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Maps of Behavioural Economics: Evidence from the Field

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Introduction

Behavioral economics has made great advances in recent decades. The awarding of the Nobel Prize in Economics to George Akerlof (2001), Daniel Kahneman (2002), Robert Shiller (2013) and Richard Thaler (2017) have cemented behavioral economics as a prominent field; one which has challenged the core assumptions of neoclassical economics. The surge of behavioral economics from the extremities to the heart of economics has been punctuated. For many years, there was a strong status quo bias in the economics discipline, which made it hard to introduce more realistic assumptions derived from psychology regarding human behavior (Berg and Gigerenzer, 2010; Sent, 2004; Thaler, 2016). Due to the persistence and risk-taking of younger scholars, however, the discipline has come to embrace behavioral economics (Thaler, 2015). In short, behavioral economics has become mainstream.

The significance of behavioral economics can be observed in many ways (Sent, 2004). Since the mid-2000s, the number of academic publications dealing with behavioral economics both in relative and absolute numbers has increased dramatically (Geiger, 2017) (see appendix 1). Scholars specializing in behavioral economics occupy positions at the most prestigious universities in the world (Sent 2004; Thaler 2015). Research centers, conferences, journals, textbooks and associations are devoted to the study of behavioral economics (Wilkinson and Klaes, 2012), and insights derived from behavioral economics are increasingly informing policy-making processes in many countries (Benartzi et al., 2017).

The gradual advancement of behavioral economics has resulted in a growing body of literature focused on the history of the field, its current state and future avenues. Early writings in the 1980s discussed the defining characteristics of behavioral economics and whether it constituted a rival or corrective to neoclassical economics (Earl, 1983; Gilad et al., 1984; Green and Kagel, 1987; Hogarth and Reder, 1987; Simon, 1987). The perimeter of behavioral economics began to coagulate in the 1990s, and reviews of studies demonstrating how humans systematically violate key assumptions of the standard rational choice model emerged (Laibson and Zeckhauser, 1998; Mullainathan and Thaler, 2000; Rabin, 1998). In the 2000s, behavioral economics established itself in mainstream economics and scholars began to tell its history, with roots traceable to scholars like Adam Smith, John Maynard Keynes and Herbert Simon (Camerer and Loewenstein, 2004; Sent, 2004). In the 2010s, the field has entered a reflective period, where the case has been made for a broadening of the horizons beyond economics and psychology (Akerlof, Oliver and Sunstein 2017; Kahneman 2013; Oliver 2017; Thaler 2015).

The burgeoning literature concerning the production of knowledge on behavioral economics provides key insights about the constitutive features of the field. Yet when accounting for the historical development and present character of the field, these studies may be subject to the same cognitive biases and imperfect heuristics identified within behavioral economics. This conundrum begs the question of how to reduce biases in the process of unraveling behavioral economics as a field of research. Rather than relying on what scholars dealing with behavioral economics “say,” one can turn to what they “do” by investigating the *actual* behavior of researchers engaged in the field.

Studying academic behavior through bibliographic references—now known as bibliometrics—provides a systematic method to ascertain the constitution of a given research front (De Solla Price 1965). While bibliometric studies cannot supplant deep readings of source materials, they instead provide a unique contribution by reflecting the history and advancement of scientific research and self-organizing scholarly communication process (Leydesdorff et al., 2014). Bibliometrics identify which units dominate the flow of information within a field, tracing the linkages between different disciplines, which allows future research to address existing knowledge gaps. Bibliometric methods have found their way into economics in general (Duarte and Giraud, 2016) and the study of behavioral economics in particular (Geiger, 2017; Laibson and Zeckhauser, 1998).

The present paper contributes to the bibliometric literature on behavioral economics. Rather than focusing on predestinated scholars, outlets and key concepts, however, it proposes an advanced exploratory approach to map the field of behavioral economics. This approach allows the paper to address important questions, such as: What are the historical roots of the field? Who are the most important authors and publications in the field? What are the geographical and institutional hubs of knowledge production? Which academic disciplines supply knowledge to the field? And does the research practice constitute a truly interdisciplinary field or is it fragmented along disciplinary lines?

The article is structured as follows. The first section introduces the field of behavioral economics and accounts for the contribution made by the article. The next section outlines the article’s bibliographic methods and data. The penultimate section provides a descriptive analysis of the data, followed by the network visualizations of the citation patterns of key authors and journals within behavioral economics together with geographic and institutional relations. The final section concludes and presents possible avenues for future research.

Data and Method

Gathering a body of literature

To extract citation data for a given research area using bibliometric tools, a corpus of relevant literature must be delimited. While the corpus need not be a complete inventory of relevant publications for bibliographic methods to be successful, it should not have too many irrelevant entries (Thor et al., 2017). We open the scope of the study to include non-journal sources within the citations. Due to the applied nature of behavioral economics, policy documents may play an important role in the communicative practice of the field; moreover, key books, such as Thaler and Sunstein's *Nudge* (2008), could be central in the network.

Instead of relying on citation data from entire journals, Boolean keyword searches in the ISI Web of Science capture relevant texts from across the entirety of available academic literature. A key challenge in Boolean searches is the trade-off between recall (number of results) and precision (number of relevant results): Loose search terms will generate a high recall and a large number of irrelevant texts, whereas tight search terms will generate a limited number of results but with fewer irrelevant results (Hayes and Weinstein, 1990). The present study simply uses the search term “behavioral economi*” to retrieve articles published in the period 1956–2016 in the Social Sciences Citation Index, giving a very precise search term reflecting the mainstream of behavioral economics research. The search term captures both American and British spelling as well as singular and plural forms. Citation data contains spelling mistakes and other irregularities requiring data cleaning. We manually identified and corrected misspellings for authors and journals with at least 15 citations.

Identifying seminal works

Reference Publication Year Spectroscopy (RPYS) is a quantitative method which traces out the historical roots of a research area by examining cited references and referenced publication years, identifying seminal texts and their impact on current research (Bornmann et al., 2016; Leydesdorff et al., 2014; Marx et al., 2014). RPYS maps aggregate reference behavior within a given research field or corpus of texts, encompassing the advancement of its history through the communities that carry it forward (Leydesdorff et al., 2014). Most research articles cite recent specialist literature, with a steep decline in references going

further back in time (Marx et al., 2014). RPYS highlights distinct citation peaks within the history of a research field, which are usually composed of a few highly cited publications that constitute the historical roots of the field. As a given research field becomes more established, the references contained within these citation peaks are no longer inhabited by seminal works and are instead distributed among numerous newer contributions. Thaler (2015) argues that early economists such as Adam Smith were in fact pioneers of behavioral economics, but the history may not be as deep as in scientific fields such as physics (Leydesdorff et al., 2014). We therefore use the start of the 18th century as the cut-off year for exploring historical texts, examining the emerging RPYS citation peaks up until 1965.

Examining similarity and centrality in the network of behavioral economics

Distance and similarity are the two primary methods for computing the relations between journals and scholars. Distance measures concern, for example, the number of citations between two journals or authors. Alternatively, this study employs a form of similarity measure termed “bibliographic coupling.” Rather than studying directed citations from Journal A to Journal B, we utilize bibliographic coupling to study co-occurrence, which implies how likely it is that Journal C references both Journal A and Journal B. If Journals A and B appear in Journal C, it indicates that they share similar characteristics (Freeman, 1978). We use bibliographic coupling to analyze the citation structure of 1872 articles on behavioral economics consisting of 104,558 citations, covering the entire period 1956–2016. We cannot expect this sample to contain a complete inventory of the literature on behavioral economics; instead, it represents the most mainstream works in the field.

