in journal trading. This has given rise to abundant comment, debates between professionals, and to a range of negotiations and experiments. The first large-scale survey on the subject was conducted by the Mellon Foundation for American Research Libraries (MEL92). After noting the increasing proportions of subscription budgets among American research libraries, the foundation suggested that electronic technology might offer a solution. The proposals from scientists mentioned earlier therefore agree with those made by American librarians. Publishers, librarians and the various intermediaries are being drawn into a whirlwind of experiments and negotiations in which the big question for all the protagonists is the role they will be playing in the future marketplace for electronic publications in science.

- However, the last twenty years or more have seen the development of an alternative exchange system centred on individual articles, as the smallest units of published scientific literature from the academic world. Any specific article may now be copied and supplied to individual readers on request, with the development of bibliographic databases providing the means, and inter-library loans the opportunity. This process was initiated by librarians, as a way of filling gaps in their collections by pooling their resources. Depending on the countries, document supply activities may involve specialised public bodies and private profit-making or not-for-profit organisations as well as libraries. Brown (BRO96, p.100-101) describes the development of the sector as a succession of stages, with inter-library loans as the first stage, followed by document supply through specialised organisations as an intermediate stage in a process which, according to the author, should culminate with electronic publishing.

Thus, whether the focus of interest is communication between researchers, journal publishing or demand for articles, the consensus of opinion is that electronic networks are destined to be the main vehicle for the circulation of scientific literature in the future. While the first two aspects (communication between researchers and scientific publishing) have been widely studied, and still are, the third has attracted much less interest so far. Discussion has mostly focused on library management issues (loans versus acquisitions, faster service, pricing and reader satisfaction), or on the practical implementation of new electronic services. Articles on these aspects have generally been of a descriptive, prescriptive or practical nature. None have appeared in France.

And yet, among all the changes associated with the shift towards electronic documentation, the article as a unit of exchange between different scientific disciplines could take on even greater importance. In this case, organisations which already exist as direct article suppliers would have information on use patterns which could be of considerable value in identifying trends for the future.

Whatever the opinions on the value of indicators based on the number of citations, which were popularised in particular by E. Garfield and the Institute for scientific information (ISI), it must be recognised that they serve a

useful function in contributing to institutional assessments of research and researchers' career patterns. The important point here is not to determine whether they give an objective picture of scientific truths, but whether they perform a benchmark function for the scientific community, in the same way as audience ratings (which are no more reliable as a representation of reality) are used by television.

However, in view of the trend towards more and more widespread networking of scientific literature, it would be of interest to discover whether these indicators give a true picture of actual demand for articles. If this is indeed the case, they could also serve as indicators of trends in the electronic publications market. If not, this would reflect a hiatus between the economics of article circulation and the economics of academic research. Such a discrepancy would, in turn, affect the organisation of electronic publishing. Indications of this sort would be of considerable importance at a time when both information and the benefit of hindsight are lacking in negotiations on the prices of electronic services (HUN97).

Drawing on statistical data from the Institut de l'information scientifique et technique (INIST), the main French document supplier, this article aims to provide additional input to the debate by formulating the following questions :

- Is it possible to characterise demand in scientific articles ? Who requests articles, and how frequently ? What articles are requested, in which disciplines and from which journals ?
- Can any relationship be identified between requests for scientific articles and the number of citations in the relevant journals ? Is there any correlation between the citation indicator and demand for articles ? In other words, can such indicators be considered relevant as a measure of actual demand for articles while also providing information on the economics of article circulation ?
- Can any conclusions be drawn from these indicators on developments to be anticipated in the field of electronic documentation ?

These questions need to be answered as part of a much wider research programme which aims to clarify the economics involved in current changes in the circulation of scientific literature.

1. Value and limitations of available data

The data analysed are the article orders sent to INIST (Institut de l'information scientifique et technique) during the month of January 1997, i.e. a total of 50000 orders. Description of INIST data :

The lines in each order form contain :

Order date

Customer code

Customer category code

Document type code (book, journal, etc.)

Code indicating whether the document is held at INIST.

Journal title

Year of publication

Code identifying the volume required

ISSN

These data did not allow us to identify individual articles, but they did allow analyses by volume.

The data are contained in four Excel files, one per week in January 1997. All statistical results given in this article were obtained from an analysis of :

- .the four-week period covered by the files
- .each separate week

This precaution was taken to avoid distortions induced by external effects and to provide a sound basis for our conclusions on the characteristics of demand at INIST, even though journal circulation was studied over one month only. For example, we checked that the most frequently requested articles (cf annexe 2) were actually requested each week. Results given as intervals are those where the figures were calculated separately for each file and placed within their minimum-maximum range.

To find out whether this set of data is representative of a broader context, two questions must be answered : first, is the month of January sufficiently representative of average monthly orders sent to INIST ? Secondly, are the orders sent to INIST representative of overall demand ?

In the first case, our sample (see Annexe 1) suggests that the answer should be yes. The trends identified were confirmed when the data for the whole year were processed.

The second question cannot be answered categorically. However, INIST is the main document supplier in France, with about 700 000 orders annually, which is equivalent to the number of documents requested through inter-library loans throughout the country. Although this suggests that some relationship exists between the structure of demand at INIST and the structure of overall demand for journal articles, it does not mean they have the same pattern. Informal exchanges of articles are extremely frequent, and we will be suggesting hypotheses throughout this article to attempt a characterisation of requests to INIST through libraries and the Internet.

As a first step, we will be looking at the data set from the customer-type angle, then from the journal-title angle. Secondly, part of the data - the fifty articles most frequently requested from INIST - will be compared to ISI findings 6 on the most frequently cited journals (ISI data are described in detail in Annexe 2). This ISI data set has often been criticised. For the purpose of this analysis, we have selected the critical study by Magri and Solari (MAG96), which demonstrates the lack of uniformity of the data and draws attention in particular to a minority group of journals which produce “extreme” results in all indicators. Since our interest here lies in the most frequently requested and cited articles, our analysis focuses on this particular group.

2. INIST article requests in January 1997

⁶<http://www.isinet.com>

85% of INIST requests concerned articles or conference proceedings. INIST used external suppliers to satisfy 8% of all requests in January (12% over the whole year).

