

NEUROECONOMICS HYPE OR HOPE? AN ANSWER

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Neuroeconomics Hype or Hope? An Answer

Alexandre Truc*

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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, we think it is time to provide an answer. Using a variety of sources ranging from Web of Science to Econlit, we assess the importance of neuroeconomics as a research program in economics. We show that after a very rapid increase in interest in the early 2000s, neuroeconomics decreased in importance after the 2010s especially when compared to the continuing rise of behavioral economics. After exploring a few explanations regarding this decreasing interest, we compare neuroeconomics and behavioral economics to emphasize key points in the ways these two programs at the frontiers of economics were constructed. Most notably, we show that neuroeconomists were more confrontational in their approach of economics, more focused on programmatic writings with few theoretical contributions, and more importantly, more oriented towards neurosciences than economics. Overall, we do find that the first 20 years of neuroeconomics as a research program in itself can be qualified to be more hype than hope.

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

*Atruc@unice.fr. Université Côte d’Azur, CNRS (Centre national de la recherche scientifique) – GREDEG (Groupe de Recherche en Droit, Economie, Gestion), France.

1 Introduction

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. During the 2000s, especially after Kahneman’s Nobel in 2001, behavioral economics became increasingly important in economics (Geiger, 2017) and an integrated part of the mainstream (Angner, 2019). During that pivotal period, neuroeconomics, a research program with similar ambitions emerged. Generally, it is considered that there exists two kinds of neuroeconomics (Vromen, 2011): the “Economics of Neural Activity” is the research program oriented towards the importation of economics model to study neural activity and improve neurosciences. “Behavioral Economics in the Scanner” is the research program oriented towards using findings from neuroscience to propose improvements and alternatives to traditional economic models.

While there are certainly differences between BE and neuroeconomics in terms of methods or historical origins (Vallois, 2011), many researchers emphasized the strong relationship between both programs, including some methodologists who group them as part of the same pluralistic turn originating from the outside of economics (Colander et al., 2004; Davis, 2008). Neuroeconomics was also presented by its proponents as the natural next step for behavioral economics, and a new scientific Eldorado as the relationship between economics and neuroscience remained unexplored at the time (Camerer et al., 2005, p.9). In the “mindful” (Camerer, 2008a) vs “mindless” (Gul and Pesendorfer, 2008) controversy, opponents to both programs lumped together neuroeconomics and behavioral economics as having the same flaws. The importation of external scientific methods, theories, concepts and values crystallized much of the debates as opponents to BE and neuroeconomics reaffirms the identity of economics as a discipline that is agnostic regarding decision-making processes, and therefore, equally uninterested in any contributions from psychology or neurosciences.

In parallel to what happened in economics, the emergence of these controversies and research programs stimulated a whole new strand of research in philosophy and history of economics (Truc et al., 2021). In the words of methodologists, by the 2010s neuroeconomics

was “hot” (Marchionni and Vromen, 2010, p.103) and “almost all of the real ‘action’ within contemporary economic methodology” was in “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, p.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 distinguish two different questions. The first question, the focus of the issue, is theoretical and ask whether neuroeconomics can be relevant to economics. Directly related to the controversies involving economists, the main issues is whether the interaction between economics and neuroscience is just lip-service with not actual content for economics (hype) or if it can actually be useful to improve economic knowledge (hope). A second question is socio-historical and ask whether neuroeconomics is programmatic writing with little influence that only generate a lot of short-term conversation (hype) or whether it is a vector of change as economists actually adopt neuroeconomics as a legitimate part of the discipline on the long-term (hope). While the first question is theoretical and epistemological, the second is more empirical and asks whether neuroeconomics is a successful approach in economics. More than ten years later the *Journal of Economic Methodology* special issue, we want to provide an answer to this second question.

In the present article we want to investigate the emergence and development of neuroeconomics as a research program in economics with the help of quantitative empirical tools. While there was certainly a lot of talk about neuroeconomics in the early 2000s and 2010s, did neuroeconomics actually successfully became a full-fledged approach in economics ? To answer this question, we mobilize a variety of data-sets from multiple databases and approach neuroeconomics through multiple lenses to cross-validate observations from different datasets.

2 Methodology

A first important aspect of this research is to identify what constitutes “neuroeconomics”. While it is a discussed specialty in the literature, its precise frontiers are difficult to identify. Is neuroeconomics only publications in economics with some neuroscience ? Does it encompass neuroscientific publications that are directly relevant to economics even when not mentioning neuroeconomics ?

A first scientometric study by Levallois et al. (2012) used a relational approach based on review articles. From a set of review articles about neuroeconomics, they identified the most important articles in neuroeconomics. While this method has many advantages, it can also be noisy and biased by the kind of review articles published in such a young field. Review articles are rarely a survey of all neuroeconomics. More often they are about a particular topic such as intertemporal choice in neuroeconomics. Therefore, the most common references in review articles can overestimate the importance of a sub-speciality if more survey articles from this speciality are published, especially in a relatively new field like neuroeconomics where there are not many general review articles or handbooks. More generally, the article by Levallois et al. (2012) does not focus on the corpus they construct from this methods, and the scientometrics approach they mobilize might not be enough to answer the question of interest to us.

For the present article, we propose a different approach which combines different corpora build from keywords, JEL codes and from articles at the frontiers between economics and neuroscience. While each corpus has its own biases, the trend observed in the different corpora can inform us about the situation of neuroeconomics.

- Google - Ngram corpus: a simple corpus to count the frequency of particular words in all google books. This corpus will help us establish how much interest do neuroeconomics generate (relatively to behavioral economics) in books.
- Econlit - JEL corpus: the Econlit database is specialized in economics publication and therefore is a good source of information to investigate neuroeconomics from the

vantage point of economics. One interesting feature is that Econlit allows to search articles by JEL codes. A first corpus we will create from Econlit will be composed of all articles tagged with BE and neuroeconomics JEL codes. This will allow us to compare both research programs as they are identified by JEL codes.

- Econlit - keyword corpora: from the Econlit database, we will also create two corpora. A first one with all articles containing the keywords “neuroeconomics” and “neuroeconomics” to identify articles that explicitly mention neuroeconomics. A second one with articles identified from a set of keywords that could only be used in neuroeconomics publications in economics (e.g., stratum, fMRI, ganglia, oxytocin). With this last corpus we can identify articles explicitly contributing to neuroeconomics even when they do not mention neuroeconomics itself.
- Web of Science - keyword corpus: Another keyword corpus will be built from all articles in all disciplines containing the keywords "neuroeconomics" and "neuro-economics" in the abstract, title, keywords by authors, or keyword plus¹.
- Web of Science - general references corpus: while the previous corpora are focused on neuroeconomics as a field, this corpus would be more general to investigate the triptych relation economics-psychology-neurosciences. With this corpus, we will measure how the citations from economics to neurosciences evolved over time (in comparison to psychology) independently from any *a priori* definition of neuroeconomics. We will also do the same for neuroscience and investigate whether economics is a discipline growing in importance in the discipline or not. This corpus will inform us more generally about whats happening at the frontiers of both fields.
- Web of Science - frontiers corpus: one final corpus will be constituted with all articles in neuroscience citing at least three economics articles and all economics articles citing

¹Keyword plus is a Web of Science features that assign keywords to articles based on the title of its references. For example, while an article might not explicitly talk about neuroeconomics in their abstract/title/keywords, it might be identified as neuroeconomics if some of its references contain the word neuroeconomics

at least three neuroscience articles.

