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Neuroeconomics Hype or Hope? An Answer

Alexandre Truc*

October 3, 2024

Abstract

Abstract: In June of 2010, a special issue in the *Journal of Economic Methodology* was introduced with the question: “Neuroeconomics: hype or hope?” (Marchionni and Vromen, 2010). More than ten years later, it is time to provide an answer. Using a variety of sources ranging from Web of Science to EconLit, I assess the importance of neuroeconomics as a research program in economics. I show that after a rapid increase in interest in the early 2000s, neuroeconomics decreased in importance beginning in the 2010s, especially compared with the continuing rise of behavioral economics. Here, I explore a number of explanations for this decline in interest. Then, I compare neuroeconomics with behavioral economics to emphasize key points of divergence in how these programs were constructed at the frontiers of economics. Most notably, I show that neuroeconomists were more confrontational in their approach to economics, more focused on programmatic writings with few theoretical contributions, and importantly, more oriented towards neuroscience rather than economics.

Keywords: Interdisciplinarity; Neuroeconomics; Behavioral Economics; Psychology; Neuroscience

JEL codes: B2, B4, D87, D9

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Founded by Daniel Kahneman, Amos Tversky, and Richard Thaler, “new” behavioral economics (BE) (Sent, 2004) emerged in the 1980s as a research program that aimed to bring economics and psychology closer together. During the 2000s, especially after Kahneman’s Nobel Prize win in 2001, BE became increasingly important in economics (Geiger, 2017) and an integrated part of the mainstream (Angner, 2019). During that pivotal period, neuroeconomics emerged as a research program with similar ambitions—to bring economics and neuroscience closer together. Generally, there exist two broad approaches to neuroeconomics¹ (Ross, 2008; Vromen, 2011): “Economics of neural activity” is a research program oriented towards the importation of economics models into neuroscience for studying neural activity. It uses economic theory and the metaphor of markets to model “the workings of the human neural architecture” (Camerer et al., 2005, 253). “Behavioral economics in the scanner” is a research program oriented towards the use of findings from neuroscience to propose improvements and alternatives to traditional economic models. It mainly consists of replicating economics experiments (e.g., the ultimatum game) in settings where brain activity is monitored, measured, and/or altered.

Although there are certainly differences between BE and neuroeconomics in their methods and historical origins (Vallois, 2011), many researchers have drawn a link between these programs, including some methodologists who have grouped these programs under the same pluralistic turn originating from outside of economics (Colander et al., 2004; Davis, 2008). Proponents of neuroeconomics have also positioned it as the natural next step for BE, arguing that neuroscience “will reshape what is believed about psychology which in turn informs economics,” and heralded it as a new scientific El Dorado, given the previously unexplored relationship between economics and neuroscience (Camerer et al., 2005, 9). In the “mindful” (Camerer, 2008a) vs. “mindless” (Gul and Pesendorfer, 2008) controversy, opponents of both programs lumped BE and neuroeconomics together as sharing the same flaws. The importation of external scientific methods, theories, concepts, and values crystallized much of this debate, as opponents of BE and neuroeconomics sought to reaffirm the identity of economics as a discipline that is agnostic towards decision-making processes and, therefore,

¹See Fumagalli (2010) for a more detailed breakdown of the heterogeneity of neuroeconomics.

equally uninterested in contributions from either psychology or neuroscience.²

The emergence of these controversies and research programs also stimulated a whole new strand of research in the philosophy and history of economics (Truc et al., 2021). By the 2010s, in the words of methodologists, neuroeconomics was “hot” (Marchionni and Vromen, 2010, 103), and “almost all of the real ‘action’ within contemporary economic methodology” was taking place within “the new, more pluralistic, mainstream: neuroeconomics, experimental economics, behavioral economics, evolutionary economics; and the associated new tools such as computational economics, agent-based modeling, and various new empirical techniques” (Hands, 2015, 72). In June of 2010, a special issue in the *Journal of Economic Methodology* was introduced with the question: “Neuroeconomics: hype or hope?” (Marchionni and Vromen, 2010). When talking about “hype or hope,” we can delineate two questions. The first question, the focus of the 2010 special issue, is theoretical and asks whether neuroeconomics has real relevance for economics. Directly related to the controversies among economists, the main issue of this debate is whether the interaction between economics and neuroscience comprises mere lip-service with no meaningful content for economics (hype) or whether it can be actually useful for improving economics knowledge (hope). The second question is socio-historical and asks whether neuroeconomics consists of programmatic writing that generated a lot of short-term conversation with little lasting influence (hype) or whether it has been a vector of change with economists actually adopting neuroeconomics as a legitimate part of the discipline over the long term (hope). While the first question is theoretical and epistemological, the second is more empirical and asks whether neuroeconomics has proven to be a successful approach in economics. More than ten years after the *Journal of Economic Methodology* special issue was released, I seek to provide an answer to this second question.

In the present article, I seek to investigate the emergence and development of neuroeconomics as a research program within the wider field of economics using quantitative empirical

²We also find a more careful comparison of BE and neuroeconomics (Bernheim, 2009), and more generally, methodologists and philosophers of economics have established important and clear distinctions between the two (Fumagalli, 2016b,a).

analysis. While there was certainly a lot of talk about neuroeconomics in the early 2000s and 2010s, the question remains: did neuroeconomics stabilize as a legitimate and successful research program in economics? To answer this question, I mobilize a variety of datasets from multiple databases, and approach neuroeconomics through multiple lenses to cross-validate observations across datasets. After presenting my methodology in the first section of this article, I quantitatively analyze the emergence of neuroeconomics, according to two definitions of the field: (1) neuroeconomics as a research program, defined by keywords and JEL codes; and (2) neuroeconomics as a frontier between economics and neuroscience, using pre-defined disciplinary categories. I observe that unlike BE, interest in neuroeconomics faded rapidly following its initial growth throughout the 2000s—2010s. In the third section of this article, I present a comparative case-study of BE and neuroeconomics, exploring the differences in how each research program was constructed, most notably in relation to their interdisciplinary ambitions. In doing so, I offer potential explanations for the contrasting growth dynamics of BE and neuroeconomics.

1 A (Short) Overview of Neuroeconomics

Neuroeconomics emerged as an explicit research program within the wider field of economics with the publication of multiple programmatic writings in the mid 2000s, including Glimcher (2004) in *Science* and Camerer et al. (2005) in the *Journal of Economic Literature*. The historical origins of the program are older than that, with links to the history of biology, psychology, economics, and neuroscience (Vallois, 2011). If we focus on the “behavioral economics in the scanner” aspects of neuroeconomics that emerged in the mid 2000s—which generated a lot of echoes in the wider field of economics—the research program is characterized by a handful of criticisms oriented towards economics.

First, neuroeconomists reject revealed preference theory and the methodological view that economists should rely solely on observed choice data. For neuroeconomists, this methodological stance is mostly rooted in perceived technological limitations that they believe may be overcome by neuroscience technologies and tools (Camerer, 2013, 426). Common method-

ological approaches in neuroeconomics include the measurement of brain activity during economics experiments to infer mental states or cognitive processes, as well as the study of other biological non-choice proxies, such as heart rate, pupil dilation, and arousal.³

Second, neuroeconomists mostly reject the existing definitions and disciplinary boundaries of economics. For example, Camerer (2013, 426) argues: “As economists, should we only pick through evidence from neuroscience and find what we need? I think the answer is no [...] In science, extreme specialization severely limits knowledge transfer for new syntheses.” For such neuroeconomists, the research program is not only about importing knowledge or tools from neuroscience to improve economics, but also about redefining disciplinary frontiers.

Third, neuroeconomists criticize economics models on descriptive and normative grounds. On the descriptive front, their criticism is similar to what behavioral economists have argued over the last few decades. Economic theory has faced many empirical and experimental anomalies that challenge its descriptive validity. While some early behavioral economists extended their criticisms to normative aspects of economic theory, it is now largely accepted that their focus has historically targeted descriptive aspects while accepting the normative rational choice theory as a benchmark to measure deviations (Heukelom, 2014). Neuroeconomists generally argue that neuroscience can help economists discriminate between different models of choice. For example, by better understanding the underlying neural mechanisms of pro-social behaviors, neuroeconomists may help discriminate between models based on the cognitive processes that explain observed behavior (e.g., reciprocity, envy). Some go further and argue that neuroeconomics could “unify the prescriptive and descriptive approaches” of economic theory and provide new foundations for decision models based on detailed decision, neural, and biological processes (Glimcher et al., 2005, 253). Following that line of thought, neuroeconomics could challenge not only the general framework of economic models (i.e., new modeling foundations) but also the basis of welfare analysis.

³To demonstrate that the methodological roads taken by economists have been largely constrained by technology, neuroeconomists often rely on the desire of older figures in economics, such as Francis Ysidro Edgeworth or Frank Ramsey, to measure non-choice data.

As presented here, this characterization of neuroeconomics hides a lot of heterogeneity within the program, since not all neuroeconomists have adhered to the more radical positions on all topics. Fumagalli (2010) provides a detailed breakdown of differences within neuroeconomics and distinguishes at least five definitions of the discipline formulated by its pioneers. The heterogeneity of neuroeconomics makes its reception in economics harder to track. Some decision theorists were rather unfavorable towards the program (Harrison, 2008; Rubinstein, 2008; Gul and Pesendorfer, 2008), but their views and degrees of rejection vary as widely as the program's definitions. For Harrison (2008), neuroeconomics promised more than it could deliver because of "academic marketing hype" and "methodological flaws," but he believed it could be of value to economics if it improved. In contrast, Gul and Pesendorfer (2008) almost completely rejected neuroeconomics on a number of fronts, ranging from the definition of economics and its frontiers, to the positive and normative value of neuroeconomics and BE.

Fumagalli (2016a) synthesizes the problems surrounding the emergence of neuroeconomics and breaks them down to five issues that persist, despite claims to the contrary: (1) neuroeconomics lacks a unifying model that would work across all involved disciplines; (2) it has limited direct explanatory relevance in economics; (3) neural findings do not help to directly discriminate between economic models; (4) neuroeconomics faces challenges in providing a unifying connection between decision utility and neural utility; and (5) neuroeconomists' introduction of new neural and biological explanatory variables has yet to impact economic decision theory.

