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**WHO IS THE "PLATZ-HIRSCH" OF THE
GERMAN ECONOMICS PROFESSION?
A CITATION ANALYSIS**

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Abstract:

In this paper, we investigate the informational content of citation-based research evaluations. To illustrate our analysis we refer to the 2005 Handelsblatt ranking of German academic economists. We make extensive use of the recently developed Hirsch-index and relate citation incidence to publication success, career age, and the topicality of the individual researchers' field of specialization. We arrive at the conclusion that citation-based indicators provide a very incomplete picture of research performance. To obtain acceptable bibliometric research evaluations, citation based indicators need to be complemented with indicators that measure publication success more directly.

JEL Classification : A11, A14, J24, J41, M 51

Keywords : research productivity, performance evaluation, rankings

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November 7, 2006

Abstract

In this paper, we investigate the informational content of citation-based research evaluations. To illustrate our analysis we refer to the 2005 *Handelsblatt* ranking of German academic economists. We make extensive use of the recently developed Hirsch-index and relate citation incidence to publication success, career age, and the topicality of the individual researchers' field of specialization. We arrive at the conclusion that citation-based indicators provide a very incomplete picture of research performance. To obtain acceptable bibliometric research evaluations, citation based indicators need to be complemented with indicators that measure publication success more directly.

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Who is the “Platz-Hirsch” of the German economics profession? A citation analysis

1. Introduction

“Platzhirsch” is the German term for “alpha animal”. Just as some kinds of animals - for example, wolfs, monkeys, chicken, and stags (“Hirsch” means stag in German) - scientists have always been very much aware of their rank vis-à-vis their peers. Traditionally, information about the pecking order among scientists used to be confined to the scientific community. Only a few superstars, such as Nobel laureates, have received acclaim in the mass media and have thus become known in the general public. Recently, however, the mass media have discovered academia as a newsworthy domain of society. Not only have research rankings of university departments begun appearing on a regular basis in newspapers and popular magazines, but so have rankings of individual scientists.

Evaluations of research prowess that are divulged in the mass media are usually based on simple bibliometric indicators that either count publications or citations. Our study has been provoked by a recently published lead article that appeared in the *Handelsblatt* (11.5.2005), the oldest German newspaper catering for the business community. In this *Handelsblatt* article, the attempt was made to identify and rank the best German economists with the help of citation counts. The first objective of our paper is to replicate the “HB research ranking” and to check its robustness with regard to reasonable variations in the considered set of citations.

In order to delineate the set of citations, any bibliometric study needs to define i) the “citing publications” in which the counted citations are to be identified, ii) the “counting period” which specifies the publication dates of the considered citing publications, iii) the “source publications” which are deemed to represent admissible citable scientific work, and iv) the “publication period” which specifies the publication

dates of the considered source publications. In the HB ranking the citing publications are the journal articles indexed by the Social Science Citation Index (SSCI), the citation period ranges from 1994 to 2004, the source publications are also limited to SSCI-indexed journal articles, and the publication period corresponds to the citation period 1994-2004. While we understand why the SSCI-indexed journal articles represent the set of citing publications and why the counting period was chosen to begin in 1994,¹ we fail to appreciate the rationale for restricting the set of source publications. Important research can be published in many kinds of outlets including monographs and non-SSCI journals, both of which are not included in the set of source publications employed by the HB-ranking. In fact, we believe that it is a greater achievement to be cited in an SSCI journal if the cited piece of research has not been published in such a journal. Take, for example, Reinhard Selten's Nobel Prize winning work which was published in 1965 in the *Zeitschrift für die gesamte Staatswissenschaft*. Selten's paper is one of the most famous and most frequently cited pieces of economic research written by a German economist, but nevertheless it did not make it into the HB ranking because it was published in the wrong journal, in the wrong year, and, one might add, in the wrong language.²

From a more technical perspective, our second main objective is to scrutinize the *methodology* used by the HB ranking (which is representative for many other research rankings) and to elaborate on the informational content of citation analyses in general. In doing so, we make extensive use of the recently developed Hirsch-index (cf. Hirsch, 2005). The Hirsch-index that gave rise to the pun in the title of this paper is claimed to represent a convenient citation-based measure to quantify an individual's research output.

We base our analysis on a data set which we constructed ourselves. In our attempt to replicate the HB ranking we recounted the citations in the SSCI journals and cross-

¹ These restrictions basically reflect the availability of the respective data in electronic form.

² This comment would also apply, for example, to Maurice Allais' Nobel prize winning work.

checked, if necessary, our results with the CVs of the cited economists. We took great care to identify the number of co-authors of the source publications, and also to eliminate self-citations and self-citations by co-authors. Since the counting procedure turned out to be extremely cumbersome, we restricted our attention to those 25 economists who were included in the top-25 list published by the *Handelsblatt*, adding only two well-known economists in order to check for the quality of the selection process adopted by the *Handelsblatt*. This leaves us with our “HB+2 sample” of 27 German economists.

The paper unfolds as follows. In Section 2 we make an attempt at replicating the HB-ranking and submit the original ranking to the sensitivity analysis outlined above. We also investigate to what extent the (career) age of the evaluated economists influences the ranking. In Section 3, we move from mere *citation counts* to indicators that are based on the *distribution of citations* across the individual economists’ publications. We first report some well known “power laws” of citation behavior and illustrate these laws with the help of our HB+2 sample of economists. Afterwards we introduce a simple indicator of research performance that is based on the *distribution of citations*, namely the Hirsch-index, and present the ranking of our select group of German economists according to this novel index. In a last step, we characterize our sample economists’ research behavior by exploiting those key properties of their idiosyncratic citation distributions which also underlie the Hirsch-index. In order to evaluate citation based indicators of research performance, we investigate the determinants of these indicators in Section 4. To be more precise, we identify the determinants of the number of citations and of the Hirsch-index of individual researchers. We arrive at the conclusion that citation success depends on publication performance, career age, and the academic topicality of the individual researchers’ field of specialization. Especially the fact that researchers who are working on “hot” subjects appear to perform better than researchers who are working on less

popular topics, leads us to conclude in the final Section 5 that the value of simple citation-based indicators may be rather limited.

2. Replication and extension of the *Handelsblatt* research ranking

2.1 Replication

The *Handelsblatt* commissioned *Thomson Scientific* to rank “German” top economists according to their respective research performance. The description of the employed bibliometric method provided in the *Handelsblatt* is, unfortunately, somewhat ambiguous. Whereas it is clear that *Thomson Scientific* restricted both the counting and publication period to the period 1994-2004, it is less clear which data base was used. The instructions given to the selected 25 economists (who were all given the opportunity to check the preliminary results and were explicitly told to restrict the source publications to journal articles indexed in the SSCI) do not square with the *Handelsblatt* statement stipulating that the citing publications encompass *all* journals indexed by *Thomson Scientific*. Personal inquiries confirmed however our presumption that only journal articles indexed in the SSCI were used (or, rather, intended to be used) as citing *and* source publications.³

In our attempt to replicate the HB research ranking of German economists we collected the requisite material from the SSCI for the original HB group and for two more economists, Martin Hellwig and Axel Börsch-Supan, who enjoy a reputation compatible with the research standing of the members of the original HB group among German economists. Since the selection process of the 25 original top-researchers is not beyond question, the inclusion of two more prominent economists serves as a convenient instrument of quality control.

³ We refer in this paragraph to personal Email communications with Nancy Bayers from *Thomson Scientific*.

The HB results and the results of our “replication” are presented in columns A and B of Table 1 in the Appendix. Comparing the two sets of results, two differences stand out. First, the number of citations that we established for the HB sample of economists are, apart from two exceptions, smaller than the numbers reported by the *Handelsblatt*, and, second, some of these differences are excessively large. Smaller differences may be due to the fact that we took great care to exclude not only self-citations but also self-citations by co-authors, whereas *Thomson Scientific* only made an attempt at excluding self-citations by the German authors. The larger differences, however, must be attributed to the way *Thomson Scientific* collected the data. Given the enormous effort it took us to arrive at a clean data set, we speculate that a significant part of the discrepancy between the two sets of results must be attributed to the fact that, as a rule, the quality of commercially compiled bibliometric data sets falls short of the expectations of the scientific community. Notice, finally, that the two economists not included in the original HB group do not invalidate the HB-ranking if one accepts the specifications of the original citation count.

2.2 Extensions

The sample of journals indexed in the SSCI is relatively small and the admission requirements applied by *Thomson Scientific* do not reflect bibliometric concerns.⁴ We have therefore extended the set of *source* publications to include *all* kinds of publications, i.e. SSCI-journal articles, other journal articles, monographs, etc. In a first step we continued to adhere to the publication period 1994-2004. In a second step, we put no restrictions whatsoever on the publication period, i.e. we included all publications

⁴ The SSCI indexes only 199 journals in the category Economics, whereas EconLit indexes 986. Moreover, it is not the case, as is sometimes asserted, that the journals indexed in the SSCI constitute the top journals in terms of quality. It is true that most top journals are indexed in the SSCI, but not all SSCI journals are top journals. This heterogeneity in journal quality calls for special provisions if the SSCI is used for bibliometric studies.

authored or coauthored by our sample economists up to the year 2004. Notice, however, that we adhere to the set of citing publications and to the counting period underlying the HB ranking. There is thus no difference across the columns of Table 1 with regard to the set of journals screened for citations. The results are presented in columns C and E of Table 1. In order to capture the individual authors' effective contributions to the cited publications, we also provide (as is common practice in the bibliometric literature) in columns D and F the respective results in terms of citations per co-author.

Extending the set of source publications in the time dimension implies that older researchers will, *ceteris paribus*, garner more citations than their younger peers. In order to correct for this career-age effect, we also computed citations per career year (see columns G and H).⁵ To be sure, by focusing on the absolute number of citations per career year we now bias the result to the disadvantage of the older researchers simply because the overall volume of citations per author has steadily increased over historic time.