Since the citation data used in this study is based on co-occurrence, the concept of “centrality” can help pinpoint key nodes within the network. More precisely, measuring “betweenness centrality” allows for the investigation of the interdisciplinarity of the field (Leydesdorff, 2007; Leydesdorff and Rafols, 2011). Betweenness centrality reflects the extent to which a node serves as a nexus of the shortest paths between other nodes within a network (Leydesdorff, 2007). If communication travels through the shortest pathway in a network, then a node linking several of the shortest paths will essentially control the flow of information (Freeman, 1978). A node with high betweenness centrality is thus crucial for the constitution of the network—if this node were to disappear, the network would collapse into disjointed clusters (Leydesdorff, 2007). Centrality is sensitive to highly cited journals, requiring normalization to

suppress this effect; for example, *Nature* or *Science* may inherently generate high betweenness centrality (Leydesdorff, 2007).

Ahlgren, Jarneving and Rousseau (2003) propose using cosine for the purpose of normalization due to the high skew of citation distributions, which is supported by growing consensus among bibliometricians (Leydesdorff, 2007). Cosine normalization converts values on a 0–1 scale and provides a similarity measure rather than a distance measure (Leydesdorff and Rafols, 2011). When using cosine, a threshold must be set because citation patterns of locally related journals are almost never equal to zero, resulting in a dense, difficult-to-read network (Leydesdorff, 2007). There are no set rules for the cosine threshold, requiring some systematic testing to achieve a good tradeoff between explanatory power and readability (Leydesdorff, Rafols and Chen 2013). We used minimum cosine thresholds of 0.2 to enhance the visualization of the networks of authors and journals. To further enhance readability, we include only journals and authors that account for at least 0.2 and 0.1 percent of the total references for their networks, respectively. This leaves a total of 81 journals and 78 authors for the analysis. The graph layout of the visualization is driven by the force-directed Fruchterman–Reingold algorithm (Fruchterman and Reingold, 1991). The algorithm iteratively minimizes the energy of the network by forcing vertices apart, while assigning an attractive force to connected vertices.

Of further interest is the structural form of the network of behavioral economics. Certain groups of journals or authors may exhibit dense communication patterns, with relatively fewer citations across these groups. Identifying such clusters allows us to highlight the interdisciplinarity within behavioral economics, which occurs within the specialized interface between fields of science (Leydesdorff, 2007). This is helpful for understanding subjects such as behavioral economics, which claim to draw on multiple research traditions. We utilize the Louvain algorithm for community detection due to its efficiency in the analysis of large networks (Blondel et al., 2008).

Analysis

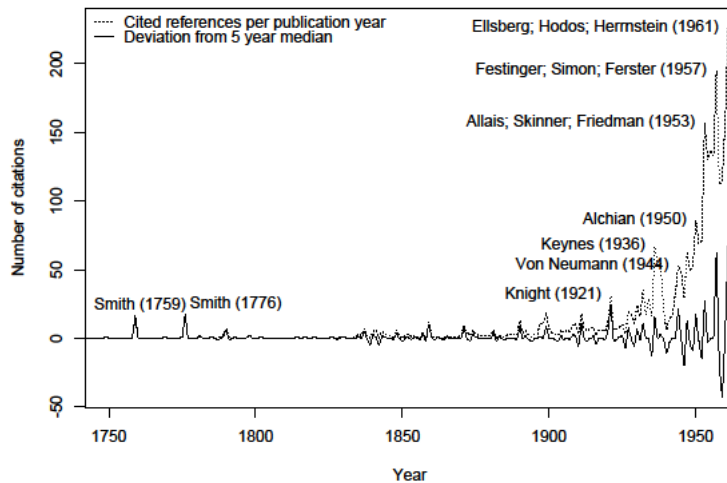
Formative authors and works

Encapsulating the formative authors and works of a research field systematically used to be challenging when applying bibliometric techniques, as most fields emerge slowly and lack clearly demarcated perimeters from the outset. By using the RPYS algorithm, however, it becomes possible to trace the historical roots of disciplines, fields and authors. Figure 1 shows the output of the RPYS analysis of behavioral

economics (1750–1965), whereas the online appendix contains the key progenitors of the field of behavioral economics.

Two seminal books by Adam Smith (1776, 2002), who is considered the forefather of neo-classical economics, have been formative for behavioral economics: *The Theory of Moral Sentiments* from 1759 and *An Inquiry into the Nature and Causes of the Wealth of Nations* from 1776. Smith's appearance is partly due to the fact that behavioral economics challenges some of his key ideas, such as the "invisible hand" and "rational self-interest," as expressed in *The Wealth of Nations*. Smith has also pioneered key thoughts, however, such as the constant fight within a person between "passions" and the "impartial spectator" in *The Theory of Moral Sentiments* (Ashraf et al., 2005; Camerer and Loewenstein, 2004; Oliver, 2017; Thaler, 2015). This fight encapsulates ideas from behavioral economics, including "loss aversion, intertemporal choice and overconfidence" (Ashraf, Camerer and Loewenstein 2005: 132). The next influential author linked to behavioral economics is Frank Knight and his 1921 book, *Risk, Uncertainty, and Profit*. Knight is overlooked in the history of behavioral economics, although he introduced the important distinction between "risk" and "uncertainty." Making decisions in the face of risk and uncertainty is a mainstay of behavioral economics. The distinction was further developed by John Maynard Keynes in his 1936 book, *General Theory of Employment, Interest and Money*. Here, Keynes coined the term "animal spirits" to describe the spontaneous behavior of humans in economic situations who are driven more by emotional impulses than rational calculations. The final influential work from the early days is *Theory of Games and Economics Behavior* from 1944 by John von Neumann and Oskar Morgenstern, which develops the so-called expected utility theory, which mathematically describes the rational choices an actor *should* make to maximize utility. While prospect theory, developed by Kahneman and Tversky (1979), is sometimes seen as the rival of expected utility theory, this is not completely accurate. The former is a positive theory about how humans actually make choices, whereas the latter is a normative theory about how they should make choices to act like *homo economicus*, the personification of economic man (Thaler 2015).