- Microsoft Academics - topics corpus: Microsoft Academics database is a web search engine for academic publications similar to google scholar. One particularity of the database is that items are classified according to hierarchized and non-mutually exclusive fields of study and topics. These classifications are created using artificial intelligence and based on similarity measures which includes contents of items, authors, and other variables to identify the discipline and topics of a individual items. Moreover, unlike Web of Science, the database includes books. While topics are relative black box, it serves as an additional measure which does not rely on keywords, JEL codes or references.

3 The Rise and (Possible) Fall of Neuroeconomics

We will first evaluate the rise of neuroeconomics as a research program. We take two important points of reference for our analysis. The first is obviously temporal. Whichever the corpus used, we first want to know if there is more or less neuroeconomics between the early 2000s and the late 2010s. A second important point of reference is behavioral economics and psychology relatively to neuroeconomics and neurosciences. While the temporal aspect of our research is important, BE will sometime act as a point of references to give us a clues about the scale of growth/degrowth of neuroeconomics. While it is largely recognized that BE is now widespread and an important part of the mainstream of economics (Geiger, 2017; Angner, 2019), the interest generated by neuroeconomics is not as clear. BE as a point of reference will also gives a point of comparison for the dynamic of both research program. If both programs have different dynamics, this tells us something about the specific dynamics of neuroeconomics rather than potential confounding factors like a varying general interest of economists for microeconomics, individual behavior, experiments, or research program claiming interdisciplinary influences.

Neuroeconomics as a Brand

When talking about research programs, name have a lot of importance and can act as “brand”(Tomer, 2007; Earl and Peng, 2012) that different group of researchers appropriate for themselves with more or less success. For example, while many research programs adopted the terms “Behavioral Economics” (Sent, 2004), since the 2000s, the term is clearly understood today as Kahneman and Tversky’s heuristics and biases research program and positively connoted. Inversely, brand can have negative impact on the way research program are received. Such is the case of research programs identified as heterodox in economics for example. Researchers are well aware of how brand can help or hinder research program 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 the time, and experimental economists were against having a specific JEL codes for the field (Maas and Svorenčík, 2016, p.39). It was important that “experimental economists” was identified as a tool that is part of mainstream economics rather than a separate research program (Maas and Svorenčík, 2016, p.37,58).

In the case of neuroeconomics, the research program rapidly emerged as an identifiable brand. Most economists in neuroeconomics were already successful economists or neuroscientists, and they promoted the field as a specific brand. They identified themselves early on as neuroeconomists (Camerer et al., 2005; Fehr and Camerer, 2007). A Society for Neuroeconomics was created in 2004 with Glimcher and Camerer as the first two presidents. In 2007, a “87-Neuroeconomics” JEL code was created, in 2008 neuroeconomists had already engaged in well-identified controversies with the more standard economists (Camerer, 2008a; Gul and Pesendorfer, 2008), and by 2009 the first textbook on neuroeconomics was published (Glimcher et al., 2009). Overall, neuroeconomists try 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 facing the stigma early experimentalists and behavioral economists in the 1960s and 1970s, neuroeconomists relied on the legitimacy given by neurosciences and by the previous success of behavioral economists to publicized

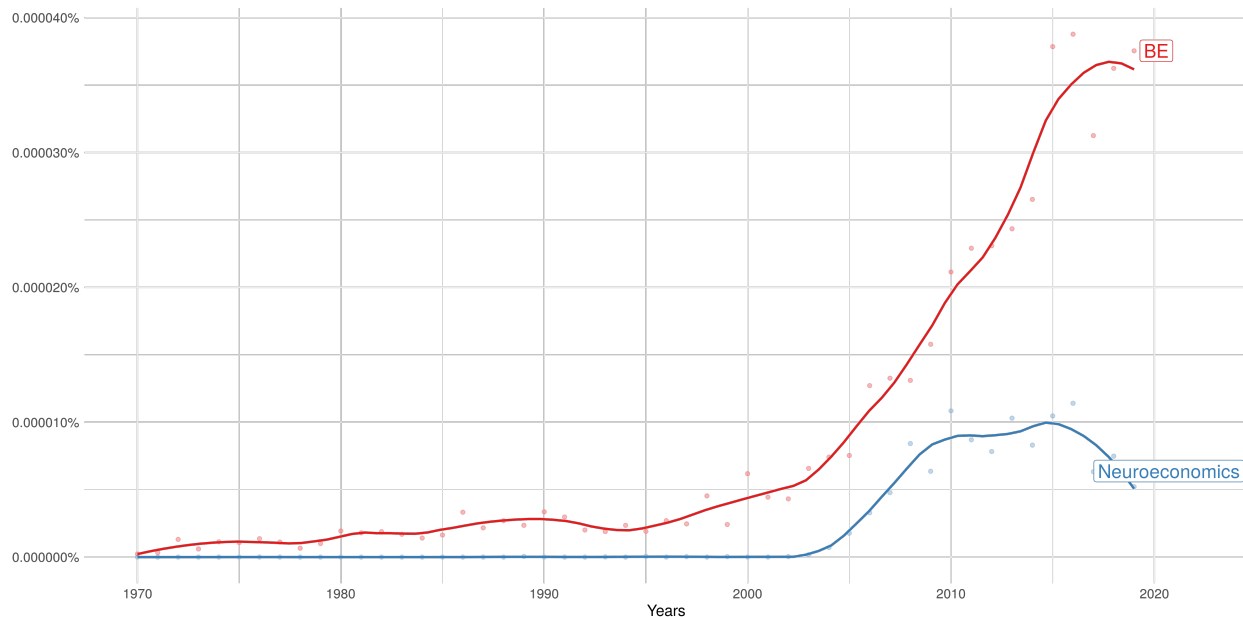


Figure 1: Frequency of “Neuroeconomics” and “Behavioral Economics” in google books (case-insensitive search, no smoothing in google)

their approach as the logical next step. As such, investigating the success of “Neuroeconomics” as a brand is already a useful first step.

Our first and more general corpus is based on Google Ngram Viewer. On the one hand, this tool is a rather crude tool. It only counts the occurrence of particular words among all the words in all google books, and it is not limited to the specific context of academia. On the other hand, it is certainly one the most general tool available to investigate how specific words generate interest and disinterest (Figure 1). The results from this first tools are clear. The interest for neuroeconomics grew rapidly in the mid 2000s, peaked in the mid 2010s with around 0.000011% all unigrams in 2010 and 2016, and decreased after. Relatively to BE, we do find that the interest for neuroeconomics grew at a similar rate than the one for BE in the early 2000s. Between 2003 and 2010, the difference between the two word occurrences remains between 0.000005 and 0.000010 points before increasing rapidly after the 2010s and up to 0.0000032 points in 2019. Despite neuroeconomics being younger, the “hype” generated by BE and neuroeconomics during the mid 2000s was similar. However, by the 2010s, it was clear that the interest for BE (most notably after Kahneman’s Nobel in



Figure 2: Shares of articles that contain particular keywords in Econlit and Web of Science. The keyword search in Econlit includes JEL codes. Neuroeconomics Keywords are “Neuroeconomics” and “Neuroeconomics”. Specialized Keywords are some of the most distinctive words of the field (e.g., stratum, prefrontal)

2002) was here to stay, while the interest for neuroeconomics was fizzling out.

