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## Unbiasing Science by Using Search Engines and Structured Methods

### Analyzing or Measuring Scientific Output

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**Abstract** – Scientific prizes are designed to encourage researchers, while scientific search engines shall support a structured literature review. Both areas are designed to help scientific work. Both should work or be granted unbiased – but depending on the point of view it seems as this is hard to achieve. While prizes are often granted to certain mainly well-known Universities and countries in which the prize was originally founded, scientific search engines have hidden algorithms as well. Searching with identical search parameters will provide different results for scientific texts when using different search engines. Within the article three different ones were explored a bit and one mean to achieve a bit of unbiased usage of the sources is PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). The meta-analysis enables each reader to follow the steps and objectivize the findings.

**Keywords** – Structured Literature Review, Biased Search Engines, Identification of Literature

## 1 Preface and Introduction

The essay takes up the article "Prizes and Productivity - How winning the Fields Medal Affects Scientific Output" by Borjas & Doran (2015). The authors research on knowledge generation as key to economic growth. Scientific prizes are designed to encourage researchers. The authors analyze how winning a prestigious prize affects future output of especially young mathematicians. They compare two groups which have similar publication rates until the award year, after which the winner's productivity declines. The later left their original fields and started working on unfamiliar topics. So, winning the Fields Medal influences scientific output in the area of mathematics.

The search engine Microsoft Academic (2021), lists more often female authors than other search engines – in one example there are 3 female authors in particular, of which Catherine Waddams Price has already contributed 35

articles to the topic or subject area. Contrary to that BASE found less documents (identical search parameters) while focusing mainly on open access articles. About 19.500 results were found for identical search term with Google Scholar. The PRISMA methodology still does not influence which search results will be searched at all – alone the number of found documents differs by each search engine

## 2 The Authors

George J. Borjas was born in Cuba, immigrated 1962 to the US. In 2002 he has won the IZA Prize in Labor Economics (Institut zur Zukunft der Arbeit [Germany] - Institute for the Future of Work). George Jesus Borjas is an American economist and the Robert W. Scrivner Professor of Economics and Social Policy at the Harvard Kennedy School. He has been described as "America's leading immigration economist" (The Economist 2021) and "the leading sceptic of immigration among economists" (Smith 2017). As he wrote many articles and books, just two shall be named here: "Immigration Economics" (Harvard University Press, 2014) and "Why Trump's New Immigration Bill Makes Sense" (POLITICO Magazine 2021).

About the year of birth of Kirk B. Doran little is known. Even in his published CV (Kirk Bennett Doran 2018) he provides information on his professional career and scientific work but does not reveal birthdate or place. He holds the Henkels Family Collegiate Chair and is an associate professor of economics at the University of Notre Dame. Doran received his bachelor's degree in physics from Harvard University in 2002, his master's degree in applied mathematics from Harvard University in 2002, and his Ph.D. in economics from Princeton University in 2008. His dissertation won the Princeton's labor economics dissertation award. Doran's research focuses on issues in labor economics, innovation economics, and international migration, with a particular focus on human capital complementarities. His work has examined the implications of large migrations of top scientists on the productivity and knowledge generation of their peers.

## 3 The Research and Its Content

The Fields Medal itself is awarded every four years on the occasion of the International Congress of Mathematicians to recognize outstanding mathematical achievement for existing work and for the promise of future achievement (Fields Medal | International Mathematical Union (IMU) 2021). It's only given to "young" mathematicians (below the age of 40). It is issued every 4 years and worth 15.000 CAN\$ (American Mathematical Society 2021).

For the research itself, two groups (winners and control group) were formed. Standard models of labor supply suggest that the post prize impact of a big win could be significant, especially when the award is granted at a

young age. The researchers found and proven, there is a negative relationship between productivity and winning the Fields Medal.

The age-productivity profile of the Fields medalists and of the losing contenders is similar until the year in which a particular mathematician wins the Fields Medal (or does not win it). The rate of output of the Fields medalists declines noticeably in the post-medal period.