From its inception, the emergence of neuroeconomics led to intense methodological debates that have persisted throughout the program's history. The centrality of methodological and epistemological issues probably explains in part why philosophers of economics have so heavily investigated the program (Marchionni and Vromen, 2010). The controversy led methodologists and economists to tackle many issues surrounding neuroeconomics, including its definition and goals. Yet, the empirical nature of neuroeconomics and its evolving importance in the wider field of economics remain largely elusive.

2 Methodology

To assess the importance of neuroeconomics as a research program, we must first identify what constitutes “neuroeconomics.” Although it is discussed as a specialty in the literature, its precise frontiers are difficult to define. Does neuroeconomics consist only of publications in economics that incorporate some neuroscience? Does it encompass neuroscience publications that are directly relevant to economics, even when neuroeconomics is not explicitly mentioned?

An earlier scientometric study by Levallois et al. (2012) used a relational approach to evaluate neuroeconomics. They identified the most important articles in neuroeconomics, based on a set of review articles. Although this method has many advantages, it can also be noisy and biased by the kinds of review articles published in such a young field. Review articles rarely present a survey of all neuroeconomics. More often, they focus on a particular topic, such as intertemporal choice in neuroeconomics. Therefore, identifying the most common references in review articles may lead researchers to overestimate the importance of a particular sub-speciality, particularly if more survey articles have been published on that sub-speciality than other topics in a young field that lacks many general review articles or handbooks. More generally, the article by Levallois et al. (2012) does not focus on publications but on the disciplinary composition of neuroeconomics institutions and laboratories, and the scientometrics approach they mobilize might not be sufficient to answer the question of interest to us.

For the present article, I employ a different approach that integrates multiple corpora built from keywords, JEL codes, and articles published at the frontier between economics and neuroscience:

- Google Ngram Corpus: This simple corpus was created based on the frequency of particular words that appear in works cataloged within Google Books. It allows us to evaluate how much interest neuroeconomics has generated in books, relative to BE.
- EconLit Neuroeconomics and Specialized Keyword Corpora: The EconLit database

focuses specifically on economics publications and therefore provides a good source of information for investigating neuroeconomics from the vantage point of economics. These two corpora are based on keyword searches. The EconLit Neuroeconomics Keyword Corpus includes all articles containing the keywords “neuroeconomics” or “neuroeconomics,” which allows us to identify articles in economics publications that explicitly mention neuroeconomics. The EconLit Specialized Keyword Corpus includes articles in economics publications that contain other neuroscience-related keywords (e.g., striatum, fMRI, ganglia, oxytocin), which allows us to identify articles that contribute to the discipline of neuroeconomics without explicitly mentioning it.

- EconLit JEL Corpus: One interesting feature of EconLit is that it allows researchers to search articles not only by keywords, but also by JEL codes. This particular EconLit corpus is composed of all articles tagged with BE or neuroeconomics JEL codes. It allows us to compare these research programs as identified by JEL code.
- WoS Keyword Corpus: Drawn from Web of Science (WoS), this keyword corpus is built from all articles published in any discipline that contain the keywords “neuroeconomics” or “neuro-economics” within the abstract, title, keywords by authors, or keyword plus.⁴
- WoS General References Corpus: While the previous corpora focus on neuroeconomics as a field, this corpus is more generally oriented to investigate the triptych relation between economics-psychology-neuroscience. With this corpus, we can measure how citations from economics to neuroscience publications have evolved over time in comparison with citations from economics to psychology publications, independently from any *a priori* definition of neuroeconomics. Likewise, we can measure how citations from these fields to economics have evolved over time. This corpus will inform us more generally about what has happened at the frontiers of these fields.

⁴Keyword plus is a WoS feature that assigns keywords to articles based on the titles and references. While an article might not explicitly mention neuroeconomics in the abstract, title, or author-generated keywords, it might be identified as neuroeconomics-related if some of its references contain the word “neuroeconomics.”

- WoS Frontiers Corpus: The final WoS corpus is composed of all articles in neuroscience that cite at least three economics articles and all economics articles that cite at least three neuroscience articles. This provides a finite set of articles that we may identify as neuroeconomics without an *a priori* definition of neuroeconomics.
- Microsoft Academics Topics Corpus: The Microsoft Academics database is a web-based search engine for academic publications, similar to Google Scholar. One particularity of this database is that items are classified according to hierarchized and non-mutually exclusive topics and fields of study. These classifications are created using artificial intelligence and based on similarity measures, which include contents of items, authors, and other variables, to identify the topics and disciplines of individual items. Unlike WoS, this database includes books as well as articles. While the construct of “topic” is a relative black box, it provides an additional measure that does not rely on JEL codes, keywords, or references.

Although each corpus has its own biases, the trends observed across corpora can shed light on the evolving position and status of neuroeconomics.

3 The Rise and (Possible) Fall of Neuroeconomics

First, I evaluate the rise of neuroeconomics as a research program. I take two important points of reference for this analysis. The first is temporal: whichever corpus is used, we want to know whether neuroeconomics has become more or less prominent since its emergence in the early 2000s. A second important point of reference is the comparison of BE with psychology, relative to neuroeconomics with neuroscience. While the temporal aspect of my research is important, this analysis of BE also provides clues about the relative scale of neuroeconomics’ growth and decline. While BE is now largely recognized as a widespread and important part of the mainstream of economics (Geiger, 2017; Angner, 2019), the scale of interest generated by neuroeconomics is not as clear. Using BE as a point of reference provides grounds for comparing the dynamics of both research programs. If the two programs

have followed different trajectories, this tells us something about the specific dynamics of neuroeconomics rather than the potential long-term trends of confounding factors, such as the varying general interest of economists in microeconomics, individual behavior, experimentation, or research programs that claim interdisciplinary influences.

3.1 Neuroeconomics as a Research Program

When talking about research programs, names carry lot of importance and may serve as “brands” (Tomer, 2007; Earl and Peng, 2012) that researchers appropriate for themselves with more or less success. For example, while many research programs from the 2000s onwards adopted the terms “behavioral economics” (Sent, 2004), that name is clearly understood today to refer with positive connotations to Kahneman and Tversky’s heuristics and biases research program. Conversely, branding may also negatively affect how research programs are received. For example, such is the case for research programs identified as heterodox in economics. Researchers are well aware of how branding can help or hinder research programs, independently of scientific questions. For example, young experimental economists would avoid being identified as “experimentalists” during the 1970s to avoid the stigma related to the program at that time, and they generally opposed the creation of specific JEL codes for the field (Maas and Svorenčik, 2016, 39). It was important for “experimental economics” to be positioned as a tool within mainstream economics rather than as a separate research program (Maas and Svorenčik, 2016, 37,58).

Unlike BE or experimental economics, neuroeconomics rapidly emerged as an identifiable research program in the very early years of its history. Most researchers in neuroeconomics were already established as successful economists or neuroscientists, and they promoted the field as a distinct research program. They identified themselves early on as neuroeconomists (Camerer et al., 2005; Fehr and Camerer, 2007). In 2004, a Society for Neuroeconomics was created, with Glimcher and Camerer as the first two presidents. In 2007, a “87-Neuroeconomics” JEL code was created, and by 2008, neuroeconomists were already engaging in well-identified debates with more mainstream economists (Camerer, 2008a; Gul

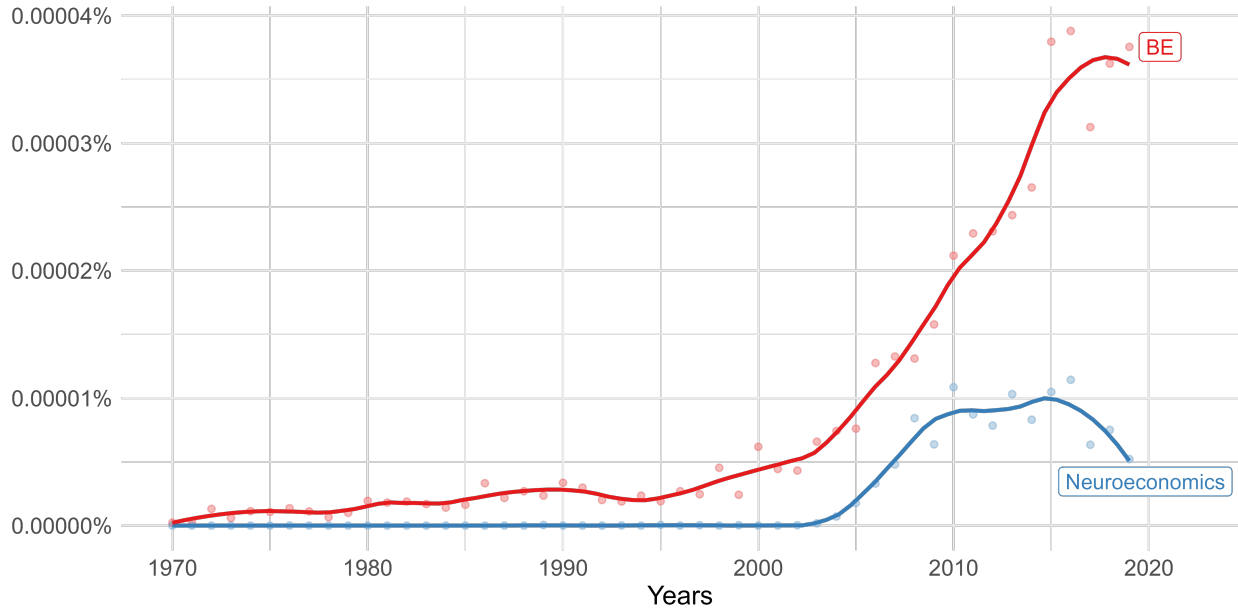


Figure 1: Frequency of “neuroeconomics” and “behavioral economics” in Google Books (case-insensitive search, no smoothing in Google)

and Pesendorfer, 2008). By 2009, the first textbook on neuroeconomics was published (Glimcher et al., 2009). Overall, neuroeconomists have tried to advance their agenda by explicitly marketing themselves as neuroeconomists and by laying out their research program with identifiable goals and privileged methods. Far from battling the stigma encountered by early experimentalists and behavioral economists in the 1960s and 1970s, neuroeconomists relied on the legitimacy granted by neuroscience and the previous success of behavioral economists to publicize their approach as the logical next step. Thus, unlike with BE or experimental economics, JEL codes and keywords provide very useful tools for investigating the historical dynamics of “neuroeconomics” as an identifiable research program.