Figure 1. Reference Publication Year Spectroscopy, 1750-1955



In the 1950s—the heyday of behaviorism—we find several texts explicitly challenging standard economic axioms. Armen A. Alchian’s article from 1950, “Uncertainty, evolution, and economic theory,” incorporates incomplete information and uncertain forecasts in the model of profit maximization as a corrective to standard economic theory. The model challenges the assumption of reference independence, which was later confirmed by studies conducted by Amos Tversky and Daniel Kahneman. “Le comportement de l’homme rationnel devant le risque: Critique des postulats et axiomes de l’ecole Americaine” from 1953 by Maurice Allais, acknowledged as a significant source of inspiration for Tversky and Kahneman, criticizes the idea that humans make informed decisions based on an accurate calculation of probabilities. The psychologist B.F. Skinner’s book from 1953, *Science and Human Behavior*, develops some of the key concepts of behaviorism, including positive and negative reinforcement. The mechanisms of reinforcement provide the micro-foundation for incentives in behavioral economics. Milton Friedman’s *Essays in Positive Economics*, also from 1953, makes the powerful argument that rational humans might not follow standard economic assumptions but that they nevertheless act in aggregate as if they do. He further states that economic models should not be judged in terms of their realism but rather their predictive power. The book is quoted in behavioral economics, where they are criticized for their unrealistic “as if” argument, which shielded the unrealistic axioms of rational choice theory for many years (Thaler 2015). Leon Festinger’s 1957 book, *A Theory of Cognitive Dissonance*, applies various bridging approaches to illuminate the discrepancy between cognition and action. In the collective memory of behavioral economics, Festinger is primarily remembered for his physical presence in different contexts rather than his theory of cognitive dissonance per se (Heukelom 2014; Thaler 2015). Nevertheless, the theory,

which states that when there is dissonance between an individual's beliefs and behavior, they will tend to alter the former rather than the latter or avoid situations or information provoking this dissonance, has been influential within behavioral economics. Herbert Simon's formative book, *Models of Man: Social and Rational: Mathematical Essays on Rational Human Behavior in a Social Setting*, introduces the now-famous concept, "bounded rationality." While Simon is now widely recognized as one of the progenitors of behavioral economics, this concept did not receive widespread attention at the time (Kahneman 2003; Thaler 2015, 2016). Kahneman and Tversky gradually changed the idea from a metaphor to a theoretical mechanism with a strong empirical micro-foundation by demonstrating how individuals suffer from systematic biases when making decisions. *Schedules of Reinforcement*, by Charles B. Ferster and B.F. Skinner from 1957, has, like Skinner's earlier book, become formative for the study of behaviorism. By using experiments with pigeons, the two authors uncovered systematic reinforcing behavioral patterns measured in terms of response rate as an indicator of strength. These schedules of reinforcement are also applicable to humans and have been important for ideas such as the automatic system and heuristics developed by Kahneman and Tversky.

Moving into the 1960s, we find three seminal texts published in 1961. "Risk, ambiguity, and the savage axioms," by Daniel Ellsberg, who, inspired by the work of Frank Knight and John Maynard Keynes, proposes what is today known as the Ellsberg paradox. According to this paradox, most individuals violate the axioms of subjective expected utility by preferring poor known odds over favorable unknown odds. "Progressive ratio as a measure of reward strength," by William Hodos, follows Ferster and Skinner by using experiments with animals—in this case studying reinforcement rates to uncover behavior mechanisms. Hodos demonstrates that the smaller the reward, the less likely a behavioral pattern will be reinforced, and that at some point the reward becomes so small that it is no longer worth the effort (i.e. the breakpoint). "Relative and absolute strength of response as a function of frequency of reinforcement," by Richard J. Herrnstein, is the final formative text for the field of behavioral economics. Herrnstein, who was involved in the pigeon experiments conducted by Ferster and Skinner, proposes the matching law; put simply, the law states that the attention an organism gives to different options is proportional to the amount of reinforcement it receives from them.

The RPYS analysis concerning the formative authors of behavioral economics reveals that the field stands on the shoulders of giants in economics, including Adam Smith, Frank Knight and John Keynes. Their early works include the idea that humans are neither rational nor do they have complete

information when making decisions. From the 1950s onwards, a strong influence from behaviorism and psychology can be traced. The focus of these studies is on how creatures actually behave and the underlying schedules behind their actions. Here, existing reviews of the history of behavioral economics seem slightly biased in favor of the economists and political scientist Herbert Simon, whereas they seem to disremember the contributions made by psychologists like B.F. Skinner, Leon Festinger, Charles Ferster, William Hodos and Richard J. Herrnstein.

Influential authors and texts

Having identified the authors and sources that stimulated behavioral economic thought, we can now turn to the heavyweights in the field and their most influential works. Table 1 presents the pantheon of behavioral economists and their most quoted texts (see online appendix for an extended version). In contrast to other studies, which focus on the most quoted scholars dealing with behavioral economics in general, the table presents the most quoted works *within* the studies that explicitly write under the label.

While the influence of early behavioral psychologists seems somewhat overlooked, the significance of psychologists Daniel Kahneman and Amos Tversky is widely recognized when telling the story of behavioral economics (Camerer & Loewenstein 2004; Sent 2004; Thaler 2015). Next to the works of Kahneman and Tversky, the importance of Richard H. Thaler is also confirmed, together with legal scholar Cass R. Sunstein (especially when looking at appendix 2). Thaler's importance to behavioral economics is also reflected in the fact that a number of his students have been co-founders of the field and are among the most quoted in the pantheon (for example, Colin F. Camerer and George Loewenstein).

“Prospect theory: An analysis of decision under risk,” an article published in *Econometrica* in 1979, where Kahneman and Tversky introduce the aforementioned prospect theory as an alternative to Expected Utility Theory, resides at the top of the pantheon. The text demonstrates that actors are willing to take greater risks if they stand to lose, whereas they are risk-averse when they stand to win. In second place we find Richard H. Thaler & Cass R. Sunstein's popular science book, *Nudge: Improving Decisions About Health, Wealth, and Happiness*, which is rather remarkable, given that it was published only ten years ago in 2008. While behavioral economics had already been on the rise academically following the awarding of the Nobel Prize in Economics to Daniel Kahneman in 2002, the book paved the way for the awareness of the field in the broader public and how insights can be used to improve human wellbeing (Bogliacino, Codagnone and Veltri 2016). The book introduces the idea of a “nudge,” which is an attempt

at utilizing various heuristics and biases to influence people to make better choices. The third most influential text is “Judgment under uncertainty: Heuristics and biases,” by Amos Tversky and Daniel Kahneman from 1974, which elaborates the concepts of heuristics and bias that are the foundation of prospect theory and now considered the bedrock of behavioral economics. Through experimental studies, the text demonstrates various types of heuristics that actors use when making judgment under uncertainty. While heuristics may reduce complexity and save time, they lead to systematic biases in decision making. An example is the availability heuristic whereby actors make decisions based on the last instances that they can recall, which might not be accurate and therefore leads to biases.

David Laibson’s “Golden eggs and hyperbolic discounting,” published in *The Quarterly Journal of Economics* in 1997, challenged the classic model of time-consistent preferences by developing an alternative model with time-inconsistent preferences. The model thus bridges the gap between the present irrational self that maximizes utility to the detriment of its future self. While behavioral economics is sometimes characterized by incorporating empirical mechanisms from psychology into economics, “Economic concepts for the analysis of behavior,” by Steven R. Hursh (1980) and “Economic demand and essential value,” by Steven R. Hursh and Alan Silberberg (2008), turn this upside down. These texts import ideas from economics into psychology and behavioral studies more generally, including whether the systems under investigation are open or closed, reinforcers’ level of elasticity, the interaction between reinforcers (complementary/substitution) and variation in choice rules. Ernst Fehr and Klaus M. Schmidt’s 1999 article, “A theory of fairness, competition, and cooperation,” provides a theoretical model which can explain earlier findings by Kahneman, Knetsch and Thaler (1986), who had shown that customers are concerned with fairness, which explains why some companies do not maximize short-term profits, even though their market position would allow them to do so, for fear of being punished. The model also explains why the vast majority of individuals cooperate rather than act according to the prediction of the standard self-interest model in games like the ultimatum game, the public good game and the gift exchange game.