Our second, third, and fourth corpora are less general than Google Ngram Viewer and more focused on academic publications. The second corpus is made of all articles mentioning “Neuroeconomics” in Web of Science (Figure 2a). This includes articles in any disciplines, including neurosciences. When looking for keywords on Web of Science, the search is made on the title, the abstract (when available), the keywords supplied by the authors, and the “Keyword Plus” supplied by Web of Science. Keyword Plus are generated from the title of the references of a given article. While an article might not explicitly talk about neuroeconomics in their abstract/title/keywords, it might be identified as neuroeconomics if some of its references contain the word neuroeconomics. From this second corpus, we observe a similar pattern as the one from Google Ngram (Figure 2a) except that the peak year is in 2008 rather than 2016 with around 0.0042% of all WoS articles.

Our third and fourth corpora are made of a similar search in the EconLit database using

keywords (Figure 2b) and JEL codes (Figure 3). Because Econlit only covers economics, these corpora were constructed to measure the interest for neuroeconomics in economics only. The third corpus is made of all articles mentioning “Neuroeconomics” and specialized keywords. This time the search does not include Keyword Plus, but it includes JEL codes. Therefore, all articles mentioning neuroeconomics in their title, abstract, keywords supplied by the authors or in the JEL codes are included. One advantage of focusing on economics articles is that we can also find neuroeconomics by using typical keywords that can only be found in the field. Neuroeconomics is a sub-field of economics that uses a variety of concepts that are very distinctive with, for example, words from neurosciences. While looking for such keywords across all disciplines do not present any interest, it is a good way to proxy publications by neuroeconomists in economics. For this particular keyword search, we search titles, abstracts, and keywords for any articles mentioning keywords highlighted by Levallois et al. (2012): “stratium”, “prefrontal”, “cortex”, “fMRI”, “ganglia”, “dopamine”, “striatal”, “oxytocin”, “insula”, “basal”, “neuroimaging”, or “brainimaging”. Specialized Keywords are a particularly robust way to identify how economists actually do neuroeconomics independently of whether they talk about “neuroeconomics” itself.

From these two keywords search, we more generally observe once again the same pattern as in the two previous corpora. The interest for Neuroeconomics grew rapidly in the mid 2000s, with a peak interest around 2010s, but it decreased after. In the case of Specialized Keywords, we find a peak interest in 2014 with an occurrences of keywords in 0.046% of all articles in EconLit (Figure 2b). In the case of the more general Neuroeconomics Keywords search, we find greater short term variation with two peaks interest in 2010 and in 2016, the same peak years as in our Ngram corpus (Figure 3a).

The fourth corpus is made from JEL codes search in Econlit. How JEL codes are used is not always clear (especially when they are recent), their uses (and misuses) touch on many issues in economics, and classifiers play an important role in the way articles are identified (Cherrier, 2017). While they are not very transparent, they are a great tool to complement previous observations they allow us to identify neuroeconomics articles that don’t explicitly

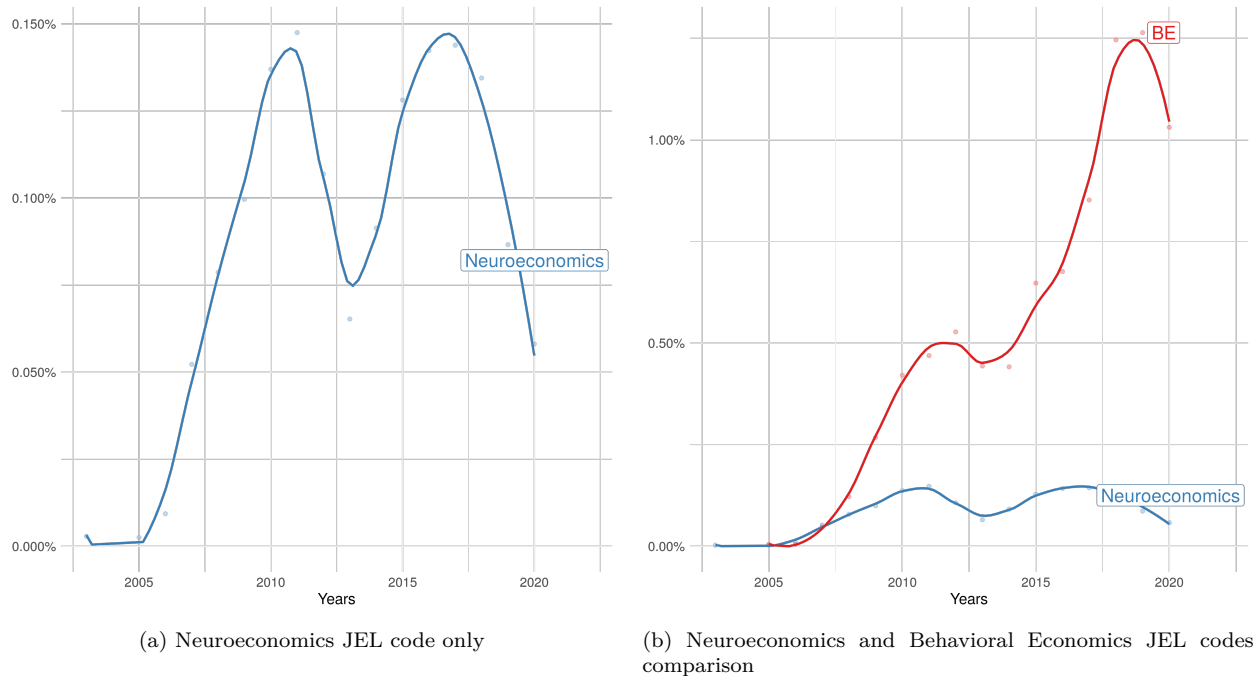


Figure 3: Shares of articles that match particular JEL codes in Econlit

mention neuroeconomics itself or any of its specialized keywords. Another advantage of JEL codes is that we can use neuroeconomics and BE JEL codes to compare the popularity of both research program in economics publications, which is harder to achieve with keywords.

The JEL code neuroeconomics emerged in 2007, slightly before the JEL code for behavioral economics. 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.

For our search we took all articles matching the D87 code for neuroeconomicsa and the D9 codes (and sub-codes D90 and D91) for BE. Despite emerging at around the same time, the BE code rapidly became a lot 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 of all EconLit articles