#### 4 Further Facts and Findings

The article reveals, but does not prove, that science is biased. At least it led to additional research which led to findings like: "...studies regarding the impact of U.S. immigration barriers on global knowledge production. ... First, among Nobel Prize winners and Fields Medalists, migrants to the U.S. play a central role in the global knowledge network—representing 20-33% of the frontier knowledge producers." (Agarwal et al. 2021)

Driven by the relation towards prizes and productivity, the following question came up: "Has anyone won a Nobel Prize and a Fields Medal?" According to modern search engines such as Google & Google Scholar, Microsoft Academic, ResearchGate and many other search engines, the answer is no. Furthermore, when analyzing the distribution of the university which had winners and their general alumnus, another discrepancy was revealed:

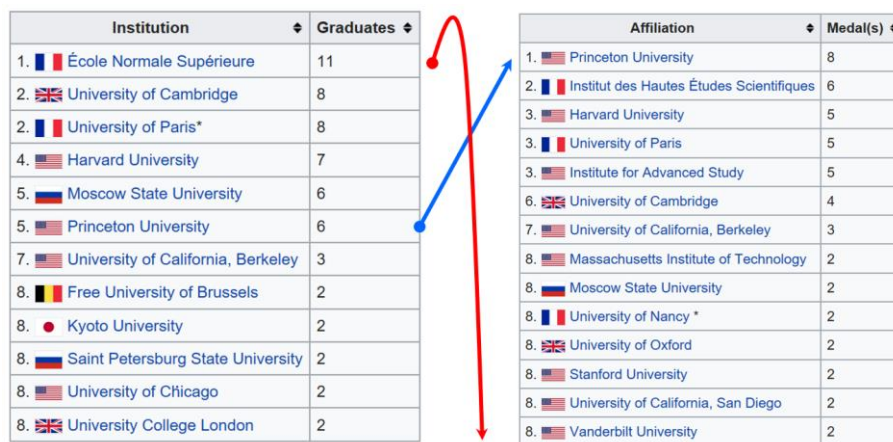


Figure 1: University ranking by alumni vs. University ranking by affiliation at time of award (Wikipedia 2021)

Additionally, the winner's distribution by country reveals 14 times US, 12 France, 8 Russia, 7 UK, 5 Germany and 3 Japan and the other countries had less prize winners. The most criticizability fact is the distribution by gender: only one woman won the Fields medal so far (American Mathematical Society 2021). Similar observations can be made today – the progress and invention of the mRNA technology by Katalin Karikó. She has worked on that research since the 1990s. Karikó found with her colleague and fellow researcher Drew Weissmann, who joined her team at the University of Penn-

sylvania in 1997, the solution to the long-researched mRNA problem. The pinnacle of their careers? Unfortunately, no. Because then Karikó experienced what happens to many female researchers: The success was not recognized as hers. When applying for the patent, her name was supposed to come second - much to the annoyance of the now 66-year-old. She revealed to Business Insider, "I said, 'No, it was my idea. I want to be first.'" (Bendix 2020). She eventually prevailed, but in the public perception remained mostly just the woman at researcher Weissmann's side. Karikó is still annoyed by this to this day - and sexism in research is still an issue today, as was evident again after the success of BioNTech: in the media, only Ugir Sahin was often named as the COVID-19 vaccine developer, even though his wife Özlem Türeci was just as involved in the research (Cox 2020).

For example, if authors have received funding for the production of their research work or if the work has been supported in any other way by a company or organization, they can indicate this here.

Authors should also indicate if there could be a conflict of interest due to their profession or other personal interests.

## 5 Relation Towards Thesis on Urban Energy Systems and Smart Meters

The literature research on the topic of consumer behavior, especially in the analysis of consumer behavior in regulated district heating markets, exactly the opposite fact stood out. Consumer behavior seems to attract many female researchers (cf. Figure 2). But that's not the area of relation which is meant by this essay.

