The citation culture
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Chapter 1

Introduction

1.1 Introduction

The need for greater accountability of scientific researchers has created a number of new professions. The scientometrician is one of these experts. They measure science scientifically, often on behalf of science policy officials. They are specialized in rating and mapping the sciences, the social sciences, and the humanities with the help of huge databases derived from the scientific literature. This is not the whole story, however. The scientometrician is not only a policy oriented professional, but also a social scientist. Scientometricians have a core journal, *Scientometrics*, jointly published by Elsevier Science and the Hungarian publishing house Akadémiai Kiadó. There is an international conference which takes place every two years, organized by their scientific association, the International Society for Scientometrics and Infometrics. Currently, there are a few hundred scientometricians in the world. They vary from a lone individual who is part of a research library or history of science department, to a large collective with around twenty full-time researchers.

The professional scientometrician emerged in the sixties. Their creation is intimately linked to the invention of the *Science Citation Index (SCI)* in Philadelphia (United States). To date, scientometricians cannot boast of many successes. They do not seem to have had a great impact on the science policy of most countries. One cannot acquire a university degree in scientometrics. Its practitioners have to cope with resistance from the scientific community and their results are not always welcomed. Moreover, while scientometricians have only a relatively short history, their prospects are in doubt. It is not clear whether the profession of scientometrics will survive the ongoing revolution in scientific communication (Wouters 1996c). Computer mediated communication is rapidly becoming the principal medium for publication and dissemination of professional and scientific results. In a few years every scientific journal will be obtainable via computer networks and databases (Wouters 1997, Wouters 1996a). These changes may lead to a crucial shift in the characteristics of the unit of publication, the scientific article. Currently, it is uncertain how this will affect the measurement of science and the development of scientometrics. Since the scientific article is one of the key objects in scientometrics, these changes in scientific publishing may very well lead to the
early death of this new profession in its present form.

This study is not a history aimed at describing the specialty in its various stages of development in a more or less “complete” way. It might be characterized as a footnote to the available history of the sociology of science, providing at most a historically and sociologically informed theoretical argument about one aspect of this history. Yet, strange as it may seem, this micro-history relates to interesting features of present-day science in general. I will argue that the development of scientometrics can best be understood if we analyze this field as both indicator and embodiment of a recently emerged subculture in science: *The Citation Culture*. This subculture has unwittingly and subtly changed core concepts of modern science such as scientific quality and influence. Because of the citation culture, *being cited* has profoundly changed its meaning over the last two decades, with a number of consequences for scientists. It has moreover contributed to the transformation of the very essence of science policy, notwithstanding scientometrics’s apparent lack of outstanding successes. This study tries to explore the possible meaning of the citation culture for the systematic generation of knowledge. To reach this goal, this analysis does not start with big concepts like power, science or truth. Instead, it will begin from the most humble entity in scientific articles, often merely visible in small-print: the reference.

### 1.2 Citing cultures

Today, a scientific publication is easily recognized by its footnotes, endnotes and references to other scientific articles or books. This is one of the features which make scientific texts so different from a journalist’s story or a novel. A scientist seems to be — at least in his professional life — an annoyingly precise person, whose claims are painstakingly documented. Not only do researchers describe their own work in minute detail (Latour & Woolgar 1986), they also conscientiously cite colleagues whose publications they have used. As is well known, this literary style has not always been the norm; it emerged only during the second half of the nineteenth century (Bazerman 1988). The present-day ensemble of norms, rules, practices and interpretations, which are invoked by researchers every time they cite someone’s work, entertain complex relationships with one another. These norms and rules do not determine citing practices in the strict sense nor do they indicate the clear meaning of the reference. Norms may even contradict one another. At the same time, a researcher is not free to do as he pleases. He must be able to justify his citing action in terms of the norms and rules of his specialty. The rules do not exist independently of the actions, however. They exist “within” the citing actions while they are nevertheless different from them. They fulfill the role of a resource which both enables and constrains researchers in their citing. This type of relationship between structure and action, rule and behaviour, is typical of cultural phenomena in general\(^1\). Therefore, this

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\(^1\)Culture is an ambiguous concept. This study follows Goudsblom (1962,1970) and Hagendijk (1996). Culture includes not only the ensemble of ideas and patterns of behaviour in a certain society, but also the relationships between society and nature as a whole. This perspective entails no
study speaks of the citing culture in science.

