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A bibliometric analysis of the disposition effect: Origins and future research avenues☆

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ABSTRACT

This paper develops a comprehensive bibliometric analysis of a well-known bias in behavioral finance: the disposition effect. Since the term was coined in 1985, the tendency for investors to sell winners too soon and hold losers in the portfolio has been amply studied. Based on data from Web of Science and the tool VOSviewer, we obtain a complete picture of the evolution of the research on the disposition effect from citation and co-citation perspectives. The research topic has intensely increased the number of publications during the last years, and we also analyze the evolution of the lines of research. The analysis includes the yearly impact factors of the journals analyzed to ensure that the quality of publications remains. A temporal overlay visualization map shows the most used terms through time to explore future venues; disposition effect seems to be less studied alone, whereas researchers try to find interrelations with other behavioral biases.

1. Introduction

The disposition effect is defined as investors' tendency to sell assets that have generated gains while holding losing assets for longer periods of time. This bias is one of the most studied behavioral phenomena since the seminal definition by Shefrin and Statman (1985). Pleßner (2017) makes a very complete content analysis to find that this effect has been extensively analyzed in many countries for both institutional and retail investors and from different theoretical, experimental, and empirical perspectives. This increasing number of publications about disposition effect is far from being an ending story.

The regret for selling loser assets could have negative consequences for financial markets, on an aggregate level, and for investors, on an individual level. Kaustia (2010a) reviews the implications of the disposition effect on financial markets, as well as on real estate markets, and the associated welfare costs such as suboptimal strategies with respect to taxes. Pleßner (2017) extends this review to the consequences of the disposition effect in terms of momentum strategies and lack of portfolio diversification (Grinblatt and Han, 2005; Goetzmann and Kumar, 2008). Although the disposition bias has been documented across different types of investors (Grinblatt and Keloharju, 2000), these negative consequences might be much more relevant for retail investors with lower levels of financial education and sophistication than for professional investors aware of this behavioral bias (Feng and Seasholes, 2005; Cici, 2012).

Despite the increasing interest in the sources and consequences of the disposition effect, few papers review specifically the literature on this bias (Amarnani, 2010; Kaustia, 2010a; Pleßner, 2017). As a part of literature review methodology, bibliometric tools use mathematical and statistical techniques to analyze a research topic based on bibliographic resources (Pritchard, 1969). This approach will obviously complete the content analyses used in the past survey literature and will serve as a solid tool for future reviews. As far as we know, only Pleßner (2017) conducts a bibliometric analysis of the disposition effect in order to categorize the papers by research method and journal quality. However, this bibliometric evidence lacks a citation or co-citation detailed analysis based on a co-occurrence relationship, that is, when two elements are present together in a document. Moreover, this analysis is only focused on papers' research method and journal rankings. This scarce bibliometric evidence on the

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disposition effect contrasts with the recent increase of bibliometric studies applied to behavioral topics (Aren et al., 2016; Calma, 2019; López-Cabarcos et al., 2020; Valcanover et al., 2020; Jain et al., 2021; Choijil et al., 2022; Singh and Walia, 2022; Ingale and Paluri, 2022). This gap is even more striking when Paule-Vianez et al. (2020) use co-word scientific maps to show that disposition effect is the second most relevant subject in the growing potential of behavioral finance.

This paper aims to provide an exhaustive bibliometric analysis on the disposition effect. The new perspective of this study is based on a citation, co-occurrence and co-citation approach using scientific maps generated with the VOSviewer software. As a part of the bibliometric tools, scientific maps will lead us to monitor the network configuration of the disposition effect literature to better understand its structure, evolution and its main participants. These scientific maps will be based on different elements, such as terms, authors, journals, countries, organizations or cited references. As an innovation within the bibliometric analysis, we also include an overlay display that pictures the most used terms over time; this is extremely useful to interpret the evolution of research topics in time and to detect future research avenues. Additionally, the study collects annual rankings information about the academic journals to investigate the average quality of publications in disposition effect through time. Based on this methodology we answer five major research questions: (1) What is the research domain of the disposition effect literature? (2) What are the influential aspects of the literature on documents, authors, sources, countries, and organizations? (3) Which are the most used terms and how do they perform? (4) What is the citation pattern in the literature? (5) Where does the literature point in terms of future research directions? Altogether, the results support the idea of a live research topic that maintains the quality of the publications in terms of impact factors.

The remainder of the paper is organized as follows. Section 2 presents the theoretical background and the empirical research on the disposition effect. Section 3 includes the methodological design, the data and the bibliometric tools used in the analysis. Section 4 presents the main results of the bibliometric analysis. Section 5 includes further research comments. Finally, Section 6 concludes.

2. A look at the disposition effect

2.1. Theoretical background

According to Shefrin and Statman (1985), a four-pillar theoretical framework could explain disposition effect. First, the prospect theory of Kahneman and Tversky (1979) identifies an editing phase of decisions under uncertainty when subjects choose a mental starting point. After that, in the evaluation phase, subjects compare possible choices against this reference point. The utility function is then defined as a value function that is asymmetric to gains and losses. The subjects behave risk averse (risk-seeking) when these comparisons are framed as possible gains (losses). The value function is therefore convex in the domain of losses and concave in the domain of gains. Kahneman and Tversky (1979) also show that the function is steeper for losses than for gains. Although many studies justify the disposition effect as a consequence of this first theoretical pillar (Odean, 1998; Shapira and Venezia, 2001; Dhar and Zhu, 2006; Barber et al., 2007; among others) there is an ongoing discussion in the literature about the capability of prospect theory to fully describe this bias (Barberis and Xiong, 2012; Kaustia, 2010b; Hens and Vlcek, 2011).[1]

Second, because of mental accounting (Thaler, 1980) subjects tend to separate distinct decisions into different accounts that are solved independently by prospect theory. Recent research in An et al. (2022) states that investors not only engage in narrow framing, the hedonic mental accounting also plays a role because investors evaluate multiple outcomes in a certain combination in whatever way makes them happiest as proposed in Thaler (1985, 1999). They conclude that the disposition effect seems to be stronger (weaker) when a portfolio is at a loss (gain). This finding relates to previous research that associates disposition effect to different market states (Lee et al., 2013; Bernard et al., 2022).

Third, regret-aversion (Bell, 1982; Loomes and Sugden, 1982) causes subjects to feel ashamed to admit a mistake because they tend to avoid regret and to seek pride. Decisions are usually judged ex post, when an investor closes a position for a loss, it becomes, irrevocably, a (ex post) mistake. However, if the investor continues to hold a loss, it might change and become a good decision in the end.