“Regulation for conservatives: Behavioral economics and the case for asymmetric paternalism,” by Colin F. Camerer, Samuel Issacharoff, George Loewenstein, Ted O’Donoghue and Matthew Rabin (2003), is a part of the debate within behavioral economics on paternalism, with which two further texts in the extended pantheon by Richard H. Thaler and Cass R. Sunstein also take issue (see appendix

3). This debate concerns how to balance between, on the one hand, using insights from behavioral economics in law to prevent citizens from doing harm to themselves, and respect for the individual freedom of choice on the other. The proponents of using behavioral insights argue that they are more efficient and targeted, whereas the opponents point out the difficulties in determining what constitutes irrational behavior where it is justifiable to correct it. The specific notion of “asymmetric paternalism” points to the fact that it is possible for authorities to act paternalistically toward people behaving with bounded rationality, while at the same time avoiding regulating people who act rationally.

Steven R. Hursh, Thomas G. Raslear, David Shurtleff, Richard Bauman and Laurence Simmons’ “A cost–benefit analysis of demand for food” from 1988 uses experiments with rats to further tease out the mechanisms of behavioral reinforcement as originally established by B.F. Skinner, Leon Festinger, Charles Ferster and William Hodos. Amos Tversky and Daniel Kahneman’s 1992 article, “Advances in prospect theory: Cumulative representation of uncertainty,” advances their prospect theory further by showing how behavior varies according to the probability of gains and losses.

Looking beyond these different items, the knowledge base of the field is comprised of journal articles and a few books produced by psychologists, economists, a legal scholar and a political scientist (see online appendix). The field is strongly dominated by men.

Table 1. Pantheon of behavioral economists and their most quoted texts

Kahneman & Tversky	Psychology	1979	Prospect theory: An analysis of decision under risk	<i>Econometrica</i>	316
Thaler & Sunstein	Economics and law	2008	<i>Nudge: Improving Decisions About Health, Wealth, and Happiness</i>	Book	235
Tversky & Kahneman	Psychology	1974	Judgment under uncertainty: Heuristics and biases	<i>Science</i>	148
Laibson	Economics	1997	Golden eggs and hyperbolic discounting	<i>Quarterly Journal of Economics</i>	122
Hursh	Psychology	1980	Economic concepts for the analysis of behavior	<i>Journal of the Experimental Analysis of Behavior</i>	112
Hursh & Silberberg	Psychology	2008	Economic demand and essential value	<i>Psychological Review</i>	109

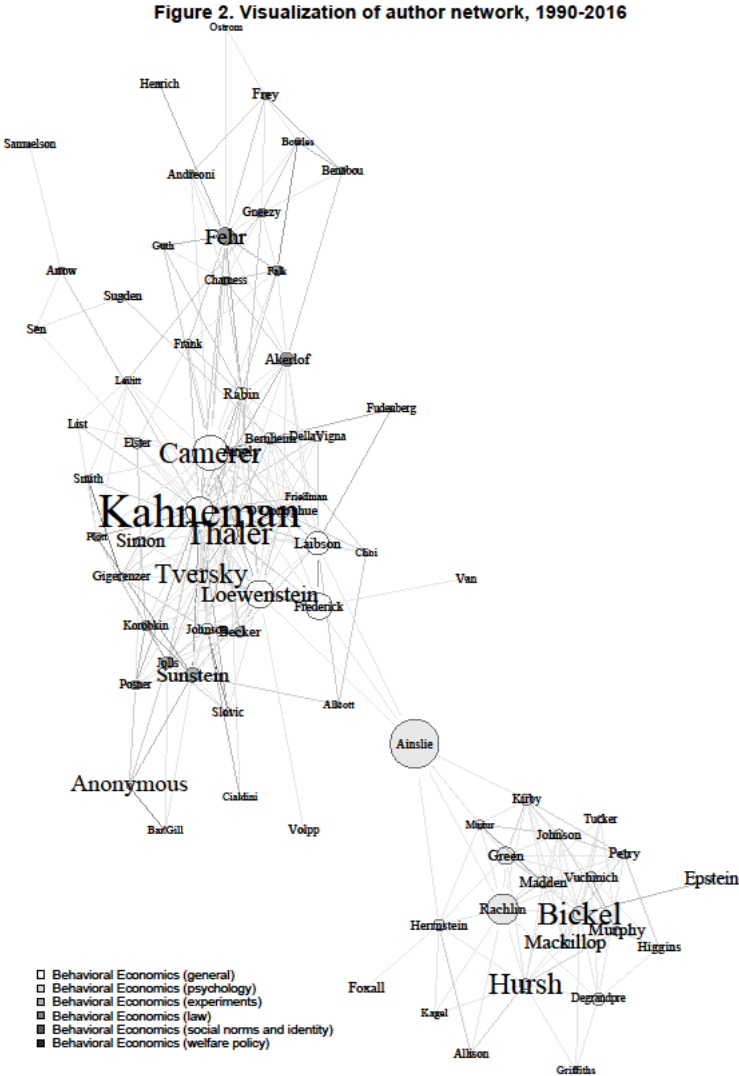
Fehr & Schmidt	Economics	1999	A theory of fairness, competition, and cooperation	<i>Quarterly Journal of Economics</i>	101
Camerer, Issacharoff, Loewenstein, O'Donoghue & Rabin	Economics and law	2003	Regulation for conservatives: Behavioral economics and the case for asymmetric paternalism	<i>University of Pennsylvania Law Review</i>	97
Hursh, Raslear, Shurtleff, Bauman & Simmons	Psychology	1988	A cost–benefit analysis of demand for food	<i>Journal of the Experimental Analysis of Behavior</i>	96
Tversky & Kahneman	Psychology	1992	Advances in prospect theory: Cumulative representation of uncertainty	<i>Journal of Risk and Uncertainty</i>	95
Tversky & Kahneman	Psychology	1981	The framing of decisions and the psychology of choice	<i>Science</i>	95
Frederick, Loewenstein & O'Donoghue	Decision science and Economics	2002	Time discounting and time preference: A critical review	<i>American Economic Association</i>	95
Kahneman	Psychology	2003	Maps of bounded rationality: Psychology for behavioral economics	<i>American Economic Review</i>	89
Hursh	Psychology	1984	Behavioral economics	<i>Journal of the Experimental Analysis of Behavior</i>	89
Kahneman	Psychology	2011	<i>Thinking, Fast and Slow</i>	Book	87

Visualization—authors

Having looked at aggregated citations, the next step is to examine the relational character between authors in terms of who is being referenced together. Figure 2 traces the network of authors working in behavioral economics. The citation pattern of these authors crystalizes the dual-core nature of the field, which combines economics and psychology. Interestingly, further sub-disciplines emerge from the network, depicted by different colored nodes. Darker edges between nodes represent higher levels of similarity, while the relative size of author names reflects their share of total citations. Node size reflects the author's betweenness centrality within the network.