The first corpus I evaluate here is based on Google Ngram Viewer. On the one hand, this tool is rather crude. It counts the occurrence of particular words among all words in all books cataloged in Google Books, and it is not limited in scope to academic publications. On the other hand, it provides one of the most comprehensive tools for investigating how specific words generate interest or not (Figure 1). The results of this analysis are clear: According to Google Ngram Viewer results, interest in neuroeconomics grew rapidly from

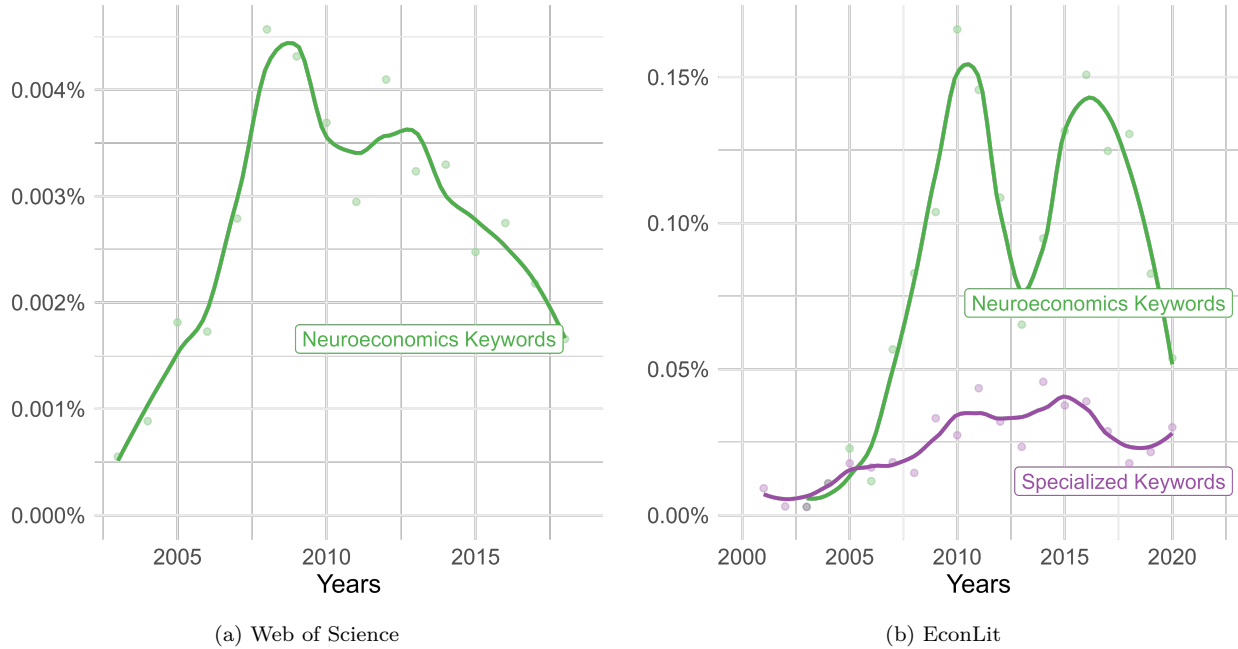


Figure 2: Shares of articles that contain particular keywords in EconLit and WoS. The neuroeconomics keywords include “neuroeconomics” and “neuro-economics.” The specialized keywords include some of the most distinctive words from within the field (e.g., striatum, prefrontal).

the mid 2000s, peaked in the mid 2010s at around 0.000011% of all unigrams in 2010 and 2016, and decreased thereafter. Compared with BE, we find that interest in neuroeconomics grew at a similar rate in the early 2000s. Between 2003 and 2010, the difference between the occurrence of the two phrases remained between 0.000005 and 0.000010 points, before increasing rapidly throughout the 2010s, up to 0.0000032 points in 2019. Despite the relative youth of neuroeconomics, it initially generated similar interest as BE. However, by the 2010s, it had become clear that interest in BE was here to stay, whereas interest in neuroeconomics was fizzling out.

The WoS, EconLit, and Microsoft Academics corpora are less broad in scope than the Google Ngram Viewer Corpus, with a narrower focus on academic publications. The WoS Keyword Corpus is composed of all articles mentioning “neuroeconomics” in WoS (Figure 2a). This includes articles published in any discipline, including neuroscience. In this corpus, we observe a similar pattern as that found with Google Ngram Viewer (Figure 2a), except the peak year arrives in 2008 rather than 2016, with around 0.0042% of all WoS articles.

The EconLit corpora are made up of similar search results from the EconLit database, based on two types of keywords (Figure 2b) and JEL codes (Figure 3). Because EconLit only covers economics publications, the EconLit corpora are constructed to measure interest in neuroeconomics within the discipline of economics specifically. One advantage of focusing on economics publications is that we can find neuroeconomics-related content by using keywords typical of the research program. Neuroeconomics is a sub-field of economics that uses a variety of very distinctive concepts. While searching for these keywords across all disciplines is not useful here, searching for these keywords within economics publications provides a good proxy for “neuroeconomics.” Specifically, the search results include articles from economics publications that mention any of the following terms (Levallois et al., 2012) in the title, abstract, or listed keywords: “striatum,” “prefrontal,” “cortex,” “fMRI,” “ganglia,” “dopamine,” “striatal,” “oxytocin,” “insula,” “basal,” “neuroimaging,” or “brain imaging.” Specialized keywords provide a particularly robust tool for identifying how economists actually do neuroeconomics, independently of whether they explicitly mention neuroeconomics by name.

In the EconLit keyword search results, we generally observe the same pattern as those found in the previous two corpora. Interest in neuroeconomics grew rapidly in the mid 2000s, with a peak in the 2010s followed by a drop afterward. In the case of specialized keywords, we find a peak interest in 2014, with the selected keywords occurring in 0.046% of all articles in EconLit (Figure 2b). In the case of the “neuroeconomics” and “neuro-economics” keywords, we find greater short-term variation, with two peaks of interest in 2010 and 2016, the same peak years found in our Google Ngram Viewer Corpus (Figure 2b).

The EconLit JEL Code Corpus compiles all articles matching the JEL codes for neuroeconomics or BE. How JEL codes are applied is not always clear, especially when it comes to new codes. The uses and misuses of these codes reflect wider issues in economics. The same code may take on different meanings as fields and sub-specialties evolve, or as authors adjust how they understand particular sub-specialties within economics. Some codes may be seen as more or less desirable depending on authors’ perceptions of sub-specialties. Thus, authors

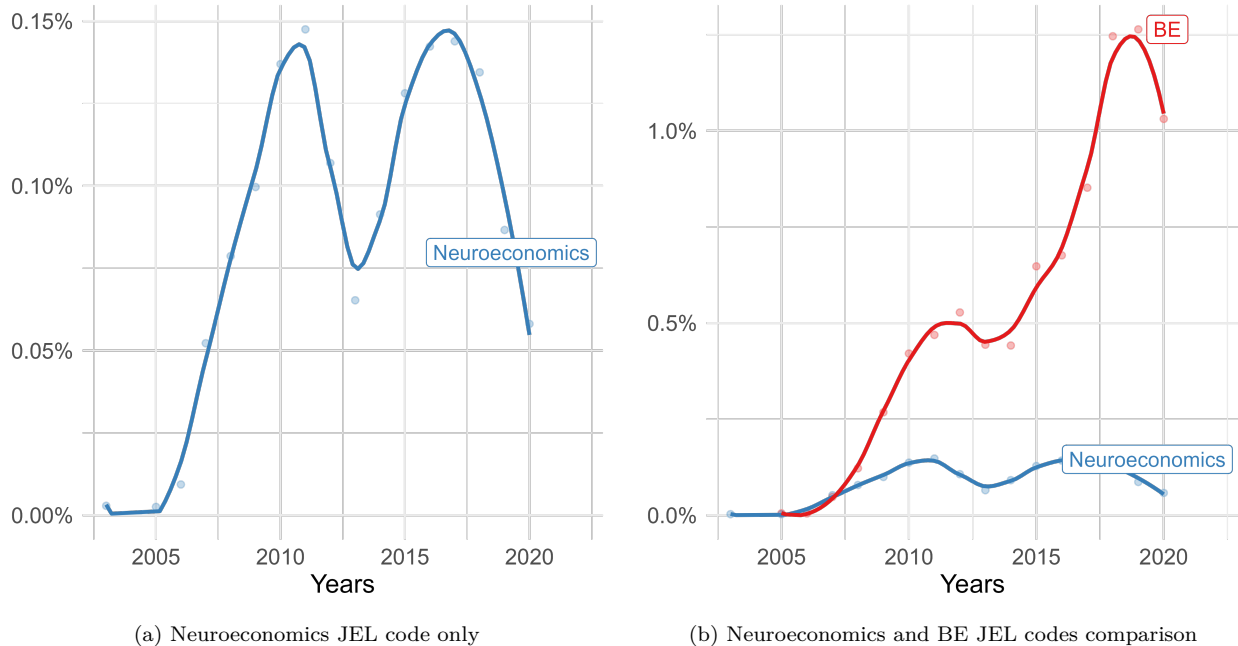


Figure 3: Shares of articles that match particular JEL codes in EconLit

may become more or less keen to adopt or reject particular codes. Finally, classifiers also play an important role in determining how articles are identified, and their decision processes are not always transparent (Cherrier, 2017). Despite these limitations, JEL codes provide a helpful tool and yield search results that complement our previous observations, by allowing us to identify neuroeconomics articles that do not explicitly mention “neuroeconomics” itself or any of its specialized keywords. Another advantage of JEL codes is that we can use BE and neuroeconomics JEL codes to compare the popularity of these research programs, which is harder to achieve using keywords. The JEL code “D87-Neuroeconomics” emerged in 2007, slightly before the JEL code for BE. The JEL code “D03-Behavioral Economics-Underlying Principles” was created in 2008 and changed to “D9-Micro-Based Behavioral Economics” only recently in 2018. Before this change, D9 was simply “Intertemporal Choice and Growth.” In the EconLit database, “D9-Micro-Based Behavioral Economics” seems to have been retroactively applied to very few articles up to the mid 2000s.