Finally, the concept of self-control is incorporated in a theory of individual intertemporal choice (Thaler and Shefrin, 1981). Investors face similar problems to the conflicts of interest in the agency relationship in organizations. Investors are both "myopic doer" and "farsighted planner". As developed in Shefrin and Statman (1985), the "doer" behavior follows a value function of utility with mental accounts not being refrained by the "planner". Subjects tend then to accelerate the feeling of pride and to postpone regret.

Altogether the disposition effect is, therefore, the tendency of investors to hold onto losses too long and sell winning investments too soon. Odean (1998) originally proposed a measure widely used to evaluate the existence of disposition effect, the difference between the proportion of gains realized (*PGR*) and the proportion of losses realized (*PLR*) computed as follows:

$$PGR = \frac{RG}{RG + UNRG} \tag{1}$$

$$PLR = \frac{RL}{RL + UNRL} \tag{2}$$

where *RG* is the total number of realized capital gains, *UNRG* is the number of unrealized gains, *RL* is the number of realized losses, and *UNRL* is the number of unrealized losses. A difference in proportions higher than 0 shows light of the existence of disposition effect. Some latter studies include not only the number of positions but the volume in the ratios (Frazzini, 2006) as well as the disposition ratio, defined as the ratio of *PGR* to *PLR*. (Cici, 2012; Andreu et al., 2020).

2.2. Empirical research

The disposition effect has extensively been tested as a central topic in behavioral finance. Retail investors from different countries received major attention (Shefrin and Statman, 1985; Odean, 1998 in the US; Shapira and Venezia, 2001 in Israel; Talpsepp, 2011 in Estonia; Leal et al., 2013 in Portugal; or Lee et al., 2013 in Taiwan, among others). Breitmayer et al. (2019) find great variation in the degree of the disposition effect across the world in a comparison of 83 countries.

Some other studies have focused on demographic characteristics such as gender (Da Costa et al., 2008; Rau, 2014) or cultural

[1] Alternatively, the reluctance to realize losses might be associated to expectations of losers outperforming today's winners in the future. Andreassen (1988) finds that subjects trade stocks expecting short-term mean reversion. The distinction between prospect theory and irrational belief in mean reversion to explain disposition effect is not always clear. An investor can try to convince herself of a recovery in a stock price rather than admit her regret to realize losses.

dimensions (Breitmayer et al., 2019) or personal background. Specifically, Dhar and Zhu (2006) define investors level of sophistication using income groups and occupation groups. They document that investor sophistication is negatively correlated with the disposition effect. Grinblatt et al. (2012) analyze data on Finnish investors and document that high IQ investors are superior stock pickers and they exhibit less of a disposition effect. Vaarmets et al. (2019) show that highly educated investors are less influenced by the disposition effect. Attention has also been drawn to individual decisions or collective decisions made by a team of investors (Rau, 2015), for instance in the management of mutual funds (Frazzini, 2006). Chen et al. (2007) confirm the existence of disposition effect among professional investors but with less intensity and no observable effect on fund performance (Cici, 2012; Andreu et al., 2020). Contrarily, O'Connell and Teo (2009) confirm that institutional investors are not subject to the disposition effect in their currency trades. Locke and Mann (2005) also find evidence of the disposition effect in professional futures traders.

Literature also shows the effect of learning by trading. Seru et al. (2010) analyze the survival of investors because some leave if their ability is poor while some other investors become better at trading with experience. Da Costa et al. (2013) in an experimental study show that higher experience reduces the disposition effect. Other laboratory and experimental studies are Weber and Camerer (1998), Da Costa et al. (2008), Magnani (2015), and Cueva et al. (2019).

The disposition effect is usually studied in the context of the behavioral finance and, more recently, in conjunction with other biases. Duxbury et al. (2015) test jointly the disposition and the house money effect and show that contemporaneously coexist in a Chinese brokerage, but house money effect moderates the disposition effect suggesting that cognitive biases need not always have negative consequences. Ho (2011), based on accounts of individual investors in the Taiwan market, shows that more overconfident investor tends to show a higher degree of the disposition effect. Analyzing the records of the accounts in the Taiwan Futures Exchange market, Chou and Wang (2011) find that overconfidence and disposition effects both give rise to positive relationships between trading activity and prior returns and that different types of traders exhibit different types and levels of behavioral biases. Lin et al. (2015) find the disposition effect impacts the herding behavior.

Recent and innovative behavioral insights, such as genetics and neuroeconomics, have investigated disposition effect (Cesarini et al., 2012; Frydman et al., 2014). Cronqvist and Siegel (2014) analyze genetic factors influencing the trading behavior of Swedish twins. New trends of research also call attention to platforms of social trading: investors alter their behavior in such a transparent trading environment. In an early study, Heimer (2016) provides evidence that social interaction contributes to the disposition effect. Liêu and Pelster (2020) show that the framing of the decision problem on social trading platforms can affect the sign of the relationship between trading in a transparent trading environment and the disposition effect. Similarly, Danbolt et al. (2022) show that the level of transparency and the way financial information is illustrated can mitigate the disposition effect.

3. Research methodology

This paper aims to analyze the research carried out by the scientific community on the disposition effect with a bibliometric approach. Bibliometric studies perform statistical analyses of scientific publications (Pritchard, 1969) to obtain objective, impartial information on a specific field of research (Zupic and Čater, 2015). Moral-Muñoz et al. (2020) analyze different software tools for conducting bibliometric analysis: Bibexcel, Biblioshiny, BiblioMaps, CiteSpace, CitNetExplorer, SciMAT, Sci^2 Tool and VOSviewer. Our choice of the VOSviewer software was motivated by the quality and the visualization of the final rendering and by the variety of the supported format for the input and the output of data. Indeed, VOSviewer is a tool for creating maps based on bibliographic databases and for visualizing and exploring these maps. It has been developed in Java programming language. It can be freely downloaded from www.vosviewer.com (Van Eck and Waltman, 2021).