The first lesson to be derived here concerns the extent of demand, which is larger than generally assumed in France and increasing steadily. Trading in journal articles is no longer a marginal form of business. It would be interesting to look at the monetary value of this activity and review the problems raised by copyright. These questions, which are of particular concern to publishers in view of their misgivings as to the development of a competing sector, have often been discussed within the profession, for example by Line et Wood (LIN75) some twenty years ago. The situation has changed, however, and the issue today is not so much to determine whether one form of document distribution is overshadowing another, as to attempt to discern those features in the current pattern which may shed more light on the shift to electronic communications, which concerns everyone with an interest in the exchange of scientific articles.

The first data processing stage provided a picture of overall customer distribution characteristics (in terms of institutional categories and behaviour patterns), and of journal distribution (in terms of the number of articles ordered by journal or by date).

2.a Customer typology

This was based on the survey carried out by the INIST marketing department, bringing the number of categories down to eight. The table 1 below shows distribution by customer numbers (in other words, the number of customers in each category who ordered at least one article in January 1997). This table shows also customer distribution by the number of requests sent (in other words, the total number of requests sent in each customer category in January 1997).

	Number of orders	% of orders	Number of customers	% customers
Public or private sector companies	22565	44,4	837	33,5
Higher education establishments	12094	23,8	709	28,4
Research organisations	12366	24,2	579	23,2
Hospitals, medical centres & clinics	1414	2,8	111	4,5
Information centre	859	1,7	51	2
Other public or private sector organisations	755	1,5	84	3,4
Individuals	486	1	100	4
Other	320	0,6	20	1
TOTAL	50859	100	2495	100

Table 1: distribution by number of requests sent to the INIST and by number of document supply customers (January 1997)

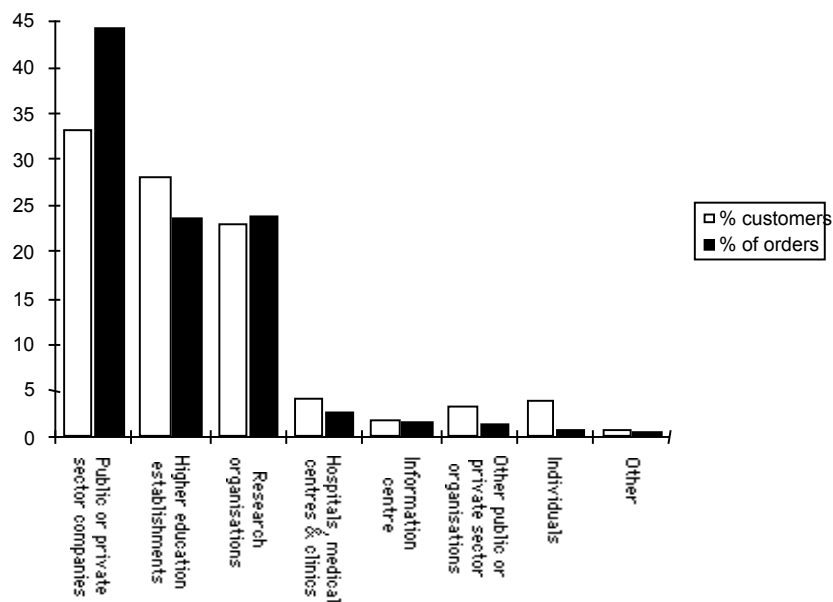


Diagram 1 :Distributions of customers and orders

Three categories stand out clearly : companies (i.e., research and development), higher education establishments (mainly academic libraries) and research organisations (CNRS laboratories and leading public sector

laboratories such as those run by the CEA, INSERM or INRA 7). However, their relative contributions need to be interpreted in different ways.

On average, each company orders nearly twice as many articles as academic libraries. This is probably due not only to the growth of research and development activities, but also to a preference in such organisations for building up their collections through orders for individual articles rather than journal subscriptions, whereas individual orders are generally a back-up solution for libraries, as they tend to look first to titles in their own catalogues to satisfy requests.

Nevertheless, the scale of demand from libraries would seem to indicate that they are less and less able to satisfy reader demand from their internal collections, or even through inter-library loans.

Demand from research organisations is very unevenly distributed. Some have obviously delegated the supply of all their scientific literature needs to INIST, while for others, INIST is only a backup solution. The distribution of demand among laboratories is unexpected from a strictly institutional point of view.

In the other customer categories, demand is low enough to be considered almost marginal. Our study shows a very low level of demand from individuals, and none from public libraries and distribution networks (distributors, subscription agencies, publishers, etc.). The French research community appears to form a self-contained whole which communicates very little with the outside world.

2.b Customer behaviour

A more detailed analysis of the data shows a very wide gap between a handful of very large clients, all within the research community, and numerous one-off orders.

56% of all customers in all categories sent less than seven requests in the month. In the business and academic library categories, which account for 68% of all orders as indicated above, the two largest customers account for only 4.4% (businesses) and 3.8% (libraries) of all requests. One customer in the business category ordered 27 articles on average. This is not a significant average, because the standard deviation works out at 781, indicating very high dispersion.

This high degree of dispersion obviously raises tremendous management problems for the document supply organisation since it greatly increases the administrative workload involved in document handling, invoicing for small orders, managing copyright fees, etc. Conversely, however, a small number of large customers carry a threat of financial vulnerability, since the loss of any one of these would give considerable cause for concern.

7 CNRS - National Centre for Scientific Research; CEA - Atomic Energy Commission; INSERM - National Institute of Health and Medical Research; INRA - National Institute of Agronomic Research

2.c Types of orders

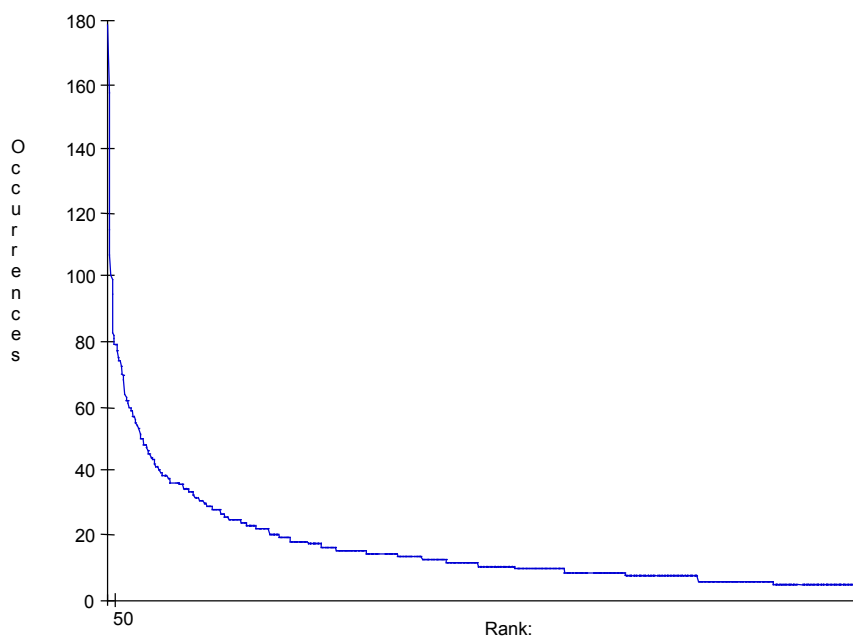
In terms of scientific disciplines, four topics account for nearly all requests : medicine, pharmacy, biology and chemistry. This is true both for the most frequently requested journals (see below) and for those least often requested. Physics is very poorly represented.