The EconLit JEL Code Corpus includes all articles matching the D87 code for neuroeconomics or the D9 code or D90 or D91 sub-codes for BE. Despite emerging at roughly the

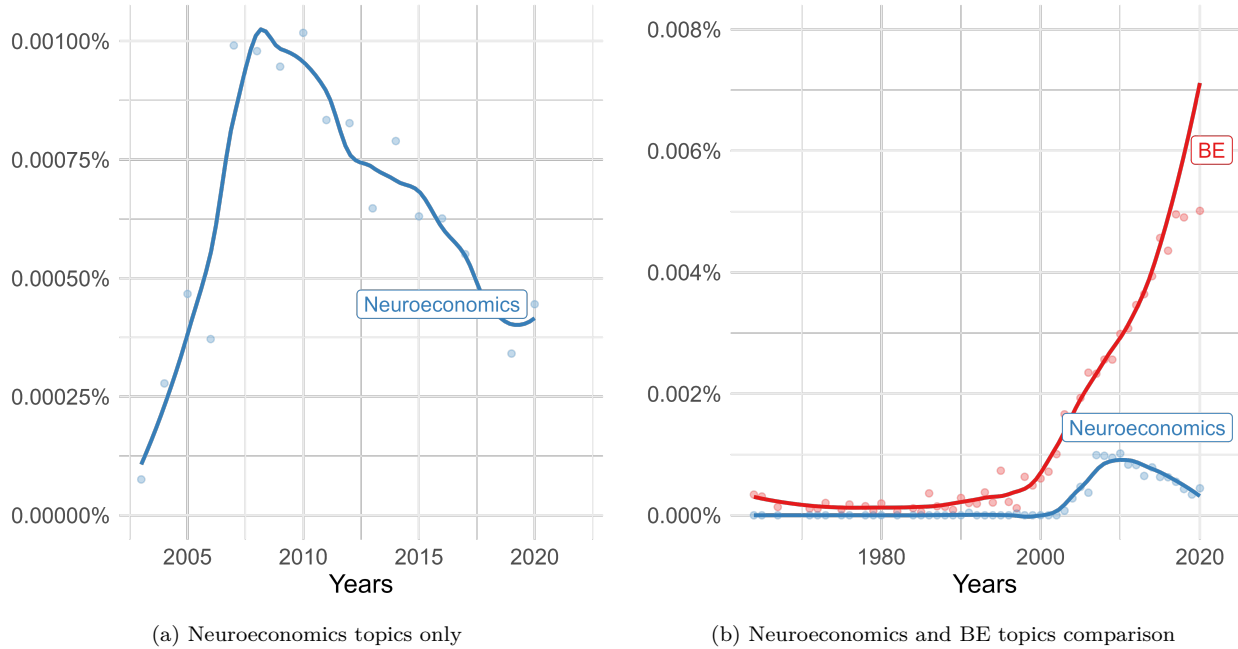


Figure 4: Shares of articles that match particular topics in Microsoft Academics

same time, the BE codes quickly became much more widespread than the neuroeconomics code (Figure 3b). While more than 1.5% of all EconLit articles were classified as BE in 2018, the neuroeconomics JEL code never represented more than 0.12% of EconLit articles during its peak year in 2016. Focusing specifically on neuroeconomics (Figure 3a), we find a very similar pattern here as in the EconLit Neuroeconomics Keywords Corpus (Figure 2b), which is not surprising, since keyword search results also include JEL codes. Overall, despite the greater short-term variation observed in EconLit, we can conclude that neuroeconomics grew rapidly when it emerged, but it has only stagnated or decreased since 2010, especially compared with BE.

Finally, with the Microsoft Academics Topics Corpus, we find a similar pattern as observed above: a rapid rise in interest in neuroeconomics throughout the 2000s, representing up to 0.0010% of all items in Microsoft Academics, followed by a rapid decline in interest, to less than 0.0004% by the end of the 2010s (Figure 4a). Similar to what we observed with Google Ngram Viewer, interest in both BE and neuroeconomics grew in the early 2000s. Although BE was much older, neuroeconomics nonetheless contended for comparable impor-

tance at that time, at least in terms of new publications. However, after peaking by 2010, neuroeconomics fell in importance, while BE maintained its rapid growth rate, securing its lead over neuroeconomics (Figure 4b).

Overall, after growing interest in the 2000s followed by stagnation in the 2010s, neuroeconomics seems to have decreased in importance. Across all corpora, we find that neuroeconomics fell far from matching the growth rate of BE from the 2010s onwards. In other words, if we think of neuroeconomics as consisting in part of “behavioral economics in the scanner” and as a sub-specialty of BE, then neuroeconomics has become a proportionally smaller component of BE overtime.⁵

While keywords and JEL codes provide useful tools for studying the publication dynamics of neuroeconomics, they do have their limitations. This may help account for the observed inconsistencies across corpora, in terms of whether interest in neuroeconomics peaked in the late 2000s (Figures 2a and 4a) or mid 2010s (Figures 1, 2b, and 3a). Rather than counting articles from different databases, I next investigate the evolving status of neuroeconomics by comparing neuroeconomics and BE as research programs at the frontiers of economics and cognitive science.

3.2 Neuroeconomics as a Frontier

Rather than trying to clearly define or delineate neuroeconomics, another way to study the historical dynamics of the discipline is to investigate what happens at the frontiers of economics and neuroscience. The “economics of neural activity” and “behavioral economics in the scanner” (Ross, 2008; Vromen, 2011) dimensions of neuroeconomics may be understood as two kinds of disciplinary interaction that have taken place at the frontiers of economics and neuroscience. In the case of “economics of neural activity,” neuroscientists borrow from standard economics models and methods to study neural activity, for example, by modelling neural behavior as rational optimizing agents. In the case of “behavioral economics in the

⁵See Truc (2022b,c) for a quantitative analysis of BE, which includes an assessment of neuroeconomics in relation to other sub-specialities of BE. In these papers, neuroeconomics is shown to be an important sub-specialty of BE in the 2000s, with decreasing importance thereafter, as other sub-specialities, such as the non-neuroeconomics study of pro-social behaviors, gained prominence.

scanner,” economists borrow from neuroscience to study individual behavior by conducting economics experiments while monitoring brain activity to find the “neural basis” of particular BE and psychological concepts (Sanfey et al., 2003; Tom et al., 2007).

To capture neuroeconomics as a frontier discipline, I compiled all articles from the WoS database that were either published in economics or in neuroscience publications. I then compiled all of the references from those articles and computed the share of citations going from one discipline to the other. As defined in the introduction, BE is generally understood to bring economics and psychology closer together, while neuroeconomics focuses on bridging economics and neuroscience. Just as I previously used BE to scale and compare the impact of neuroeconomics within the wider field of economics, I will now use the relationship between economics and psychology to scale and compare the relationship between economics and neuroscience. The advantage of this approach is that it allows us to investigate neuroeconomics without *a priori* defining what it is. However, it poses a different kind of challenge, since it requires us to define “economics” and “neuroscience.” For the present article, I used the US National Science Foundation (NSF) classification system, which assigns disciplines to particular journals. This system includes 143 fields of research (e.g., sociology, psychiatry), which are grouped under two large domains: natural sciences, engineering, and biomedical sciences (NSE) and social sciences and humanities (SSH).

If we look at the citations from economics to neuroscience publications, we find again a pattern of decreasing interest in neuroscience beginning in the 2010s (Figure 3a). If we exclude the exceptional year of 2005, we find a significant peak of about 0.15% of references between 2008 and 2014. Then, the relative weight of references to neuroscience publications falls back to about 0.12%. This declining share of references to neuroscience publications is countercyclical to what we observe in references to psychology publications or more general sciences journals, such as *Nature*, *Science*, or *Plos ONE*, which continuously increase from about 0.5% of all economics references in the early 2000s to more than 1.5% in 2018 (Figure 5b). More generally, the share of references to neuroscience publications is quite low in relative terms. In 2018, publications in economics journals cited psychology journals 10