Previous literature provides reviews of behavioral finance and disposition effect under qualitative content analysis approaches or under quantitative bibliometric analysis. On the one hand, the content analysis is defined by Downe-Wamboldt (1992) as "a research method that provides a systematic and objective means to make valid inferences from verbal, visual, or written data in order to describe and quantify specific phenomena". Some examples focused on the disposition effect are Amarnani (2010) or Pleßner (2017), whereas Aren et al. (2016) enlarges the analysis to the whole behavioral research area. On the other hand, the bibliometric approach has also been used in our field (Calma, 2019; Ingale and Paluri, 2022; López-Cabarcos et al., 2020; Paule-Vianez et al., 2020; Valcanover et al., 2020; Jain et al., 2021; Choijil et al., 2022; Singh and Walia, 2022), but these studies had different goals: Calma (2019) is devoted to a single journal; Ingale and Paluri (2022) use a different software based on R-language; López-Cabarcos et al. (2020) are focused on investor sentiment; Paule-Vianez et al. (2020) use a different software – SciMAT-; Valcanover et al. (2020) use the same software, but are focused on behavioral finance experiments; Jain et al. (2021) analyze the Scopus database; Choijil et al. (2022) are focused on herding behavior; Singh and Walia (2022) are focused on momentum investing.

The bibliometric research enables us to explore the relevance of the studies on the disposition effect based on journals, countries, terms, organizations or the most cited authors, along with the most relevant connections between them. Fig. 1 illustrates the entire research design of our study in detail.

3.1. Data

The dataset used in this study is extracted from Clarivate Analytics Web of Science (WoS) database, a high-quality database which covers all the top journals since 1950. Web of Science is the most known scientific database in the world, covering an extensive range of disciplines and allowing comparisons across scientific areas (Archambault et al., 2006; Wang et al., 2016).

Web-based Web of Science was first launched in 1997 and renamed Web of Science Core Collection around 2014 (Liu, 2019). According to Clarivate Analytics (2022), Web of Science Core Collection is "the premier resource on the Web of Science platform and the world's original citation index for scientific and scholarly research. It contains over 21,100 peer-reviewed, high-quality scholarly journals published worldwide in over 250 sciences, social sciences, and arts & humanities disciplines. Conference proceedings and book data are also available". Our search is carried out in the Web of Science Core Collection on 1st November 2021 including all the papers published up to that moment and downloaded in plaintext format to be processed with the software. The search is performed by the field *theme* (which includes title, abstract, and keywords). Our primary word search is "disposition effect". Most of our research contributions use that concept but an extended definition of the behavioral finance phenomenon is also needed to avoid missing relevant studies. Disposition effect is defined as the tendency to sell winners too soon and hold/ride

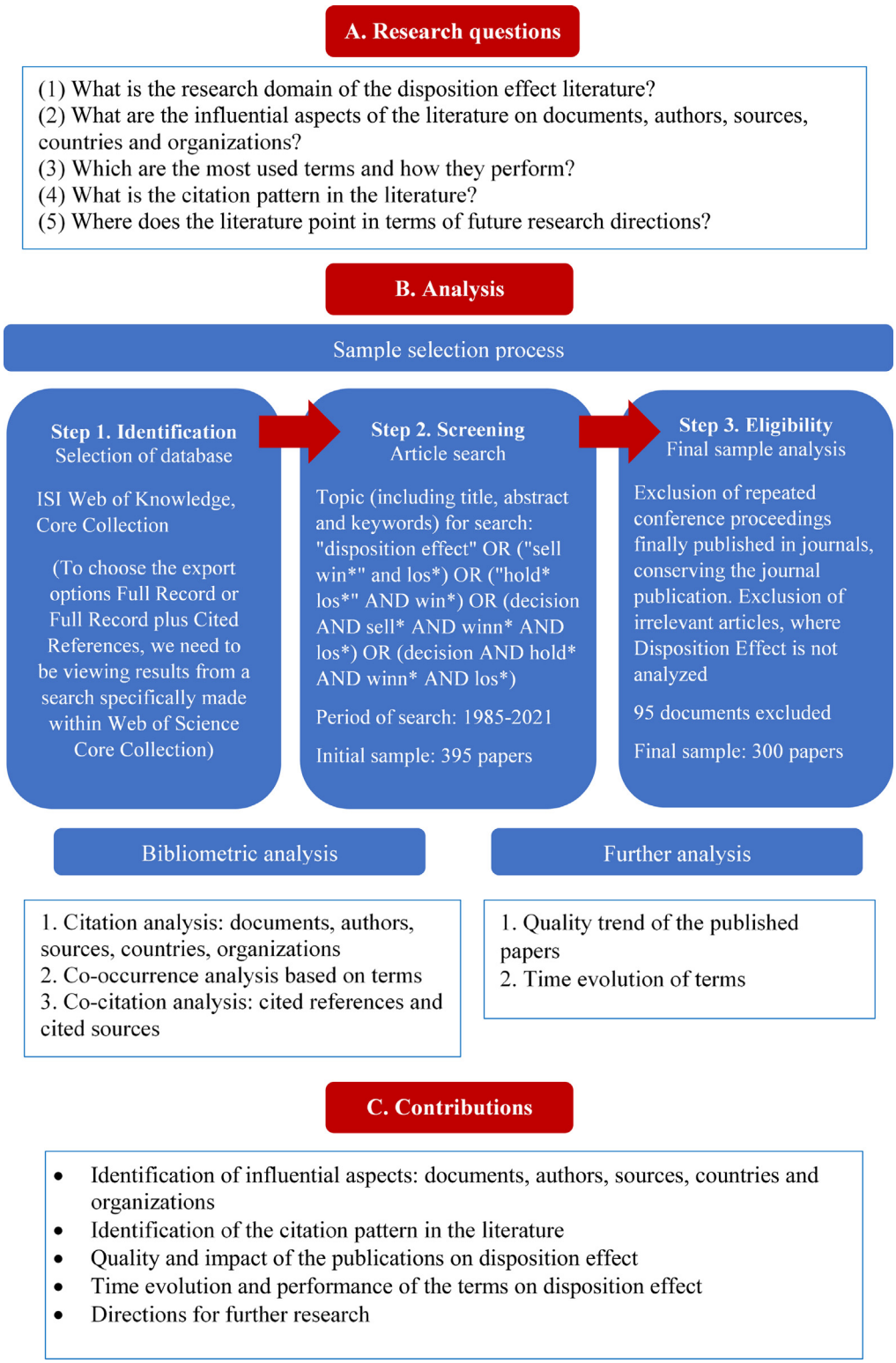

Fig. 1. Research Design.

losers too long. Thus, we complete our search strategy as follows: "disposition effect" OR ("sell win*" and los*) OR ("hold* los*" AND win*) OR (decision AND sell* AND winn* AND los*) OR (decision AND hold* AND winn* AND los*) with the Boolean term* aimed at extending the searches to cover different suffixes. This meticulous search enlarges the scope in Pleßner (2017). In all, our initial sample includes 395 papers.