Other subjects barely appear, especially in the human and social sciences, mathematics and information technology. English-language titles are ubiquitous, and the top-ranking French-language title, *La revue du praticien (Paris)*, in 75th place with 54 orders, is a popularising publication.

Our analysis confirmed that these characteristics are also valid for journals that were only requested once. This result was derived from a random sample because of the large quantities involved (cf. example in Annexe 3). One notable difference was the substantial number of foreign-language titles. A previous study showed that, in chemistry at least, each article is generally requested once only (DEL89). This is confirmed by the data from this study, in terms of volume.

2.d Distribution of orders

About 20.000 journal titles were needed to satisfy the 50.000 requests sent in January 1997. INIST's own collection contains 23.000 titles. The distribution of orders by journal title (results are given with margins) shows that 52% to 55% of titles are requested once only, and 3% to 4% of titles are requested more than 10 times.



**Diagram 2 : INIST journal ranking by article requests
(January 1997)**

The Zipfien-type distribution of journal circulation (HAI82) observed (Diagram 2) obeys standard bibliometric laws and is common to most libraries (LEE92). A very small number of journals is in considerable demand, while the majority are only requested occasionally, which results in high dispersion : the distribution of demand at INIST is similar to that in libraries or document systems. The regularity of the above curve is characteristic of Zipf's standard law of bibliometrics.

The distribution of requests in relation to the year of publication of articles provides another classic example of distribution in scientific and technical information : the more recent the article, the greater the demand. However, dispersion is again very high : although 26% of orders were for articles published in 1996, 14% of articles requested were published before 1980.

INIST's annual statistical study found the same distribution result. The standard 80/20 rule (80% of orders concern only 20% of titles) has been confirmed regularly over the six years since the organisation's statistics system has been able to calculate it. From this point of view, INIST is a classic example of librarianship.

INIST therefore functions in the same way as a library, with high dispersal of demand in terms of both titles (collections) and years (conservation).

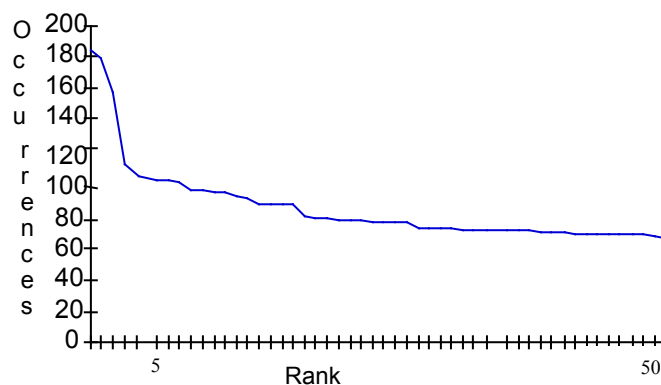
3. Journal requests and journal citations

The second stage in our analysis of the data set involved comparing the 50 journals most frequently requested from INIST with the 50 journals most frequently cited according to ISI, and - in a less detailed analysis - with their citation frequency in French academic libraries. This was similar to the Scales study carried out twenty years ago (SCA76) on requests to the British Library. However, the two studies are not readily comparable since the context as well as the time scales and geographical criteria have changed a great deal.

This was not a neutral sample, since the focus is no longer on a population of representative journals but on a group with very specific characteristics. Any conclusions drawn from the analysis are therefore only valid for those characteristics.

3.a Journals most frequently requested from INIST

The table in annexe 2 shows the fifty journals most frequently requested from INIST in January 1997. The distribution of these journals, Diagram 3, is identical to zoom in on the first part of the curve described earlier, diagram 2.



**Diagram 3 : the fifty journals most frequently requested from INIST
(January 1997)**

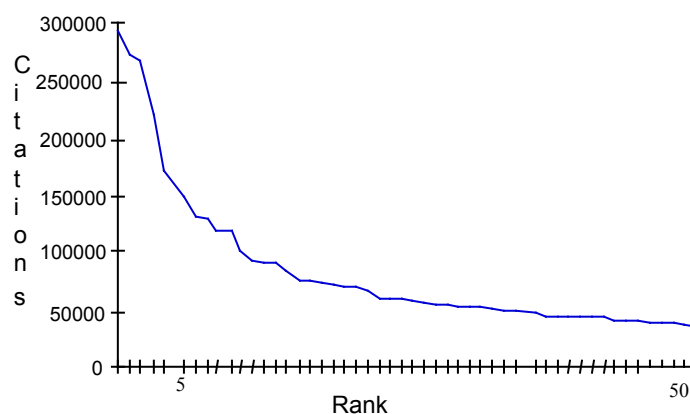
The curve shows that the first four journals fulfil a specific function. These are the *Journal of Biological Chemistry*, *Lancet*, *Proceedings of the National Academy of Sciences (USA)* and the *New England Journal of Medicine*. In the case of the first, third and fourth of these, one of the reasons for their ranking is the number of articles published each year. According to ISI, the *Journal of Biological Chemistry* is by far the most productive in terms of the annual number of articles published, along with *Physical Review B* (which is not in the INIST list, see below). The third and fourth titles are also among the top-ranking journals in terms of article numbers. Demand for *Lancet* is a special case. This is borne out by observations for the entire year and cannot therefore be considered incidental. This point will be discussed later on in this article.

Beyond these three journals, the curve decreases steadily.

One interpretation of the pattern of demand at INIST might be that there are gaps in the material offered by libraries. To check this, references to the relevant journals in the French Union Catalogue were noted (cf. annexe 1) to see whether there was any link between demand at INIST and the presence of the journals in libraries. The link could have operated either way, depending on whether collections were built up according to demand or on the basis of inter-library sharing agreements. In fact, no clear correlation emerged from the figures. Contrary to conclusions drawn twenty years ago by Lines and others for the UK, there is no obvious relationship between title availability in libraries, as indicated by the French Union Catalogue, and demand at INIST.