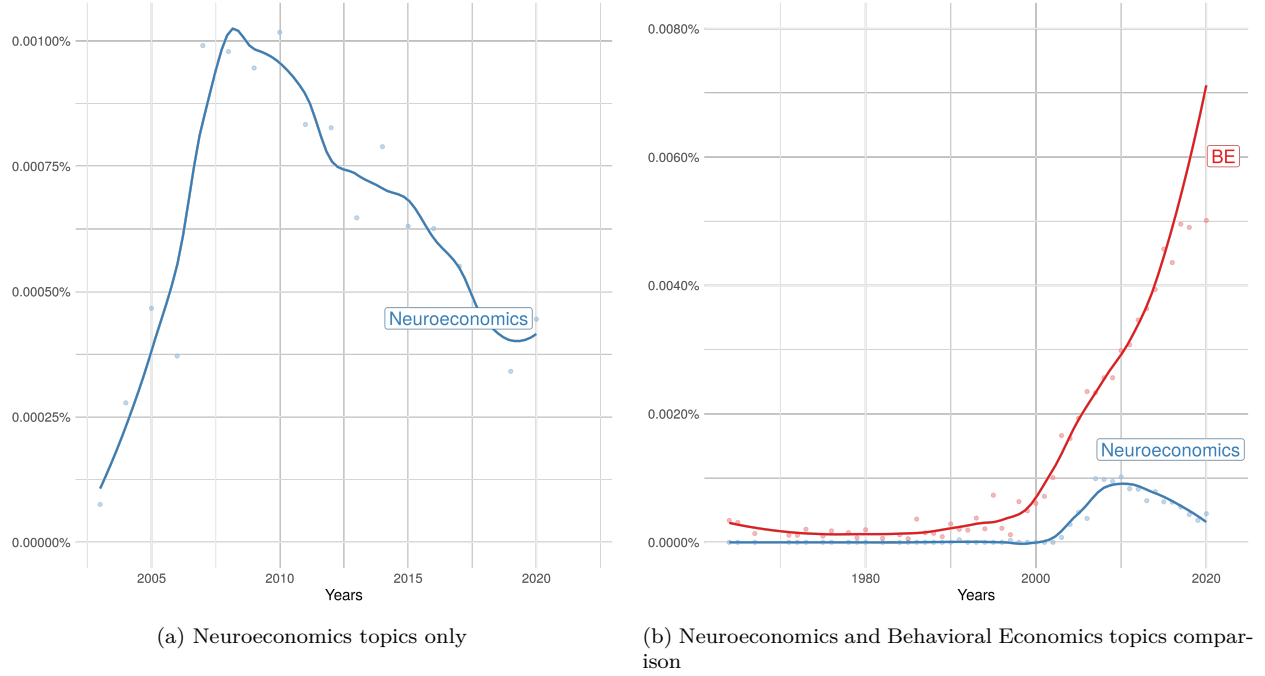


Figure 4: Shares of articles that match particular topics in Microsoft Academics

during its peak year in 2016. In the case of neuroeconomics, we find a very similar pattern as in the Econlit Keyword Corpus as keywords (Figure 2b) as keywords search also include JEL codes. Overall, despite the greater short terms variations observed in Econlit, we can conclude that neuroeconomics grew rapidly when it emerged, but has only been stagnating or decreasing since 2010 especially when compared to BE.

Finally, one final corpus is made using topics from the Microsoft Academics database. According to this source, we find a similar pattern as the one mostly observed previously: a rapid rise of neuroeconomics up until the 2010 with up to 0.0010% of all items in microsoft academics, followed by a rapid decreasing interest to less than 0.0004% at the end of the 2010s (Figure 4a). Similar to what was observed with Google Ngram Viewer, in the early 2000s the growing interest for BE and neuroeconomics was similar. While BE is a lot older than neuroeconomics, neuroeconomics was a contender to be as important as BE during that time in terms of new publications. However, after the 2010s, and as neuroeconomics fell in importance, BE maintained its rapid growth rate and secured its lead over neuroeconomics (Figure 4b).

Overall, after growing interest in the early 2000s, and a stagnation in the early 2010s, neuroeconomics seems to have decreased in importance after the mid 2010s. In all corpora, we find that neuroeconomics is far from growing as quickly as BE after the 2010s. In other words, if we think of neuroeconomics as partly “behavioral economics in the scanner”, neuroeconomics is proportionally becoming a smaller part of behavioral economics overtime.

While keywords and JEL codes are good way to approach neuroeconomics, they have their limitations. We have some inconsistencies whether the peak of neuroeconomics is in the late 2000s (Figure 2a and 4a), or mid 2010s (Figure 1, 2b, and 3a). Rather than counting articles in different database, we investigate neuroeconomics differently by focusing on neuroeconomics and BE as research program at the frontiers of economics and neurosciences.

Neuroeconomics as a Frontier

Another way to approach neuroeconomics is to simply investigate what is happening at the frontiers of economics and neuroscience. As such, the distinction between “Economics of Neural Activity” and “Behavioral Economics in the Scanner” (Vromen, 2011) can be understood as the two kind of disciplinary interactions that takes place at the frontier of both disciplines. In the case of “Economics of Neural Activity”, neuroscientists borrow from economics to study neural activity, while in the case of “Behavioral Economics in the Scanner”, economists borrow from neuroscience to work on individual behavior.

To capture neuroeconomics as a frontier, we simply took all articles from the Web of Science database that were either published in economics or in neurosciences. We then took all of the references of all of these articles and computed the share of citations going from one discipline to the other. Just like we used behavioral economics previously as a way to scale the impact of neuroeconomics, we will study how economics and neurosciences relate to psychology and general sciences as a benchmark. The advantage of such methods is that it allows us to investigate neuroeconomics without *a priori* definition of what is neuroeconomics. However, it also poses a different kind of challenges as it imposes us to define what is “economics” and what is “neurosciences”. For the present article we used