Citing behaviour seems to vary according to personal traits. Whereas one author will devote detailed attention to the list of references, another could not be less interested (though this cannot be said too loudly). Nevertheless, the overall citing properties of the publications within a certain field share the same characteristics. The mathematician tends not to cite many publications. The biomedical researcher, on the other hand, is not afraid to cite hundreds of articles. The historian also likes references, but in a different way. The literary scholar goes about citing in quite another way. It seems therefore better to speak of the citing culture in the plural form. The sciences host many types of citing culture, each slightly different from the other. A conceptual core that is mutually shared by every one of them cannot be isolated; the various citing cultures resemble one another, as members of one family do. It is possible, of course, to abstract certain general notions and claim that these constitute the core. For example, a scientist is supposed to cite honestly: he must have read the article and have found it useful in some way. The question is, however, in what way this differs from the generally accepted norm of honesty. The moment one tries to become more concrete, and asks what it means to cite honestly and correctly, the answer becomes specialty-bound. Citing cultures not only differ between specialties, they also vary between journals. This is not exclusive to typographical format. It also has to do with the type of reference, its number, its position in the text etcetera. Thus, the historical development of scientific publishing since the nineteenth century has provided for a fairly stable ensemble of citing cultures in science.

1.3 Unintended consequences of being cited

The gradual development of regular citing behaviour in scientific publishing has created a new resource for research and policy: citation data. It did not take long before these data began to be used. With hindsight, it seems an almost inevitable outcome of some straightforward reasoning. If researchers cite the work they find useful, often cited (“highly cited”) work is apparently more useful to scientists than work which receives hardly any citations at all. Hence, the number of times an article is cited, seems to be an accurate measure of its impact, influence or quality. The same is true of the collected articles of one particular scientist, research group, journal or even institution. The more they are cited, the greater their influence. Sloppy work will not often be cited, except in heated controversies — or so the reasoning goes. Therefore, citation frequency seems a good way of objectively measuring scientific usefulness, quality, or impact.

Whatever one’s view on the import of being cited, citation frequency is generally supposed to measure something that already exists. This is based on an implicit realist perspective with respect to the process of scientific communication: the indicator is seen as a more or less direct upshot of scientists’ activities. There-
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fore, citation analysis — the art of measuring numbers of citations — provides a window onto the communication processes between scientists. Consequently, scientometrics, in which citation analysis has a central position, is defined as the quantitative study of scientific communication (Narin 1976).²

This study questions these realist interpretations of measuring science by citations. It will be shown that the citation culture is not a simple aggregate or derivative of citing culture in science. The citation as used in scientometric analysis and science and technology indicators is not identical to the reference produced at the scientist’s desk. This is the first claim of my study: the citation is the product of the citation indexer, not of the scientist. Citation analysis has only been feasible on a discernable scale since the invention of computerized citation indexes. This is also the reason that the Science Citation Index (SCI), the Social Science Citation Index (SSCI) and the Citation Index for the Arts & Humanities (CI&H) (all invented by the same man) are the dominant databases in citation analysis. Getting to know the citation a little better implies looking into the production of these indices. Therefore, this enquiry into the citation culture starts with the origin of its main component (chapter 2).

From the early years of this century, research librarians have systematically applied citation analysis (Gross & Gross 1927, Gross & Woodford 1931, Cole & Eales 1917, Broadus 1967, Brookes 1988, Cason & Lubotsky 1936, Earle & Vickery 1969, Raisig 1960, Fussler 1949, Burton 1959a, Burton 1959b, Barrett & Barrett 1957, Cole 1952, Dyson 1952). They collected data on the frequency with which journals were cited. Supposed to measure the usefulness of subscriptions to these journals for their clients the scientists, journal citation analysis was a tedious job, however, since lists of references of many articles in lots of different journals had to be collected to measure the citation frequency of even a single journal. This seems to have been the main reason for the relative scarcity of these citation analyses.

The situation changed abruptly, however, with the invention of the Science Citation Index by Eugene Garfield. Using the SCI, it took far less work to extract citation frequencies from the data. It became even possible to measure the frequency with which an individual was cited, a feat previously unheard of. Nevertheless, the scientific community was not enthusiastic. Many researchers did not even use the SCI for its stated purpose as a bibliographic tool — to find relevant publications in the exponentially growing mountain of scientific literature. Neither did many researchers use it to keep abreast of their citation status, a measure without clear meaning to many scientists. The prevailing reaction was hostile or indifferent. The difficult birth of the citation index relates, at least partly, to the translation process needed for the citation culture to prosper. The need for this translation process is the result of the novel way in which the SCI represents science.