The next step (see Fig. 1) is the filtering of papers. Some contributions are repeated as proceedings of a conference and a final published version in a journal. Five duplicated contributions are, therefore, excluded while retaining the journal publication. On the other hand, the exhaustive terms' search translates into a number of papers not directly related to behavioral finance or treating disposition effect very superficially. The inclusion should be based on the relevance of the contribution (Zott et al., 2011).

Two authors independently review the selection. The final sample comprises 300 papers for the analysis, which includes 276 articles published in academic journals, 2 book chapters, and 22 conference papers. The unique academic journal count amounts to 106 over the sample period. Considering 2020 in its entirety, almost 60% of the publications with Journal Impact Factor Percentile are ranked in the first or second quartile, and approximately 20% in the first quartile.

3.2. Descriptive analysis

Fig. 2 shows that the earliest paper was published in 1985. The number of publications and citations was relatively stable until 2004 and exponentially increased afterwards. The number of publications per year is less than one during the period 1985–2004, showing an average of 13 citations. Afterwards, the publications reach 26 and 1071 citations in the year 2020. The application of the Chow test to these time series confirms that the most significant structural break was in 2004. In addition, regression analyses report positive and significant exponential slopes for both the number of publications and the number of citations.[2] The seminal paper of Shefrin and Statman (1985) did not receive much attention during the first years after publication, but it did later on, probably together with the increasing attention to behavioral finance topics. Kaustia (2010a) also states that investor behavior was uninteresting at that time. Daniel Kahnemann won the Nobel Prize in 2002 followed by Robert Shiller in 2013, and Richard Thaler in 2017. Further, behavioral contents were included in the Chartered Financial Analyst programs since 2012, showing that the financial industry also paid close attention to this area. The increasing academic and media attention jointly with the availability of relevant information and technical developments led to the proliferation of research papers on the disposition effect.

All this provides evidence that the disposition effect is far from a decline phase in the finance research field. Two out of three papers were published after 2014 and a very similar distribution is obtained for the number citations. These findings are consistent with the exponential growth in the behavioral finance field (Paule-Vianez et al., 2020; Ingale and Paluri, 2022).

Depending on the research method, the publications are categorized in four clusters: theoretical, survey/review&comment, experimental, and empirical. This classification is gathered in Fig. 3, revealing the disposition effect as a robust empirical phenomenon throughout the whole analysis period. Most of the publications (58.3%) are empirical while experimental studies come second (27.3%). Approximately, 12.0% of the publications develop theoretical models and survey/review contributions share the residual 2.3% in this field.

To test the hypothesis of an attenuation of the disposition effect as the levels of sophistication and experience of investors increase, we categorize the publications according to the type of investors analyzed. Fig. 4 identifies whether disposition effect publications exclusively analyze the behavior of professional investors. This figure shows that the main attention has been placed on individuals with 88% out of the total number of publications. The first papers that exclusively focused on professional investors were published in 2004.

[2] Details of the Chow test, the slopes and significance levels of the exponential regression are available upon request.

3.3. Bibliometric tool

Using the VOSviewer software, we then generate knowledge maps on different relevant aspects of the 300 papers selected. We first develop a citation analysis (Van Eck and Waltman, 2010) based on the following items: documents, authors, sources, countries and organizations. The relatedness of documents (or authors, or sources, or countries, or organizations) on the maps is determined based on the number of times they cite each other. The software allows downloading text files containing the cluster, weights and scores associated with the items on the maps, to complement the visual interpretation with tables. From these files, we have built the tables in Section 4.1.

Further, we develop a co-occurrence analysis (Callon et al., 1983) based on terms. Terms are identified by the VOSviewer software using natural language processing algorithms. The relatedness of terms is based on the number of documents in which they occur together. The number of co-occurrences of two terms is the number of publications where both terms appear together in the title, abstract, or keyword list (Van Eck and Waltman, 2017).

Finally, we perform a co-citation analysis (Small, 1973) to analyze the citations included in the 300 papers of our sample. It is based on the following items: cited references and cited sources. The relatedness of items is determined by the number of times they are cited together. It is important to highlight the difference between citation and co-citation: a citation link is a link between two items where one item cites the other. A co-citation link is a link between two items that are both cited by the same document.

4. Results of the analysis

4.1. Relevance of documents, authors, sources, countries and organizations

The papers of Odean (1998) and Shefrin and Statman (1985) are, without any doubt, seminal references of disposition effect. The number of citations of these two articles is by far superior to that of the next study in the list of most cited articles, as shown in Table 1.

The most prolific author is Newton da Costa Jr. with 7 articles published in our list of 300 papers. Following, eight authors have 4 articles published, namely (in order of citations): Darren Duxbury, Nisha Goyal, Satish Kumar, Sergio Da Silva, Tonn Talpsepp, Jungshik Hur, Matthias Pelster and Hana Dvorackova. Table 2, however, gathers the list of authors working on the disposition effect according to their impact measured as the number of received citations. The top 3 positions, as expected, are held by the authors of the two seminal papers: Terrance Odean, Hersh Shefrin and Meir Statman.

Another indicator of the maturity of the research on the disposition effect is the list of the most prolific journals. Table 1 shows that three out of the five most cited articles have been published in The Journal of Finance, but it is not the most prolific journal. Table 3 reports the list of the top 10 academic journals ranked by the number of published documents. However, the number of citations reveals that the impact of The Journal of Finance is outstanding. These top 10 journals are responsible for 37.3% of the total publications on the disposition effect topic. According to the last available rankings, the three most prolific journals (Journal of Behavioral Finance, Journal of Banking & Finance, Review of Financial Studies) are ranked in the average Journal Impact Factor percentiles as 34.6, 71.9 and 95.1, respectively, with the percentile 100 as the highest impact factor. The list slightly differs from the behavioral finance analysis of Paule-Vianez et al.