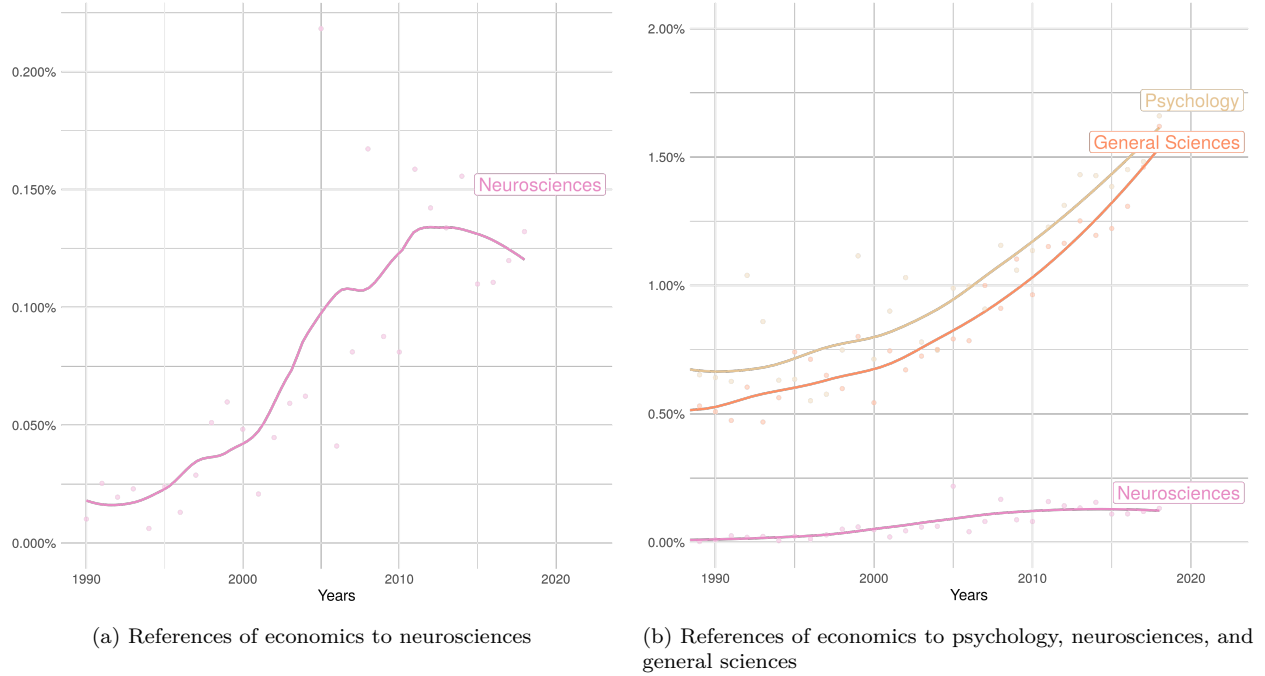


Figure 5: Shares of references to particular disciplines in economics

the US National Science Foundation (NSF) classification system that assign disciplines to particular journals. This system includes 143 fields of research (e.g., sociology, psychiatry), which are themselves 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 neurosciences, we do find back the observed pattern of a decreasing interest for neurosciences after 2010s (Figure 3a). After a significant peak of around 0.15% of all economics references to neurosciences between 2008 and 2014 (if we exclude the exceptional year of 2005), the relative weight of neurosciences never fell back to around 0.12%. This decreasing share of references to neurosciences is also countercyclical to what we observe with psychology or more general sciences journals like *Nature*, *Science* or *Plos ONE* who both continuously went up from around 0.5% of all economics references in the early 2000s to above 1.5% in 2018 (Figure 5b). More generally, the share of references to neuroscience is quite low in relative terms. In 2018, psychology journals were cited 10 times more often than neurosciences journals in economics.

To test the robustness of our category, we also used WoS categories which are non-exclusive. In other words, journals can be tagged as belonging to multiple disciplines. The sum of all references can therefore go way beyond 100% as a reference can belong to multiple disciplines. This is particularly useful for neurosciences as it is a relatively young field, and that, more generally, is often identified as at the frontiers of multiple disciplines belonging to cognitive sciences (Thagard, 2005, 2010). However, it is also potentially biased in a different ways as all articles in a psychology journals that publishes some neuroscience will have all some of its articles identified as both psychology and neuroscience.

Between the 1990s and late 2000s, we do find that both categories present similar growth rate and level in economics. However, after the 2010s, while NSF category clearly decreases, the WoS category only slow down and stabilize at around 0.18% of all references (Figure 6). WoS categories are larger than the NSF, they capture more references and therefore present a higher level. It is also not surprising that after the late 2000s both categories are increasingly disconnected. If economists cite more psychology and less neurosciences, and that the WoS categories classify many journals as both psychology and neuroscience, it creates a tension between the two trends as the slope of the curve ends up as the mix of both trends. Finally, the emergence of recent journals at the frontiers of economics and neurosciences (e.g., *Journal of Neuroscience, Psychology, and Economics* created in 2008) might also impact the differences between both classification as WoS allows such journals to belong to multiple disciplines. Overall, we still find that citations from economics to neuroscience are at a very low level when compared to psychology. The citations from economics to neurosciences probably mostly capture neuroeconomics as “Behavioral Economics in the Scanner”. How about citations from neurosciences to economics and “Economics of Neural Activity” ?

Unlike the previous trend observed, we find that the intertemporal dynamics of citations from neuroscience to economics follow a straightforward upward trend (Figure 7a). While citations from economics to neuroscience decreased after the 2010s, the interest of neuroscientists towards economics seems to only increase. We also find another interesting

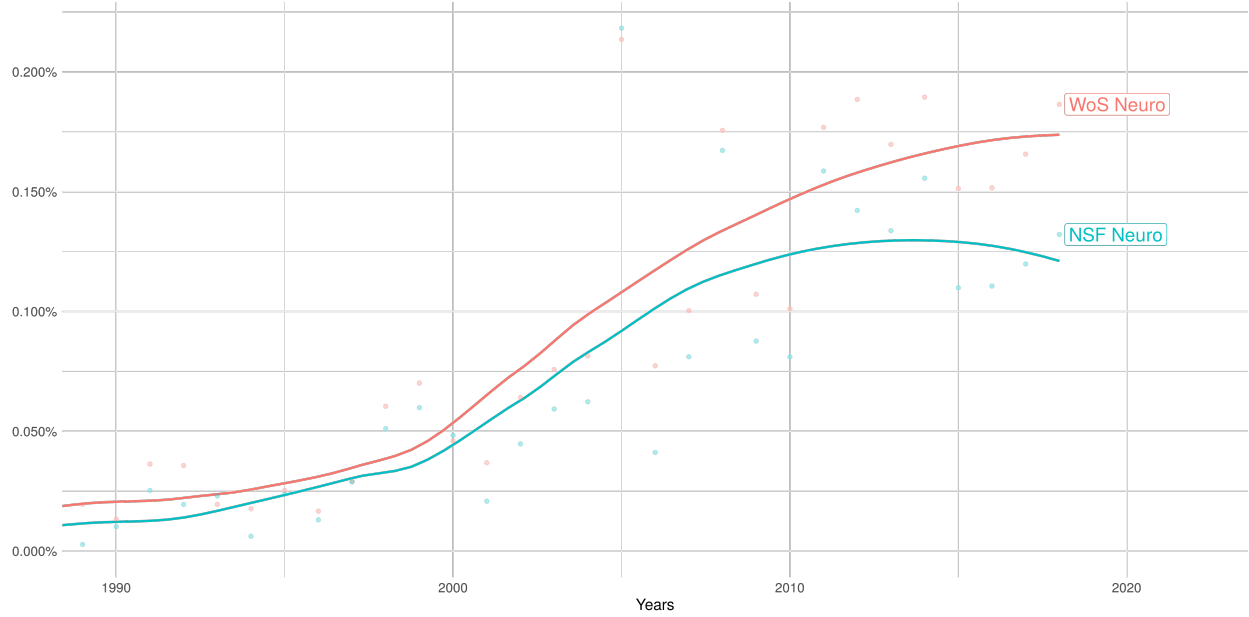


Figure 6: Shares of references to neurosciences in economics according to WoS and NSF classifications

trend rarely discussed in the literature on neuroeconomics. While up until the late 2000s references in neurosciences to management and to economics were growing at a similar rate, after the 2010s the growth rate of references to management went up drastically compared to economics (Figure 7a). It is difficult to pinpoint a single phenomenon to this trend as the “management” category encompass a variety of journals dedicated to applied psychology, consumer research and marketing. One potential explanation is simply that neurosciences became more interested towards this variety of applied journals in relation to consumer behavior. Another potential lead is the emergence of neuromarketing in the late 2000s which Levallois et al. (2021) identify as consolidating around 2007-2008. However, this remains relatively unrelated to economics as a discipline.