3.b Journals most frequently cited according to ISI

The distribution curve (diagram 4) for the ISI list of the fifty articles most frequently cited in 1996 (cf. table in annexe 2)⁸ has the same shape as the first curve :



**Diagram 4 : the most frequently cited 50 journals according to ISI
(JCR 1996)**

Again, the curve shows an obvious, if slightly less abrupt drop after the first five titles. These are the *Journal of Biological Chemistry*, *Proceedings of the National Academy of Sciences (USA)*, *Nature*, *Science*, and the *Journal of the American Chemical Society*. Again, the number of articles published may explain the popularity of three of the top-ranking journals.

However, two titles, *Nature* and *Science*, appear to fulfil a different role in the circulation of ideas, and even have a specific format. In both cases, the pattern remains atypical throughout the year, and is comparable to the pattern noted above for the *Lancet* which fulfils a similar role, albeit in the more specialised field of medicine.

One possible explanation may be that these journals are commonly found in laboratories as researchers generally use them to scan the latest research news. However, data for the whole year show that INIST fulfils a conservation function for *Nature* and *Science*, since 60% of requests for these titles concern articles published before 1990 (which is the reverse of the overall trend). Requests for the *Lancet* concern more recent articles. A more detailed analysis of requests in January 1997 shows that these requests are mostly from the business sector, probably pharmaceutical laboratories whose documentary practices carry significant weight in the data set.

The structure of the ISI sample was analysed in more general terms by M.-H. Magri and A. Solari (MAG96), using the "box-plot" method. The authors showed that the sample included an "extreme" group of journals, accounting for less than 10% of the sample, for which the citation indicators were well beyond average values.

⁸ For our purposes, the relevant indicator is the number of journal citations in the previous year. The well-known "impact factor", a ratio calculated for citations of the most recent articles, is not meaningful for the purposes of this study, because the analysis of INIST article requests was made for the entire collection and not just recent issues.

By limiting the analysis to the fifty top titles, any conclusions refer to the top segment of a group which already has exceptional characteristics. This is an important point which has to be taken into account in our interpretation.

3.c Comparison between the INIST and ISI lists

The relationships between trade in articles and citation indicators were assessed on the basis of reciprocal correlation between the two lists. Specifically, two linear correlation coefficients were calculated.

First, the linear correlation (r) between demand for the 50 journals most frequently requested from INIST and the number of citations in the ISI sample was calculated. The result was $r=0.640$, and checking r resulted in a theoretical r^* value of 0.452 with 0.1% for 48 degrees of freedom, which confirms the correlation to within 0.1%. The graph below shows the cluster obtained.

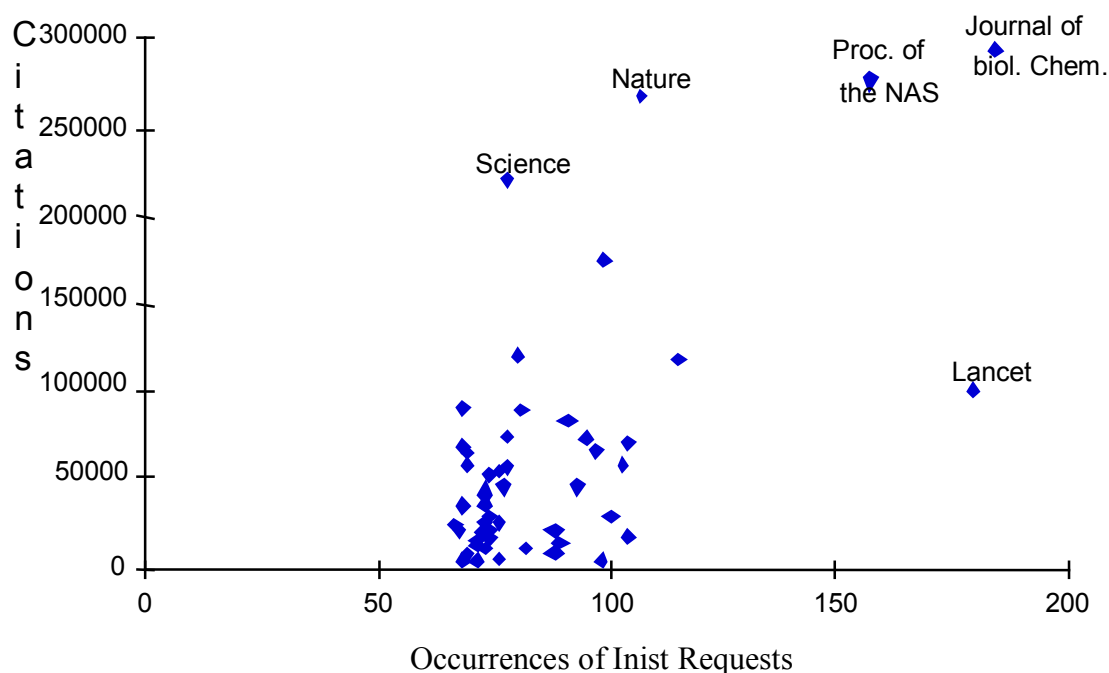


Diagram 5 : relationship between requests and citations for the 50 journals most frequently requested from INIST(January 1997)

The graph raises three comments/questions :

- 3 journals (Lancet, Science, Nature) are located at the periphery of the cluster, which confirms that they have a specific function.

-cluster density is far from uniform. The correlation was therefore calculated without the four top-ranking INIST journals (see graph for the 50 journals most frequently requested from INIST). The resulting correlation (0.349) is significantly lower. Checking r resulted in a theoretical r^* value of 0.308 with 5% for 44 degrees of freedom, which confirms the correlation to within 5%.

- several extensively requested journals demonstrate low citation rates - see also the inverse case, Diagram 6 below.