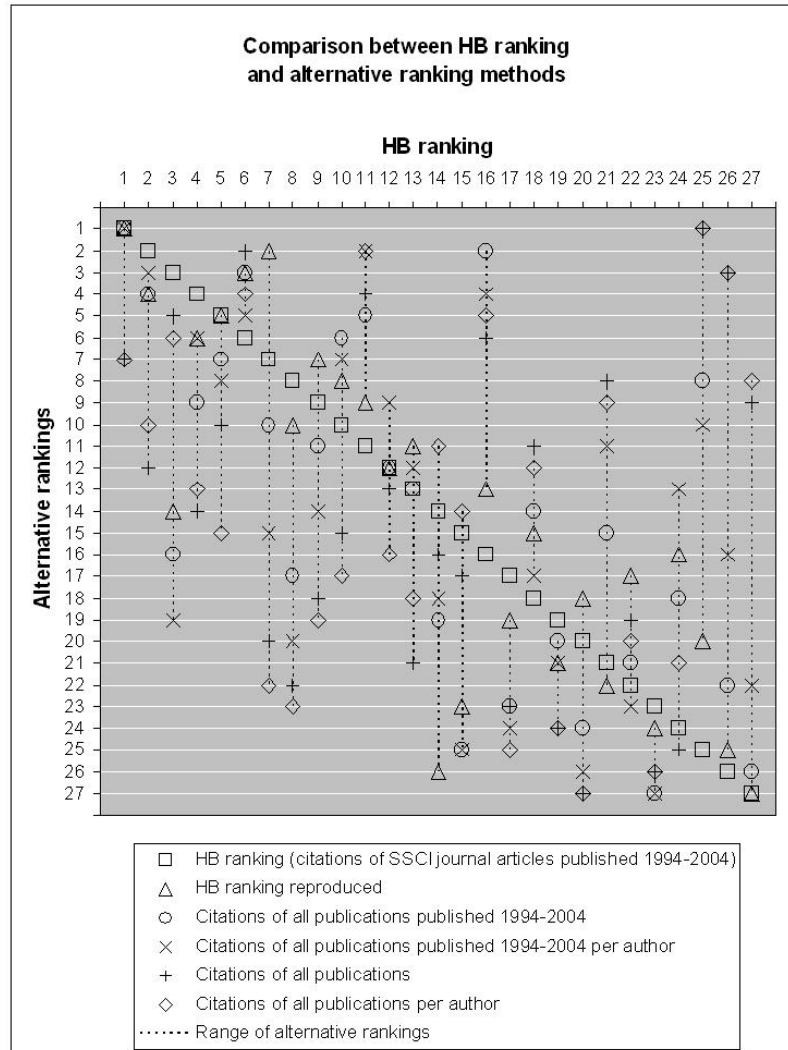
Figure 1 summarizes the citation counts presented in Table 1 by depicting the respective individual rankings of our 27 sample economists. The main conclusion that can be drawn is the following: rankings of individual researchers based on mere citation counts are very sensitive to changes in the counting method.⁶ This statement becomes evident if one adopts, for example, the view taken in sporting events, i.e. by restricting one's attention to the top-three (podium) places. Together, the six counting methods illustrated in Figure 1 (or, for that matter, in columns A-F in Table 1) yield nine different top-three researchers, i.e. every third researcher can be dragged on the podium, depending on which method is used. Even if the dubious *Handelsblatt* method of merely

⁵ In accordance with the relevant literature, we assume that an academic career begins in the year in which a scientist obtains his or her doctoral degree.

⁶ We admit that in the *Handelsblatt* article it is pointed out quite clearly that the exact ranking of the individual economists depends very much on the employed method.

counting “SSCI inbred” citations is disregarded, none of the four remaining methods yields the same three podium places.

Figure 1



Looking at the *range* of individual rankings instead of *top-three places* is not more comforting. Even economists who were assigned bottom places by the HB-ranking, can make an appearance at the very top if the counting method is slightly changed. Take, for example, the Nobel laureate Reinhard Selten. The HB ranking placed him at the bottom and also our replication ranking assigns him only rank 19. Extending the set of

source publications promotes him already to rank 8, whereas extending the time period makes him the unchallenged top dog (or Platzhirsch) in our sample. This leading position, by the way, is not due to the fact that his challengers are significantly younger; he continues to lead the pack if one corrects for career-age effects (see columns G and H in Table 1). Moreover our two additions to the original HB sample do very well indeed if one adopts some alternative counting method. Martin Hellwig makes the podium and Axel Börsch-Supan, who appears to make a poor showing according to the original HB method, can easily be assigned a top-ten place in the German economics profession if all publications are included.

To be sure, all of the indicators considered up to now are mere citation *counts*, implying that the ranking of some researcher might be completely dominated by a single highly cited publication. If one believes that a research indicator should take a larger part of the evaluated oeuvres into account, one needs to consider the *distribution* of citations over some non-trivial sub-set of publications. This we will do in the next section.

3. Distributions of citations and the Hirsch-index

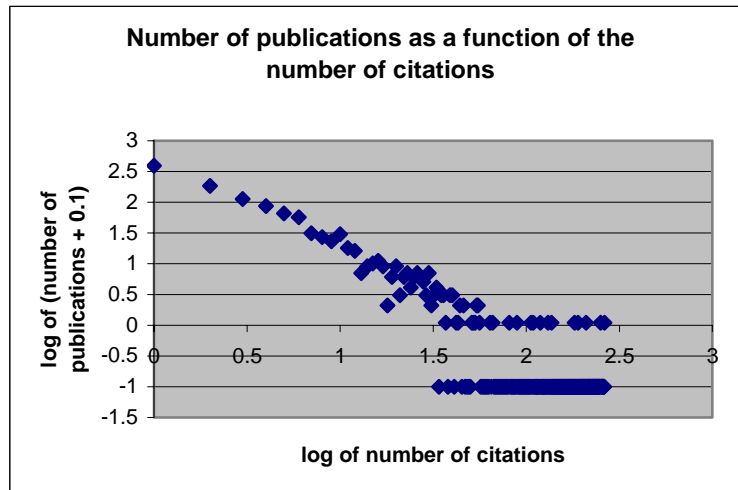
3.1. Power laws of citation

According to van Raan (2006), the “most basic distribution function” of bibliometric indicators relates the number of publications to the number of citations referring to these publications. It is well known that the function $P(C)$, where P denotes the number of publications and C the number of citations, follows (at least in the range of C that is representative for most publications) a *power law* of the form $P(C) = \alpha C^{-\beta}$.⁷ Figure 2 illustrates the logarithmic version ($\log P = \log \alpha - \beta \log C$) of the relationship $P(C)$ for the publications of all 27 economists in our HB+2 sample. As can be seen from this figure,

⁷ See van Raan (2006) for references to the respective literature.

392 publications authored or co-authored by our sample economists have been cited only once [$\log(392.1)=2.6$], 185 publications have been cited twice [$\log(185.1)=2.3$], and so on in a fairly decreasing order; only individual publications [$\log(1+0.1)\approx 0$] have been cited more than 60 times [$\log 60 = 1.8$].

Figure 2



The plot closely resembles the distributions identified by van Raan (2005) for Dutch research groups in chemistry and the medical sciences.⁸ The plot depicted in Figure 2 reveals that the power law explains the relationship $P(C)$ quite well in our sample - at least for the papers that are cited up to about 50 times ($\log 50 \approx 1.7$). This corresponds to about 78% of all citations and about 92% of all publications. The close fit of the power law also transpires from an OLS regression based on the logarithmic version of $P(C)$. In order to avoid the $\log(0)$ problem, we only include papers cited less than 34 times ($\log 33 = 1.52$) in our regression to arrive at the estimate $\log P = 6.29 - 1.47 \log C$ which explains 91% of the variance of P .

A second important power law governs the number of citations per publication if the publications y are ordered according to citation success, i.e. in a descending order

⁸ We use all citations reported between 1994 and 2004, whereas van Raan (2005) restricts his analysis to citations appearing in a time window of three years.

beginning with the most cited paper $y=1$. Taking again all publications authored or co-authored by the economists in our HB+2 sample, we arrive at Figure 3 which shows that the most highly cited publication received 264 citations ($\log 264=2.42$), whereas the publications ranked at place 100 in terms of citation success received only 20 citations ($\log 20=1.3$), etc.

Figure 3

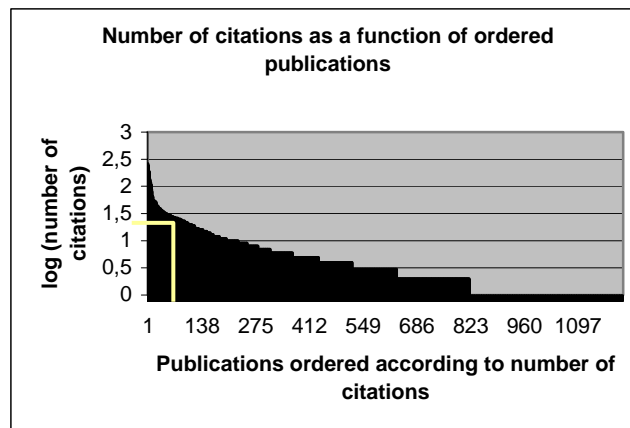
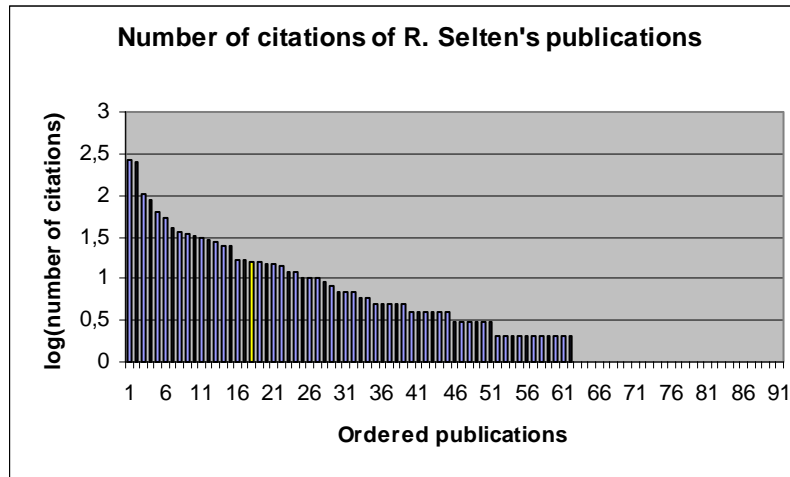


Figure 3 conveys the impression that the relationship $C(y)$, i.e. the number of citations C received by publication y , can be described by the power function $C = \alpha y^{-\beta}$. To corroborate this conjecture, we again take logs and use OLS to estimate the regression equation $\log(C) = \log \alpha - \beta \log(y) + \varepsilon$. The estimate based on the full sample of 1211 publications [$\log(C) = 8.05 - 1.12 \log(y)$] explains 93% of the variance of $\log(C)$, whereas the estimate based on the sub-sample of those 231 publications that received at least 10 citations [$\log(C) = 6.12 - 0.69 \log(y)$] explains 98% of the variance. Notice that the most highly cited publications escape the power law as can be seen from the kink (at around $y=30$) in the distribution depicted in Figure 3.