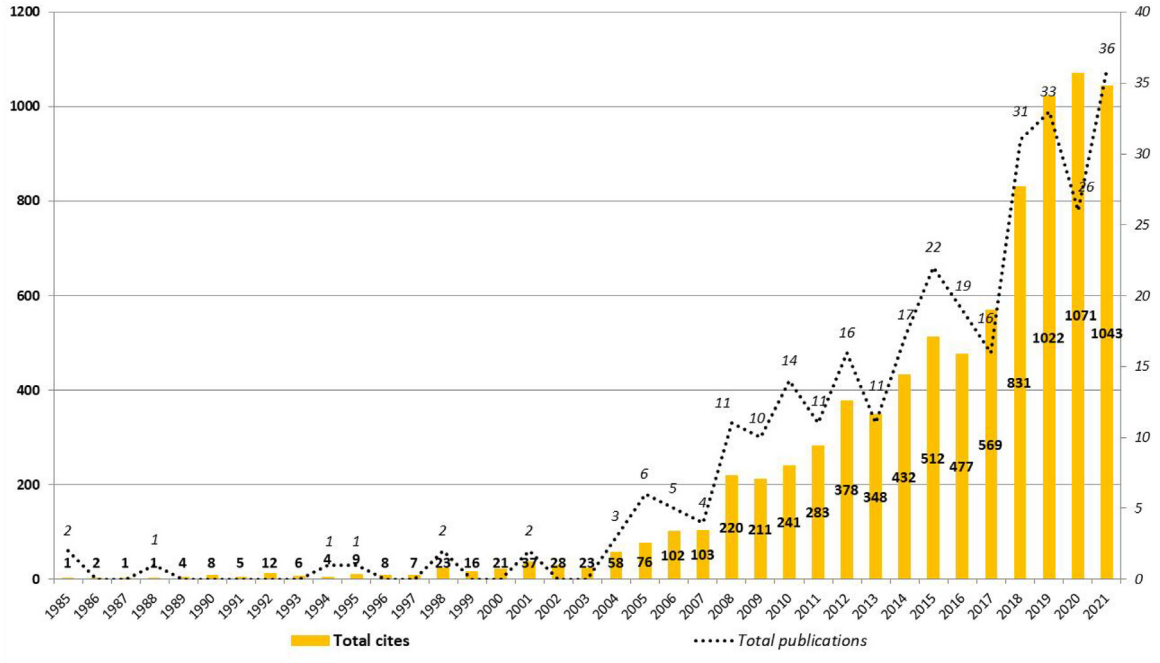

Fig. 2. Disposition Effect: Publications and Citations (1985-Oct 2021).

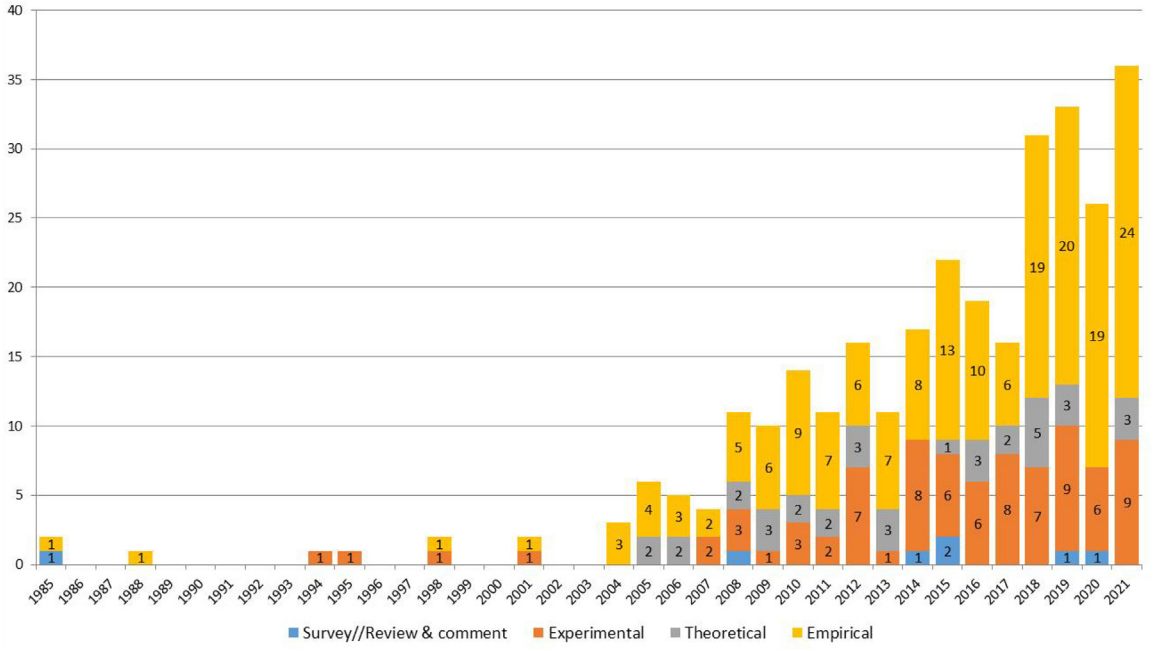

Fig. 3. Disposition Effect: Publications in Research Categories (1985-Oct 2021).

(2020), but the top 3 journals in their ranking are also included in Table 3, i.e. Journal of Banking & Finance, Journal of Behavioral Finance and Journal of Financial Economics.

We then analyze in Table 4 the most prolific countries publishing research on the disposition effect. Some countries that do not appear in Table 4 because they have published fewer documents have received an important number of citations, France or Finland, for instance with 213 and 276 citations to their 9 and 7 documents, respectively. Considering the average normalized citations, Spain, the USA and the Netherlands would rank as the top 3 countries, respectively.[3] It is interesting to notice that the number of links displayed in Table 4 reveals an important international research network with authors from different countries working together.

[3] The normalized number of citations received by the documents published by a country equals the number of citations divided by the average number of citations of all documents published by a country in the same year and included in the data that is provided to VOSviewer. The normalization corrects for the fact that older documents have more time to receive citations than more recent documents (Van Eck and Waltman, 2017). Details of the normalized citations are available upon request.