We then calculated the linear correlation between the citation frequency of the 50 top-ranking journals in the ISI list and the frequency of requests for the same journals from INIST. This worked out as $r=0.600$, confirming the correlation to within 0.1%. Correlation is therefore substantially similar in both cases. The graph below shows the cluster obtained

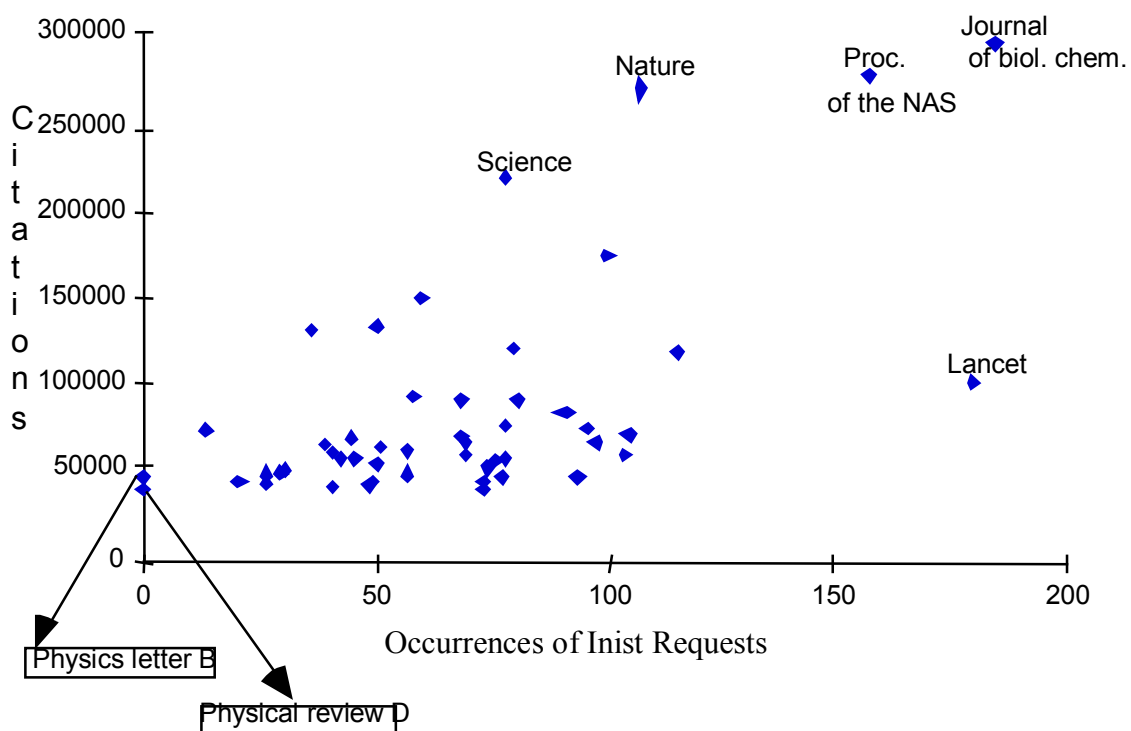


Diagram 6 : relationship between requests and citations for the 50 most frequently cited journals according to ISI. (JCR 1996)

Again, the resulting cluster is not uniform, although less obviously so than in the previous case. The position of the journals which play a significant part in the structure of the cluster stands out in a similar way. When the four top-ranking ISI journals are left out of the calculation, the resulting correlation coefficient, $r=0.331$, is much lower. However, the same conclusion is still valid.

Similarly for Diagram 6, where we observe two averaged cited journals (Physics letter B, Physical review D) having zero demand and some with very low request ratio. It is the latter observations that indicate the existence of hidden and closed communication circles in electronic form (not electronic publishing) ; the first observation (Diagram 5) shows that some journals are heavily requested, but their use does not seem to be mirrored by citations in further work. This implies that although a statistical correlation exist for the large portion of journals demanded/cited, the correlation is not valid at the end of the curves. If demand=use to know the demand may supplement knowledge about cited journals, e.g. in application/patent areas, where citations given are scarce. To confirm the correlation with another method, for a longer series, the titles which appeared among the first 100 in both lists were counted, in intervals of 10, in the journals most frequently requested from INIST :

INIST classification	Of which x titles in the 100 journals most frequently cited according to INIST
Top 10	x= 5
Top 20	x=10
Top 30	x=16
Top 40	x=18
Top 50	x=26
Top 60	x=27
Top 70	x=35
Top 80	x=42
Top 90	x=49
Top 100	x=57

Table 2
Intersection of the first 100 in the both lists : Inist, Isi.

There is a surprising degree of regularity in the series, which differs from the pattern of British Library requests observed twenty years ago by Scales (SCA76), where the increase in the proportion of titles appearing in both lists was very gradual. Two apparently contradictory conclusions may be drawn from this regularity :

- on the one hand, the number of citations does provide a fairly reliable market indicator for articles from the group of reputed journals, since an obvious correlation emerges ;
- on the other hand, the degree of notoriety as measured by the number of citations does not seem to have had any influence on demand for half of the top-ranking group. The indicator therefore leaves a significant number of titles aside. A more thorough analysis of titles which do not appear in both lists is required.

3.d Journals not included in either list

The following tables show the journals which are included in one of the lists but rank below the top 200 according to the criteria used in the other list.

Journal title	INIST rank	INIST requests	ISI rank	ISI cit.
<i>Journal of virology</i>	248	29	36	49304
<i>Journal of molecular biology</i>	258	28	37	47133
<i>Journal of bacteriology</i>	301	25	39	46238
<i>Inorganic chemistry</i>	311	25	46	41161
<i>Physical review A</i>	515	19	44	42320
<i>Astrophysical journal</i>	830	12	18	71220
<i>Physics letters B</i>	0	0	40	45827
<i>Physical review D</i>	0	0	49	38641

Table 3
Titles included in the 50 most frequently cited journals according to ISI (JCR 1996) but rarely or never requested from INIST (January 1997)

This table clearly highlights a group of physical sciences and astrophysics journals which seem to be very popular with scientists, but whose contents do not seem to be exchanged through conventional document supply channels. One reason for this may be the growth of pre-print servers in these disciplines, based on the service launched by P. Guinsparg, in which case it may be said that electronics have superseded hard copy documentation.

Our analysis qualifies this interpretation which, if based on transposition, may lead to confusion between cause and effect. The success of the Guinsparg initiative was also due to article exchange practices which already existed between researchers in this discipline, and also to existing journal subscriptions taken out by laboratory libraries. In fact, the evidence suggests that the small number of official document requests is not a recent phenomenon, and also that there is a longstanding specific relationship with these publications within the physics community :

- thus, even Line and Wood back in 1975 found only one physics title (*Journal of Applied Physics*) among the journals most frequently photocopied at the British Library (LIN75).