The largest cluster contains highly cited and central authors in the economic side of the network, including two of the early drivers of behavioral economics: Kahneman and Thaler. While their

respective research partners, Tversky and Sunstein, are less central, this can partly be attributed to how the bibliometric algorithm constructs the network based on the first author of a given text. Surprisingly, these heavyweights are not the most central when considering the network as a whole. Younger behavioral economists serve as mediators bridging the gap between psychology and economics, with a common interest in time-inconsistent preferences. Loewenstein’s key works pertain to intertemporal choice within economics utility models (Loewenstein and Prelec 1992) and more psychologically influenced research on self-control and visceral factors, such as drug addiction (Loewenstein 1996). We also find David Laibson, known for his work on hyperbolic demand curves (Laibson, 1997).



To the north of the main cluster is a group of authors predominantly known for weaving social norms into economics research. Key concepts applied by these researchers include identity (Akerlof

and Kranton, 2000), institutions (Ostrom, 1990) and fairness (Fehr and Schmidt, 1999). Moving counter-clockwise, we find researchers in welfare economics and policy, including well-known authors such as Amartya Sen and Paul Samuelson. Arrow (1963) is the most central author in this cluster, known for showing how imperfect consumer information in healthcare may lead to market inefficiency, calling into question fundamental assumptions of market equilibrium. Next, we find a small group providing experimental evidence that raises questions regarding key concepts, such as prospect theory (Plott and Zeiler 2005), while others find that lab results may both overstate and underplay the importance of social preferences (Levitt and List 2007). Legal scholars known for kick-starting the behavioral approach to law dwell to the south of the main cluster (Jolls, Thaler, and Sunstein 1998; Korobkin and Ulen 2000).

On the opposite side of the map is the second-largest cluster, comprised mainly of psychologists and psychiatrists. These authors largely incorporate behavioral economics into research on behavioral reinforcement and rewards, such as hyperbolic discounting in gambling (Rachlin, Raineri & Cross 1991) and delay-discounting to investigate impulsivity in drug addicts (Kirby, Petry & Bickel 1999; Bickel, Marsch & Carroll 2000). While not the most cited author in the network, American psychologist George Ainslie is quite clearly the strongest binding agent in it, serving as the interface between the domains of psychology and economics. Ainslie's (1975; 1992) work primarily concerns the impact of delayed rewards on choice among both human and non-human subjects, where more immediate rewards are preferred to future rewards, as implied by hyperbolic discounting. His conceptualization of the inter-temporal bargaining between these present and future “selves” remains among his key contributions. The shared interest in this inner struggle appears to be the tie that binds psychologists and economists together in the field of behavioral economics.

Viewing behavioral economics scholars as a temporal network (see the animation in the Online Appendix) reveals the early influence of behavioral psychologists in developing the field, particularly Steven Hursh. The influence of Kahneman, Thaler and other heavyweights is first felt in the early 2000s. Distinct disciplinary sub-communities emerge among the economists in 2011, while the psychologists gradually shrink into one community. Meanwhile, the disciplinary boundary between the two cores of behavioral economics becomes more clearly etched over time as the field matures.

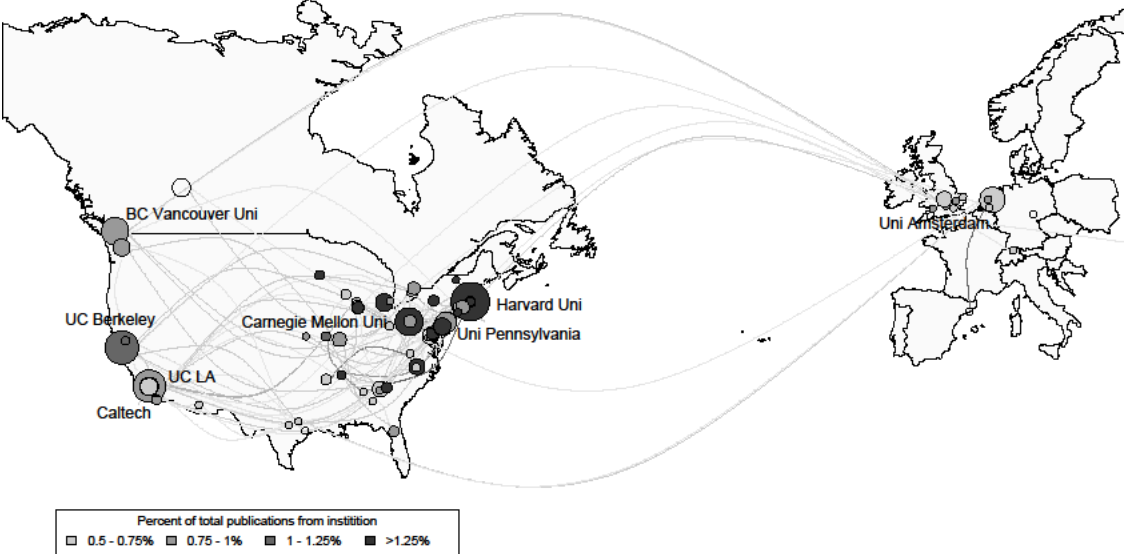
The geography of behavioral economics

We can also use bibliometric tools to map out the spatial relations of behavioral economics (Leydesdorff and Persson, 2010). Figure 3 depicts the institutional co-occurrence among the corpus of texts. A dense

web of connections interweaves the American universities together with notable transatlantic connections to universities in Canada, the United Kingdom and the Netherlands. The network depicts the domination of American coastal universities, which create central pathways and generally have the largest share of publications.

Several University of California campuses are among the top institutions in terms of the flow of information within behavioral economics. Most notably, the University of California Berkeley plays a gatekeeping role in the network and was pivotal in the proliferation of behavioral economics. In 1987, psychologist Daniel Kahneman and economist George Akerlof taught one of the first interdisciplinary courses on behavioral economics, both going on to win the Nobel Prize in Economics. Today, the university has a dedicated Initiative for Behavioral Economics and Finance, co-directed by Stefano DellaVigna, another key author and central economist in the network.

Figure 3. Visualization of institutional network, 1990-2016



The University of Pennsylvania is similarly influential. Notably, the institution houses the Center for Health Incentives & Behavioral Economics (CHIBE), headed by Professor of Medicine Kevin Volpp. Professor of Economics and Psychology George Loewenstein is the director of the University’s Roybal Pilot Program under CHIBE, focusing on applying behavioral economics to real-world health

problems. Loewenstein is also the co-director of the Center for Behavioral Decision Research at Carnegie Mellon University, another key institution seeking to design and test behavioral interventions to inform policymaking. Carnegie Mellon also has substantial historical significance, as it is Herbert Simon's alma mater.

Unsurprisingly, several of the key institutions in the network are found in the city of Cambridge, Massachusetts. The Department of Behavioral Economics at Harvard is chaired by David Laibson, and further notable staff include Matthew Rabin and Sendhil Mullainathan, both professors of economics. Mullainathan's absence from the network of top authors is curious, as he is considered a key scholar of "new" behavioral economics (Sent, 2004). MIT houses the Sloan Neuroeconomics Lab, a research center studying anomalous decision making through behavioral economics and neuroscience. MIT's Drazen Prelec is also absent from the list of key authors, despite his contributions to neuroeconomics—a combination of behavioral economics and neuroscience.