²For a reflexive and constructivist systems-theoretical approach that also sees scientometrics as the study of scientific communications see Leydesdorff (1995).
1.4 An objective representation of science

1.4.1 Representation

In this study, the concept of representation is not taken to mean “mirroring reality”. Scientometrics does not mirror science, neither does the scientific literature. In general, representing means both “speaking or acting on behalf of” and “being able to stand in for”. Every representation is the product of the interaction between the phenomenon it represents and its own production rules\(^3\). Obviously, many types of representation exist. Knowledge, including scientific knowledge, can also be represented as a representation of the world\(^4\). A given body of knowledge is built upon other representations. Sometimes it makes sense to order these according to their contingency relations. Scientific literature for example is based on research and is one of its most important direct products. Relative to daily practice in laboratories, literature is therefore a “first order” representation. In the same vein, citation analysis and scientometrics are based on scientific literature and are another step removed from underlying research practice. In other words, they can be seen as “second order” representations of what goes on in laboratories. This study draws upon these two bodies of knowledge and practice and can therefore be seen as a “third order” analysis and representation. These different representations are related through translation, distortion and transformation, more than through linear reflection.

1.4.2 The SCI

The Science Citation Index\(^5\) is not merely a bibliographic instrument. It also creates a new picture of science via bibliographic references found in scientific literature. As the Terminology & Definitions section of the SCI explains:

> The Citation Index is an alphabetic list of references given in bibliographies and footnotes of source articles arranged by first author. Each reference is followed by brief descriptions (citations) of the source articles which cite it.

In this way, the SCI provides a fundamentally new representation of science. There had been similar devices before. However, these were confined to certain disciplines; the SCI is the first citation index aimed at the whole of scientific literature. It creates an image of this type of literature in the same way as a telephone book creates an image of the inhabitants of a city.

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\(^{4}\)This view deviates from Ankersmit (1990) who pictures science in a surprisingly realist way. Contrary to his views, this study does not assume a fundamental divide between science and history.

\(^{5}\)By the term Science Citation Index are also meant the Social Science Citation Index and the Arts & Humanities Citation Index, all published by the Institute for Scientific Information (ISI), except when otherwise indicated.
Scientific literature is a representation of scientific research, produced by selectively emphasizing some cognitive features and neglecting others (Knorr-Cetina 1981, Latour & Woolgar 1986). The SCI in its turn represents scientific literature (it does not use any elements of science outside this literature) and is, consequently, a second order representation of science. Every representation is different from its object. After all, without differences the representation would be pointless. The SCI creates these differences by the selection of features of the literature it processes. Since the resulting index structure cannot be made at will by its producers, they do not know beforehand what will result from their work. If we take “reality” to be that which resists (Hacking 1983, Latour 1984), scientific literature is the real, independently existing, object of the citation index. Therefore, while the index depends on the literature, this relationship is not reciprocal, at least initially. Because of this relationship between literature and index, the SCI can be perceived as an objective (i.e. non-subjective) representation of scientific literature: “When using citation data, we draw on a multi-disciplinary, objective, and internally consistent data base, the Science Citation Index” (Small & Griffith 1974).

Almost immediately after its first publication, the SCI data were used in citation analysis. This type of research claims to be objective due to the above mentioned objective character of the SCI: “Citation analysis is objective because it is based on written information that anyone can check. It is the aggregate of the subjective decisions of all publishing scientists” (Aaronson 1975). Given the massive amount of data contained in the SCI, advanced statistical techniques, like co-citation clustering, need to be used. However, this does not seem to diminish the objectivity of the analytical results:

Many of the relationships we have uncovered are, of course, known to the specialists themselves, since they were established by their own citing patterns, but the perspective this method offers is far broader than can be achieved by any individual scientist. This is the crux of the method: the observed relationships are in substance those which have been established by the collective efforts and perceptions of the community of publishing scientists. Our task is to depict these relationships in ways that shed light on the structure of science. (Small & Griffith 1974)

Apparently, three points are important. First, the SCI portrays science from a nonobtrusive outsider’s position. Therefore structures can be revealed which cannot be perceived in that form from the position of the researcher in the represented field. Second, scientists seem to get the citation pattern back that they produced themselves. This study will show that this is not as obvious as it seems. Third, making sense of the SCI requires specific procedures, except if one only

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This partly contradicts Lynch & Woolgar (1990, 13) who state: “our position is that representations and objects are inextricably interconnected”. The fact that the human race is inextricably dependent on representations, does however not necessarily mean that every specific representation is inextricably interconnected with every object it represents. In this case study it is literature already in existence (a representation of science) which is processed by the indexers.