Despite the upward trend of economics and management in neuroscience, the relative share of the references to both disciplines is very low in neurosciences when compared to its counterpart in economics. While we find that the highest share of references to economics in neuroscience is around 0.05%, it was 0.15% in economics. Overall, we can say that the level of interest between neurosciences and economics remain, generally, relatively low even

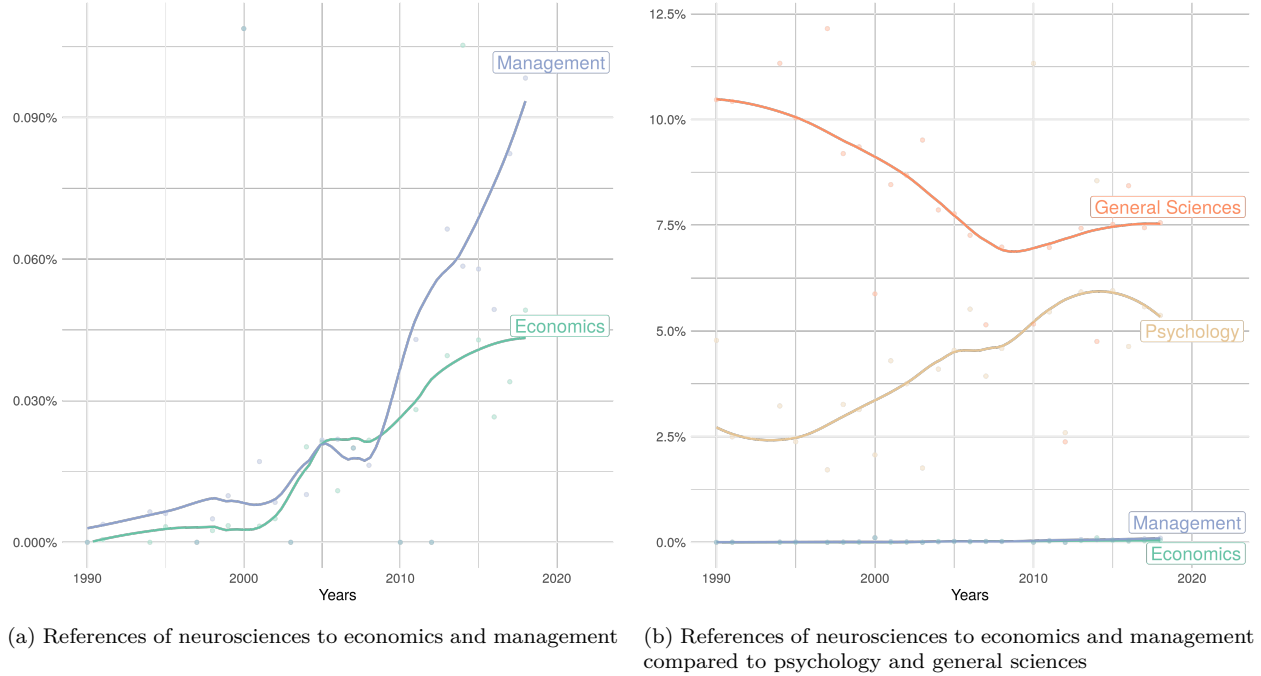


Figure 7: Shares of references to particular disciplines in neuroscience

with favorable dynamics (Figure 7b).

Overall, one strong trend we find across our different corpora is that neuroeconomics and neurosciences generated a lot of attention in economics during the 2000s, even sometime to a growth rate comparable to BE which had emerged almost 20 years earlier. However, after the 2010s, this attention had either declined or stagnated which indicates that the emerging relationship between neuroscience and economics seemed to be more “hype” than “hope”. The low importance of neuroeconomics and neuroscience in economics is particularly notable when it is compared to the importance of BE and psychology in economics.

4 Building a research program from the outside

Behavioral economics and neuroeconomics are seen as sharing many common characteristics. Behavioral economics could be seen as a research program at the frontier of economics and psychology, while neuroeconomics as a research program at the frontier of economics and

neurosciences. In both cases, the research programs originate from outside of economics (Davis, 2008, p.359) with an explicit orientation to change economics with the help of cognitive sciences. More generally, it is often put forward that neuroeconomics share a common origin story with behavioral economics. For example, in the “short history” section of Glimcher et al.’s (2009) handbook on neuroeconomics, the origin of the field is partly identified as partly originating from economics. The history span from Adam Smith and 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 behavioral economics with the publication of (Allais, 1953) as a “critical” point to understand “where Neuroeconomics came from” (Glimcher et al., 2009, p.xix) especially when understood as “behavioral economics in the scanner”. Finally, the term of “behavioral economics in the scanner” itself pinpoint the strong links that have been identified by philosophers of economics (Vromen, 2011).

Despite these common characteristics, we find important differences in the way behavioral economics and neuroeconomics have been received in economics. This is particularly puzzling. Why did economists accepted the influence of cognitive psychology while, apparently, rejecting cognitive neurosciences ? We can identify multiple causes to these differences in the litterature. Neuroeconomics is often identified as a discipline cognitively further away from economics than psychology (Moya-Anegón et al., 2004; Levallois et al., 2012) making the interdisciplinarity between the two harder (e.g., learning how to produce or read fMRI measures). This also manifests in very different research practices that hamper collaborations. Economists journals have long review cycles and they have favored alphabetical author order for a long time (Li and Yi, 2021), which in turn encourage collaborations between a limited number of authors (Van Praag and Van Praag, 2008). At the opposite, neurosciences journals tend to have shorter review cycles and favor contribution-based author order, which in turn lead neuroscientists to engage in large-team collaborations (Levallois et al., 2012, p.5). From an epistemological point of view, the differences in levels of explanations between economics and neuroscience might mean that neuroeconomics is simply irrelevant to eco-

nomics (Kuorikoski and Ylikoski, 2010). Neuroeconomics faces many methodological issues from a lack of unity (Fumagalli, 2010) to reverse inference fallacy (Bourgeois-Gironde, 2010). Finally, the integration of neuroeconomics also involved expensive hardware and methods (*versus* cheap experiments on students or econometrics) that is unusual in economics and represent concrete obstacles to easier integration (Clithero et al., 2008, p.2349).

While the previous listed elements are important, one could imagine that if neuroeconomics had capture the attention of economics, economists and neuroeconomists would at least try to tackle some of this issues to accommodate the program in a way that would make it more amenable to economics. For example, the expensiveness of neuroeconomics also come with the possibility of claiming bigger grants from natural sciences institutes, and there are ways to do neuroeconomics experiments that are cheaper than using fMRI (e.g., hormones). Large-team collaborations might be harder to publish in top economics journals, but it is also a doorway to publications in other prestigious venues like *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 experiments in economics were common, and economics laboratory already existed. The infrastructure was here. The gap to run neuroeconomics experiments in a contemporary context might be smaller than the one faced by experimentalists in the 1960s when nothing of the sort even existed. For example, using hormones or transcranial magnetic stimulation simply involve introducing new tools in otherwise normal economics experiments.² Regarding methodological issues, one could imagine neuroeconomics might have developed around methods and questions more fitting to economists. In the early years of experimental economics, economists rapidly tackled some methodological issues they had with experimental psychology by developing a distinct methodology more

²While we often think of early economics experiments as something easy to imitate because classroom experiments are cheap to run, Vernon Smith emphasize the big investments necessary to actually build 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 Svorenčik, 2016, p.85)

oriented to wards economics questions, most notably by refusing deceptions and only doing incentivized experiments (Maas and Svorenčik, 2016, p.77). More generally, many epistemological issues related to the particularities of neuroscience, such as explanatory relevance, also concern psychology (Gul and Pesendorfer, 2008). Such issues did not necessarily prevent behavioral economics from successfully emerging in economics.

The goal of this section is not to give a definitive answer on one identifiable cause. Taken all together, these issues matter and could have contributed to the possible fall of neuroeconomics, but we want to put them aside for a moment. Instead of epistemological issues, we want to explore a different kind of explanations that is more rarely discussed. Contrasting how behavioral economists and neuroeconomists have constructed their research program from the start, we want to make a comparative case-study of how two research programs both at the frontiers of economics and neurosciences adopted very different approaches to economics.

Addressing an Economics Audience

Both behavioral economics and neuroeconomics were partly founded by researchers that were not economists. As such, both fields faced similar issues: convincing economists that contributions from psychology and neuroscience were relevant to economics.