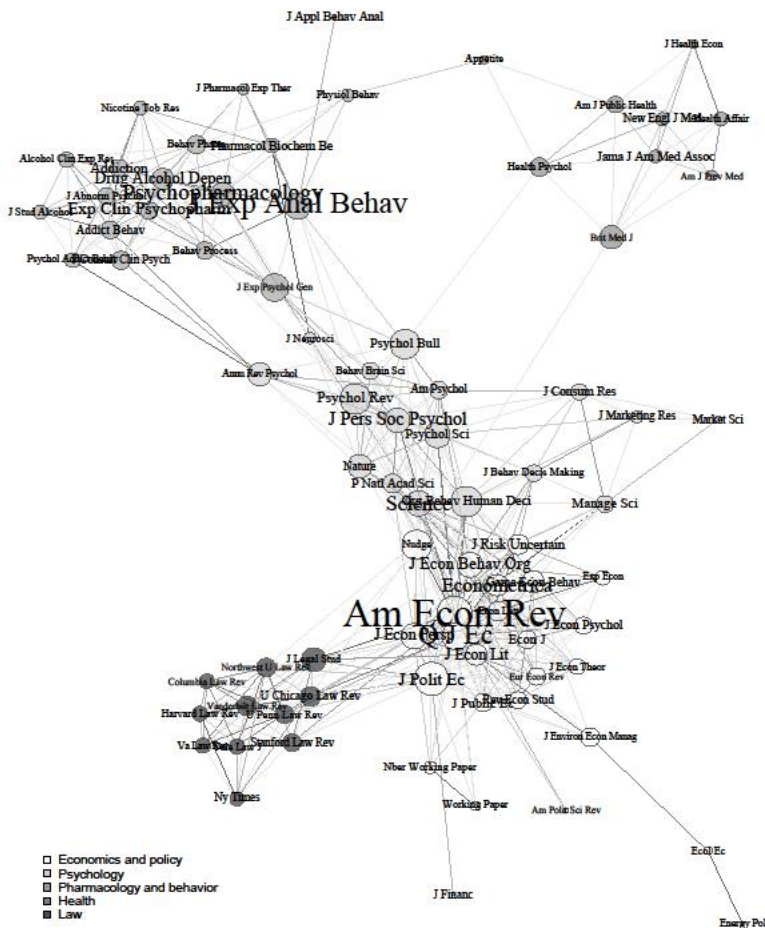
The lack of central non-academic institutions is surprising, considering how institutions such as the World Bank, European Commission and OECD have published their own reports on the policy applications of behavioral economics (OECD, 2017; Sousa Lourenço et al., 2016; World Bank, 2015). For not to forget the establishment of dedicated units using behavioral economics, such as the United Kingdom's prolific Behavioural Insights Team. The sole exception is the National Bureau of Economic Research (NBER), a private research institution based out of Cambridge, Massachusetts. NBER played a formative role in behavioral economics in the 1980s, providing funding opportunities and workshops for young economists who were interesting in drawing on psychology (Heukelom, 2007). The institution continues to host conferences on behavioral economics and publishes working papers by key authors in the field (Sent, 2004).

Visualization—publication outlets

As the final step on the journey in behavioral economics, this section maps out the network of journals and books engaging with behavioral economics (Figure 4). We highlight the most important sources in each disciplinary cluster judged by their betweenness centrality. We then identify the main contributions of the most central publication outlets to behavioral economics in terms of their most cited works. The dual influence of economics and psychology also becomes evident in the visualization of publication citation patterns, where these two research fronts can be clearly identified as the center of the network, bridging together the more peripheral fields such as law, health and behavioral pharmacology.

The largest cluster consists of traditional economics journals as well as political science journals and the book *Nudge*. Several journals within the cluster of journals are highly central to the network in terms of betweenness centrality. Highest is the *American Economic Review*, publishing the article based on Kahneman's (2003) Nobel prize acceptance speech, O'Donoghue and Rabin's (1999) work on present-biased preferences, and Thaler and Sunstein's (2003) much-debated article on the paradoxical libertarian paternalism concept. Thaler and Sunstein's (2008) highly accessible and successful behavioral economics best-seller *Nudge* also plays a central role, serving as gatekeeper between the fields of economics and policy and the medical journals in the network. Interestingly, *Nudge* establishes this connection through the *British Medical Journal*. Considering that the British were pioneers in the nudging movement with the establishment of the Behavioral Insights Unit, this is a logical connection, especially considering the widespread use of nudging in healthcare.

Figure 4. Visualization of journal network, 1990-2016



West of the economics and policy cluster we find a tightly woven community of law journals. The legal cluster also includes *The New York Times*, known for publishing popular science articles on behavioral economics (Sent, 2004). The central system of economics journals serves as the communicative pathway for knowledge from the field of law to the rest of the network. If we removed these economics journals, law would become isolated, as there are no direct routes to other research fields. The dense connections between law journals indicate a strong level of bibliometric co-occurrence, suggesting that legal scholars in behavioral economics are highly specialized and tend to be cited alongside other works from within their field. The *Journal of Legal Studies* and the *University of Chicago Law Review* are most central within the legal community, adjoining the legal field with economics and policy journals.

Journal of Legal Studies includes works such as Gneezy and Rustichini's (2000) novel piece demonstrating that fines have the opposite effect when aimed at reducing tardiness among parents picking up their children from daycare, as well as Jolls and Sunstein's (2006) proposal to address the limits of bounded rationality through legal strategies that can steer people toward more rational behavior. The *University of Chicago Law Review* puts forth another of Sunstein and Thaler's (2003) masterpieces on libertarian paternalism, as well as Glaeser's (2006) follow-up rebuttal to the concept, arguing that systematic biases in human decision-making should make us *more* wary of government intervention rather than serving as a justification for paternalistic policies.

Moving north from the economics and policy community, we find an influential cluster consisting of psychology journals, as well as the high-impact general science journals *Nature* and *Science*. The central *Psychological Bulletin* publishes Lea's (1978) examination of the relation between the traditional economic demand curve and behavioral reinforcement theory, Ainslie's (1975) use of economics and social psychology to examine impulsiveness, and a psychological study of the role of emotion in decision-making under risk by Loewenstein et al. (2001). *Psychological Review* is the most central, publishing Hursh and Silberberg's (2008) work utilizing behavioral economics methods with nonhuman subjects to assign value to behavioral reinforcements, Gigerenzer and Goldstein's (1996) usage of algorithms to investigate the limits of rationality, as well as further contributions from behavioral economics heavyweights such as Simon, Kahneman and Tversky. *Science* is at the frontier between economics and psychology. Its central location is sensible due to its generally high impact factor and the fact that it does not focus on a specific research field but is a general interest journal, allowing it to publish contributions from psychology, economics and so forth. Notably, *Science* published two of Tversky and Kahneman's (1974, 1981) classic works on heuristics, biases and framing, as well as Johnson and Goldstein's (2003) influential piece revealing how default settings (i.e. opt-in vs. opt-out) influence choice regarding organ donation. While *Science* is at the interface between the two core fields, the *Psychological Bulletin* and *Psychological Review* connect to research on behavioral pharmacology and addiction research, as well as medicine.