There is feedback, though, which will be treated later in this chapter.
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wishes to see one’s own citation score. It is not very illuminating to read the index from the first page to the last. The patterns in the index can only be read with the help of statistical techniques. Far from diminishing the objectivity of citation analysis, these statistical manipulations of the data contribute to the validity of its results.

Not only are SCI and citation analysis engaged in an object–representation relationship to scientific literature (the basis of its perceived objectivity), the index is moreover applicable to the whole of scientific literature because it neglects the substantive claims and counter-claims in the literature. Whereas the scientific literature represents science by focusing on its cognitive claims (the content of the articles and books published), the SCI represents scientific literature by obliterating this content and focusing instead on its formal properties. It only processes references, author names, institutional addresses, titles, language names and types of publication. This selection creates a new, unified representation of science, diverging from the compartmental picture one gets if one tries to read all scientific publications. This latter endeavour is not only impossible because of the vast number of journals and books published but because of the large number of different languages involved. Every specialty and discipline speaks its own language (de Wilde 1992). The SCI translates this tower of Babel into an integrated whole by drastically reducing its complexity.

This creates a host of new possibilities. For example, one specialty can be compared to another (Small & Griffith 1974). Moreover, as Garfield (1970) has it: “the SCI tells how each brick in the edifice of science is linked to all the others”. Therefore, it is conceivable that maps of science can be created, an idea first put forward by geneticist Gordon Allen and later advocated by Derek de Solla Price.

Such maps, it was hoped, can indicate the state of science in a particular year, and by their changes from year to year, the overall progress of science. (Small & Sweeney 1985a)

In short, the SCI portrays science as a citation network. It is based on the assumption that no significant contributions to scientific knowledge are being missed in this way. Price (1965a) developed the following argument in the early years of citation analysis using the SCI:

since 10 percent of all papers contain no references and another, presumably almost independent, 10 percent of all papers are never cited, it follows that there is a lower bound of 1 percent of all papers on the number of papers that are totally disconnected in a pure citation network and could be found only by topical indexing or similar methods; this is a very small class, and probably a most unimportant one.

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8 This has varied somewhat over the years, but this does not affect the argument.
9 This does not mean, of course, that this disciplinary structure of science would be static. New specialties are, on the contrary, constantly created at the interface of old ones.
10 This was the foundation of ISI’s project to produce Atlases Of Science (Starchild et al. 1981, Garfield et al. 1984).
Given the regularity of its citing cultures, the representation of science as a citation network is generally seen as a reasonably accurate picture of science. This position common to scientometrics and the sociology of science is based on three assumptions:

1. The actual production of the citation index in Philadelphia does not fundamentally change the elements it uses. The SCI is consequently seen as the product, not of the indexers, but of the publishing and citing scientists.

2. The citing behaviour of scientists is assumed to be both sufficiently important and regular enough to shed light on the characteristics of science and to justify citation analysis.

3. The object–representation relationship between scientific literature and the SCI is assumed to result in an objective relationship between the reality of science and the results of citation analysis. This entails a translation of the notion of objectivity from it being engaged in the dualism objective—subjective to it being part of the polarity true—false.

In summary, the claim of citation analysis to objectivity and truthfulness is built on the SCI being different from, as well as identical to scientific literature. It is identical in as much as it uses elements of scientific literature and is consequently contingent on the patterns among these elements. Were scientists not referring to others regularly, a citation index would make no sense at all. This relationship of identity between the citation index and scientific literature is responsible for the index’s objectivity: aren’t scientists simply getting back what they have created themselves in the first place? At the same time, the index entails a drastic reduction of the complexity of scientific literature. In this difference between the index and its object lies the novelty of its representation of science. Moreover, the SCI gives the outsider’s perspective on science. This external positioning contributes to its objectivity as well as to its novelty.