This power law remains valid if one moves from a *group* of researchers to the level of *individual* researchers. Figure 4 shows the respective line-up of the arguably most prominent German economist, the Nobel laureate Reinhard Selten. Using OLS to

estimate the equation $\log(C_i) = \log \alpha_i - \beta_i \log(y_i) + \varepsilon_i$ for $i = \text{Selten}$, we arrive at $\log(C_{\text{Selten}}) = 6.90 - 1.53 \log(y_{\text{Selten}})$.

Figure 4

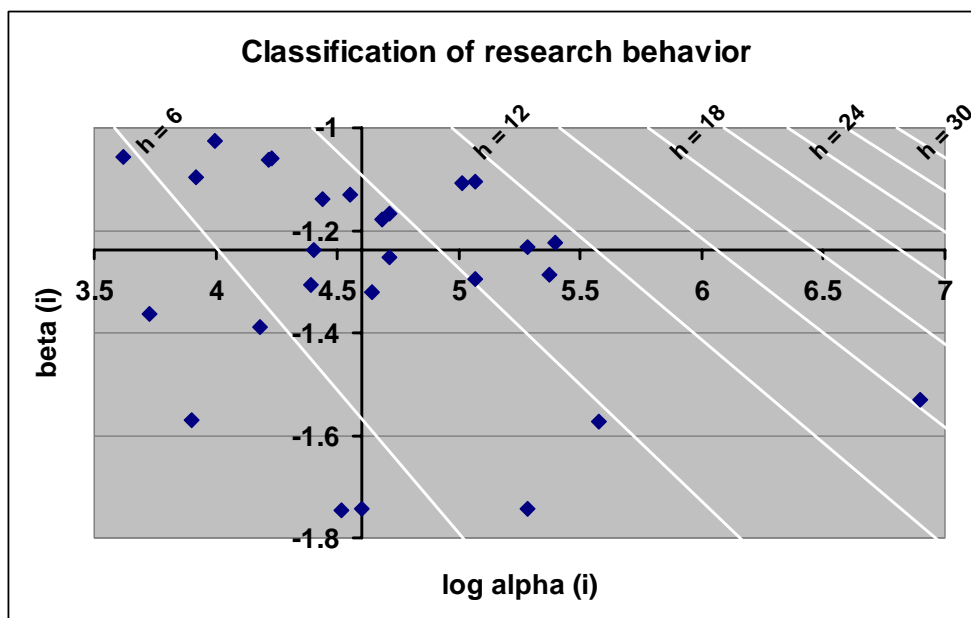


The estimates of $\log(\alpha_i)$ and β_i for all 27 economist included in our HB+2 sample are summarized in Figure 5, the point $(\log \alpha_i, \beta_i) = (6.90, -1.53)$ close to the right-hand edge of the figure representing, for example, Reinhard Selten's estimated citation line-up. The adjusted R-squared statistics range from 88% to 98%, with the mean R^2 amounting to 93%.

Figure 5, which places the axes at the respective median values, gives rise to a straight forward classification of the 27 analyzed economists. Those economists whose citation profile resembles Selten's profile make an appearance in the south-western quadrant. Since the large value of α indicates a high citation incidence of their best-received work, these economists certainly work on *hot topics*. The relatively low value of β , on the other hand, indicates that their lesser work has received relatively little peer recognition, which characterizes them as *sprinters*. The economists located in the north-eastern quadrant, accordingly, are working on more *pedestrian subjects*, but can be characterized as *long distance runners*. The highest peer recognition is, of course, enjoyed by researchers working on hot topics with the stamina of long distance runners.

If this specie existed in pure bred, its representatives would turn up in the upper right hand corner of Figure 5 which is, however, empty. Quite widespread, on the other hand, is the genus of researchers who get out of breath, even on the beaten track. It goes without saying that they are not represented in our exclusive sample - the lower left hand corner in Figure 5 is accordingly empty, too. The white lines represent iso-h-curves for Hirsch-values h ranging from 6 on the left hand side to 30 in the top right corner.

Figure 5



3.2. The Hirsch-index

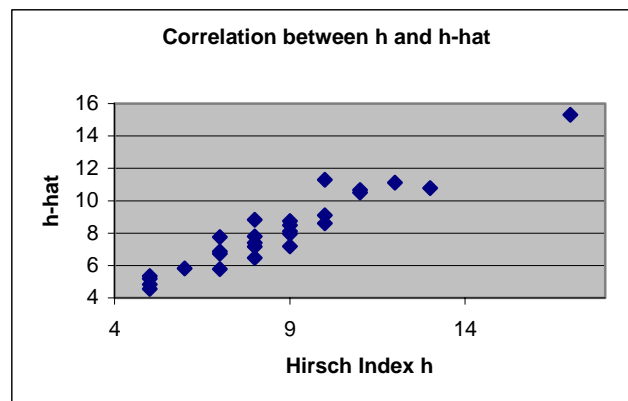
The physicist J.E. Hirsch recently developed a new index to quantify an individual scientist's research performance. Hirsch's index h is based on the *distributional properties* of the evaluated scientist's citation line-up and is defined as follows:

A scientist has index h if h of his or her n papers have at least h citations each, and the other $n-h$ papers have no more than h citations. (Hirsch, 2005)

Our data set shows, for example, that Reinhard Selten has index 17, i.e. each of his 17 most highly cited publications has been cited at least 17 times, and his next highly cited publication has received less than 17 citations.

The Hirsch-index h is closely related to the power law of individual citation success. Since, according to the power law $\hat{Z}_i = \hat{a}_i - \hat{\beta}_i \log(y_i)$, where $Z = \log(C)$, $a = \log(a)$, and a variable with a hat denotes an estimated value, an estimate of the Hirsch-index is obtained by setting $\log C = \log y = \log h$ which yields $\hat{h} = \exp(\hat{a}/(1 + \hat{\beta}))$. Taking, for example, $\hat{a}_{Selten} = 6.90$ and $\hat{\beta}_{Selten} = 1.53$ yields $\hat{h}_{Selten} = 15.3$ which falls somewhat short of the actual value $h = 17$. Nevertheless, Figure 6 shows that the power law of individual citation success is rather accurate: the estimated values of the Hirsch-index correlate quite closely with the actual h values, at least in our HB+2 sample.

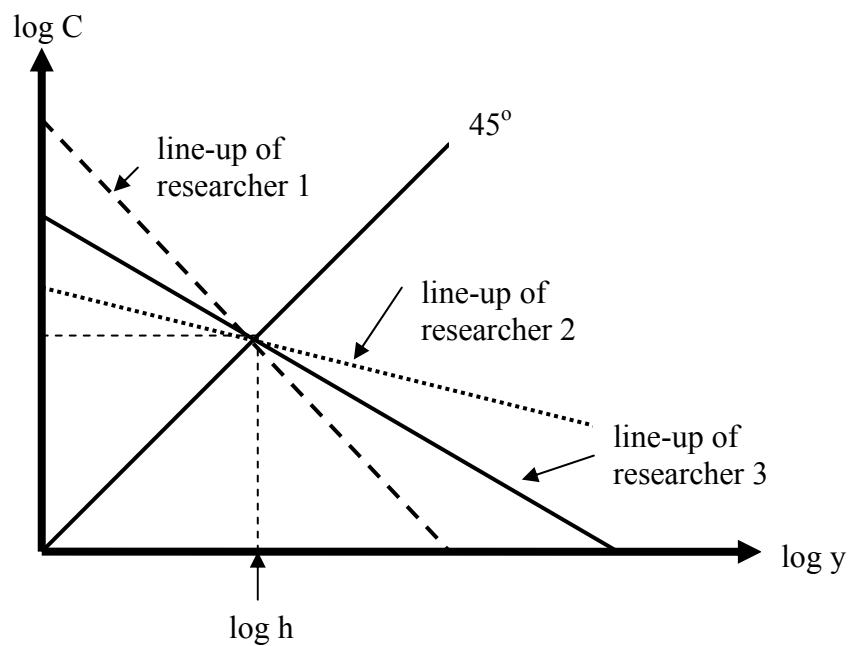
Figure 6



The power law of individual citation success also neatly illustrates the basic idea behind the Hirsch-index. Figure 7 depicts the citation line-ups of three archetypal researchers (if the power law perfectly describes the actual distribution of citations, the citation line-ups can be represented by straight lines in a double-logarithmic diagram). The value of the h -

index is determined by the intersection of the researchers' respective citation line-ups and the 45°-degree line. Even though the three distributions of citations as illustrated by the citation line-ups are quite different – researcher 1 being in our terminology a sprinter working on hot topics and researcher 2 a long distance runner working on more pedestrian subjects – all three researchers have the same h-index.

Figure 7



The ranking of the 27 members of our HB+2 sample of German economists according to the Hirsch-index is to be found in column I of Table 1. Since, quite generally, the value h divided by the career age should provide a useful yardstick to compare scientists of different seniority (see Hirsch 2005, p.2), we also present a ranking according to this criterion in the last column of Table 1.

4. Citations and publications

4.1 Comparing the Hirsch-index with traditional indicators of research output

In order to demonstrate the advantages of his novel indicator, Hirsch (2005) compares the h-index with five indicators commonly used in the bibliometric literature.

The first indicator mentioned by Hirsch is a scientist's *total number of publications*. This indicator - which is, for example, used by the semi-official German *Centrum für Hochschulentwicklung* (CHE) - has the severe drawback that it neglects quality, importance and impact of the recorded publications if the set of admissible publications is not severely restricted.⁹ The second indicator is the one used in the HB-ranking: the *number of citations*. This indicator is, as we have shown, hard to establish if one insists on adequate accuracy, may be inflated by a small number of big hits, and gives undue weight to review articles. Computing the ratio of the first two indicators yields the indicator *citations per publication*. Unlike the first two indicators, the *citations per publication* indicator is not contaminated with a career-age bias; it may, however, reward low productivity and penalize high productivity. This is so because a researcher who has published only a few well-cited publications does much better according to this indicator than another researcher who can boast the same number of well-cited publications but, in addition, has also published a series of papers that have drawn less peer attention. Using the *citations per publication* indicator in a simple-minded manner generates perverse incentives and may give rise to absurd rankings. An example of such a misguided attempt to use this indicator can be found in the 2005 *FOCUS* ranking of German university departments.^{10,11} A superior indicator – because it is unlikely to provide undesirable

⁹ For a critique of the CHE research ranking in economics, see Ursprung (2003).