- de la Vega (VEG99), observing communication practices between researchers in theoretical physics, showed that this was a very close-knit community with a high degree of loyalty to its own journals, which were always available in hard copy in laboratory libraries. In addition, American, European and French physics societies, which also publish the main physics journals, play a fundamental part in the exchange of knowledge and the organisation of the community. These special features have made the physics community a kind of laboratory for studies on developments in electronic publishing. Regarding the topic we are concerned with here, a point of particular interest is that the incorporation of electronic journals into pre-print servers is raising entirely new questions for the various interested parties, as described by one authority on the subject (TIM98) :

Archiving has always been the responsibility of libraries, which unfortunately are also the most important customers of a scientific publisher. The basic conundrum is that if publishers make an electronic archives available, they will undercut one of the most important activities of their major customers, that of archiving the historical record. An online archive makes it unnecessary to go to the library to access old copies of the journal; therefore, the library loses its incentive to subscribe to the journal. Furthermore, an archive searchable by title, author, full-text, etc. moves the task of locating the

information from the library catalogue to the desk of the user. It also assigns the responsibility for supporting that service to the publisher, not the librarian. Thus, no matter how you look at it, an electronic archive, offered by the publisher, is a threat to the publisher's major customer -- not a situation that encourages rapid innovation.

Journal title	ISI rank	ISI Cit.	INIST rank	INIST requests
<i>Journal of applied polymer science</i>	201	11980	33	74
<i>Journal of materials science</i>	209	11663	19	83
<i>Chemical and pharmaceutical bulletin</i>	277	9206	18	89
<i>Chemical engineering science</i>	301	8383	44	70
<i>Polymer engineering and science</i>	472	5486	26	77
<i>Chemosphere</i>	519	4914	48	69
<i>Pharmaceutical research</i>	526	4848	40	72
<i>International journal of pharmaceuticals</i>	592	4373	11	98

Table 4
Titles included in the 50 journals most frequently requested from INIST (January 1997), but not often cited according to ISI (JCR 1996)

This table is not so readily interpreted. Particular care is needed with regard to the bias in the ISI sample. An overall rank in 200th position can be an excellent result in a specialised discipline. However, the journals indicated here appear to focus more on research and development than on academic research : in other words, a key criterion for assessing articles from these journals might be whether an application has been made for a patent on the results, rather than the number of citations. If confirmed, this interpretation would demonstrate the value of coupling the two criteria to reflect the characteristics of article demand.

Conclusion

Apart from the reservation made in the previous paragraph, there does seem to be a relationship between citations and demand for articles in medicine, pharmacology, biology and chemistry, at least for the most frequently requested articles. Over one year, these disciplines alone account for 63% of all articles requests to INIST.

One possible interpretation of this empirical observation may lie in the widespread and longstanding use of bibliographic tools and data bases which were pioneered by these disciplines, through the National Library of Medicine and Medline on the one hand and the American Chemical Society and Chemical Abstracts on the other. However, these tools owe their existence to the specific way in which scientific information circulates in any case in these particular disciplines, and also to the fact that articles in these subjects are in considerable demand, especially from industry. Industrial competition is very strong in these disciplines which is not the case elsewhere, and this is a determining factor in the way articles are circulated.

This suggests that there is indeed a potential market for electronic articles from the most reputed journals in these disciplines.

Three journals, *Nature*, *Science*, and *The Lancet*, fulfil a specific function. The use of these journals and their articles deserves a specific analysis in terms of the circulation of scientific information. Their role as magazines could provide them with a unique function in communications networks : indeed, *Science* already has an ambitious marketing strategy in this area. In view of the structure of demand, marketing the collection as a whole may be well prove to be profitable.

Patterns for the other titles and disciplines using electronic networks may prove to be very different. Although we do not claim to have covered the subject exhaustively, nor even to provide a fully researched basis for the following arguments, they may help to interpret our findings :

- journals in the physical sciences and astrophysics are frequently cited, but are much more rarely requested from INIST, if at all, although they are included in INIST's holdings. Our interpretation for this was given earlier, and it may be assumed that in these disciplines, exchanges of material through electronic networks will continue to evolve in a distinct way which will be largely determined by the organisation of the scientific community itself.
- the absence of mathematics journals in both the ISI and INIST lists may be due to the lesser value ascribed to citations, to the smaller size of the community, to the fact that independent documentation circuits have existed for many years in France (Math-doc unit) and abroad, and to the lesser degree of interest from the business community. As for the physics community, it is likely that electronic document circulation will continue to be managed to a large extent by the community itself.
- In computer and engineering sciences, where citations are considered differently and where we have shown not only the extent but also the dispersion of demand, the future pattern of electronic publishing seems much less clear-cut. Neither the scientific community, nor the publishers, nor the libraries appear to be capable of establishing an adequate configuration for electronic publishing.

No such deductions can be drawn from our data on journals in the social and human sciences. This group is much larger than the others in terms of the number of researchers and publications, but does not use INIST as a channel for the distribution of information. The citations criterion does not seem particularly relevant either. This suggests that in these disciplines, the journal medium - considered as a single uniform support for articles - together with the importance of language itself - implies a different type of relationship. Our opinion is that in these disciplines, any interpretation should be based on a different analysis altogether.

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<http://www.inist.fr/>

Institute for scientific information

<http://www.isinet.com/>

Economie du document - circulation des articles scientifiques

<http://www.enssib.fr/eco-doc>

Annexe 1

DESCRIPTION OF CCN DATA

The French Union catalogue of Serial Publications (CCNPS - *Catalogue Collectif National des Publications en Série*) :

The CCN-PS (Catalogue Collectif National des Publication en série) is the national serial publication union catalogue in France.

Existing since 1983, it is an essential tool for article suplying since periodical articles constitute the majority of documents requested on inter library loan, nationally.

The data base was set up in 1983 and combines several files to provide a list of more than one million journal collections, or over 280 000 different titles in nearly 3000 libraries.

The availability of the CCN in Cd-Rom is named Myriade, a useful tool for libarries to enable the location of both French and foreign-language serial publications.