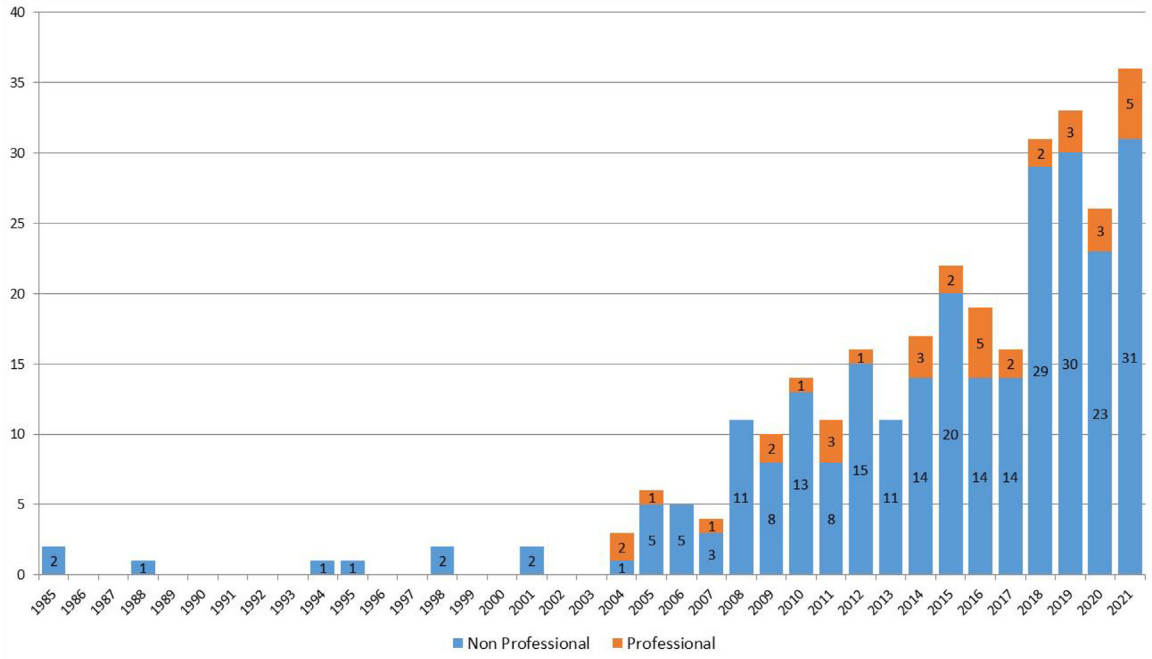

Fig. 4. Disposition Effect: Publications according to type of investor (1985-Oct 2021).

Table 1
Disposition effect: Most cited publications.
Source: Web of science core collection.

Title	Authors	Journal	Year	# of citations
Are investors reluctant to realize their losses?	Odean, T.	The Journal of Finance	1998	1196
The disposition to sell winners too early and ride losers too long: Theory and evidence	Shefrin, H. and Statman, M.	The Journal of Finance	1985	1085
Prospect theory, mental accounting, and momentum	Grinblatt, M. and Han, B.	Journal of Financial Economics	2005	307
The disposition effect in securities trading: an experimental analysis	Weber M. and Camerer, C.F.	Journal of Economic Behavior & Organization	1998	296
The disposition effect and underreaction to news	Frazzini, A.	The Journal of Finance	2006	289

Note: This table shows the five most cited articles included in our sample. The table reports the title of the publication, the authors, the name of the journal, the publication year, and the number of citations up until 1st November 2021.

Table 2
Disposition effect: Top authors (Number of received citations).
Source: Web of science core collection.

Name	# of documents	# of citations	Name	# of documents	# of citations
Odean, Terrance	1	1196	Xiong, Wei	3	410
Shefrin, Hersh	1	1085	Barberis, Nicholas	2	375
Statman, Meir	1	1085	Han, Bing	1	307
Grinblatt, Mark	2	433	Camerer, Colin F.	1	296
Weber, Martin	2	415	Frazzini, Andrea	1	289

Note: This table shows the 10 most cited authors included in our sample. The table reports the name of the authors, the number of published documents, and the number of received citations up until 1st November 2021.

Table 5 provides more information on the origin of the authors, focusing on the institution they belong to, ordered first by the number of published documents, and second by the number of citations. This table gathers the top 10 positions due to space limitations. Additionally, although not reported, with 4 documents published but fewer citations, it is worth mentioning Tallinn University of Technology (Estonia), Tsinghua University (China), Paderborn University (Germany), Radboud University (the Netherlands), University of Warwick (UK), and Universidade de São Paulo (Brazil). According to the average normalized citations, the top three institutions in the ranking are Boston College (USA), Malaviya National Institute of Technology (India), and Yale University (USA). The reported institutions of Table 5 also show multiple links with other institutions, a similar finding to the one in Table 4. Apparently, institutions from the USA seem to have a higher number of links.

Table 3
Disposition effect: Most prolific journals (Number of published documents).
Source: Web of science core collection.

Journal	# of documents	# of citations	Journal	# of documents	# of citations
Journal of Behavioral Finance	27	235	Journal of Economic Behavior & Organization	9	380
Journal of Banking & Finance	14	465	Journal of Financial Economics	8	834
Review of Financial Studies	13	547	Review of Behavioral Finance	8	32
Journal of Behavioral and Experimental Finance	10	38	Management Science	7	532
The Journal of Finance	10	3060	Journal of Financial and Quantitative Analysis	6	174

Note: This table shows the 10 most prolific journals included in our sample. The table reports the name of the journal, the number of published documents, and the number of received citations up until 1st November 2021.

Table 4
Disposition effect: Most prolific countries (Number of published documents).
Source: Web of science core collection.

Country	# of documents	# of citations	# of links	Country	# of documents	# of citations	# of links
USA	102	5460	16	South Korea	13	94	13
China	46	451	15	Brazil	12	86	16
Taiwan	29	262	16	India	12	107	13
England	25	441	16	Australia	10	98	11
Germany	23	651	16	Netherlands	10	98	13

Note: This table shows the 10 most prolific countries included in our sample. The table reports the country, the number of published documents, the number of received citations, and the number of links between countries up until 1st November 2021.

Table 5
Disposition effect: Most prolific institutions (Number of published documents).
Source: Web of science core collection.

Institution	# of documents	# of citations	# of links	Institution	# of documents	# of citations	# of links
Universidade Federal de Santa Catarina (Brazil)	7	74	18	Aalto University (Finland)	4	206	23
Yale University (USA)	6	735	34	Chinese University of Hong Kong	4	202	22
University of Chicago (USA)	6	556	32	Malaviya National Institute of Technology (India)	4	86	16
University of Michigan (USA)	5	191	24	University of Sidney (Australia)	4	72	15
University of Southern California (USA)	4	388	31	National Taiwan University (Taiwan)	4	52	10

Note: This table shows the 10 most prolific institutions included in our sample. The table reports the name of the institution, the number of published documents, the number of received citations, and the number of links between institutions up until 1st November 2021.

4.2. Co-occurrence network analysis

The co-occurrence analyses help identify the most relevant terms in the research on the disposition effect. The visualization of the mapping enables us to define clusters of the main topics or lines of research.

The unit of our study is a term. The program selects 156 terms with a minimum number of 10 observations that appear in the title and the abstract. The sample is then manually refined, using a thesaurus file which is useful for ignoring general terms (e.g., *author* and *context*), for merging synonyms (e.g. *decision* and *decision making*) and for correcting spelling differences (e.g. *behavioral finance* and *behavioural finance*). Finally, 128 unique terms are obtained and the program selects 60% of the most relevant terms, which results in 77 terms retained.