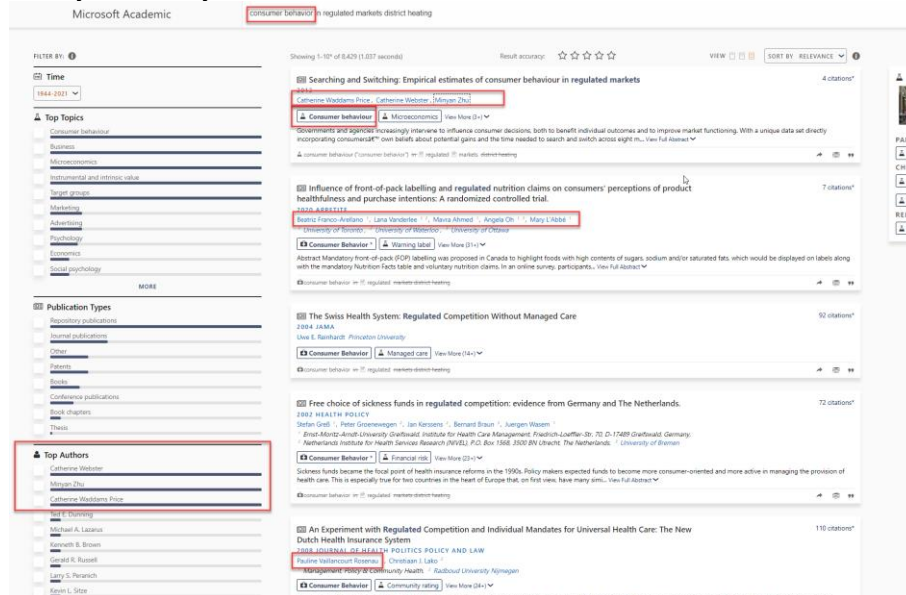


Figure 2: Microsoft Academic - Search term: consumer behavior in regulated markets district heating

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A comparative search at the scientific search engine BASE<sup>1</sup> (Bielefeld Academic Search Engine) showed a totally different picture. At Microsoft Academic (Microsoft Academic 2021), there are 3 female authors in particular, of which Catherine Waddams Price has already contributed 35 articles to the topic or subject area.

In total the search engine revealed 8,429 found documents. Contrary to that BASE found less documents (identical search parameters) while focusing mainly on open access articles:

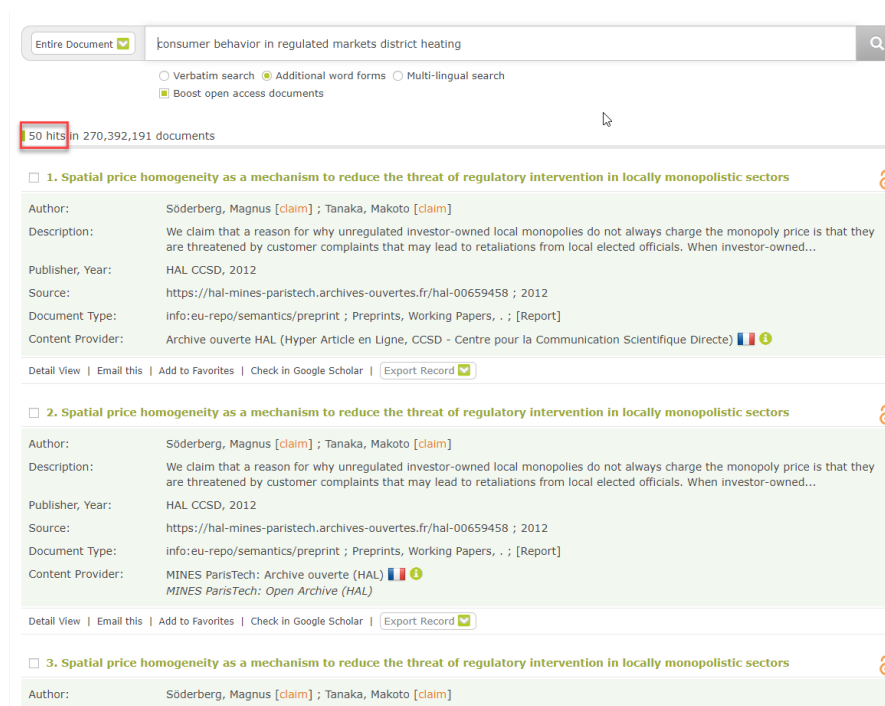


Figure 3: Search result by search term consumer behavior in regulated markets district heating

About 19.500 results were found for identical search term with Google Scholar. While at first glance, not only did Microsoft Academic provide the most significant results, but also promoted female researchers on top. This research experience provided further proof – a researcher certainly needs to gather information from genuine and reliable sources