¹⁰ FOCUS is a German weekly magazine comparable to NEWSWEEK or TIME. The results of the ranking are available on-line: <http://focus.msn.de/wissen/campus/unilisten>.

¹¹ The citation indicator that entered the *FOCUS* ranking considered only journal articles indexed in the SSCI. Departments with very few but highly cited SSCI journal articles outranked departments that produced a large number of (well received) SSCI-articles that were

incentives - is the *number of significant publications*, defined as the number of publications with more than x citations, where the *arbitrary* number x needs, of course, to be adjusted for different levels of seniority. The last criterion mentioned by Hirsch is the *number of citations to each of the y most cited publication*. The disadvantage of this criterion is that it is not a single number and the choice of y is again arbitrary.

We agree with Hirsch that his h-index avoids many of the disadvantages of the indicators presented above: h is relatively easy to compute, robust with respect to measurement errors, reflects to some extent quality, does not give undue weight to big hits, and rewards high productivity. Moreover, it is based on an endogenous number of considered publications and citations, and is thus suited to compare scientists even if their total number of papers and citations is very different.

The “standard” bibliometric indicators listed by Hirsch do, however, not represent the most potent competitors of his h-index. The superiority of the Hirsch-index can only be established by comparing it with the most advanced bibliometric indicators. Van Raan (2005), for example, compares the Hirsch-index with his so-called “crown index”, which is the average number of citations per publication divided by an appropriate field-based worldwide average. The crown index thus takes into account that citation incidence may be field specific. Van Raan arrives at the conclusion that the h-index and his crown index are both in line with peer evaluations; for fields (such as economics) characterized by a low citation incidence, the crown indicator does, however, appear to more closely reflect peer evaluations than the Hirsch-index.

Another class of indicators worth comparing with the Hirsch-index are measures of quality-weighted publication output. This kind of indicator is well established in the field of economics (see, for example, the special issue No. 6 of the JEEA, 2003) and has

(unsurprisingly) not all of them highly cited. Using citations per article thus does not represent an escape from measuring department size.

been used to chart the research landscape of the German economics profession (see Rauber and Ursprung 2006 a and b). We, therefore, now turn to relate the Hirsch-index to a standard measure of quality-weighted publication output.

4.2 The relationship between citations and publications

The body of literature that attempts to identify the determinants of citation success is surprisingly small. Prominent studies on the citation behaviour of economists are Laband (1986 and 1990), Johnson (1997), Laband and Tollison (2000) and Medoff (2003). All of these studies select a sample of articles and regress the number of times each article was cited within a certain time window on a set of explanatory variables which always includes some measure of author reputation, the length of the article and (in four of the five studies) either a measure of the quality of the journal in which the article was published or a set of journal dummy variables. Depending on the focus of the respective study, further explanatory variables are included: referee quality and a dummy variable for lead articles in Laband (1990); self-citations, the author's career age, the article's degree of specialization and the number of co-authors in Johnson (1997), who also tests for and finds evidence of discrimination against female economists;¹² the co-author variable in even more detail in Medoff (2003); and the acknowledgement and reference profile of the investigated articles in Laband and Tollison (2000). The focus of our investigation is somewhat different since we want to relate citation-based indices of individual research performance to a standard measure of these researchers' quality-weighted publication output. Our observations are, therefore, not single articles but entire research oeuvres. Only in subsection 4.3, where we analyze the influence of the field of

¹² Interestingly, Ayres and Vars (2000) do not find any evidence of discrimination against female researchers in law journals (on the contrary, female and minority authors appear to be cited more often in law). Medoff (2003) does not find any in the economics profession either.

specialization on an economist's citation success, do we have to come back to the level of individual articles.

In our regression analyses of citation success, we measure the economists' published oeuvres with the help of the "CLpn" scheme developed by Combes and Linnemer (2003), which converts each journal publication k indexed in EconLit into standardized units of AER-page equivalents.¹³ Apart from the number of pages p , the conversion takes journal quality w and the number n of co-authors into account.¹⁴ Publication output of economist i is thus defined as

$$OUT_i(T) = \sum_k \frac{P_{k(i)} W_{k(i)}}{n_{k(i)}},$$

where the summation includes all publications authored or co-authored by economist i up to time T . This measure of publication output can conveniently be split up into a quantity and a quality component:

$$QUANT_i(T) = \sum_k \frac{P_{k(i)}}{n_{k(i)}} \quad \text{and} \quad QUAL_i(T) = \frac{OUT_i(T)}{QUANT_i(T)}.$$

We conjecture that OUT as well as its components $QUANT$ and $QUAL$ have a positive impact on research success as measured by citation-based indicators. Since younger economists will, *ceteris paribus*, receive fewer citations than their older peers simply because their work has been exposed to the academic community for a shorter time, we include the standard indicator of career age, namely the number of years since the researcher has been granted his or her doctoral degree, in our regression.

We begin our analysis by regressing the Hirsch-indices h associated with our 27 HB+2 economists (see column I, Table 1) on their respective oeuvres at the end of 2004

¹³ We did not, however, take into account that the number of words per page differs across journals.

¹⁴ The quality weight of the five top-tiered journals is normalized to unity. The sixteen second-tiered journals' imputed weight amounts to two thirds. Weights then decline in discrete steps (one half, one third, one sixth) down to the minimum weight of one twelfth.

as measured by our variable *OUT*. The result (see Table 2, column 1) indicates that the size of the oeuvre has a significant influence on citation success as measured by the Hirsch-index. Since we employed a count data regression based on a Poisson distribution, the estimated coefficient of 0.002 represents a semi-elasticity, i.e. an increase of an economist's oeuvre by 100 AER-equivalent pages increases his Hirsch-index by 20%, or alternatively, an increase of *h* from the sample median of 8 by one point can be attained by increasing the oeuvre by 62.5 AER-equivalent pages. The regression in the second column of Table 2 shows that publication *quantity* as well as *quality* significantly contributes to citation success. Given the distinct time profile of citations of individual publications one would expect a researcher's Hirsch-index to increase with increasing career age. Including our measure of career age indeed shows that the respective effect is quite pronounced and statistically significant. According to our regression presented in the third column of Table 2, a ten years "advantage" in career age translates, *ceteris paribus*, into a 16% increase in the Hirsch-index.

Table 2

dep. variable	(1) h	(2) h	(3) h	(4) CIT	(5) weighted CIT
Constant	1.82 (20.41)	1.58 (11.63)	1.39 (7.61)	3.84 (10.33)	3.25 (7.87)
OUT	0.0021** (3.83)				
QUANT		0.00082** (5.21)	0.00048* (2.12)	0.00076* (2.00)	0.00084* (2.05)
QUAL		0.53* (2.12)	0.50 ⁺ (1.75)	1.22 ⁺ (1.88)	1.32 ⁺ (1.88)
AGE			0.016* (2.07)	0.049** (4.53)	0.054** (4.29)
<i>adj R</i> ²	36.5%	34.1%	50.5%	73.5%	75.0%
obs.	27	27	27	27	27

estimation method: ML/QML, Huber/White standard errors and covariance, Poisson Count

** significant at 1%, * 5%, + 10%, z-statistics in parenthesis

If the Hirsch-index is replaced by the mere number of citations, the qualitative results do not change: We present the regression explaining total citations in column 4 of Table 2 and, in column 5, the regression explaining the number of citations weighted by the respective number of co-authors. We also estimated all five equations presented in Table 2 with OLS. Since the qualitative results did not change we conclude that the basic message of these results is quite robust.

Nevertheless, we realize of course that our HB+2 sample is too small to yield watertight econometric results. We therefore analyzed two larger samples in an attempt to provide additional supporting evidence. The first sample of economists was taken from the RePEc homepage in February 2006 (Research Papers in Economics: <http://repec.org/>). RePEc publishes bibliometric data on the top 5% authors of their network. These indicators, in particular, include the “Number of Citations, Weighted by Number of Authors” (ANb_Cites), the “Number of Journal Pages, Weighted by Number of Authors and Simple Impact Factor” (ASc_Pages), and the “Number of Journal Pages, Weighted by Number of Authors” (ANb_Pages). Our RePEc sample consists of the 213 authors who are among the top 5% authors according to *all* three indicators. Since ANb_Cites, ASc_Pages, ANb_Pages and ASc-Pages/ANb_Pages closely resemble the variables *CIT*, *OUT*, *QUANT* and *QUAL* that we employed to analyze our HB+2 sample, we again regressed the number of citations, or, alternatively, the Hirsch-index h , on research output and its constituent components. The regression results which are summarized in the first three columns of Table 3 are well in line with our previous findings.

The second sample of economists consists of all 183 economists who worked at a German university in the year 2004 and had, at that time, published at least 10 journal articles indexed in EconLit. For these economists, we computed the Hirsch-index based

on the citation statistics published by *Scholar.Google* in February 2006. Notice that the citations gleaned from *Scholar.Google* are not necessarily citations referring to these economists' *published* work since *Scholar.Google* also includes citations of working papers and monographs.¹⁵ The Hirsch-index based on *Scholar.Google* is, therefore, a more up-to-date indicator than the h index used in the regressions above. Moreover, we would like to stress that Hirsch-index based on *Scholar.Google* is a rather inaccurate measure of citation success because one cannot identify bona fide citations without scrutinizing the source of the citation. We, nevertheless, feel that our indicator may well be meaningful in a sample that is as large as ours.