The software uses distance-based mapping techniques to get a network visualization of the co-occurring terms, as presented in Fig. 5. The distance is proportional to the relatedness and the size of the node to its occurrence. There are five representative clusters with at least five terms.[4]

The map has multiple connections; it is logical given that the topic is very specific. The clusters of the map can be associated with particular subtopics. The green cluster gathers the papers that describe the disposition effect and its connections with psychological foundations because the cluster includes terms such as prospect theory, reference point, winner, loser or preference, among others. The blue cluster focuses on individual investors in financial markets: We can identify connections with terms such as trade, trader, warrant, futures market and trading behavior. The yellow cluster gathers the experimental studies, in which questionnaires are designed for a close experiment to identify the disposition effect (experiment, participant, decision making subjects over general "assets"). The purple cluster includes a specific

[4] A robustness check analysis has been carried out generating the knowledge maps based on keywords. The program selects 1010 keywords with a minimum number of five observations. The cleaning process of the thesaurus and the selection of the keywords with the greatest total link strength results in 68 unique keywords. VOSviewer generates four clusters with a minimum of 10 keywords. Further details are available upon request.

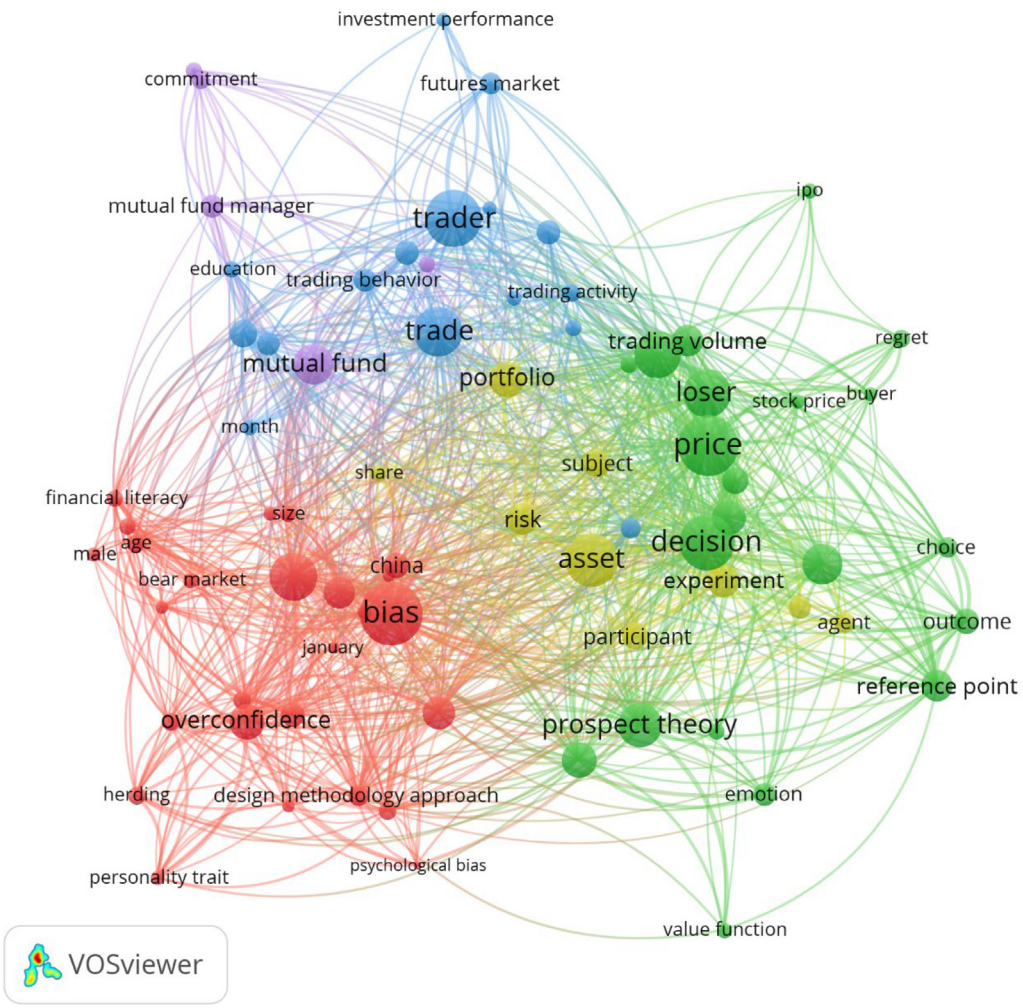

Fig. 5. Disposition Effect: Network Visualization of Co-Occurring Terms in Publications (1985-Oct 2021).

line of research focused on professional portfolio managers (mutual fund, mutual fund manager). Finally, the red cluster includes the papers in which the disposition effect has been checked under different circumstances or investors' characteristics (male, age, financial literacy, bull, bear market, size…). This cluster also includes the papers in which the disposition effect has been analyzed together with other phenomena in behavioral finance (overconfidence, herding, momentum, January, behavioral bias). Overconfidence seems to be the major behavioral bias studied in tandem with the disposition effect, thereby confirming the relevance of both topics as provided by the scientific maps of Paule-Vianez et al. (2020).

4.3. Co-citation analysis

The co-citation analysis will help us evaluate the foundations of the disposition effect, that is, the patterns of the citations made in the literature on the disposition effect. First, the unit of analysis is the cited references, which identify the most relevant papers that impact on the literature on the disposition effect. The most important nodes of Fig. 6 match the two seminal papers of the disposition effect research (Shefrin and Statman, 1985; Odean, 1998), followed by other relevant papers shown in Table 1. However, the big node of the study of Kahneman and Tversky (1979) shows that prospect theory is one of the key elements of the disposition effect, which sets a reference point for differential human behavior when making decisions. Fig. 6 also represents three clusters of those papers cited in the field. The central space of this co-citation map is occupied by the articles with higher impact: The biggest nodes. The right side (blue cluster) mostly depicts those relevant papers published during the first stage of development of the disposition effect in the literature. On the contrary, the left side (green cluster) of the map mostly includes the relevant papers published in the latter period of exponential increase in interest in this topic, since 2005.

Second, we represent the network considering the cited sources as the unit of analysis. The visualization is shown in Fig. 7. The most influential academic journal on the disposition effect research is The Journal of Finance as it is the biggest central node of the map. The journals of the highest impact factor are in the blue cluster. The green cluster groups more quantitative academic journals. The yellow cluster comprises, in general, more practitioner journals, and, finally, the red cluster includes the larger number of journals, mostly focused on behavioral aspects or psychology.