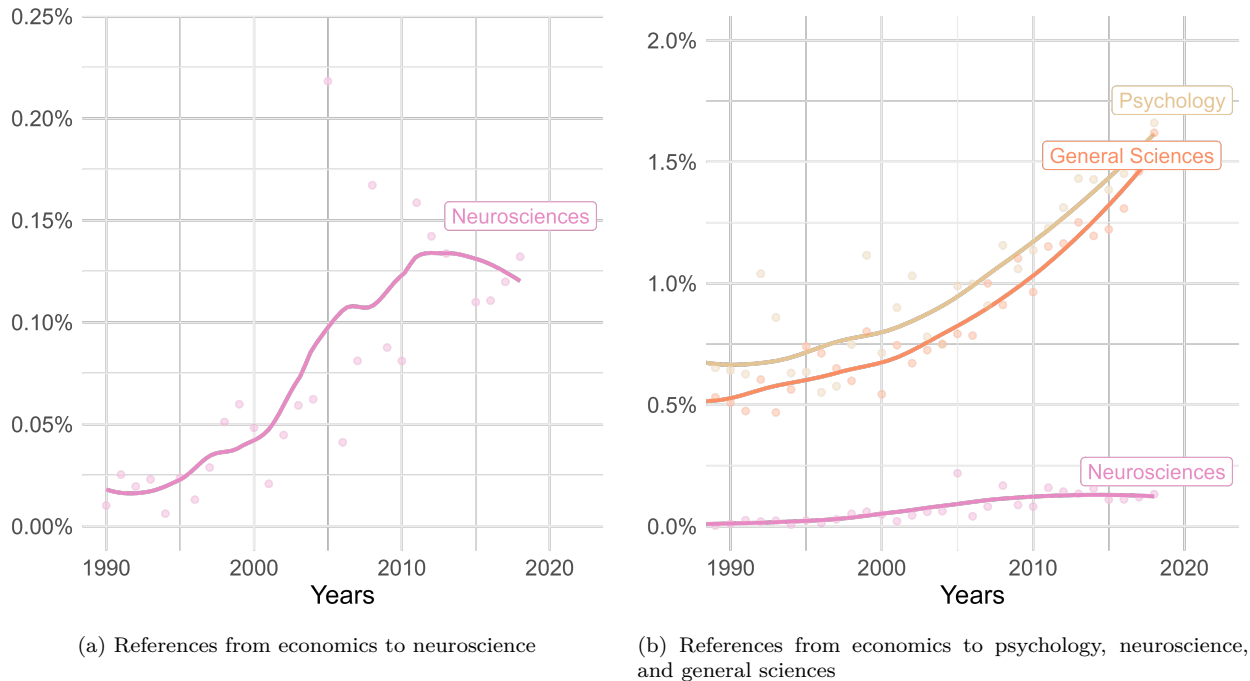


Figure 5: Shares of references from economics publications to particular disciplines, according to NSF classifications

times more often than they cited neuroscience journals.

To test the robustness of the NSF disciplinary classifications, I also used WoS classifications, which are non-exclusive. In other words, journals can be tagged by WoS as belonging to multiple disciplines. The sum of all references may therefore go far beyond 100%, since a reference may belong to multiple disciplines. This classificatory system is particularly useful for studying neuroscience because it is a relatively young field and, more generally, it is often positioned at the frontiers of multiple disciplines within cognitive sciences (Thagard, 2005, 2010). However, this classificatory system is also potentially biased in a different way, since for example, a psychology journal that publishes some neuroscience will have all of its articles identified as falling within both psychology and neuroscience.

Between the 1990s and late 2000s, we find that citations from economics to neuroscience publications present similar growth rates and levels under both the NSF and WoS classificatory systems. However, after the 2010s, while citations from NSF-classified economics to neuroscience journals clearly decline, citations from WoS-classified economics to neuro-

science journals merely slowed in growth and stabilize at around 0.18% of all references (Figure 6). WoS categories are larger than NSF categories, they capture more references, and they, therefore, present a higher level. It is also not surprising that after the late 2000s, the trends observed in both classification systems diverge. If economists cite more psychology and less neuroscience, and the WoS system classifies many journals as both psychology and neuroscience, then it creates a tension as the slope of the curve reflects a combination of both trends. Finally, the recent emergence of new journals at the frontiers of economics and neuroscience (e.g., *Journal of Neuroscience, Psychology, and Economics*, launched in 2008) might also influence the differences observed between the NSF and WoS classification systems, since the WoS allows such journals to belong to multiple disciplines. Overall, we still find that citations from economics to neuroscience journals present at a very low level, compared with citations to psychology. It is likely that citations from economics to neuroscience journals mostly capture neuroeconomics as “behavioral economics in the scanner,” since “economics of neural activity” mostly consists of importations from economics to neuroscience.

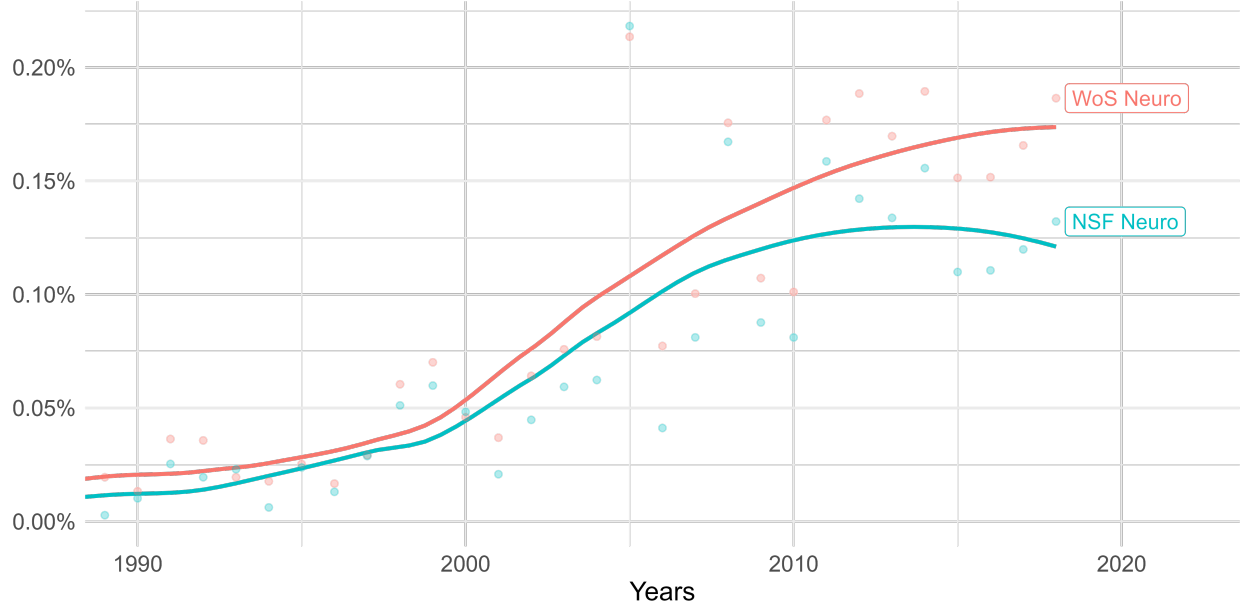
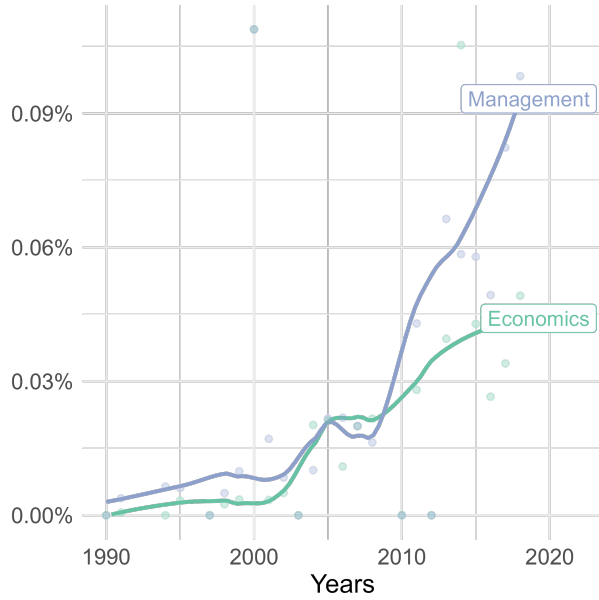


Figure 6: Shares of references from economics to neuroscience publications, according to NSF vs. WoS classifications

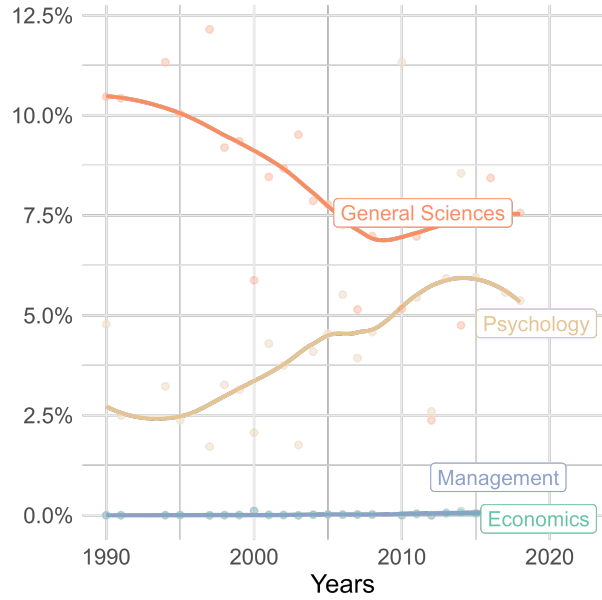
How about citations from neuroscience to economics publications and the “economics of neural activity”? Unlike the previous trend, we find that the intertemporal dynamics of citations from neuroscience to economics publications follow a straightforward upward trend (Figure 7a). While citations from economics to neuroscience journals decreased beginning in the 2010s, interest among neuroscientists towards economics seems to have only increased. We also find another interesting trend, rarely discussed in the literature on neuroeconomics. Up until the late 2000s, references from neuroscience to management vs. economics journals grew at a similar rate; however, throughout the 2010s, the growth rate of references to management journals increased drastically compared with references to economics journals (Figure 7a). It is difficult to pinpoint a single phenomenon that may account for this trend since the “management” category encompasses a variety of journals dedicated to applied psychology, consumer research, and marketing. One potential explanation is that neuroscientists became more interested in this variety of applied journals as they relate to consumer behavior. Another potential factor is the emergence of neuromarketing in the late 2000s, which Levallois et al. (2021) identify as consolidating around 2007–2008. However, neuromarketing remains relatively unrelated to economics as a discipline.

Despite the upward trend in references from neuroscience to economics and management journals, the relative share of references to both disciplines remains low, compared with the share of references from economics to neuroscience journals. The share of references from neuroscience to economics peaks at about 0.05%, while the share of references from economics to neuroscience peaks at about 0.15%. Overall, we can conclude that the level of interest between neuroscience and economics remains relatively low, even with favorable dynamics (Figure 7b).

