'Superstar' concentrations of scientific output and recognition

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Research characterizing the structure of large-scale networks such as the World Wide Web has provided substantial evidence that the distribution of hyperlinks follows a ‘power law’ with a relatively small number of sites having a large number of hyperlinks directed towards them, while the vast majority of sites have very few in-links. The preferential attachment model of Barabási and Albert (1999) proposes that power laws can emerge in a growing network where new nodes have a tendency to link to existing popular nodes that have a high number of in-links. Within the social sciences, the implications of power laws on the Web have been assessed in the context of the prominence of political information (Hindman et al. 2003) and the availability of scientific information and expertise (Caldas et al. 2008).

The economics of superstars (Rosen 1981) has been used to explain why in certain fields, such as the arts and sport, there is a concentration of output among a few individuals, and an associated marked skewness in the distribution of income, with very large rewards at the top (the “winner-takes-all” phenomenon described by Frank and Cook 1995 is an elaboration of Rosen's earlier work). In this essay, it is argued that the economics of superstars can explain the emergence of power laws on digital networks such as the Web, and provide important insights into how cyberinfrastructure may change the practice of scientific research.

The economics of superstar scientists

Rosen (1981) observed that the distribution of income of artists can be ‘stretched out’ in the right-hand tail, compared with the distribution of talent, indicating that the differences in success (measured by income) can be far greater than the differences in talent. He proposed two explanations for this. First, consumer preferences lead to small differences in talent being magnified into larger earnings differences (with greater magnification at the top of the scale), as a result of the imperfect substitution among different sellers (the example used by Rosen is: if a surgeon is 10 percent more successful in saving lives, most people would pay more than a 10 percent

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premium for his services). Second, the existence of 'joint consumption technology' means that the cost of production does not rise in proportion to the size of a seller's market, allowing a concentration of output on the few sellers who have most talent.

The economics of superstars is highly relevant here because cyberinfrastructure (and the Internet on which it sits) is a prime example of a joint consumption technology: via cyberinfrastructure, a scientist can make available her or his data or methods (e.g. simulation code) and there will be no difference (in terms of cost) whether these research resources are accessed by only a handful or thousands of researchers.

For Adler (1985), an interesting puzzle about stardom is that stars are often not more talented than many artists who are less successful, and he presents a model where large differences in earnings can exist with no differences in talent. Adler argues that consumers accumulate 'consumption capital' in art, and that the more consumption capital they possess the greater the enjoyment from each encounter with the art. Thus, stardom is not due to the stars' superior talent but because people are inherently social and find value in consuming the same art that others do. The formal model has dynamics that are similar to preferential attachment (but based on economic theory): consumers initially select an artist at random and, by chance, one artist ends up with more patrons than the rest, and this initial advantage leads to new consumers preferring that artist and existing consumers switching to him or her.

One can envisage a similar phenomenon in e-Science: researchers use cyberinfrastructure to access the data or methods of a particular researcher, not because of quality but because this researcher is already popular or prominent. This already happens in citations where authors may be cited on a topic because they are recognized 'names' in the field, even though the person making the citation may not even have read the relevant article.

Cyberinfrastructure and the creation of superstar scientists

Cyberinfrastructure may therefore facilitate the emergence of superstar scientists, leading to a concentration of scientific authority or impact. For economists, the existence of concentration always leads to questions about efficiency. Drawing from Adler (2005), if cyberinfrastructure leads to superstar scientists, the e-Science 'market' will be inefficient (from an economist's perspective) if barriers to entry exist, and that will in turn depend on exactly how superstars emerge.

If superstar scientists emerge because of differences in talent, no matter how small these differences may be (as per Rosen's model), then there are no barriers to entry and the e-Science market will be efficient. In contrast, if superstars emerge because other researchers preferentially use Grid-enabled research resources that are the most 'popular' (and not necessarily the 'best'), as per the model of Adler, then barriers to entry will exist, and the e-Science market will be inefficient. In such a case, there would be an argument for government regulation to lower the barriers to entry, perhaps via appropriate allocation of public funding of Grid-enabled research resources such as data and methods.

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