Annexe 2

The fifty journals most frequently cited and requested

The fifty journals most frequently cited according to the ISI sample

(JCR 1996)

Journal title	ISI Citations	INIST requests	INIST ranking	Myriade
1. <i>Journal of biological chemistry</i>	293024	184	1	157
2. <i>Proceedings of the national academy of science - USA</i>	276659	158	3	214
3. <i>Nature</i>	270077	107	5	391
4. <i>Science</i>	221696	79	24	344
5. <i>Journal of the american chemical society</i>	174540	99	10	152
6. <i>Cell</i>	149477	60	61	143
7. <i>Physical review letter</i>	132797	50	86	120
8. <i>Physical review B -Condensed matter</i>	130789	35	182	69
9. <i>Journal of chemical physics</i>	120281	81	21	117
10. <i>New england journal of medicine</i>	118106	115	4	176
11. <i>Lancet</i>	100526	179	2	171
12. <i>Biochemistry</i>	91747	58	67	28
13. <i>Journal of immunology</i>	89503	69	46	111
14. <i>American journal of physiology</i>	89048	82	20	98
15. <i>Cancer research</i>	82343	91	15	91
16. <i>Journal of physical chemistry - US</i>	73237	79	23	107
17. <i>Journal of clinical investigation</i>	72294	95	13	111
18. <i>Astrophysical journal</i>	71220	12	830	54
19. <i>Biochimica et biophysica acta</i>	69557	104	6	81
20. <i>Journal of cell biology</i>	67402	69	45	133
21. <i>Blood</i>	67238	44	112	102
22. <i>Circulation</i>	64644	97	12	81
23. <i>Brain research</i>	63958	70	43	49
24. <i>Embo journal</i>	62920	38	156	97
25. <i>Journal of geophysical research</i>	61912	51	83	89
26. <i>Journal of experimental medicine</i>	60034	57	70	98

27. <i>Molecular and cellular biology</i>	58647	40	134	68
28. <i>Biochemical and biophysical research communications</i>	56993	103	8	116
29. <i>Journal of organic chemistry</i>	56632	70	42	98
30. <i>Journal of applied physics</i>	55355	79	22	133
31. <i>Applied physics letters</i>	55205	42	123	90
32. <i>Nucleic acids research</i>	54784	45	104	86
33. <i>JAMA - Journal of the american medical association</i>	53060	77	28	111
34. <i>Tetrahedron letters</i>	52693	50	88	83
35. <i>Biochemical journal</i>	50291	75	32	80
36. <i>Journal of virology</i>	49304	29	248	82
37. <i>Journal of molecular biology</i>	47133	28	258	111
38. <i>Cancer</i>	47014	57	71	103
39. <i>Journal of bacteriology</i>	46238	25	301	126
40. <i>Physics letters B</i>	45827	0	0	69
41. <i>Febs letters</i>	45436	93	14	101
42. <i>British medical journal</i>	44982	78	25	97
43. <i>Analytical biochemistry</i>	42553	74	35	120
44. <i>Physical review A</i>	42320	19	515	45
45. <i>Endocrinology</i>	42263	49	91	18
46. <i>Inorganic chemistry</i>	41161	25	311	72
47. <i>Journal of neuroscience</i>	40357	48	97	25
48. <i>Gastroenterology</i>	39531	40	141	78
49. <i>Physical review D</i>	38641	0	0	89
50. <i>Analytical chemistry</i>	37777	74	36	191

The fifty journals most frequently requested from INIST

(January 1997)

Journal title	INIST requests	ISI Citations	ISI ranking	Myriade
1. <i>Journal of biological chemistry</i>	184	293024	1	157
2. <i>Lancet</i>	179	100526	11	171
3. <i>Proceedings of the national academy of science - USA</i>	158	276659	2	214
4. <i>New england journal of medicine</i>	115	118106	10	176
5. <i>Nature</i>	107	270777	3	391
6. <i>Biochimica et biophysica acta</i>	104	69557	19	81
7. <i>Chest</i>	104	19456	107	68
8. <i>Biochemical and biophysical research communications</i>	103	56993	28	116
9. <i>Journal of chromatography</i>	100	30985	62	99
10. <i>Journal of the american chemical society</i>	99	174540	5	152
11. <i>International journal of phrmaceutics</i>	98	4373	592	19
12. <i>Circulation</i>	97	64644	22	81
13. <i>Journal of clinical investigation</i>	95	72249	17	111
14. <i>Febs letters</i>	93	45436	41	101
15. <i>Cancer research</i>	91	82343	15	91
16. <i>American journal of epidemiology</i>	90	15778	145	46
17. <i>Annals of the New York academy of science</i>	89	22362	90	63
18. <i>Chemical and pharmaceutical bulletin</i>	89	9206	277	34
19. <i>Journal of materials science</i>	83	11663	209	54
20. <i>American journal of physiology</i>	82	89048	14	98
21. <i>Journal of chemical physics</i>	81	120281	9	117
22. <i>Journal of applied physics</i>	79	55355	30	133
23. <i>Journal of physical chemistry</i>	79	73237	16	107
24. <i>Science</i>	79	221696	4	344
25. <i>British medical journal</i>	78	44982	42	97
26. <i>Polymer engineering and science</i>	77	5486	472	27
27. <i>The journal of urology</i>	77	26622	76	59

28. <i>JAMA - Journal of the american medical association</i>	77	53060	33	111
29. <i>Journal of clinical microbiology</i>	75	22248	92	39
30. <i>Neurology</i>	75	30132	65	54
31. <i>Archives of internal medicine</i>	75	17256	132	69
32. <i>Biochemical journal</i>	75	5291	35	80
33. <i>Journal of applied polymer science</i>	74	11980	201	49
34. <i>American journal of cardiology</i>	74	27656	71	58
35. <i>Analytical biochemistry</i>	74	42553	43	120
36. <i>Analytical chemistry</i>	74	37777	50	191
37. <i>Biochemical pharmacology</i>	74	20338	103	49
38. <i>Archives of biochemistry and biophysics</i>	73	21420	97	86
39. <i>Journal of colloid and interface science</i>	72	16676	136	67
40. <i>Pharmaceutical research</i>	72	4848	526	15
41. <i>Environmental science and technology</i>	72	14199	161	3
42. <i>Journal of organic chemistry</i>	70	56632	29	98
43. <i>Brain research</i>	70	63958	23	49
44. <i>Chemical engineering science</i>	70	8383	301	46
45. <i>Journal of cell biology</i>	69	67402	20	133
46. <i>Journal of immunology</i>	69	89503	13	111
47. <i>Annals of internal medicine</i>	69	36850	52	91
48. <i>Chemosphere</i>	69	4914	519	11
49. <i>Neuroscience letters</i>	68	22249	91	30
50. <i>Applied an environmental microbiology</i>	67	25831	79	85

ISI journal citations (JCR 1996) not included in the INIST list (January 1997)
(ranking from 1 to 50)