Table 3

dep. variable	(1) CIT INT	(2) CIT INT	(3) h INT	(4) h GER	(5) h GER	(6) h GER
Constant	5.47 (62.47)	4.53 (20.11)	1.99 (20.20)	1.37 (14.12)	1.69 (15.96)	1.76 (19.51)
AScP (OUT)	0.00020** (6.57)					
ANbP (QUANT)		0.00088** (6.05)	0.00035** (4.30)	0.00119** (8.39)	0.00148** (9.41)	0.00101** (6.74)
AScP/ANbP (QUAL)		0.2072** (5.01)	0.076** (4.21)	1.57** (7.34)	1.53** (7.19)	0.92** (4.50)
AGE					-0.0186** (-5.53)	-0.0149** (-4.96)
CITEMAX dummy						0.266** (7.45)
adj R ²	19.76%	22.76%	13.36%	33.91%	42.69%	57.41%
obs.	208	208	208	183	183	183

INT: international sample, GER: German sample

Estimation method: ML/QML, Huber/White standard errors and covariance, Poisson Count

** significant at 1%, * 5%, z-statistics in parenthesis

The regression results which are presented in columns 4 and 5 of Table 3 at least indicate that this may be so.¹⁶ Only the coefficient of the career age variable does not correspond

¹⁵ In order not to bias our results, we have, however, excluded citations to text books.

¹⁶ Again, we estimated all equations presented in Table 3 with OLS without obtaining qualitatively different results.

to our previous results - and this aberration can easily be explained. Cohort effects become noticeable in the larger sample that is not restricted to top performers but also includes less accomplished and even journeymen researchers.¹⁷

4.3 Enter: the field of specialization

A determinant which is conspicuously absent from most studies of citation behaviour in the economics profession is the field of specialization. After all, it is obvious that the sizes and growth rates - as measured, for example, by the number of articles published - differ a great deal across narrowly defined subject areas in economics, as do, conceivably, the citation habits. Even though one may suspect that size effects play an important role, the direction is not a priori clear: In small fields, there are fewer articles that may refer to one's own work, but on the other hand it is more likely that one is cited because there are not so many competing publications to choose from.

In a first cursory attempt to identify effects that may be traced to the fact that an author works in a hot subject area, we have experimented with a dummy variable which classifies the authors into three groups according to the number of citations garnered by their highest-cited publication.¹⁸ We believe that this variable captures, to some extent, the popularity of the author's field of specialization but is not directly related to the h-index because we transform the original variable into a dummy variable. Moreover, as we have demonstrated above (see, for example Figure 3), the most highly cited articles escape the power law which, in turn, determines the h-index. The estimate of the coefficient of this CITEMAX dummy variable is reported in the last column of Table 3.

¹⁷ It is well known that cohort effects in the research performance of German economists are substantial (see Rauber and Ursprung, 2006 a and b).

¹⁸ For authors whose most highly cited publication is cited less than 50 (between 50 and 100, more than 100) times the dummy variable assumes the value 0 (1, 2). The number of citations of the highest cited publication varies in this sample between 0 and 1048, the median being 35.

The positive value of the estimated coefficient indicates that economists working on hot topics may well profit from a significant field effect.

To corroborate this result we now turn to more sophisticated regressions in which individual articles replace individual authors as observations. This has the decided advantage that the subject area can be identified more directly. As mentioned above, field effects have, up to now, not received a great deal of attention. Only the study by Medoff (2003) includes field variables, namely the one-letter JEL codes of the analyzed articles, but neither reports nor comments on the estimated coefficients. In contrast, Laband and Tollison (2000) include JEL subject codes in their model explaining the probability of co-authorship but not in their model explaining citation success.

We followed a somewhat different strategy in capturing field effects than the previous literature. Since we are primarily interested in detecting effects emanating from the *size* and *growth* of the respective subject areas, and less in identifying the specific fields in which German economists can earn many citations, we did not include field dummies in our regressions but rather measures of the size and growth rate of the respective fields.¹⁹ The *current size of field* variable is defined as the percentage of EconLit-indexed journal articles that share (within a 3-year window around the year of publication) a given 4-digit JEL-code, whereby each article is associated with the largest of the indicated JEL-code fields. The *growth of field* variable measures the rate of growth of the field size from the current to the next 3-year period, whereby each article is associated with the fastest growing of the indicated JEL-code fields. The other explaining variables that we included in our regression are fairly standard: the article's number of authors and the square thereof, the article's number of pages and its time of exposure

¹⁹ A related but reverse approach has been taken by Archibald and Finifter (1990) who estimate multivariate functions explaining the volume of citations generated by entire journals. These authors include a measure of sub-field sizes but not journal quality as an explanatory variable. Rather, it is the objective of their study to estimate the quality of the evaluated journals which is identified by the difference between the actual and the estimated number of citations.

(age) in years, journal quality as given by the measure proposed by Combes and Linnemer (2003), and the author's reputation at the time of the article's publication.²⁰ We have also included dummy variables capturing the effect of journal publications versus other publication outlets, dummies for field journals, general journals and dummies for journals that specialize in publishing notes (letters) and surveys. Finally, we have included author dummies and article cohort dummies. Table 4 reports the results of our Poisson regressions and also includes some summary statistics which are a prerequisite for the interpretation of the reported marginal effects. We have also run OLS and Negative Binomial regression as a robustness check. The respective results are reported in Table 5 and Table 6 in the Appendix. All regressions are based on the publications of our HB+2 sample of economists.

The results of our regressions are in line with the received wisdom: The number of authors, the length of a paper and its age all have a positive but decreasing effect on the total number of citations received, and journal quality and author reputation (as measured by the author's reputation *at the time of publication*) also have a positive impact. Interestingly, *subsequent* publication success appears to have an additional positive effect on how often a paper is cited. In other words, early papers of authors who, after its publication, became well known in the profession will be cited more often than similar papers of authors who remain less visible in the research community.²¹

²⁰ Author reputation corresponds to our measure OUT of research output for $p=n=1$.

²¹ The definition of the variable "author reputation (since publication)" corresponds to the definition of the variable "author reputation (at the time of publication)" but the summation runs from the publication year to the year 2004.

Table 4

Model	Min	Max	MFX at	POISSON MFX	POISSON MFX	POISSON MFX	POISSON MFX
Authors	1	8	1.80	3.756 (1.58)	5.840 ⁺ (1.77)	5.383 (1.41)	3.622 (1.60)
Authors (Squared)	1	64	3.24	-0.760 ⁺ (-1.65)	-1.230 ⁺ (-1.79)	-1.129 (-1.53)	-0.746 (-1.61)
Pages (Log)	0.00	6.81	3.05		2.495** (3.11)	0.635 (0.55)	2.420** (3.42)
Age of Paper (Log)	0.00	3.83	2.23	3.883 ⁺ (1.78)	4.633 ⁺ (1.92)	9.552** (3.19)	15.635** (5.75)
Journal Quality	0.08	1.00	0.42			9.287** (3.08)	9.085** (4.20)
Author Reputation (at time of publication)	0.00	17.86	5.45	7.336** (3.80)	7.322** (3.82)	8.989** (3.74)	6.581** (2.92)
Author Reputation (since publication)	0.00	16.86	4.44	7.175** (3.50)	6.923** (3.33)	8.509** (3.25)	5.451* (2.37)
Growth of Field (in 100% next 3 years)	0.67	68.33	1.96				0.417** (2.62)
Current Size of Field (in % of all fields)	0.00	1.63	0.55				-17.375** (-3.68)
Current Size of Field (Squared)	0.00	2.65	0.30				10.872** (3.47)
Journal Article Dummy				3.196** (2.69)	3.741** (3.22)	5.505** (4.74)	
Field Journal Dummy				-4.170* (-2.52)	-4.618** (-2.56)	-1.655 (-0.88)	
Survey Journal Dummy				16.389* (2.26)	13.441 ⁺ (1.69)	46.640* (2.28)	
Notes Journal Dummy				-5.171** (-8.22)	-5.020** (-5.74)	-6.238** (-6.20)	
Author Dummies				Yes	Yes	Yes	Yes
Paper Cohort Dummies				Yes	Yes	Yes	Yes
Observations				1067	850	494	264
Pseudo R-square				0.228	0.267	0.348	0.475

estimation method: Poisson regression, robust Huber-White Sandwich estimators

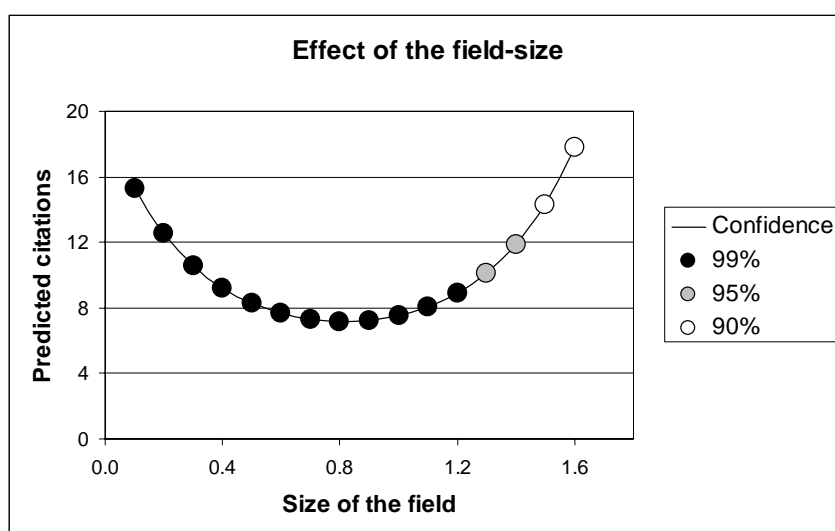
marginal effects at means shown

** significant at 1%, * 5%, + 10%, z-statistics in parenthesis

As far as our crucial variables capturing the field effects are concerned, it transpires that publishing in expanding fields is very important for citation success. Even

though this hardly comes as a surprise - jumping a bandwagon has never hurt a scientist - this effect has not been estimated (and therefore sufficiently appreciated in the scientometric literature) before.

Figure 8



By contrast, the pattern of the field-size effect is more remarkable. The identified convex shape of the relationship between field size and citation success shows (see Figure 8) that economists working in small, if not obscure fields of specialization, and economist doing research in large mainstream fields do better in terms of being cited than their peers who specialize in garden-variety fields of research.²² It is well worth pointing out that the identified field effects are substantial. In the OLS regression, the size effect gives rise to an increase in the R^2 of more than 17% and the growth effect increases the

²² The confidence levels indicated in Figure 8 refer the confidence level of the variable SIZE or the confidence level of the variable SIZE-SQUARED, whichever is lower. Figure 8 is based on a Poisson regression using Huber/White estimates of standard errors and the variables AUTHORS, AUTHORS-SQUARED, LOG AGE OF PAPER, AUTHOR REPUTATION AT TIME OF PUBLICATION, AUTHOR REPUTATION SINCE PUBLICATION, GROWTH OF FIELD, CURRENT SIZE OF FIELD and CURRENT SIZE OF FIELD SQUARED. The *predicted citations* result from marginal effects measured at their respective variable means. Including the variable JOURNAL QUALITY in the regression reduces the number of observations from 477 to 264, which does, however, not change the qualitative features of the result (see Figure 8' in the Appendix).