A community of journals within the fields of behavioral pharmacology and substance abuse research lie north of the central psychology cluster. The *Journal of the Experimental Analysis of Behavior* publishes several of Hursh's (1980, 1984; Hursh et al., 1988) early contributions to the field of behavioral economics, which borrow economic concepts to develop a more nuanced science of behavioral psychology. Additionally, *Psychopharmacology* publishes several works by Bickel et al. (1995; 1999; 2000) that

incorporate behavioral economics concepts such as hyperbolic discounting into pharmacological research, implying that the efficacy of drug reinforcement may be heterogeneous.

The final community consists of medical journals connecting to both the psychology and the economics and policy networks, with a weaker connection to the field of pharmacology. *Health Psychology* bridges the gap to the psychology cluster, publishing works including behavioral economics analyses relating to childhood obesity and snacking behavior (Epstein et al., 1991; Goldfield and Epstein, 2002). In the *British Medical Journal*, key articles mainly concern policy aspects, including critical reflections and potential pitfalls regarding the use of nudging and behavioral economics to tackle health problems (Loewenstein et al. 2012; Marteau et al. 2011).

The temporal network of journals shows the early dominance of psychological journals, with the cluster of economic journals gradually growing in influence through the 2000s both in terms of the number of citations and network centrality (see Online Appendix). Initially the network is largely amorphous in terms of disciplinary structure, but these divisions crystalize as time progresses.

Conclusion

This article systematically mapped the field of behavioral economics by analyzing citation data from the Web of Science using advanced bibliometric methods. In so doing, it has provided empirical evidence on the authors, geography and publication outlets that together constitutes the morphing field of behavioral economics.

The first part focused on the formative authors for the field, highlighting the importance of Adam Smith, Frank Knight, John Keynes and Herbert Simon. It also illuminated the somewhat forgotten ancestors from behavioral psychology, including B.F. Skinner, Leon Festinger, Charles Ferster, William Hodos and Richard J. Herrnstein. Looking at the cumulative knowledge base measured in terms of quotes, the study confirmed the well-known influence of Daniel Kahneman and Amos Tversky as well as Richard H. Thaler, Cass R. Sunstein, Colin F. Camerer and George Loewenstein. As with the forerunners in the field of behavioral economics, however, there seems to be a blind spot regarding behavioral psychologists. The list of the most quoted works includes several texts by psychologist Steven R. Hursh, who wrote under the label “behavioral economics” several decades before the term gained widespread attention. Behavioral economics is not merely a field where psychology has provided evidence-based axioms and theories for economics but also where reverse cross-pollination has taken place: ideas from economics have consolidated studies of especially reinforcing schedules in psychology. This also becomes evident when

moving beyond the basic citation frequencies to consider the relational aspects in terms of author networks. Here, two main clusters emerge: one comprising scholars writing within mainstream behavioral economics and another consisting of behavioral psychologists. The network analysis of authors also illuminated several sub-clusters of scholars dealing with issues including social norms and identity, law, welfare policy and behavioral economics experiments.

The second part addressed the geography of behavioral economics, demonstrating a strong Anglo-Saxon core. This might be unsurprising given that behavioral economics had its epicenter in the US and most of the key scholars in the field work at Anglo-Saxon universities. In terms of institutions, the study revealed the key role of University of California Berkeley, Harvard University and University of Pennsylvania in terms of knowledge production and network centrality.

The third and final part of the paper examined the means of communication in the field in terms of central journals and books. Compared to the more granular author-level analysis, the network of publication outlets demonstrated that the field is composed of and draws on five sub-areas: 1) economics and policy, 2) psychology, 3) pharmacology and behavior, 4) health and 5) law. It showed that journals including *American Economic Review*, *Journal of the Experimental Analysis of Behavior*, *Psychological Bulletin* and *Health Psychology* are central for communication in the field. It also provided further evidence of the importance of Thaler and Sunstein's (2008) blockbuster book, *Nudge*.

Having examined the past and present of the field, it is also possible to make some cautious remarks regarding the future. At the author level, we see a strong influence of male scholars educated in economics and psychology, but we hope to see a more heterogeneous composition of authors in terms of educational background and gender in the coming years. At the institutional level, there is currently a strong Anglo-Saxon dominance. The gospel of behavioral economics is becoming increasingly diffuse, however, so we can expect a more geographically diverse set of research hubs in the future. At the journal level, a varied knowledge base can be observed. Yet there is still potential for broadening the scope towards, for instance, neuroscience or sociology. Taken together, behavioral economics is expected to become further pluralized in the future; perhaps to the extent that it will fulfill Thalers' (2017) prophecy and vanish because it has become the standard way of thinking.

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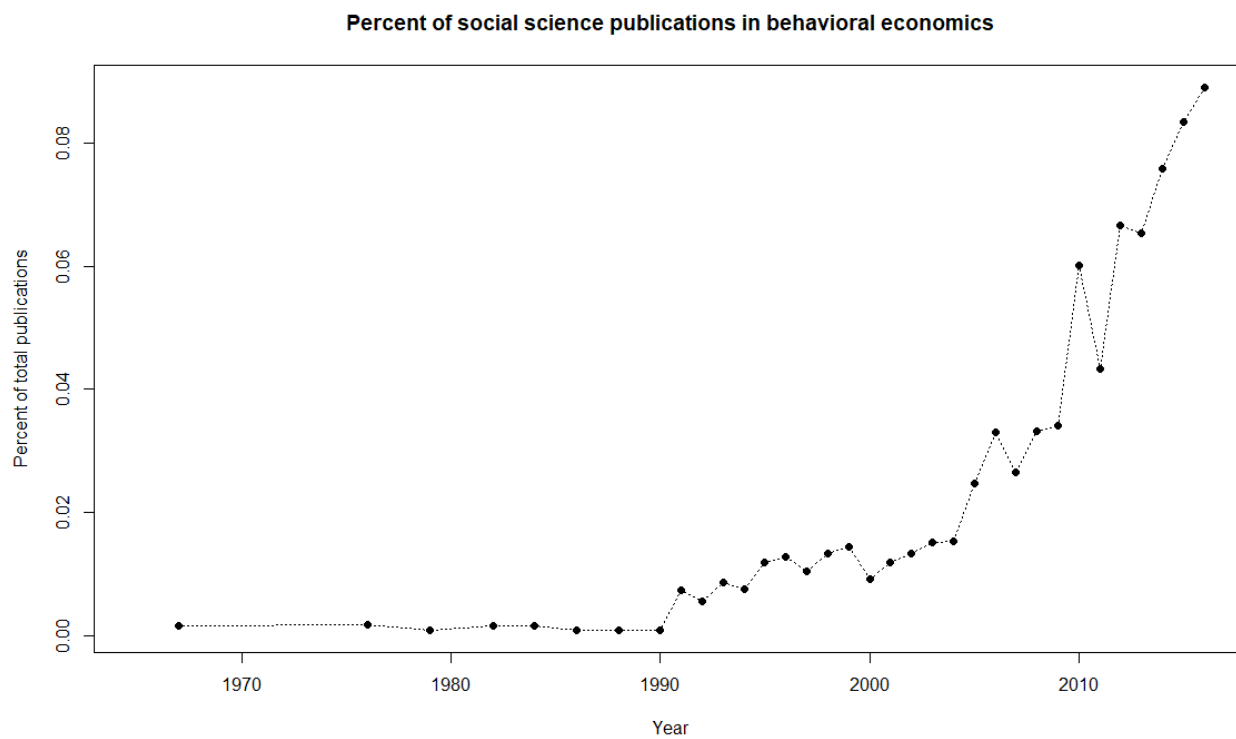
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For Online Publication: Appendix Figure 1: Percentages of articles in the social sciences dealing with behavioral economics