Journal title	INIST rank	INIST requests	ISI rank	ISI citations	Myriade
<i>Cell</i>	61	60	6	149477	143
<i>Biochemistry</i>	67	58	12	91747	28
<i>Journal of experimental medicine</i>	70	57	26	60034	98
<i>Cancer</i>	71	57	38	47014	103
<i>Journal of geophysics research</i>	83	51	25	61912	89
<i>Physical review letters</i>	86	50	7	132797	120
<i>Tetrahedron letters</i>	88	50	34	52693	83
<i>Endocrinology</i>	91	49	45	42263	18
<i>The journal of neuroscience</i>	97	48	47	40357	25
<i>Nucleic acids research</i>	104	45	32	54784	86
<i>Blood</i>	112	44	21	67238	102
<i>Applied physics letter</i>	123	42	31	55205	90
<i>Molecular and cellular biology</i>	134	40	27	58647	68
<i>Gastroenterology</i>	141	40	48	39531	78
<i>Embo journal</i>	156	38	24	62920	97
<i>Physical review B</i>	182	35	8	130789	69
<i>Journal of virology</i>	248	29	36	49304	82
<i>Journal of molecular biology</i>	258	28	37	47133	111
<i>Journal of bacteriology</i>	301	25	39	46238	126
<i>Inorganic chemistry</i>	311	25	46	41161	72
<i>Physical review A</i>	515	19	44	42320	45
<i>Astrophysical journal</i>	830	12	18	71220	54
<i>Physics letters B</i>	0	0	40	45827	69
<i>Physical review D</i>	0	0	49	38641	89

Journals requested from INIST (January 1997) and not included in the ISI list (JCR 1996)
(Ranking from 1 to 50)

Journal title	ISI rank	ISI citations	INIST rank	INIST requests	Myriade
<i>Annals of internal medicine</i>	52	36850	47	69	91
<i>Journal of chromatography</i>	62	30985	9	100	99
<i>Neurology</i>	65	30132	30	75	54
<i>American journal of cardiology</i>	71	27656	34	74	58
<i>Journal of urology</i>	76	26622	27	77	59
<i>Applied an environmental microbiology</i>	79	25831	50	67	85
<i>Neuroscience letters</i>	91	22249	49	68	30
<i>Annals of the New York academy of science</i>	90	22362	17	89	63
<i>Journal of clinical microbiology</i>	92	22248	29	75	39
<i>Archives of biochemistry and biophysics</i>	97	21420	38	73	86
<i>Biochemical pharmacology</i>	103	20338	37	74	49
<i>Chest</i>	107	19456	7	104	68
<i>Archives of internal medicine</i>	132	17256	31	75	69
<i>Jornal of colloid and interface science</i>	136	16676	39	72	67
<i>American journal of epidemiology</i>	145	15778	16	90	46
<i>Environmental science and technology</i>	161	14199	41	72	3
<i>Journal of applied polymer science</i>	201	11980	33	74	49
<i>Journal of materials science</i>	209	11663	19	83	54
<i>Chemical and pharmaceutical bulletin</i>	277	9206	18	89	34
<i>Chemical engineering science</i>	301	8383	44	70	46
<i>Polymer engineering and science</i>	472	5486	26	77	27
<i>Chemosphere</i>	519	4914	48	69	11
<i>Pharmaceutical research</i>	526	4848	40	72	15
<i>International journal of pharmaceutics</i>	592	4373	11	98	19

Annexe 3

Random sampling of journals requested once only from INIST

(January 1997)

Random samples were taken four times in succession. No outstanding differences were observed. One of the samples is given below as an example.

- 10TH NAMCR : CONFERENCE, 1982 MAY : HAMILTON, CANADA
- APPLICATIONS AND THEORY OF PETRI NETS - 6TH EUROPEAN CONFERENCE JUNE 1985
- CHEMICKE ZVESTI
- ENGINEERING MANAGEMENT JOURNAL
- INDIAN DRUGS
- JOURNAL OF FLUORINE CHEMISTRY
- MAGNESIUM IN VEHICLE DESIGN
- PALEOBIOLOGY
- RECENTI PROGRESSI IN MEDICINA
- THE ITALIAN JOURNAL OF GASTROENTEROLOGY
- ADVANCES IN APPLIED MICROBIOLOGY
- BIOCHEMISTRY : (EASTON)
- COASTAL ENGINEERING : (AMSTERDAM)
- EUROPEAN JOURNAL OF OBSTETRICS AND GYNECOLOGY
- INFLAMMATION RESEARCH
- ADVANCES IN PERITONEAL DIALYSIS
- ASPECTS OF SPONGE BIOLOGY, 1975 MAY, ALBANY NY
- CANCER BIOTHERAPY
- CRITICAL CARE CLINICS
- EUROPEAN WORKSHOP IN PERIODONTOLOGY FEB 1993 ITTINGEN
- HUMAN PSYCHOPHARMACOLOGY
- IZVESTIA SIBIRSKOGO OTDELENIA AKADEMII NAUK SSSR. SERIA HIMICESKIH NAUK
- JOURNAL OF MORPHOLOGY : (1931)
- LOZARSTVO I VINARSTVO
- NIHON KYOBU GEKA GAKKAI ZASSHI
- POLYMER-PLASTICS TECHNOLOGY AND ENGINEERING : (SOFTCOVER ED)
- REVUE DES MALADIES RESPIRATOIRES
- TECHNIQUES AND APPLICATIONS OF PATH INTEGRATION
- SOVIET JOURNAL OF OPTICAL TECHNOLOGY
- SOVIET JOURNAL OF SUPERHARD MATERIALS
- SOVIET PHYSICS JOURNAL

- SOVIET PHYSICS, JETP
- SOVIET PHYSICS, LEBEDEV INSTITUTE REPORTS
- SOVIET PHYSICS. TECHNICAL PHYSICS
- SOVIET PHYSICS. USPEKHI
- SPECIAL PUBLICATION - ROYAL SOCIETY OF CHEMISTRY
- SPECIALITY CHEMICALS : (REDHILL)
- SPECTROCHIMICA ACTA. PART A : MOLECULAR SPECTROSCOPY
- SPECTROCHIMICA ACTA. PART B : ATOMIC SPECTROSCOPY
- SPEECH MONOGRAPHS
- SPRINGER SERIES IN CHEMICAL PHYSICS
- STAHL UND EISEN : (1881)
- STATISTICESKIE PROBLEMY UPRAVLENIA
- STATISTIQUE ET ANALYSE DES DONNEES
- STEEL - STRENGTHENING MECHANISMS - PROCEEDINGS F A SYMPOSIUM, 1969 MAY, ZU
- STEEL RESEARCH
- STEROIDS
- STOCHASTIC PROCESSES AND THEIR APPLICATIONS
- ANNALS OF HUMAN BIOLOGY
- ANNALS OF MATHEMATICAL STATISTICS
- ANNALS OF MATHEMATICS
- ANNALS OF SURGERY