R^2 by another 9%. Estimates of the determinants of citation success that do not allow for sub-field effects are, therefore, likely to be unreliable.

5. Conclusions

There is no single bibliometric indicator that captures, in a definite manner, the ill-defined concept that is commonly called “research performance”. The search for such an indicator resembles the search for the Holy Grail. Fortunately, we do not really need such an unambiguous and uncontroversial measure of research performance. The strategic objective of scientometrics lies in developing indicators which can serve as useful instruments for the management of research units – not more, but also not less.

Among the bibliometric indicators that have been used in the past, some measures are better, others worse, and still others are outright dangerous. Dangerous indicators are those which give rise to perverse incentives such as the indicators employed by the CHE (total number of publications) and FOCUS (citations per article). The indicator employed by the HB-ranking (total number of citations) does seem less objectionable in principle. However, restricting not only the citing but also the source publications to the journals indexed in the SSCI is quite problematic because this restriction abets scientific inbreeding by not giving credit to work published in outsider-journals. Moreover, it transpires once more that bibliometric data that is compiled by a commercial contractor is liable to lack accuracy. Our own experience with collecting citations indicates that sufficiently accurate citation data can only be had at a price which exceeds the willingness to pay of a general interest newspaper or magazine. This appears to be the main reason why the *Handelsblatt* has, in the meantime, changed the methodology for the

2006 ranking and has switched to a publication-based bibliometric indicator.²³ Another shortcoming of simple citation counts is that they are heavily influenced by the so-called *halo effect* of very successful publications which escape the power law of citations. These publications are cited over and above their relative scientific merit and are, thus, likely to bias any ranking.²⁴

As we have demonstrated, the “halo bias” can be avoided by using the Hirsch-index *h*. Some other unappealing features that are common to all citation-based indices of research performance however remain. These unappealing features include the fact that undue weight is given to research results that mainly serve as an input for further research (the development of novel research methods is a case in point). In a sense, this is akin to measuring a firm’s revenue by only counting sales to other firms, or to measuring a country’s economic performance with the help of national investment. In any event, it appears to be a rather masturbatory way of measuring research virility since it does not give due respect to the principal of academic research, i.e. the society at large, which is, after all, mainly interested in “final” results. A further, second, drawback of citation based indicators consists of the fact that the time lag involved is substantial and, for obvious reasons, much longer than for publication based indicators.

Last, and most important, citation based indicators of individual research performance are heavily influenced by the individual researcher’s field of specialization.

²³ See http://www.handelsblatt.com/news/default_302032_1136616.aspx. This change of doctrine also reflects the commendable concern for high quality on the part of the journalists responsible for the HB-ranking. If we arrive at the conclusion that the HB-ranking was based on insufficiently accurate data, this result should thus in no way be construed to imply that the *Handelsblatt* did not make a valiant attempt at producing something worthwhile. Our point is rather that probably all commercially produced rankings based on mere citation counts are flawed simply because sufficiently accurate citation data sets turn out to be prohibitively expensive.

²⁴ Interestingly, great academic successes can also turn into a substantial loss of citations. If, for example, everybody referring to the concept of *subgame perfection* cited Reinhard Selten’s 1965 article in the *Zeitschrift für die gesamte Staatswissenschaft*, Selten would probably have more citations than all other ranked authors together.

The fact that the citation behaviour is discipline specific has been recognized for a long time. This is why advanced indicators (such as van Raan's *crown index* referred to above) relate citation numbers to discipline-specific world wide averages. Even though we readily acknowledge that much remains to be done to measure sub-field effects on citation success, we contend that our study clearly indicates that field effects bias comparisons not only between disciplines but also within disciplines. This pretty much disqualifies mere citation counts and derivatives thereof as reasonable indicators of individual research performance. Our conclusion appears to be all the more appropriate since we have other bibliometric indicators at our disposal which are not afflicted with these shortcomings. In particular, we have shown that the now well established index of (quality) weighted publication output determines citation success to some extent without being afflicted with the many problems idiosyncratic to citation-based indicators.

We thus conclude that citation-based indicators provide a rather contorted and unfocussed picture of research performance. To arrive at acceptable bibliometric research ratings, citation based indicators need to be combined with and adjusted by indicators that measure publication success more directly.²⁵

²⁵ The most recent *Handelsblatt* research ranking of German economists which was published on 18 September 2006 has reached this conclusion independently of our analysis. The 2006 ranking uses a standard indicator of quality weighted journal publications and is a clear improvement over the 2005 ranking (not to speak of the dilettante attempts undertaken by CHE and FOCUS). Two features render the 2006 HB ranking especially attractive: (1) forthcoming journal publications are taken into account and (2) each economist is given the opportunity to provide the *Handelsblatt* with information about his or her publication record which is then used to continuously update the ranking on the respective web site.

REFERENCES

- Archibald, R. and D. Finifter, Multivariate citations functions and journal rankings, *Eastern Economic Journal* 16, 151-58, 1990
- Ayres, I. and F. Vars (2000): Determinants of citations to articles in elite law reviews, *Journal of Legal Studies* 29, 427-450.
- Combes, P. and L. Linnemer (2003): Where are the economists who publish? Publication concentration and rankings in Europe based on cumulative publications, *Journal of the European Economic Association* 1, 1250-1308.
- Hirsch, J.E. (2005): An index to quantify an individual's scientific research output, arXiv:physics/0508025 v5 29 Sep 2005
- Johnson, D. (1997): Getting noticed in economics: The determinants of academic citations, *The American Economist* 41, 43-52.
- Laband, D. (1986): Article popularity, *Economic Inquiry* 24, 173-179.
- Laband, D. (1990): Is there value-added from the review process in economics? Preliminary evidence from authors, *Quarterly Journal of Economics*, 341-352.
- Laband, D. and R. Tollison (2000): Intellectual collaboration, *Journal of Political Economy* 108, 632-647.
- Medoff, M. (2003): Collaboration and quality of economic research, *Labour Economics* 10, 597-608.
- van Raan, A.F.J. (2006): Statistical properties of bibliometric indicators: Research group indicator distributions and correlations, *Journal of the American Society for Information Science and Technology* 57, 408-430
- van Raan, A.F.J. (2005): Comparison of the Hirsch-index with standard bibliometric indicators an with peer judgement for 147 chemistry research groups, <http://arxiv.org/abs/physics/0511206>
- Rauber, M. and H. Ursprung (2006a): Evaluation of researchers: A life cycle analysis of German academic economists, CESifo working Paper No. 1673, February
- Rauber, M. and H. Ursprung (2006b): Life cycle and cohort productivity in economic research: The continental European experience as exemplified by the case of Germany, Mimeo, University of Konstanz
- Selten, R. (1965): Spieltheoretische Behandlung eines Oligopolmodells mit Nachfrageträgheit, *Zeitschrift für die Gesamte Staatswissenschaft* 121, 301-324 and 667-689
- Tahai, A. and G.W. Kelly, An alternative view of citation patterns of Quantitative Literature cited by business and economic researchers, *Journal of Economic Education*, 1996.
- Ursprung, H.W., Schneewittchen im Land der Klapperschlangen: Evaluation eines Evaluators (Evaluation of a Ranking Agency), *Perspektiven der Wirtschaftspolitik* 2, 177-190, 2003.

Appendices

Table 1

Table 5

Table 6

Figure 8-prime

some additional information about highly cited papers

Figure 8'

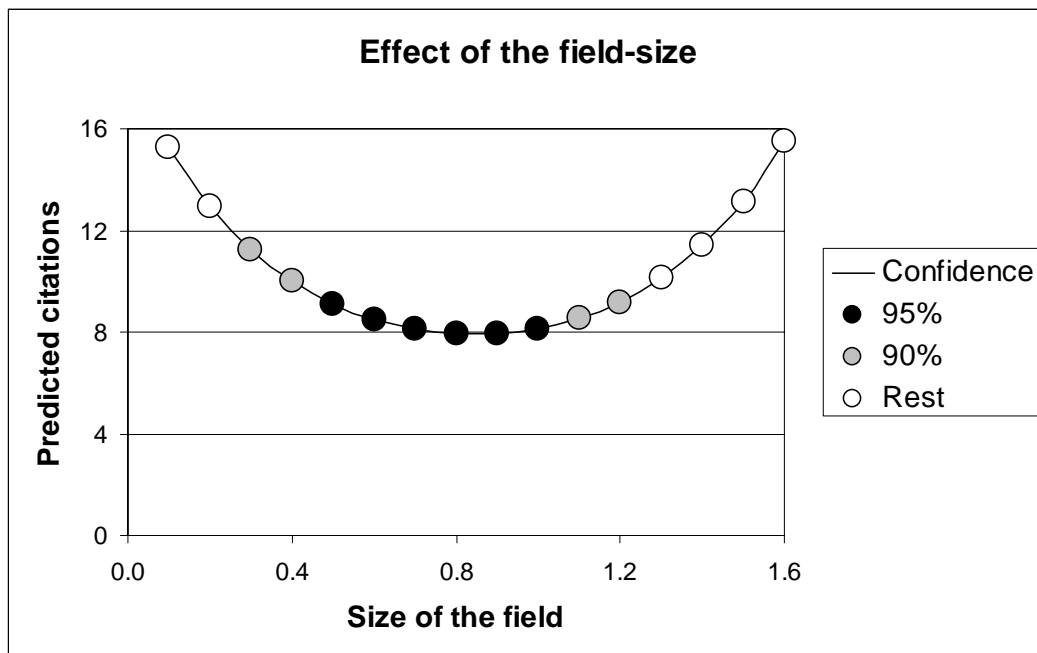


Table 5

Model	OLS	OLS	OLS	OLS	OLS
Constant	-9.855 (-0.74)	-17.731 (-1.13)	-28.829 (-1.35)	-130.804** (-3.76)	-116.782** (-3.58)
Authors	2.866 (1.38)	7.009* (2.04)	6.351 (1.22)	5.800 (1.19)	7.810 ⁺ (1.70)
Authors (Squared)	-0.489 (-1.30)	-1.336 ⁺ (-1.86)	-1.309 (-1.18)	-1.105 (-1.09)	-1.443 (-1.52)
Pages (Log)		2.034* (2.45)	2.049 (1.15)	6.638** (3.34)	6.686** (3.59)
Age of Paper (Log)	2.506 (0.79)	2.697 (0.72)	6.225 (1.19)	17.625* (2.38)	18.469** (2.67)
Journal Quality			12.956** (3.06)	18.611** (4.13)	15.919** (3.75)
Author Reputation (at time of publication)	10.618** (3.28)	8.898* (2.36)	13.044** (2.59)	31.123** (4.10)	23.259** (3.22)
Author Reputation (since publication)	10.393** (3.09)	8.508* (2.17)	12.529* (2.40)	29.242** (3.82)	21.134** (2.90)
Growth of Field (in 100% next 3 years)					3.682** (5.74)
Current Size of Field (in % of all fields)				-27.123* (-2.44)	-34.470** (-3.30)
Current Size of Field (Squared)				16.613* (2.10)	21.677** (2.91)
Journal Article Dummy	3.528* (2.56)				
Field Journal Dummy	-5.381** (-2.90)				
Survey Journal Dummy	12.939 (1.33)				
Notes Journal Dummy	-10.652* (-2.30)				
Author Dummies	Yes	Yes	Yes	Yes	Yes
Paper Cohort Dummies	Yes	Yes	Yes	Yes	Yes
Observations	1067	850	494	264	264
Adjusted R-square	0.068	0.095	0.100	0.275	0.365