Overall, one strong trend we find across corpora is that neuroeconomics and neuroscience generated a lot of attention in economics during the 2000s, even at a growth rate comparable to BE, which had emerged almost 20 years earlier. However, beginning in the 2010s, this interest either stagnated or declined. This suggests that the frontier between neuroscience and economics generated a lot of short-term interest without substantially changing



(a) References from neuroscience to economics and management



(b) References from neuroscience to economics and management, compared with psychology and general sciences

Figure 7: Shares of references from neuroscience to particular disciplines

the relationship between the two disciplines in the long term. The limited importance of neuroeconomics and neuroscience in economics is particularly notable when compared with the importance of BE and psychology in economics.

4 Different Approaches to Interdisciplinary Research Programs: A Comparative Study of BE and Neuroeconomics

Arguably, BE and neuroeconomics share many common characteristics. BE may be seen as a research program at the frontier of economics and psychology, while neuroeconomics may be seen as a program at the frontier of economics and neuroscience. In both cases, the programs originate at least in part from outside of economics (Davis, 2008, 359) and aimed to change the field through interdisciplinary interaction with cognitive sciences. More

generally, observers have argued that neuroeconomics shares a common origin story with BE. For example, in the “short history” section of Glimcher et al. (2009), the origins of neuroeconomics are identified as having some roots in economics. The history spans from Adam Smith and the emergence of neoclassical economics to the advent of BE as a legitimate part of economics. Following that interpretation, neuroeconomics is seen as largely overlapping with BE, with the publication of Allais (1953) serving as a “critical” point for understanding “where neuroeconomics came from” (Glimcher et al., 2009, xix), especially when we focus on the “behavioral economics in the scanner” dimension of the field. Finally, the term “behavioral economics in the scanner” itself highlights the strong links that philosophers of economics have drawn between BE and neuroeconomics (Ross, 2008; Vromen, 2011).

Despite these common characteristics, we find important differences in how BE and neuroeconomics have been received in economics. This is worth investigating. Why did economists accept the influence of cognitive psychology, while apparently rejecting cognitive neuroscience? We can identify multiple causes for these differences in the literature. Neuroscience is often identified as a discipline that is historically and cognitively positioned further away from economics than psychology (Moya-Anegón et al., 2004; Levallois et al., 2012). The cognitive cost of learning neuroscience for economists is higher than for many other disciplines (e.g., learning how to produce or read fMRI measures), thus posing barriers to interdisciplinarity between the two disciplines. This also manifests in very different research practices and publication norms that hamper collaboration. Economics journals have long review cycles and have long favored alphabetical author order (Li and Yi, 2021), which in turn encourages collaborations among a limited number of authors (Van Praag and Van Praag, 2008). Conversely, neuroscience journals tend to have shorter review cycles and favor contribution-based author order, which in turn encourages neuroscientists to engage in large-team collaborations (Levallois et al., 2012, 793). The co-authorship practices of psychology are generally identified as falling between those of economics or social sciences and natural sciences (Fanelli and Glänzel, 2013, 6; Fanelli and Larivière, 2016). From an epistemological point of view, the differences in levels of explanation between eco-

nomics and neuroscience might also mean that neuroeconomics lacks explanatory relevance for economics (Kuorikoski and Ylikoski, 2010; Fumagalli, 2014, 13). Neuroeconomics faces many methodological issues, from lack of unity (Fumagalli, 2010) to reverse inference fallacy (Bourgeois-Gironde, 2010). Finally, the integration of neuroeconomics into the wider field of economics also involves expensive hardware and methods, which is unusual in economics and presents a concrete obstacle to interdisciplinary integration (Clithero et al., 2008, 2349).

Although those barriers are important, one could imagine that if neuroeconomics had more successfully captured the attention of economists, then economists and neuroeconomists would at least try to tackle some of those issues to accommodate the program's integration. For example, the expenses associated with neuroeconomics also come with the potential to claim larger grants from natural sciences institutes. Moreover, there are ways to do neuroeconomics experiments that are cheaper than using fMRI. For example, studying hormones generally involves the simple administration of hormones to experimental subjects, a relatively inexpensive protocol compared with the use of fMRI (Kosfeld et al., 2005; Nave et al., 2017). Large-team collaborations might be harder to publish in top economics journals, but they provide a path to publication in other prestigious venues, such as *Nature* or *Science* (Fehr and Camerer, 2007), which are increasingly oriented towards economics (Editorial, 2020). The difficulty of running neuroeconomics experiments might also be overemphasized. Neuroeconomics emerged in a context where economics experiments were common and economics laboratories already existed. With that infrastructure in place, the barriers to running neuroeconomics experiments in a contemporary context might be smaller than those faced by early experimentalists in the 1960s, when nothing of the sort existed. For example, using hormones or transcranial magnetic stimulation simply involves the introduction of new tools to otherwise normal economic experiments.⁶

⁶We often think of early economics experiments as easy to imitate because classroom experiments are cheap to run. However, Vernon Smith emphasizes the large investments needed to actually build an economics laboratory: "it really takes a major commitment and deep development of human capital because you don't learn to run experiments by reading about experiments [...] Well, you can have an acceptance of what comes out of experimental economics as a body of knowledge, and that is happening. But I would say that probably more universities ought to be doing it that aren't now. But it takes a lot of resources." (Maas and Svorenčík, 2016, 85)

Regarding methodological issues, one may imagine that neuroeconomics could have developed around methods and questions more fitting to economists. In the early years of experimental economics, economists rapidly tackled some of the methodological issues that they took with experimental psychology by developing a distinct methodology more oriented towards economics questions—for example, most notably, by refusing deceptions and only conducting incentivized experiments (Maas and Svorenčík, 2016, 77). More generally, many epistemological issues related to the particularities of neuroscience, such as explanatory relevance, also concern psychology (Gul and Pesendorfer, 2008), even if the extent of the issues may be more substantial in the case of neuroscience (Bernheim, 2009; Fumagalli, 2014, 13). Such issues alone did not necessarily prevent BE from successfully emerging in economics.

The goal of this section is not to definitively identify one cause for the different trajectories of BE and neuroeconomics. Taken together, all of these issues likely matter and may have contributed to the decline in interest in neuroeconomics. However, I want epistemological issues aside for a moment and explore another potential explanatory factor that is more rarely discussed: the socio-historical dynamics of research programs. To contrast how behavioral economists and neuroeconomists constructed their research programs from the start, I present a comparative case-study of how two research programs at the frontiers of economics and cognitive sciences adopted very different approaches to changing economics.

4.1 Addressing an Economics Audience

Both BE and neuroeconomics were partly founded by researchers who were not economists. As such, both fields have faced a similar challenge: convincing economists that contributions from psychology or neuroscience are relevant to economics. In the 1970s, Kahneman and Tversky broadened their psychological approach by organizing workshops to gather economists and psychologists together. More importantly, they also published in the best economics journals in a way that was not overly confrontational. To publish in economics, Kahneman and Tversky carefully employed rhetoric that would convince economists. While it took them five years to publish *Prospect Theory: An Analysis of Decision under Risk* in

1979, “the last four of these five years were used to tweak a, for the most part, finished argument to fit an economic audience” (Heukelom, 2014, 119). For example, they “carefully avoided the term rational” and instead favored “reasonable” to avoid making Kahneman and Tversky (1979) their position appear as an explicit critique of economics (Heukelom, 2014, 120). Despite the fact that both were psychologists with no prior publications in economics, we also find few explicit references to psychology in the early economics work of Kahneman and Tversky (Truc, 2022a). Finally, Kahneman and Tversky (1979) maintained the role of traditional economic theory as a normative benchmark, which made their behavioral approach less threatening and more compatible with existing economics theory (at least from a normative point of view).

The BE community in the 1980s was split on how to achieve success in economics. Some favored an explicit adoption of the BE label in publications, the creation of specialized journals, and an approach that consisted in chipping “away at mainstream” rather than “add to it” (Gilad et al., 1984, 7), but Kahneman, Tversky and Thaler favored accommodating economists in a way that would make psychology more acceptable especially when compared with “older” attempts to promote psychology in economics. When BE developed as a more systematic research program in the 1980s under the auspices of the Sloan-Sage Foundations, these strategies would be shared among members of the Sloan-Sage boards. Members of the program understood that the focus of the program should not be centered around “the rational, maximizing, economic paradigm” (Heukelom, 2012, 274), as the advisory committee “actively tried to prevent a theoretical economic discussion of neoclassical economic theory” (Heukelom, 2014, 156). Bringing Thaler within the program also proved an important move for making BE relevant to economists, with advisory committee members intending his pairing with Kahneman to lead to “more market oriented” contributions (Heukelom, 2014, 154). For the most part, this panned out, as collaboration with Thaler led Kahneman to a very prolific period of co-authored publications in economics journals (Truc, 2022a).

In contrast to Kahneman and Tversky’s approach, early proponents of neuroeconomics rapidly emphasized the revolutionary potential of neuroeconomics (Fumagalli, 2010, 2016b,

90). From the perspective of Camerer, one of the earliest proponents of neuroeconomics, the interaction between neuroscience and economics could challenge some economics traditions, such as the “preferences-beliefs-constraints structure” (Camerer et al., 2005, 9). For Camerer, neuroeconomics could take either an incremental approach rooted in the traditional foundations of economics, similar to BE, or a radical approach with new foundations, which: “involves turning back the hands of time and asking how economics might have evolved differently if it had been informed from the start by insights and findings now available from neuroscience” (Camerer et al., 2005, 10). More generally, neuroeconomists have not always engaged economists in a pedagogical manner. For example, Rubinstein once stated: “Colorful diagrams, which mean nothing to economists, are presented as clear evidence. To me, they look like a marketing gimmick [...] I almost always have the feeling of being (unintentionally) manipulated” (Rubinstein, 2008, 486). Camerer responded to this statement in a relatively dismissive rather than pedagogical or strategic manner: “The fact that economists don’t know how to interpret these diagrams is a statement about what economists don’t know, not a statement about what neuroscientists do know” (Camerer, 2008b, 374). Finally, while behavioral economists have explicitly maintained the role of normative economics theory, neuroeconomists “implicitly undermine its normative foundations” in the way they have historically focused on learning and reward theories rather than economics rational choice theory as benchmarks (Vallois, 2011, 192).