1.5 The quest for a citation theory

Because of the first two assumptions of citation analysis, the references of scientific articles — and only these — are supposed to be the building blocks of the citation index. Therefore, the citing behaviour of the authors of scientific texts has a direct relationship to the value of citation analysis. The latter must be accounted for in terms of the former, since the value of the citation is “ultimately grounded” (Chubin & Hackett 1990) in the referencing behaviour of the scientist. This has been the main paradigm from which the sociology of science has tried to construct a citation theory. One of the first systematic expositions of citing behaviour is provided by Robert Merton’s sociology of science. It explains references in terms of the norms of science. Because of the constraining function of these norms, citing behaviour of scientists will display certain regularities:

\[\text{This is a general feature of the notion of scientific objectivity (Ashmore 1989)}.\]
Science is public not private knowledge. Only by publishing their work can scientists make their contribution (...) and only when it thus becomes part of the public domain of science can they truly lay claim to it as theirs. For that claim resides only in the recognition of the source of the contribution by peers. (...) The anomalous character of intellectual property in science (...) links up with the correlative moral as well as cognitive requirement for scientists to acknowledge their having made use of it. Citations and references thus operate within a jointly cognitive and moral framework. (Merton 1977)

Since the emergence of constructivism in the sociology of science, the act of citing has been analyzed in rather different ways. Empirical research has, moreover, revealed a bewildering multitude of motivations, functions and causes of references in scientific communication. Sometimes referencing is interpreted as the giving of credit where credit is due, sometimes as ways of persuading the reader, in other cases as merely perfunctory. The role of the reference, both in the citing text and with respect to the cited text, turned out to be equally varied. Scientometricians have repeatedly deplored the resulting lack of a proper and satisfactory theory of citing (Cronin 1984, Cronin 1981, Cozzens 1981, Cozzens 1985, Cozzens 1989, Luukkonen 1990, Luukkonen 1997), or analyzed the deficiencies of existing ones (MacRoberts & MacRoberts 1989, MacRoberts & MacRoberts 1984). Hence the call for “a citation theory”:

Not enough is known about the ‘citation behavior’ of authors - why the author makes citations, why he makes his particular citations, and how they reflect or do not reflect his actual research and use of the literature. When more is learned about the actual norms and practices involved, we will be in a better position to know whether (and in what ways) it makes sense to use citation analysis in various application areas. (Smith 1981)

Often the problem is felt to be the private nature of the act of citing:

Logically, the use of citations as a basis for value judgements should imply that there is a universally recognized convention among authors. However, this convention, in so far as one can be said to exist, displays a remarkable resistance to standardization. (Cronin 1984)

In other words, the second assumption of citation analysis is partially fulfilled: scientists cite one another often enough to make a citation index feasible. It does not, however, legitimate citation analysis in the strict sense of a theoretically consistent scientometrical explanation. Within the scientometric community the practice of citation analysis lacks consensus about its theoretical foundations:

we still have a theoretically underdeveloped understanding of what these bibliometric data actually mean. The continuous call for a theory of citation in quantitative science studies is itself indicative of the urgency to explore more systematically the relations between the use of scientometric methods and qualitative approaches in STS. (Leydesdorff 1987)
1.6 The reference and the citation

The attempts or rhetorical devices to ground citation theories in referencing behaviour are based on the supposition that the reference and the citation are actually identical signs. But this is a tacit assumption, mostly hidden from view. When discussed explicitly, scientometricians seem perfectly aware of the difference between a reference and a citation. Price (1970) was the first to call attention to the distinction between the two signifiers, Narin (1976, 3) and Egghe & Rousseau (1990) later pointed to the same. The difference between the reference and the citation is, however, interpreted as a technical difference, hardly relevant for anyone but the inherently meticulous:

If one wishes to be precise, one should distinguish between the notions ‘reference’ and ‘citation’. If paper R contains a bibliographic note using and describing paper C, then R contains a reference to C and C has a citation from R (Price 1970). Stated otherwise, a reference is the acknowledgement that one document gives to another, while a citation is the acknowledgement that one document receives from another. So, ‘reference’ is a backward-looking concept while ‘citation’ is a forward-looking one. Although most authors are not so precise in their usage of both terms, we agree with Price (1970) that using the words ‘citation’ and ‘reference’ interchangeably is a deplorable waste of a good technical term. (Egghe & Rousseau 1990)

When authors expand on the distinction between reference and citation, they focus on the different characteristics of the distributions of references and citations. For example, Gilbert & Woolgar (1974) point to this (see also Chubin & Moitra 1975, Krauze et al. 1977):

In a growing field, the characteristics (such as the average age and number) of the references in a paper will not necessarily be the same as those of the citations to a paper. The work of some studies is confused by giving both citations and references the same name. (Gilbert & Woolgar 1974)

Since these distributions of references and citations are not the topic of most scientometricians, the distinction Egghe & Rousseau (1990) refer to is glossed over most of the time.