Table 6

Model	Min	Max	MFX at	NBREG MFX	NBREG MFX	NBREG MFX	NBREG MFX
Authors	1	8	1.80	2.755** (2.99)	4.941** (3.23)	7.260** (3.16)	3.786+ (1.76)
Authors (Squared)	1	64	3.24	-0.499** (-2.93)	-1.003** (-3.13)	-1.481** (-3.03)	-0.699 (-1.56)
Pages (Log)	0.00	6.81	3.05		2.169** (6.14)	1.904* (2.52)	2.804** (3.42)
Age of Paper (Log)	0.00	3.83	2.23	5.452** (3.87)	6.364** (3.78)	10.277** (4.36)	15.554** (4.77)
Journal Quality	0.08	1.00	0.42			11.215** (5.90)	10.506** (5.62)
Author Reputation (at time of publication)	0.00	17.86	5.45	6.309** (4.74)	6.088** (3.88)	8.231** (4.14)	6.147* (2.12)
Author Reputation (since publication)	0.00	16.86	4.44	6.144** (4.47)	5.759** (3.56)	7.912** (3.88)	5.053+ (1.73)
Growth of Field (in 100% next 3 years)	0.67	68.33	1.96				0.430+ (1.75)
Current Size of Field (in % of all fields)	0.00	1.63	0.55				-11.812** (-3.09)
Current Size of Field (Squared)	0.00	2.65	0.30				7.967** (2.78)
Journal Article Dummy				2.542** (4.57)	3.147** (4.67)	5.619** (5.23)	
Field Journal Dummy				-3.756** (-3.64)	-4.267** (-3.76)	-1.493 (-1.36)	
Survey Journal Dummy				13.078 (1.18)	10.294 (0.93)	27.661 (1.30)	
Notes Journal Dummy				-4.870** (-7.40)	-4.754** (-4.98)	-5.628** (-5.59)	
Author Dummies				Yes	Yes	Yes	Yes
Paper Cohort Dummies				Yes	Yes	Yes	Yes
Observations				1067	850	494	264

estimation method: negative binomial regression, marginal effects at means shown

** significant at 1%, * 5%, + 10%, z-statistics in parenthesis

Table 1	HB original A	HB replicated B	all 1994-2004 publications C	C weighted by # authors D	all publications E	E weighted by # authors F	E / AGE G	F / AGE H	Hirsch- index h I	h / AGE J
Bester H	101	68	77	46	240	199	10.9	9.0	8	0.36
Börsch-S.	n.a.	15	72	55	377	258	17.1	11.7	8	0.36
Burda M	88	84	168	94	307	210	16.2	11.1	9	0.47
Gueth W	198	182 3	282 3	165	748 2	366	22.0	10.8	10	0.29
Haerdle W	288 3	94	155	70	516	303	21.5	12.6	11	0.46
Harhoff D	140	138	246	138	256	147	17.1	9.8	9	0.60 3
Hassler U	75	66	71	43	91	63	7.0	4.8	5	0.38
Hellwig MF	n.a.	66	105	96	569 3	425 3	17.2	12.9	11	0.33
Komlos J	104	45	116	93	251	211	9.0	7.5	8	0.29
Konrad KA	157	152	182	104	212	129	13.2	8.1	9	0.56
Lux T	297 2	180	264	215 3	271	219	16.9	13.7	7	0.44
Moldovanu B	161	129	146	69	157	79	10.4	5.3	8	0.53
Noeldeke G	89	80	96	48	148	74	10.6	5.3	5	0.36
Oechsler J	87	81	86	45	88	47	7.3	3.9	5	0.42
Ockenfels A	190	185 2	200	100	200	100	25.0	12.5	5	0.62 2
Roeller LH	83	82	105	48	204	117	10.7	6.2	8	0.42
Schmidt KM	392 1	356 1	410 1	255 1	461	300	30.7 2	20.0 2	9	0.60 3
Selten R	74	80	207	123	1439 1	1128 1	32.0 1	25.1 1	17 1	0.38
Sinn HW	134	133	262	224 2	551	481 2	19.7	17.2 3	12 3	0.43
Snowder D	84	77	167	117	419	251	13.5	8.1	10	0.32
Uhlig H	132	106	169	130	269	182	16.8	11.4	9	0.56
von Hagen J	93	95	315 2	176	509	323	25.4 3	16.1	13 2	0.65 1
von Thadden EL	129	121	169	112	188	131	12.5	8.7	7	0.47
Wagner J	211	172	206	153	262	202	11.9	9.2	7	0.32
Wellisch D	74	83	130	107	133	110	8.3	6.9	7	0.44
Wolters J	88	78	111	62	142	78	4.2	2.3	6	0.16
Zimmermann KF	206	175	217	133	319	192	15.2	9.1	10	0.48

Author	Title	Citations 1994-2004	Share of authors total citations	Sum of shares
Bester, H.	Screening vs. rationing in credit markets with imperfect information, <i>American Economic Review</i> 75 (4): 850-855, 1985	67	31.2%	56.7%
	The role of collateral in credit markets with imperfect information, <i>European Economic Review</i> 31 (4): 887-899, 1987	28	13.0%	
	and Guth, W., Is altruism evolutionarily stable?, <i>Journal of Economic Behavior and Organization</i> , 1997	27	12.6%	
Boersch-Supan, A.	and Hajivassiliou, V.A., Smooth unbiased multivariate probability simulators for maximum likelihood estimation of limited dependent variable models, <i>Journal of Econometrics</i> 58, 347 - 368, 1993	119	35.2%	50.6%
	and Hajivassiliou, V., Kotlikoff, L. and Morris, J., Health, children and elderly living arrangements: a multi-period multinomial probit model with unobserved heterogeneity and autocorrelated errors, <i>Topics in the Economics of Aging</i> (ed. D. Wise). Chicago: University of Chicago Press, 1991	27	8.0%	
	Econometric Analysis of Discrete Choice: With Applications on the Demand for Housing in the U.S. and West Germany, <i>Lecture Notes in Economics and Mathematical Systems</i> 296, Springer-Verlag, Berlin, 1987	25	7.4%	
Burda, M.	and Wypolcz, C., Gross worker and job flows in Europe, <i>European Economic Review</i> 38 (6): 1287-1315, 1994	55	19.0%	38.4%
	Unemployment, Labour Market Institutions and Structural Change in Eastern Europe, <i>Economic Policy</i> 16, pp. 102-137, 1993	30	10.4%	
	and Wypolcz, C., Macroeconomics: A European Text, <i>Oxford University Press</i> , 2001	26	9.0%	
Gueth, W.	and Schmittberger, R., Schwarze, B., An experimental-analysis of ultimatum bargaining, <i>Journal of Economic Behaviour & Organisation</i> 27 (3): 329-344, 1995	210	29.2%	50.0%
	and Tietz, R., Ultimatum bargaining behaviour - a survey and comparison of experimental results, <i>Journal of Economic Psychology</i> 11, 1990	109	15.2%	
	On ultimatum bargaining experiments - a personal view, Report No. 9317, Tilburg University, Center for Economic Research, Germany, 1993	40	5.6%	
Härdle, W.	Applied Nonparametric Regression, <i>Econometric Society Monographs</i> , 1995	81	16.0%	37.2%
	and Stocker, TM, Investigating smooth multiple-regression by the method of average derivatives, <i>Journal of the American Statistical Association</i> 84 (408): 986-995, 1989	55	10.9%	
	and Mammen, E., Comparing nonparametric versus parametric regression fits, <i>Annals of Statistics</i> 21 (4): 1926-1947, 1993	52	10.3%	
Harhoff, D.	Stahl, K. and Woyvode, Legal form, growth and exit of West German firms—empirical results for manufacturing, construction, trade and service industries, <i>Journal of Industrial Economics</i> 46, 453-515, 1998	27	12.3%	35.2%
	and Narin, F., Scherer, F. M., and Vopel, K., Citation Frequency and the Value of Patented Inventions, <i>The Review of Economics and Statistics</i> 81(3): 511-515, 1999	26	11.9%	
	and Körting, T., Lending relationships in Germany: Empirical results from survey data, <i>Mimeo, Wissenschaftszentrum Berlin</i> , 1997	24	11.0%	
Hassler, U.	and Hassler, U., On the power of unit root tests against fractional alternatives, <i>Economics Letters</i> 45: 1-5, 1994	17	37.0%	87.0%
	Regression of spectral estimators with fractionally integrated time series, <i>Journal of Time Series Analysis</i> 14, 369-380+ Corrigendum; 14, 549, 1993	13	28.3%	
	(Mis)specification of long-memory in seasonal time series, <i>Journal of Time Series Analysis</i> 15, 19-30, 1994	10	21.7%	