Successfully integrating new tools from outside a discipline involves a lot of pedagogical effort. In the case of experiments in economics, a lot of effort was invested in “educating editors” (Maas and Svorenčik, 2016, 60) or “lowering the barriers to entry” (Maas and Svorenčik, 2016, 71). While behavioral economists put a lot of emphasis on making experiments and psychology relevant to economists by adapting their discourse to an economics audience, neuroeconomists were less concerned with these issues. Obviously, neuroeconomists were not operating within same context. BE was already successful by the time neuroeconomics emerged, and proponents of the program who were also behavioral economists, such as Camerer, were already successful economists. This may help account for Camerer’s rela-

tively bold approach in promoting neuroeconomics, compared with the more conciliatory tack of Kahneman and Tversky, who were non-economists and complete outsiders in the 1970s. However, the scientific capital accumulated by behavioral economists did not necessarily translate to neuroeconomics, even if the program appeared to its proponents as the next natural step.

4.2 Programmatic Writings vs. Flagship Contributions

Another important difference between BE and neuroeconomics is that the former did not emerge as a research program right from the start, but rather only after some flagship successes. With the publication of *Prospect Theory: An Analysis of Decision under Risk* in 1979, Kahneman and Tversky did not forward a distinct research program but rather a theoretical contribution to the wider field of economics. They did not even mention the words “behavioral economics,” and nothing foretold that this contribution would lead to the emergence of a vast research program. Kahneman and Tversky did not publish again in economics until 1986 (Kahneman et al., 1986). In one of the more programmatic-looking articles in the early history of BE, “Toward a Positive Theory of Consumer Choice,” Thaler (1980) likewise did not explicitly mention “behavioral economics” but simply wrote that “prospect theory is proposed as the basis for an alternative descriptive theory.” Prospect theory was not conceived as a larger BE research program until Sloan-Sage graced the stage in the mid 1980s.

Thus, BE emerged around a central theoretical flagship contribution that was followed later by others. In the words of Eric Wanner, one of the program’s organizers at the Sloan-Sage Foundations in 1985: “simply accumulating more demonstrations of anomalies or of the unrealistic character of foundational assumptions seems unlikely to have a serious impact on mainstream economics” (Heukelom, 2012, 274). Behavioral economists had identified statistically significant anomalies, but Kahneman and Tversky knew that to convince the mainstream, they would need mathematically sophisticated theoretical contributions that economists would accept (Heukelom, 2014, 152, 155). Rather than building BE around

programmatic writings that would highlight the potential of a new research program at the frontier of economics and psychology, Kahneman and Tversky approached economics with a contribution that economists would value, as well as anomalies that they could not ignore. Much like Richard Selten’s approach to behavioral and experimental economics, Kahneman and Tversky followed the principle that “experimental research is most potent when it goes in tandem with economic theory”(Svorenčik, 2021, 344). From the early years of BE to the late 2000s, Kahneman and Tversky (1979) was identified as one of the most central contributions of the field (Truc, 2022b, 405). The articulation of a few important economic theories coupled with a variety of experiments remained a pattern throughout the history of BE. New research directions in the field were structured around major theoretical contributions, such as intertemporal decision for Laibson (1997) and pro-social behavior for Rabin (1993) and (Fehr and Schmidt, 1999) (Truc, 2022b, 419). Experimental economists avoided establishing a particular journal or particular JEL code that would set them apart from mainstream economics (Maas and Svorenčik, 2016, 39), and behavioral economists only received a JEL code more than 25 years after the creation of the program. In other words, behavioral economists followed the classic literary advice for good storytelling: *show, don’t tell*.

Neuroeconomists took the opposite path, by telling before showing. Rather than entering economics with a flagship contribution, they immediately presented themselves as a distinct research program. It took less than a decade for neuroeconomists to have their own JEL code, a journal, and a handbook written by the leading figure of the field (Section 3.1). More importantly, neuroeconomists in the early years focused as much on clarifying the field’s goals as publishing their contributions to it. Many neuroeconomics articles comprise programmatic writings on the research program’s goals, progress, framework, and methods—what might be achieved by bringing economics closer to other cognitive sciences (Glimcher, 2004; Camerer et al., 2005; Sanfey et al., 2006; Camerer, 2008a; Rangel et al., 2008; Camerer, 2008b, 2013). Among the most cited references in the WoS keyword corpus (Table 1), Sanfey et al. (2003)’s application of neuroeconomics to the ultimatum game is cited as frequently

as Camerer et al. (2005)’s programmatic article on neuroeconomics. Moreover, the third most cited reference in the WoS Keyword Corpus (Table 1) and the most cited article in the WoS Frontiers Corpus (Table 2) is Kahneman and Tversky (1979). This emphasizes not only the “behavioral economics in the scanner” dimension of the program, but also the fact that we do not find a flagship neuroeconomics reference published in economics that could play a similar role as Kahneman and Tversky (1979) in the 1980s emergence of BE. In both corpora, the most cited neuroeconomics contributions are not published in economics journals, and the only neuroeconomics reference in economics that is not also identifiable as BE is Camerer et al. (2005)’s programmatic article. In other words, the most important articles for neuroeconomics are only published in non-economics journals, and the only important neuroeconomics publications in economics journals are a 40-year-old BE article and a programmatic article about how economists should do more neuroscience. This last finding emphasizes an important difference between BE and neuroeconomics: while BE was founded by psychologists publishing in economics, neuroeconomics was structured around non-economics publications.

4.3 Disciplinary Interactions and Integration

While BE is located at the frontiers of economics and psychology, its early proponents invested a lot of care in ensuring that economists and psychologists shared influence in the development of the program. As expressed by Kahneman on the early years of the program: “Tversky and I viewed our research primarily as a contribution to psychology, with a possible contribution to economics as a secondary benefit” (Kahneman, 2003a, 1449). Members of the advisory committee consisted equally of economists and psychologists, and invited researchers and grants were carefully balanced in a way that would prevent one discipline from having much more influence on the other within the program (Heukelom, 2014, 168). Although interdisciplinarity played an important role in the evolution of BE (Grüne-Yanoff, 2016), observers have suggested that the program became more economics- than psychology-focused as time went on (Braesemann, 2019), even if there are more subtleties in the changing

Reference	Share of articles citing	Journal
Sanfey et al. (2003)	18.3	<i>Science</i>
Camerer et al. (2005)	18.1	<i>Journal of Economic Literature</i>
Kahneman and Tversky (1979)	17.2	<i>Econometrica</i>
McClure et al. (2004)	16.0	<i>Science</i>
Schultz and Montague (1997)	11.4	<i>Science</i>
Kable and Glimcher (2007)	11.3	<i>Nature Neuroscience</i>
Glimcher and Rustichini (2004)	10.8	<i>Science</i>
Hsu et al. (2005)	9.7	<i>Science</i>
Platt and Glimcher (1999)	8.6	<i>Nature</i>
Rangel et al. (2008)	8.6	<i>Nature Reviews Neuroscience</i>
King-Casas et al. (2005)	8.3	<i>Science</i>
Padoa-Schioppa and Assad (2006)	8.3	<i>Nature</i>
Tom et al. (2007)	8.3	<i>Science</i>
Plassman et al. (2007)	8.2	<i>Journal of Neuroscience</i>
Sanfey et al. (2006)	7.9	<i>Trends in Cognitive Sciences</i>
Knutson et al. (2007)	7.9	<i>Neuron</i>
Montague and Berns (2002)	6.8	<i>Neuron</i>
Rilling et al. (2002)	6.8	<i>Neuron</i>
Dequervain et al. (2004)	6.8	<i>Science</i>
Demartino et al. (2006)	6.8	<i>Science</i>

Table 1: Most cited references in the WoS Keyword Corpus

Reference	Share of articles citing	Journal
Kahneman and Tversky (1979)	20.4	<i>Econometrica</i>
Sanfey et al. (2003)	14.7	<i>Science</i>
Kable and Glimcher (2007)	10.5	<i>Nature Neuroscience</i>
Tom et al. (2007)	10.4	<i>Science</i>
McClure et al. (2004)	10.2	<i>Science</i>
Güth et al. (1982)	9.0	<i>Journal of Economic Behavior & Organization</i>
Hsu et al. (2005)	8.6	<i>Science</i>
Fehr and Schmidt (1999)	8.3	<i>Quarterly Journal of Economics</i>
Tversky and Kahneman (1992)	8.3	<i>Journal of Risk and Uncertainty</i>
Schultz and Montague (1997)	8.2	<i>Science</i>
Kuhnen and Knutson (2005)	6.9	<i>Neuron</i>
Knoch et al. (2006)	6.8	<i>Science</i>
Rangel et al. (2008)	6.8	<i>Nature Reviews Neuroscience</i>
Breiter et al. (2001)	6.6	<i>Neuron</i>
Huettel et al. (2006)	6.3	<i>Neuron</i>
Padoa-Schioppa and Assad (2006)	6.3	<i>Nature</i>
Camerer et al. (2005)	6.2	<i>Journal of Economic Literature</i>
Platt and Glimcher (1999)	6.1	<i>Nature</i>
PREUSCHOFF,2006	6.0	<i>Neuron</i>
Demartino et al. (2006)	6.0	<i>Science</i>

Table 2: Most cited references in the Frontier Corpus

relationship between economics and psychology (Truc et al., 2020). Three important elements helped to make the program more economics-oriented. First, Kahneman and Tversky both started to publish extensively in economics, such that by the mid 1980s, the vast majority of Kahneman’s publications were in economics journals (Truc, 2022a). These publications were also located in some of the most influential economics journals rather than more specialized publications or (worse) new journals dedicated to BE. Second, pairing Thaler with Kahneman was intended to help shift the program towards more “market-oriented” topics and in new directions that would settle the economics-oriented nature of BE (Heukelom, 2014, 154). Finally, questions of interdisciplinarity were more implicit than explicit in most publications by leading behavioral economists, especially compared with those of neuroeconomists. While behavioral economists would sometimes cite articles in psychology, the question of whether BE was economics, psychology, an integration of both disciplines, or a temporary instance of interdisciplinarity was very rarely explicitly discussed in the 1980s. For example, in their opening critique and proposal of an alternative model, Kahneman and Tversky (1979) do not mention the role of psychology as a discipline. Even more programmatic writings, such as contributions by Thaler (1980), do not explicitly discuss the role that psychology should play in a positive theory. As BE garnered more success at the end of the 1990s, the question of interdisciplinarity emerged more explicitly, with Kahneman affirming the interdisciplinary nature of BE in two articles published in the *American Economic Review* (Kahneman, 2003a) and *American Psychologist* (Kahneman, 2003b). Even then, Kahneman’s perspective was countered by other behavioral economists, such as Rabin, who suggested that the relationship between economics and psychology should remain limited to the extent that it helps develop a synthesis between standard and behavioral theory (Rabin, 1998, 2002, 2013).