The first article found by Microsoft Academic was: Searching and Switching: Empirical estimates of consumer behavior in regulated markets. Centre for Competition Policy, Working Paper, 11–13. (Waddams Price, C., Web-

<sup>1</sup> BASE (Bielefeld Academic Search Engine) is one of the world's largest search engines for scientific web documents. The index includes over 240 million documents from over 8,000 data providers. For about 60% of the documents indexed in BASE, the full texts are freely accessible (open access). The operator of the BASE search engine is Bielefeld University Library.

ster, C., & Zhu, M. (2013). It was cited by other researchers (e.g. (Mountain and Burns 2021)). Inspired by the original mentioned article some further searches were executed to verify if the top document by Microsoft Academic would have been found or can be found by Google Scholar as well. The following searches were executed, and the first page of results was checked:

Table 1: Search term and results by Google Scholar

Search term	Result
Searching and Switching: Empirical estimates of consumer behaviour in regulated markets	19.200 results, nothing found, none of the authors
consumer behaviour in regulated markets	17.500 results, nothing found, none of the authors
consumer behavior in regulated markets	18.400 results, nothing found, none of the authors, but many more articles related to the initial search term on consumer behavior
consumer behaviour regulated market	18.700 results
consumer behavior regulated market	35.200 results
Waddams Price, C., Webster, C., & Zhu, M	216 results, first result direct hit

Basically, all search engines can identify the searched literature / journal articles. But identical search criteria do not always provide the same search result.

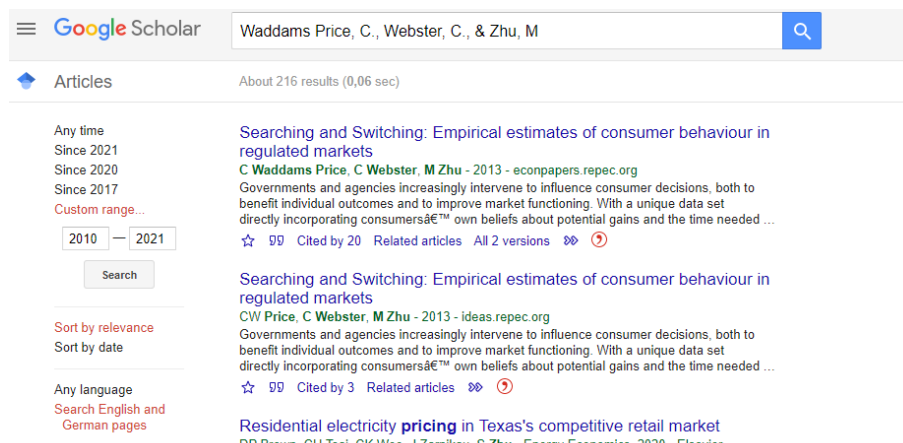


Figure 4: Search result by direct author search

## 6 Summary & Conclusion

Search engines as well as committees to grant a prestigious prize have a huge bunch of objectives to follow for selecting the right work to honor or use as search result. Nevertheless, both have hidden criteria – each selection is biased. This is not even necessarily intentional – but guidance is needed to avoid biased criteria as much as possible. During research, especially the start: searching and evaluating the existing literature, certain methods have proven to be useful. The aim of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) Statement is to help authors improve the reporting of systematic reviews and meta-analyses (Liberati et al. 2009). Although the award nominating committees probably follow a similar approach, the rationale behind selecting mainly one type of winning person is sometimes hidden and a good methodology does not prevent faults. The PRISMA methodology still does not influence which search results will be searched at all – alone the number of found documents differs by each search engine. But combining several engines is not supported by too many bibliographical tools or databases. Microsoft Academic already includes several scientific databases, as well as Google Scholar. But still – with identical search terms, both find different results. Therefore the PRISMA could also be used for reporting systematic reviews of other types of research, particularly evaluations of interventions (Page et al. 2020). For the planned research the identification of existing literature is a crucial part. But here special attention should be paid to the selected search engines. The drawn conclusion is highly influenced by the found search result. But here several comparison runs will be needed to detect the most stable and reliable search engine to identify the needed and worthwhile literature and researchers to be cited.

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