A publishing author positions his text in a host of networks: a field-specific semantic one, a network of journals, an institutional network and so forth. The extraction of a citing network from the literature is, it should be stressed, one of the many possible representations of this literature. Whatever meanings the references have — we have already seen these can be very different — they are a striking feature of science. Their presence may even decide on the fate of the knowledge claims involved: “you can transform a fact into fiction or a fiction into fact just by adding or subtracting references” (Latour 1987). References share an important quality. Each reference is an inscription (Latour & Woolgar 1986),

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12This depends on one’s interpretation of the calls for a general citation theory: they can both be read as sincere attempts to construct such a theory, or as rhetorical moves to allay criticisms of citation analysis. These two ways of reading are not necessarily contradictory.
describing a certain text by a standardized code consisting of combinations of the title, author name, journal or publisher, year of publication, and page numbers. In other words, a reference, itself a piece of text, points to another text, the cited one. This does not mean, of course, that the latter can be found at the place the reference suggests. Since the reference is only a representation of the cited text, and not the cited text itself, the latter does not even have to exist. The reference can also be seen as a representation of what the author has read. Again, this does not have to be the case.

Irrespective of the way it is interpreted by the various theories of citing behaviour, the reference belongs to the citing text. Thus, the reference is completely defined by the citing text it belongs to and the cited text to which it points. In semiotic terms, the reference is a sign — a sign may be defined as the elementary unit of a representational system with the cited text as its referent.

The basic function of the Science Citation Index (and similar devices) is to turn an enormous number of lists of references upside down. Instead of organizing these references according to the articles they belong to, they are organized according to the articles they point to. If reference R of citing article A points to article B, the corresponding citation C is initially nothing else than a different format of reference R. The citation is the mirror image of the reference. This seemingly rather innocent inversion has important consequences. By creating a different format of the lists of references — by organizing the references not according to the texts they belong to, but according to the texts they point to — they become attributes of the cited instead of the original, citing, texts. Semiotically, the citing text is the referent of the citation. Hence the reference differs from its corresponding citation: the latter is produced from the former by inverting it. This inversion process is the basic symbolic act of producing a citation index and, actually, its fundamental operation. Without the inversion as the semiosis (creation of a new sign) of the citation, using the references to make an index would merely produce a reprint of bibliographies. The index would not be different enough from the scientific literature (its referent) to add information and thus be useful as a search instrument. The same inversion operation defines citation analysis. The basic act of citation analysis is a straightforward one: counting the number of times a text is referred to. Every citation analysis is based on counting the number of citations. The moment one starts to count citations of a cited text, one assumes this tells us something (whatever it may be) about the cited text or its position. Otherwise, the counting itself would be utterly pointless.

Thus, the giving of reference is one operation. The making of citation is a second one, reflexive towards the former as well as contingent on it. The shift in attribution of the two signs from the citing to the cited context is the crucial step. To be precise, it is also possible to stop the inversion halfway by attributing the reference to communication between the citing and the cited authors. In this case one would create a symmetric sign. One can then redefine communication as the process that is indicated by the reference.\footnote{This is especially important if, as is often the case, the analyst does not have access to data concerning possible physical acts of communication between researchers. Narin’s Influence Methodology (Narin 1976) is an example of this interpretation.}
The inversion of a reference into a citation is a symbolic operation. It does not have to be embodied in any specific way; and if it does, this embodiment takes various forms. A citation index is not the inevitable result. For example, whenever a scientist “counts citations” by checking the bibliographies of articles looking for references to his work, he inverts references to citations. This private act of making citations does not amount to much, however. Only the production of publicly available citations counts. This is the reason that being cited is not exactly the same as receiving a citation. Although in principle every reference can be inverted to a citation, in practice many references do not enjoy this privilege. Citation indexes are therefore crucial in bibliometrics: only through these bibliographic devices do citations become publicly available, countable and therefore socially relevant.

It can therefore not be taken for granted that the scientist’s desk would be the citation’s birthplace by definition. A citation theory explaining citation analysis and related processes clearly cannot coincide with a satisfactory theory of citing behaviour. The act of citing is still important, but not because it gives the citation. Scientists are not so much creating the end product but more the raw materials of the indexing process. If a researcher or a scholar refers to a scientific article, he does not “give a citation”, however odd this conclusion may seem, even to critics of citation analysis (Edge 1979). I do not mean to say that people using the term citation in its natural language meaning are wrong. In English, citation can mean both the sign citation and the sign reference. I am only saying that, if one wishes to analyze the citation, one should not be confounded by the beautiful ambiguity of natural language. It is essential to define the terms precisely.