Conversely, neuroeconomists rapidly presented their program as a strongly interdisciplinary one positioned at the frontiers of economics, psychology, and neuroscience. Camerer optimistically calls for the creation of a common trade language between disciplines, a “lingua franca” of social sciences (Buyalskaya et al., 2021, 2), as well as a “unifying frameworks to

explain behaviors across disciplines” (Buyalskaya et al., 2021, 9). Even if some researchers such as Rangel et al. (2008, 545) focused on neuroeconomics as a way to build “bridges” between disciplines, leading figures of the field adopted the more radical posture of disciplinary integration: “Economics, psychology, and neuroscience are converging today into a single, unified discipline with the ultimate aim of providing a single, general theory of human behavior” (Glimcher, 2004, 447). Economists are generally not sympathetic towards interdisciplinarity, in either their practices or declarations (Fourcade et al., 2015; Truc et al., 2020). For example, 57% of economists favor mono-disciplinary-produced knowledge, which constitutes the highest rate among social scientists (Fourcade et al., 2015). Behavioral economists made it clear over time that BE aimed to contribute to economics rather than integrate psychology with economics. This may have helped to make their interdisciplinary contributions more acceptable. Conversely, even if neuroeconomists actively strive to develop a program that integrates economics with neuroscience, that might be difficult to achieve given the propensity of economists to reject such propositions. The scientometric evidence presented here suggests that neuroeconomics is not a research program positioned equally at the frontiers of economics and neuroscience—and that, unlike BE, neuroeconomics might be more neuroscience than economics.

An important issue here relates to the historical origins of neuroeconomics. As I discussed above, proponents of neuroeconomics often emphasize their historical ties to BE, which provides a way to link neuroeconomics to an already successful research program in economics. However, historically, the ties of neuroeconomics to neobehaviorism, and more generally to neuroscience, are comparatively quite strong (Levallois et al., 2012). A clue of this tie may be found in the name itself, “neuroeconomics.” In WoS, the first occurrence of the word is found in an old 1991 article by Tenhouten (1991) about “the emergence of the ethnoneurologies.” In this article, the author speculates about the future emergence of a variety of disciplines based around neuroscience: neurosociology, neuroanthropology, neuropolitics, neuroeconomics, neurophilosophy, neuroaesthetics, neuroepistemology, and so on. This prehistoric occurrence of “neuroeconomics” emphasizes one important trait: the emer-

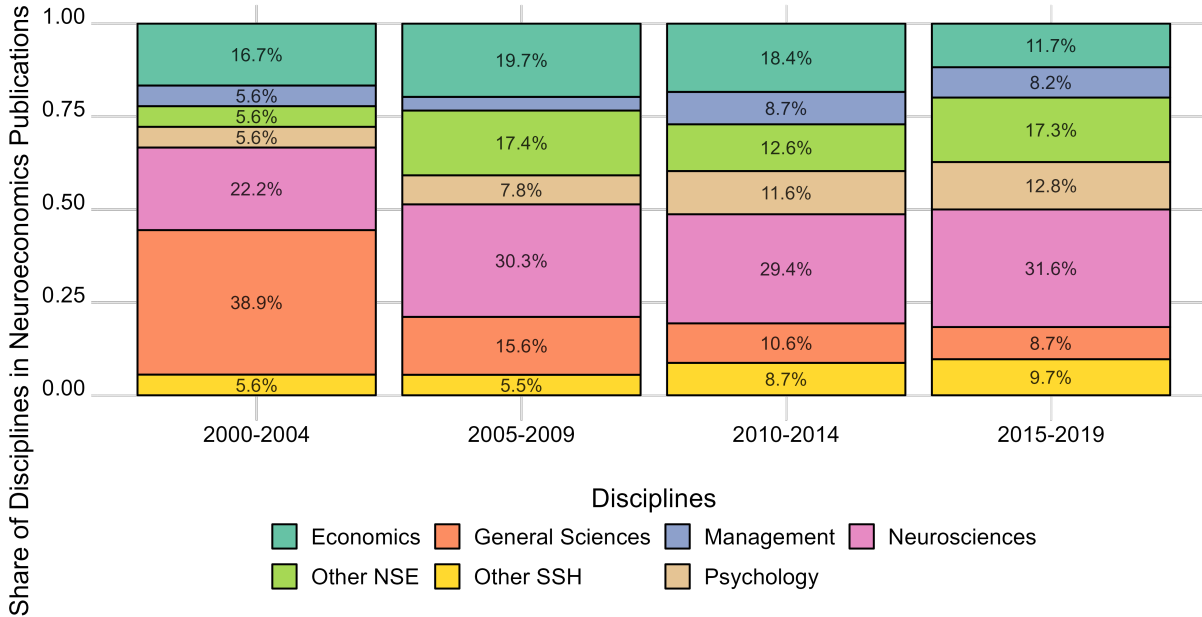


Figure 8: Share of different disciplines in the WoS Neuroeconomics Keyword Corpus

gence of neuroeconomics has not resulted from a particular affinity between neuroscience and economics but rather as part of a more general movement of neuroscience toward other social sciences under the umbrella of the “neuroX” (Vidal and Ortega, 2017, 59). Even if each of these fields has its own internal specificity, what characterizes all of them is their shared orientation towards the “application of neurobiological concepts and methods to problems that had been the traditional preserve of the humanities and the human sciences” (Vidal and Ortega, 2017, 59). My goal here is not to settle the question of whether neuroeconomics is an imperialist enterprise or not (Fumagalli, 2018); however, it is important to emphasize that neuroeconomics is part of a larger research program in which economics plays only a minor role. This has become particularly relevant over the last few years, as neuroeconomics has blurred the lines between economics, management, and the psychology of consumer research, with the development of research programs such as “Consumer Neuroscience” (Karmarkar and Plassmann, 2019).

The minor role of economics in neuroeconomics is also visible in the corpora presented here. As I discussed above, with the exception of BE publications, most of the most cited

neuroeconomics references not published in economics journals (Table 1 and 2). In the WoS Keyword Corpus, the share of neuroeconomics publications in economics decreases from 19.7% in the late 2000s to 11.7% in the late 2010s (Figure 8). The share in general sciences journals (e.g., *Science*, *Nature*) also decreases, in favor of specialized journals in neuroscience and a variety of natural sciences. This combination of trends positions neuroeconomics as a program that might be unconvincing to most economists, given their unfavorable attitudes towards interdisciplinarity.

5 Conclusion

Neuroeconomics is a lot younger than BE, but it nonetheless successfully generated attention at a similar rate in economics during the 2000s. This is also true in the methodology of economics, where neuroeconomics became a leading issue for philosophers, most notably those asking whether neuroeconomics was “hype” or “hope” (Marchionni and Vromen, 2010). Even as philosophers tackled emerging neuroeconomics, we find that it decreased in importance only a few years later in the early to mid 2010s. This trend is particularly notable when compared with the continuing rise of BE.

If neuroeconomics is understood as “behavioral economics in the scanner,” or a sub-specialty of BE, then it represents an increasingly minor sub-specialty in the field. Although many factors may have contributed to the disparate reception of neuroeconomics vs. BE within economics, I have focused specifically on how neuroeconomists approached economics in different ways than behavioral economists did. In their rhetoric, early neuroeconomists were more revolutionary and upfront in what they hope to achieve when compared with the more incremental and conciliatory approach of behavioral economists. Unlike BE’s *show, don’t tell* approach, which focused on publishing papers in economics that could become the foundation of a potential future research program, neuroeconomists entered the scene with programmatic writings and immediately laid out their intentions for a large-scale program. Finally, unlike behavioral economists, neuroeconomists did not position economics at the center of their research program. They published most of their contributions in non-economics

journals. More generally, neuroeconomics is not a specialty that results from a privileged relationship between economics and neuroscience. Rather, it is a research program embedded in a larger interdisciplinary turn, with growing links between neuroscience and many humanities and social sciences (e.g., neurophilosophy, neuroanthropology). Obviously, the context faced by neuroeconomists and behavioral economists was very different, with the former potentially benefiting from the sympathy and acceptance built by behavioral economists for experiments and cognitive sciences. This difference of context might help account for the contrasting postures adopted by behavioral economists and neuroeconomists.

The declining interest in neuroeconomics from the 2010s onwards does not mean that neuroeconomics is dead, but it has certainly lost momentum as a research program, and especially as an economics program. Neuroeconomics might find a home in other disciplines, as part of the larger galaxy of “neuroX.” It is also possible that a new wave of neuroeconomics research might build in the future, renewing the initial surge of interest observed in the 2000s and reviving the economics-oriented aspects of the program. This could result from new research directions, as neuroeconomics matures. The emergence of new technologies might also make neuroscience more amenable to economists’ interests. However, as of now, we can say with some certainty that the initial emergence of neuroeconomics as a research program at the frontiers of economics and neuroscience in the 2000s and 2010s represented more of a rapid burst of short-term interest—akin to how we defined “hype”—rather than an enduring long-term bridge-building program between both disciplines.

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