In the 1970s, Kahneman and Tversky, broaden their approach by organizing workshops that would gather economists and psychologists. More importantly, they also publish in the best economics journals themselves in a way that was not overly confrontational. To publish in economics, Kahneman and Tversky were actually careful with a rhetoric that would convince economists. While it took them five year to publish Kahneman and Tversky (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, p.119). For example, they “carefully avoided the term rational” and instead favor “reasonable” as to avoid making Kahneman and Tversky (1979) appear as an explicit critique of economics (Heukelom, 2014, p.120), and we also find very few explicit references to psychology in the early work of Kahneman

and Tversky in economics (Truc, 2021a) despite both of them being psychologists with no publications in economics. Finally, Kahneman and Tversky (1979) maintained the role of traditional economic theory as a normative benchmark which made the behavioral approach less threatening as it was made compatible with existing theory (at least from a normative point of view).

More generally, the approach of Kahneman and Tversky involved accommodating economists, in a way that would make psychology more acceptable. When behavioral economics developed as a more systematic research program in the 1980s in the Sloan-Sage Foundations, these type of strategies would also be shared across the board. It was understood by members of the program that the main issue should not be centered around “the rational, maximizing, economic paradigm” (Heukelom, 2012, p.274) as the advisory committee “actively tried to prevent a theoretical economic discussion of neoclassical economic theory” (Heukelom, 2014, p.156). Bringing Thaler within the program also proved to be a particularly important move make BE more relevant to economists as the pairing with Kahneman was intended to lead to more market oriented contributions (Heukelom, 2014, p.154).

At the opposite of Kahneman and Tversky’s strategy, early proponents of neuroeconomics rapidly emphasized the revolutionary potential of neuroeconomics. For Camerer, one of the earliest proponents of neuroeconomics, the interaction with neurosciences could challenges some economics traditions, such as the ‘preferences-beliefs-constraints structure’ (Camerer et al., 2005, p.9). For Camerer, neuroeconomics could lead to either an incremental approach (based on the traditional foundations of economics in a similar fashion as 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, p.10). More generally, neuroeconomists did not always engage economists in a pedagogical manner. For example, Rubinstein explains: “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, p.486). Camerer

responded to this statement in a relatively dismissing - 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, p.374). Neuroeconomists who are not economists also rely heavily on language borrow from natural sciences rather than psychology or economics such as when (Montague, 2007, p.219) explain the interest of neuroeconomics by arguing: “there is no more fundamental structure for an organism than to behave so as to recharge their batteries; consequently, each moment of existence is attended by the need to value that moment and its near-term future quickly and accurately.” Finally, while behavioral economists explicitly maintained the role of normative economic theory, neuroeconomists “implicitly undermine its normative foundations” in they way they historically focused on learning and reward theories as benchmarks rather than economics rational choice theory (Vallois, 2011, p.192).

Bringing new tools from other disciplines involved a lot of pedagogical efforts. In the case of experiments in economics, a lot of intention was put into “educating editors” (Maas and Svorenčík, 2016, p.60) or “lowering the barriers to entry” (Maas and Svorenčík, 2016, p.71). While behavioral economists put a lot of emphasis on making experiments and psychology relevant by adapting their discourse to an economic audience, neuroeconomists were less concerned with these questions. Obviously, neuroeconomists did not face the same context. Behavioral economics was already successful when neuroeconomics emerged, and proponents of the program that were also behavioral economists like Camerer were already successful economists. As such, there is a good reason for him to be bolder when promoting neuroeconomics when compared to Kahneman and Tversky who were non-economists and complete outsiders in the 1970s. However, the scientific capital accumulated as behavioral economists does not necessarily translate in neuroeconomics even if for its proponents it appear to simply be the natural next step.

Programmatic Writings vs Flagship Contributions

Another important element between behavioral economics and neuroeconomics is that the former did not emerge as a research program from the start, but rather emerged as a research program after some flagship successes.

With the publications of Kahneman and Tversky (1979), Kahneman did not present a research program, but rather a theoretical contribution. The word “behavioral economics” are not even mentioned, and nothing foretells that this contribution is going to lead a vast research program. Kahneman and Tversky did not publish in economics after until 1986 (Kahneman et al., 1986). In one of the more programmatic-looking articles “Toward a Positive Theory of Consumer Choice”, Thaler (1980) does not mention behavioral economics, but simply that “prospect theory is proposed as the basis for an alternative descriptive theory”. Prospect theory was not conceived as a large research program until the Sloan-Sage explicitly entered the stage in the mid 1980s with the behavioral economics research program.

More generally, behavioral economics emerged by building itself around one (and later a few) central theoretical flagship contributions. 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, p.274). Behavioral economists had anomalies, but Kahneman and Tversky knew that to convince economists, they would need mathematically sophisticated theoretical contributions that economists would accept (Heukelom, 2014, p.152, p.155). Rather than creating BE around programmatic writings that would highlight the potential of a research program at the frontier of economics and psychology, Kahneman and Tversky approached economists with a contribution that economists would value, and anomalies 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, p.344). From the early years of BE to the late 2000s, (Kahneman and Tversky, 1979) was rapidly identified as one of the most central contribu-

tion of the field (Truc, 2021b, p.12). This articulation of a few important economics theories coupled with a variety of experiments remained mostly true throughout the history of BE as new research directions in the field structured themselves around major theoretical contributions like Laibson (1997) for intertemporal decision or Rabin (1993) and (Fehr and Schmidt, 1999) for pro-social behaviors (Truc, 2021b, p.11). Experimental economists avoided having a particular journal or a particular JEL code that would set them apart from economics (Maas and Svorenčik, 2016, p.39), and behavioral economists got their JEL code more than 25 years after the creation of the program. In other words, behavioral economists did follow a literary advice of good storytelling: show, don't tell.

Neuroeconomists followed the opposite path and first told before showing. Rather than entering economics with a flagship contribution, they immediately presented themselves as a separate research program. It took less than a decade for neuroeconomists to have their JEL code, a journal, a handbook written by the leading figure of the field (section 3), and more importantly, the early years of neuroeconomics were as much about publishing contributions to the field than clarifying its goals. Many neuroeconomics articles are programmatic writing about the goal of the research program, its methods and framework, its progress, and what could 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) application of neuroeconomics to the ultimatum game is as cited as Camerer et al. (2005) programmatic article. Moreover, the third most cited references in the WoS keyword corpus (Table 1) and the most cited article in the frontier corpus (Table 2) is Kahneman and Tversky (1979). This emphasizes the “behavioral economics in the scanner” nature of the program, but also the fact that we do not find a flagship reference in neuroeconomics that could play a similar role as Kahneman and Tversky (1979) in the 1980s when BE emerged. This difference with BE is particularly striking when we take into account that the most cited neuroeconomics contributions are not published in economics journals. In both corpora, the only reference in economics that is not BE is (Camerer et al., 2005) programmatic

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

article. In other words, the most important articles for neuroeconomics are only published in non-economics journals, and the only important publications in economics are 40 years old behavioral economics article, and a programmatic article about how economists should do more neuroscience.

This last results emphasize one last important difference between BE and neuroeconomics. While behavioral economics was founded by psychologists publishing in economics, neuroeconomics structured around non-economics publications.