The results of research into citing behaviour of scientists may still be relevant but cannot, contrary to received wisdom in scientometrics and science studies, be regarded as sufficient to explain the role and function of the citation. For this, the symbolic process at work in citation indexing needs to be analyzed. As noted, it is not a hard and fast rule that citations are ISI-made. Anyone can invert references. The problem is in the necessary scale of the process. It only makes sense to produce citations in large quantities. This makes the whole endeavour a complicated one, especially if one wishes to create a bibliographic instrument in science as a whole. So far, this has only been done by ISI in Philadelphia, which explains the central position its databases occupy in the field of scientometrics.

1.7 The citation representation of science

To sum up, the citation is a new sign, different from the reference it builds upon. Its evolution and impact can best be understood if this feature is taken as the point of departure. Moreover, an individual citation does not have much impact. It is the ensemble of indicators that has shaped a novel representational form of science and technology, based on scientific literature.

\[14\] An inventor’s perspective on the production of the citation index can be found in Garfield (1979, chapter 3).
Chapter 5 will analyze how these signs of science have been constructed and have created a new type of representation of science and technology based on scientific literature. As has already been said, scientific literature is not a mirror of the research process. One can read Science or Nature to acquire knowledge about natural or social phenomena. They and more specialized journals can also be used to gauge the current situation in, for example, the sociology of violence or solid state physics. Researchers commonly read in both ways at the same time. The scientific literature is able to perform this double function because by representing the natural world (in the natural sciences), the social world (in the social sciences) or another world (in the humanities and engineering sciences), it immediately also represents scientific research.

To put it in more general terms, the literature is a heavily stylized representation of science and technology, focusing on cognitive claims and recontextualizing these (Knorr-Cetina 1981). Science’s substantive claims and results are the core around which the literature is organized. The scientometric indicators mentioned above are rooted in literature. They capture various relationships between publications. But, and this is a crucial point, they ignore their content. The scientometric representation of scientific literature is built on its formal properties. The ensemble of indicators generate a re-representation of science and technology which expressly ignores the cognitive dimensions involved. As a result, two very different representations have come into existence. This study explores the interactions between these two representational forms of scientific and technological research in science policy and science studies.

The act of representing is not just an intellectual but always also a political intervention (Haraway 1991, Hacking 1983, Rouse 1987, Hagendijk 1996, Sassower 1995). Scientometricians play at politics by creating a specific image of the sciences they analyze. This study is made political by representing scientometrics as being one of the principal embodiments of the new citation culture. The question is not whether the scientometric representation is a “correct” or a “false” one, but how it differs from the representational format based on science’s substantive claims and results. This difference creates new options for science policy. Chapter 6 traces the early introduction of the scientometric representation via science and technology indicators in Dutch science policy. This chapter tries to sketch the emergence of a policy market for science and technology indicators by looking in detail at the introduction of these indicators into science policy in the Netherlands. Science policy is commonly analyzed in terms of conflicting and converging interests. I hope to show in the concluding chapter (chapter 8) that science policy can perhaps more fruitfully be analyzed as an intricate interplay between various science representations. Using this perspective, the citation culture can also be located more precisely: at the interface between science and politics. The citation culture is a hybrid; it is both political and scientific. Citation indicators and scientometrics may deal mostly with rather dry technical, instrumental and methodological issues, nevertheless they have created an irreversible transformation in the politics of science.

15This chapter is contrary to the preceding two not historical in character but is a conceptual deconstruction of the most important indicators.
CHAPTER 1. INTRODUCTION

Although the profession of scientometrician is a highly political one, science policy was not the first domain to encounter the new sign citation. Sociologists of science, like Robert Merton and Derek Price, recognized the potential of the SCI long before most science policy officials had even heard of it. Chapter 4 will analyze the interaction between the emerging citation culture, the “science of science”, and the sociology of science. It is certainly not meant to be an attempt to write the history of the science of science. The chapter merely looks in somewhat more detail than present histories of the sociology of science have done, at the way the SCI has affected the emerging science studies. The new index seemed to be significant for sociology in two respects. First, it was a rich source of new data for the sociological study of science. Second, it promised to make an old dream come true: the application of “the scientific method” to science itself, an idea central to the science of science. This approach entailed the idea of rationally analyzing and managing scientific research to increase the interaction between science and society (Bernal 1939). The invention of the citation index with its “objective” data seemed to enable a more objective analysis of science than was previously feasible. The scientific method could finally be applied to science itself! Since science was conceived as a more objective form of knowledge than history for example, the seductiveness of this prospect to people like Derek Price can hardly be overstated. They embarked enthusiastically on the SCI. This led to the merging of the older tradition of the science of science with the citation culture, the result being scientometrics. In other words, chapter 4 tells the story of the birth of scientometrics as a distinctive scientific specialty.