For Online Publication: Appendix Table 1: Key forerunners in the field of behavioral economics

<i>Year</i>	<i>Author(s)</i>	<i>Profession(s)</i>	<i>Title</i>	<i>Source</i>	<i>Citations</i>	<i>Percent of year</i>
1759	Smith	Economics & philosophy	<i>The Theory of Moral Sentiments</i>	Book	15	93.75
1776	Smith	Economics & philosophy	<i>An Inquiry into the Nature and Causes of the Wealth of Nations</i>	Book	13	76.47
1921	Knight	Economics	<i>Risk, Uncertainty and Profit</i>	Book	20	64.52
1936	Keynes	Economics	<i>General Theory of Employment, Interest and Money</i>	Book	29	43.28
1944	Von Neumann & Morgenstern	Mathematics/economics	<i>Theory of Games and Economic Behavior</i>	Book	28	52.84
1950	Alchian	Economics	Uncertainty, evolution, and economic theory	<i>Journal of Political Economy</i>	10	11.62
1953	Allais	Economics	L'extension des Théories de L'équilibre Economique Général et du Rendement Social au cas du Risque	<i>Econometrica</i>	36	22.94
1953	Skinner	Psychology	<i>Science and Human Behavior</i>	Book	25	15.92
1953	Friedman	Economics	<i>Essays in Positive Economic</i>	Book	38	24.21
1957	Festinger	Psychology	<i>A Theory of Cognitive Dissonance</i>	Book	26	13.33
1957	Simon	Political science	<i>Models of Man: Social and Rational: Mathematical Essays on Rational Human Behavior in a Social Setting</i>	Book	28	14.36
1957	Ferster & Skinner	Psychology	<i>Schedules of Reinforcement</i>	Book	17	8.72
1961	Ellsberg	Economics	Risk, ambiguity, and the savage axioms	<i>The Quarterly Journal of Economics</i>	36	15.92
1961	Hodos	Psychology	Progressive ratio as a measure of reward strength	<i>Science</i>	24	10.62

1961	Herrnstein	Psychology	Relative and absolute strength of Response as a Function of Frequency of Reinforcement	<i>Journal of the Experimental Analysis of Behavior</i>	30	13.27
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For Online Publication: Appendix Table 2: Influential authors and works in behavioral economics

<i>Author(s)</i>	<i>Profession(s)</i>	<i>Year</i>	<i>Title</i>	<i>Source</i>	<i>Citations</i>
Kahneman & Tversky	Psychology	1979	Prospect theory: An analysis of decision under risk	<i>Econometrica</i>	316
Thaler & Sunstein	Economics and law	2008	<i>Nudge: Improving Decisions About Health, Wealth, and Happiness</i>	Book	235
Tversky & Kahneman	Psychology	1974	Judgment under uncertainty: Heuristics and biases	<i>Science</i>	148
Laibson	Economics	1997	Golden eggs and hyperbolic discounting	<i>Quarterly Journal of Economics</i>	122
Hursh	Psychology	1980	Economic concepts for the analysis of behavior	<i>Journal of the Experimental Analysis of Behavior</i>	112
Hursh & Silberberg	Psychology	2008	Economic demand and essential value	<i>Psychological Review</i>	109
Fehr & Schmidt	Economics	1999	A theory of fairness, competition, and cooperation	<i>Quarterly Journal of Economics</i>	101
Camerer, Issacharoff, Loewenstein, O'Donoghue & Rabin	Economics and law	2003	Regulation for conservatives: Behavioral economics and the case for asymmetric paternalism	<i>University of Pennsylvania Law Review</i>	97
Hursh, Raslear, Shurtleff, Bauman & Simmons	Psychology	1988	A cost–benefit analysis of demand for food	<i>Journal of the Experimental Analysis of Behavior</i>	96
Tversky & Kahneman	Psychology	1992	Advances in prospect theory: Cumulative representation of uncertainty	<i>Journal of Risk and Uncertainty</i>	95
Tversky & Kahneman	Psychology	1981	The framing of decisions and the psychology of choice	<i>Science</i>	95
Frederick, Loewenstein & O'Donoghue	Decision science and Economics	2002	Time discounting and time preference: A critical review	<i>American Economic Association</i>	95
Kahneman	Psychology	2003	Maps of bounded rationality: Psychology for behavioral economics	<i>American Economic Review</i>	89
Hursh	Psychology	1984	Behavioral economics	<i>Journal of the Experimental</i>	89

Kahneman	Psychology	2011	<i>Thinking, Fast and Slow</i>	<i>Analysis of Behavior</i>	87
O'Donoghue	Economics	1999	Doing it now or later	<i>American Economic Review</i>	81
Samuelson & Zeckhauser	Economics	1988	Status quo bias in decision making	<i>Journal of Risk and Uncertainty</i>	78
Simon	Political science	1955	A behavioral model of rational choice	<i>Quarterly Journal of Economics</i>	73
Murphy & MacKillop	Psychology	2006	Relative reinforcing efficacy of alcohol among college student drinkers	<i>Experimental and Clinical Psychopharmacology</i>	73
Rabin	Economics	1998	Psychology and economics	<i>Journal of Economic Literature</i>	73
Tversky and Kahneman	Psychology	1991	Loss aversion in riskless choice: A reference-dependent model	<i>Quarterly Journal of Economics</i>	72
Thaler	Economics	1980	Toward a positive theory of consumer choice	<i>Journal of Economic Behavior & Organization</i>	71
Bickel, Marsch & Carroll	Psychology and psychiatry	2000	Deconstructing relative reinforcing efficacy and situating the measures of pharmacological reinforcement with behavioral economics: A theoretical proposal	<i>Psychopharmacology</i>	71
Jacobs & Bickel	Psychology	1999	Modeling drug consumption in the clinic using simulation procedures: Demand for heroin and cigarettes in opioid-dependent outpatients	<i>Experimental and Clinical Psychopharmacology</i>	70
Camerer	Economics	2003	<i>Behavioral Game Theory: Experiments in Strategic Interaction</i>	Book	70
DellaVigna	Economics	2009	Psychology and economics: Evidence from the field	<i>Journal of Economic Literature</i>	68
Thaler & Sunstein	Economics and law	2003	Libertarian paternalism	<i>American Economic Review</i>	66

Kahneman, Knetsch & Thaler	Psychology, and economics	1990	Experimental tests of the endowment effect and the Coase theorem	<i>Journal of Political Economy</i>	65
Bickel, DeGrandpre, Higgins, Hughes	Psychology and psychiatry	1990	Behavioral economics of drug self-administration: I. functional equivalence of response Requirement and drug dose	<i>Life Sciences</i>	64
Sunstein & Thaler	Law and economics	2003	Libertarian paternalism is not an oxymoron	<i>University of Chicago Law Review</i>	62