Hellwig, MF	and Gale, D., Incentive-compatible debt contracts: The one-period problem, <i>Review of Economic Studies</i> 52, pp. 647-663, 1985	182	35.7%	53.3%
	On the aggregation of information in complete markets, <i>Journal of Economic Theory</i> 22, pp. 477-498, 1980	51	10.0%	
	Banking, Financial Intermediation and Corporate Finance, in A. Giovannini and C. Mayer, (eds.), <i>European Financial Integration (Oxford, Clarendon Press)</i> , 1991	39	7.6%	
Komlos, J.	Stature, Living Standards, and Economic Development: Essays in Anthropometric History, <i>University of Chicago Press</i> , 1994	28	13.1%	33.2%
	Nutrition and economic development in the eighteenth-century Habsburg monarchy: an anthropometric history, <i>Princeton Univ. Press</i> , 1989	24	11.2%	
	The height and weight of west point cadets - dietary change in antebellum America, <i>Journal of Economic History</i> 47 (4): 897-927, 1987	19	8.9%	
Konrad, K.	and Glazer, A., A signaling explanation for charity, <i>Irvine Economics Paper</i> No. 90-92-35, University of California, 1992	26	13.6%	28.3%
	and Lommerud, KE, Family policy with non-cooperative families, <i>Scandinavian Journal of Economics</i> 97 (4): 581-601, 1995	17	8.9%	
	and Buchholz, W., Strategic transfers and private provision of public goods, <i>Journal of Public Economics</i> 57 (3): 489-505, 1995	11	5.8%	
Lux, T.	and Marchesi, M., Scaling and criticality in a stochastic multi-agent model of a financial market, <i>Nature</i> 397 (6719): 498-500, 1999	56	23.1%	59.9%
	The stable Paretian hypothesis and the frequency of large returns: An examination of major German stocks, <i>Volkswirtschaftliche Diskussionsbeiträge</i> 72, University of Bamberg, Germany	46	19.0%	
	The socio-economic dynamics of speculative markets: Interacting agents, chaos, and the fat tails of return distributions, <i>Journal of Economic Behavior & Organization</i> 33 (2): 143-165, 1998	43	17.8%	
Moldovanu, B.	and Jehiel, P. and Stacchetti, E., How (not) to sell nuclear weapons, <i>American Economic Review</i> 86 (4): 814-829, 1996	23	20.7%	53.2%
	and Jehiel, P., Efficient design with interdependent valuations, <i>Econometrica</i> (5): 1237-1259, 2001	20	18.0%	
	and Jehiel, P., Strategic nonparticipation, <i>Rand Journal of Economics</i> 27 (1): 84-98, 1996	16	14.4%	
Noeldeke, G.	and Schmidt, K., Option contracts and renegotiation: a solution to the hold-up problem, <i>Rand Journal of Economics</i> 26, pp. 163-179, 1995	53	37.1%	76.2%
	and Samuelson, L., An Evolutionary Analysis of Backward and Forward Induction, <i>Games and Economic Behavior</i> 5, 225-254, 1993	36	25.2%	
	and Schmidt, K.M., Sequential Investments and Options to Own, <i>Rand Journal of Economics</i> 29, pp. 633-653, 1998	20	14.0%	
Ockenfels, A.	A Theory of Equity, Reciprocity and Competition, <i>American Economic Review in press</i> , 2000	137	74.5%	89.7%
	and Weimann, J., Types and Patterns - An Experimental East-West-German Comparison of Cooperation and Solidarity, <i>Discussion Paper</i> , Department of Economics, University of Magdeburg, 1996	14	7.6%	
	and Roth, A., Last-minute bidding and the rules for ending second-price auctions: Evidence from eBay and Amazon auctions on the Internet, <i>American Economic Review</i> 92(4), 2002	14	7.6%	

Oechssler, J.	and Huck, S., The indirect evolutionary approach to explaining fair allocations, <i>Games and Economic Behavior</i> 28 (1): 13-24, 1999	27	38.0%	62.0%
	and Huck, S. and Normann, H., Stability of the Cournot process - experimental evidence, <i>International Journal of Game Theory</i> 31 (1): 123-136, 2002	10	14.1%	
	Decentralization and the coordination problem, <i>Journal of Economic Behavior & Organization</i> 32 (1): 119-135, 1997	7	9.9%	
Roeller, LH	Proper Quadratic Cost-Functions with an Application to the Bell System, <i>Review of Economics and Statistics</i> 72 (2): 202-210, 1990	28	14.6%	38.5%
	and Parker, P., Collusive conduct in duopolies: Multimarket contact and cross-ownership in the mobile telephone industry, <i>Rand Journal of Economics</i> 28 (2): 304-322, 1997	27	14.1%	
	Modelling cost structure: the Bell system revisited, <i>Applied Economics</i> 22, 1661-74, 1992	19	9.9%	
Schmidt, KM	and Fehr, E., A theory of fairness, competition, and cooperation, <i>Quarterly Journal of Economics</i> 114 (3): 817-868, 1999	190	41.9%	62.3%
	and Nöldeke, G., Option Contracts and Renegotiation - A Solution to the Hold-Up Problem, <i>Rand Journal of Economics</i> 26, pp. 163-179, 1995	54	11.9%	
	Managerial Incentives and Product Market Competition, <i>Review of Economic Studies</i> , vol. 64, issue 2, pages 191-213, 1997	39	8.6%	
Selten, R.	Reexamination of the Perfectness Concept for Equilibrium Points in Extensive Games, <i>International Journal of Game Theory</i> 9, 1-12, 1975	263	19.5%	46.0%
	and Harsanyi, J., A General Theory of Equilibrium Selection in Games, <i>MIT Press</i> , Cambridge, 1998	251	18.6%	
	The Chain-Store Paradox, <i>Theory and Decision</i> 127, 138, 1978	106	7.9%	
Sinn, HW	Tax Harmonization and Tax Competition in Europe, <i>European Economic Review</i> 34 (2-3): 489-504, 1990	40	7.6%	20.5%
	Capital income taxation and resource allocation, <i>Studies in mathematical and managerial economics</i> , Vol. 35, 1985	36	6.8%	
	A theory of the welfare state, <i>Scandinavian Journal of Economics</i> 97 (4): 495-526, 1995	32	6.1%	
Snower, DJ	and Lindbeck, Assar, The Insider-Outsider Theory of Employment and Unemployment, <i>MIT Press</i> , 1988	131	35.3%	55.8%
	and Lindbeck, Assar, Wage setting, unemployment, and insider-outsider relations, <i>American Economic Review</i> , Papers and Proceedings 71: 235-239, 1986	46	12.4%	
	and Lindbeck, Assar, Reorganization of firms and labor market inequality, <i>American Economic Review</i> , 1996	30	8.1%	
Uhlig, H.	and Taylor, J.B., Solving non-linear stochastic growth models: a comparison of alternative solution methods, <i>Journal of Business and Economic Studies</i> 8, pp. 1-18, 1990	44	16.8%	42.7%
	and Sims, C.A., Understanding unit rooters: a helicopter tour, <i>Econometrica</i> 59, pp. 1591-1599, 1991	39	14.9%	
	A toolkit for analysing nonlinear dynamic stochastic models easily, <i>Discussion Paper</i> 101. Federal Reserve Bank of Minneapolis, 1995	29	11.1%	

von Hagen, J.	Fiscal Arrangements in a Monetary Union. Evidence from the U.S." In D. Fair and C. de Boissieux (eds.), <i>Fiscal Policy, Taxes and the Financial System in an Increasingly Integrated Europe</i> . Deventer: Kluwer	36	7.4%	19.0%
	and Harden, J., National budget processes and fiscal performance, <i>European Economy: Towards Greater Fiscal Discipline, Reports and Studies</i> , no. 3, 1994	31	6.3%	
	and Fratianni, M., The European Monetary System and European Monetary Union, <i>Westview Press</i> : San Francisco, CA, 1991	26	5.3%	
Von Thadden, E.L.	Long-term contracts, short-term investment and monitoring, <i>Review of Economic Studies</i> 62 (4): 557-575, 1995	33	20.8%	59.7%
	and Berglof E., Short-Term versus Long-Term Interests - Capital Structure with Multiple Investors, <i>Quarterly Journal of Economics</i> 109 (4): 1055-1084, 1994	32	20.1%	
	and Bolton, P., Blocks, liquidity, and corporate control, <i>Journal of Finance</i> 53 (1): 1-25, 1998	30	18.9%	
Wagner, J.	The Post-Entry Performance of New Small Firms in German Manufacturing-Industries, <i>Journal of Industrial Economics</i> 42 (2): 141-154, 1994	44	19.4%	40.5%
	Firm Size, Firm Growth, and Persistence of Chance - Testing Gibrats Law with Establishment Data from Lower Saxony, 1978-1989, <i>Small Business Economics</i> 4 (2): 125-131, 1992	29	12.8%	
	Export, Firm Size, and Firm Dynamics, <i>Small Business Economics</i> , 7, 1, pp. 9-41, 1995	19	8.4%	
Wellisch, D.	Theory of Public Finance in a Federal State, <i>Cambridge University Press</i> , Cambridge, 2000	30	26.8%	65.2%
	Interregional Spillovers in the Presence of Perfect and Imperfect Household Mobility, <i>Journal of Public Economics</i> 55, 1994	25	22.3%	
	and Wildasin, D., Decentralized Income Redistribution and Immigration, <i>European Economic Review</i> 40, 1996	18	16.1%	
Wolters, J.	and Hassler, U., Long Memory in Inflation Rates - International Evidence, <i>Journal of Business & Economic Statistics</i> 13 (1): 37-45, 1995	32	26.9%	43.7%
	and Teräsvirta, T. and Lütkepohl, H., Modeling the demand for M3 in the unified Germany, <i>Working paper series in economics and finance</i> 113, Stockholm School of Economics, 1996	11	9.2%	
	and Kirchgässner, G., US-European interest rate linkage: a time series analysis for West Germany, Switzerland, and the United States, <i>Review of Economics and Statistics</i> , 69, 675-84, 1987	9	7.6%	
Zimmermann, K.F.	and Winkelmann, R., Recent developments in count data modelling: Theory and application, <i>Journal of Economic Surveys</i> , 9, 1±24, 1995	31	10.4%	29.2%
	and Veall, M.R., Pseudo-R2 measures for some common limited dependent variable models, <i>Journal of Economic Surveys</i> 10 (3), pp. 241-259, 1996	30	10.1%	
	and Veall, M.R., Pseudo-R2S in the Ordinal Probit Model, <i>Journal of Mathematical Sociology</i> 16 (4): 333-342, 1992	26	8.7%	