Scientometrics appears to be a hybrid specialty of social science. It is located at the interface of science proper and science policy. It produces indicators as policy instruments. In other words, scientometrics is one of the regulatory sciences (Jasanoff 1990). What these specialties have in common is that their development is strongly shaped by the regulatory process. Moreover, scientometrics is aimed at regulating science itself, at least partly. It is therefore a reflexive regulatory science. Building upon the analysis in chapter 4 and chapter 6, chapter 7 tries to profit from this reflexive capacity by applying scientometrics to itself in order to understand the socio-cognitive evolution of scientometrics.

1.8 Representing scientometrics

This study hopes to provide an informative account of the citation culture. I realize that this analysis differs from the usual perspectives on citations entertained by scientometricians, science policy officials, sociologists of science, or researchers in general. Scientometricians feel they are measuring science, either as “scientists of science” or as sociologists. For science policy people, scientometrics is just one of many sources of policy instruments. Scholars in science studies tend to view scientometrics merely as a method without theory. Lastly, scientists tend to be divided into two groups: opponents and supporters. This is also true of researchers in the social sciences and the humanities. Adversaries raise all sorts of arguments against measuring science in general (e.g. the unmeasurable creative
nature of scientific discovery) and citation analysis in particular (e.g. the lack of meaning of the citation). The proponents of citation analysis tend to see the scientometric scrutiny of the scientific process as a means of improving the quality of research, notwithstanding its limitations.

This account of the citation culture cuts across these divides. I present this representation as a stand-in for the usual image of scientometrics. This study will try to show that the citation culture as a hypothetical construct can explain the dynamics of measuring science more elegantly than either of the aforementioned more usual accounts. This does not invalidate the stories of these actors. I hope that scientometricians and science students will recognize part of themselves. At the same time, all competing analyses of scientometrics mentioned earlier are somehow actors’ accounts. This may give the impression that my account is somehow more encompassing than theirs. After all, their stories are part of mine whereas my story is not included in theirs. I am the analyst, they are the actors. My arguments may therefore seem more powerful. In short, I could present my analysis as a birds-eye view of scientometrics whereas the actors are inevitably myopic.

Unfortunately, I cannot in all honesty present my case this way. As the author of this study I cannot escape also being an actor in the field I am studying. By analyzing scientometrics I belong to the specialty of science studies. This is just one of many studies in the field of science studies. I cannot claim any special privilege for my analysis compared with those of my colleagues. This is also true of my colleagues’ accounts of scientometrics. But these are the very competitors mentioned earlier! Thus, my analysis does not have any privileged position vis-à-vis theirs. This is not all, however. Scientometrics is also part of science studies. Scientometrics, like science studies in general, is capable of analyzing science. It can also, again like science studies, analyze itself. Such an analysis is included in chapter 7. This study is therefore both scientometric and non-scientometric. Thus, I am not only an actor in science studies in general, but also in scientometrics in particular. To be more precise: I am an actor precisely because I am an analyst. Apparently, the usual distinction between actor and analyst breaks down. This is the very issue around which the discussion about reflexivity revolves in science studies, an issue that will again be touched upon in chapter 8.

As has already been said, this representation of scientometrics is inevitably also a political intervention. I do not side with or fight against the citation culture. This study is not a polemic but an analysis. This does not mean, however, that I would be a neutral intermediary or a reconciliator. I do not strive for consensus in these matters. The most I can hope for is that this study will give a new perspective which can be used as a resource by whoever wishes so. Science studies are politically relevant since they deconstruct a powerful source of knowledge and a source of power. How to deal with this political dimension in our analyses remains a matter of contention. All possible positions on the spectrum between a strict separation of science and politics (Collins 1991) and explicitly siding with one party (Scott, Richards & Martin 1990) have been defended. Hagendijk (1996) has pointed to the reflexive nature of this debate: the fact that methodological

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16This may often be the case in contemporary history.
neutrality has political consequences (and is therefore not neutral) does not mean that siding with one party in a controversy is less problematic. The analysis of the citation culture you are about to read, deals with these issues by incorporating the controversy over measuring science for policy (mostly by citation) in the analysis itself. This entails a translation of political questions into analytical ones, which is itself a political act (Sassower 1995). As a consequence, old political choices may be seen in a new light. Whether — and if so how — the new analytical questions should in their turn be translated into political matters is up to you as the reader of this study.