Disciplinary Interactions and Integration

While BE is at the frontiers of economics and psychology, a lot of care was put into insuring that both economists and psychologists had an equal share of power in the development of the program. As expressed by Kahneman about the early years of his research 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, p.1449). Members of the advisory committee were equally economists and psychologists, invited researchers and grant were carefully balance in a way that would prevent one discipline from having a

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	Quarterly Journal of Economics
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	Neuron
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	Neuron
Huettel et al. (2006)	6.3	Neuron
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	Neuron
Demartino et al. (2006)	6.0	<i>Science</i>

Table 2: Most Cited References in the Frontier Corpus

lot more influence on the other within the program (Heukelom, 2014, p.168). While it is recognized that interdisciplinarity played an important role in the evolution of BE (Grüne-Yanoff, 2016), it is also often postulated that the program became, overall, more economics than psychology as time went on (Braesemann, 2019) even if there is more subtleties to the changing relation between economics and psychology (Truc et al., 2020). Three important elements contributed to making the program oriented towards economics. First, Kahneman and Tversky both started to publish in economics extensively, and by the mid 1980s, the vast majority of Kahneman’s publications were in economics journals(Truc, 2021a). These economics publications were also in some of the most influential journals rather than specialized journals, or worse, new journals dedicated to behavioral economics. Second, pairing Thaler with Kahneman was expected to help reorient the program towards more “market-oriented” topics and help steer the program in new directions that would settle the economics-oriented nature of BE. Finally, interdisciplinarity in BE was an implicit question in most publications by leading behavioral economists. While behavioral economists would sometime cite articles in psychology, the question of whether BE was economics, psychology, an integration of both disciplinary, or a temporary interdisciplinary was very rarely explicitly discussed in the 1980s. Thaler (1980) programmatic writing does not mention explicitly the role that

psychology should play in such a positive theory. As behavioral economics garnered more success at the end of the 1990s, the subject emerged more explicitly with Kahneman reaffirming the interdisciplinary nature of BE with two similar in the *American Economic Review* (Kahneman, 2003a) and in the *American Psychologist* (Kahneman, 2003b). However, Kahneman's perspective also faced the one of other behavioral economists like Rabin who instead suggested that the relationship between economics and psychology should remain limited to the extent that it help develop a synthesis between standard and behavioral theory (Rabin, 1998, 2002, 2013).

At the opposite, neuroeconomists rapidly present the program as a strongly interdisciplinary-oriented program at the frontiers of economics, psychology and neurosciences. Camerer is optimistic and wishes for the creation of a common trade language between disciplines, a “lingua franca” of social sciences (Buyalskaya et al., 2021, p.2), as well as a “unifying frameworks to explain behaviors across disciplines” (Buyalskaya et al., 2021, p.9). If some like (Rangel et al., 2008, p.545) focused on neuroeconomics as a way to build “bridges” between disciplines, the more radical posture of disciplinary integration was also adopted by leading figures of the field: “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, p.447). More generally,

Economists are not sympathetic towards interdisciplinarity both in their practices (Truc et al., 2020) and in their declarations. For example, 57% of economists favor mono-disciplinary produced knowledge (Fourcade et al., 2015). Behavioral economists made it clear that BE was oriented towards contributing to economics rather than an integration of psychology and economics. This might have helped making the interdisciplinarity contributions of behavioral economists more acceptable. At the opposite, even if neuroeconomists want to make the program equally economics and neurosciences, it might be difficult to achieve given that economists are more prone to reject such propositions. Moreover, we find multiple clues that neuroeconomics might not be so equally economics and neurosciences.

A first important issues relate to the historical origin of neuroeconomics. As we dis-

cussed previously, proponents of neuroeconomics often emphasize their historical ties to BE, a way to attach neuroeconomics to an already successful research program in economics. However, historically, the ties of neuroeconomics to neobehaviorism, and more generally to neurosciences, are quite strong (Levallois et al., 2012). Another clue to this strong historical tie is also captured by the name “neuroeconomics”. In Web of Science, the first occurrence of the word “neuroeconomics” was actually in an old 1991 article by Tenhouten (1991) about “the emergence of the ethnoneurologies”. In this article, the author speculate about the emergence in the future of a variety of disciplines based around neurosciences: neurosociology, neuroanthropology, neuropolitics, neuroeconomics, neurophilosophy, neuroaesthetics, neuroepistemology... This prehistoric occurrence of “neuroeconomics” emphasize one important element: the emergence of neuroeconomics is not the result of a particular affinity between neurosciences and economics, but instead it is part of a more general movement of neurosciences towards other social sciences under the umbrella of the “NeuroX” (Vidal and Ortega, 2017, p.59). Even if each of these fields have internal specificity, what characterizes all these research fields is that they are oriented 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, p.59). Our goal here is not to settle the question of whether it is an imperialist enterprise or not (Fumagalli, 2018), but it is important to emphasize that neuroeconomics is part of a larger research program in which economics play a minor role. This has been particularly important in the last few years as neuroeconomics blurs the line between economics, management and the psychology of consumer research with research programs like “Consumer Neuroscience” (Karmarkar and Plassmann, 2019).

The minor role of economics is also visible in our own corpus. As we previously discussed, most of the central references of neuroeconomists are not in economics with the exception of behavioral economics’ publications (Table 1 and 2). In the Web of Science keyword corpus, the share of publications in economics has been decreasing from 19.7% in the late 2000s to 11.7% in the late 2010s (Figure 8). The share of General Sciences journals (e.g., *Science*,



Figure 8: Share of different disciplines in our WoS neuroeconomics keyword corpus

Nature) has also been decreasing to the favor of specialized journals in neurosciences and a variety of natural sciences. This combination of elements do make neuroeconomics a program that might be unsympathetic to most economists given their attitude to interdisciplinarity.

5 Conclusion

Neuroeconomics is a lot young than behavioral economics, but it still successfully generated attention at a similar rate than BE during the 2000s. This led neuroeconomics to become a leading issue of philosophers of economics during the 2010s, most notably by asking whether it was “hype” or “hope” (Marchionni and Vromen, 2010). As philosophers tackled this emerging new field, we find that it is only a few years later that neuroeconomics clearly decreased in importance during the early/mid 2010s. This is especially true when compared to the continuing rise of BE.

If neuroeconomics is understood as “BE in the scanner”, a sub-specialty of BE, then it is an increasingly minor specialty in BE. While we find many potential explanations for the

contrasting reception of neuroeconomics and behavioral economics, we have focused on how neuroeconomists approached economics very differently than behavioral economists. The rhetoric of neuroeconomists was more revolutionary and upfront in what they wanted to achieve when compared to the conciliatory approach of behavioral economists. Unlike BE's "show, don't tell" approach, neuroeconomists emerged with programmatic writings and laid out their intents for a large scale program rather than directly publishing papers in economics that could become the foundation of a potential future research program. Finally, unlike BE, neuroeconomists did not put economics at the center of the field but rather as one discipline among others in a more general cognitive turn. Obviously, the context faced by neuroeconomists and behavioral economists was very different, as they benefited from the sympathy and acceptance build up by behavioral economists for experiments and cognitive sciences. This difference of context might explain some of the contrasting postures adopted by behavioral and neuroeconomists.

The decreasing interest for neuroeconomics after the 2010s does not mean that neuroeconomics is dead, but it 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" and outside of economics. Another possibility is that we could find a new wave of neuroeconomics in the future that might renew the hype of the 2000s and revive the economics part of the program. But as of now, we can say with some certainty that neuroeconomics as a research program at the frontiers of economics and neuroscience during the 2000s and 2010s was a more hype than hope.

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