5. Further research on the disposition effect

There are two open research questions about the future of the financial research on the disposition effect bias. First, it is necessary to clarify the quality trend of the published papers, and second, what the expected tendencies or hot topics are in the near future.

Referring to the publications about the disposition bias, Pleßner (2017, p. 25) states that "the average quality of major academic

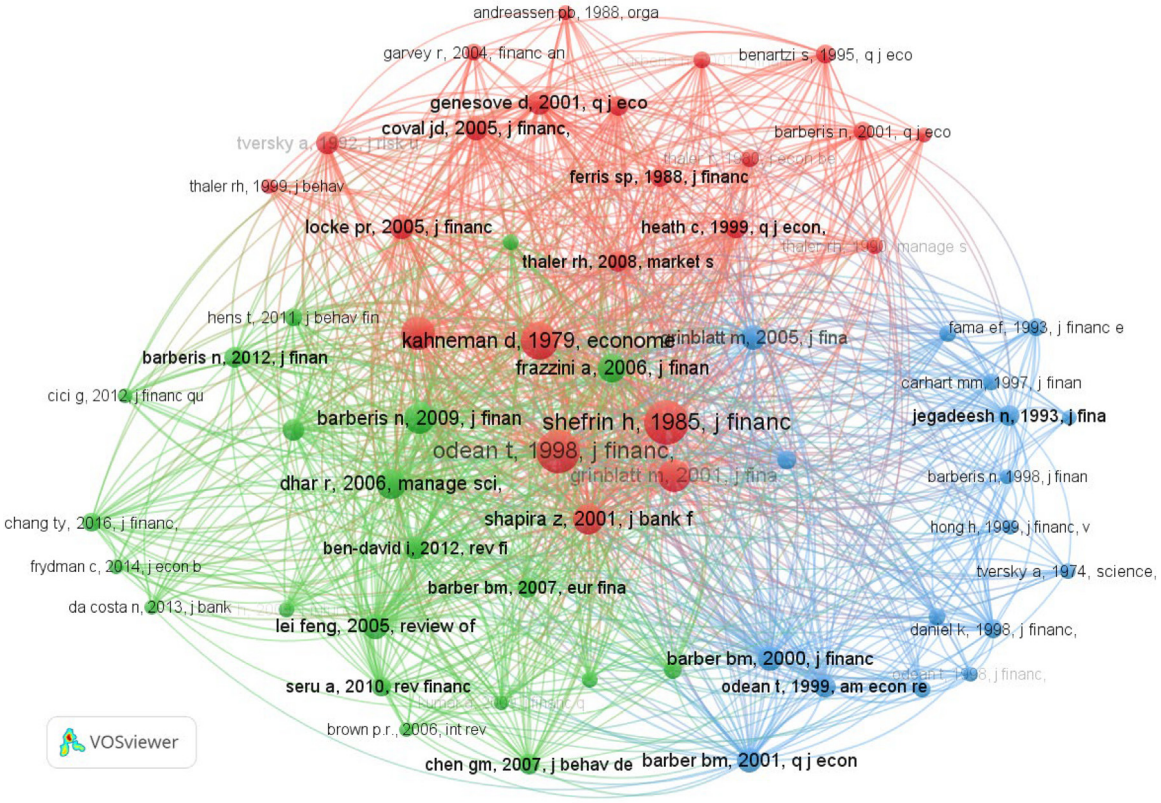

Fig. 6. Disposition Effect: Network Visualization of Co-Citation (Cited References) in Publications (1985-Oct 2021).

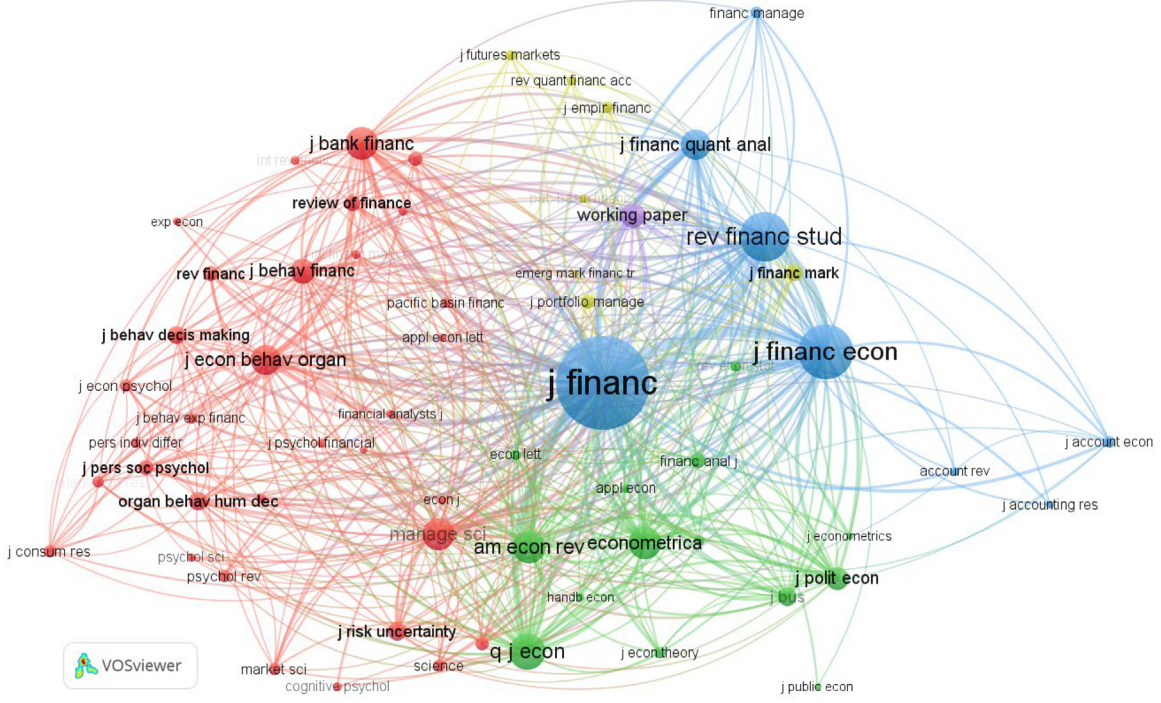

Fig. 7. Disposition Effect: Network Visualization of Co-Citation (Cited Sources) in Publications (1985-Oct 2021).

contributions has deteriorated over time". This finding could be a sign that the disposition effect as a relevant research topic is on the decline. To test robustly this hypothesis, we construct a dataset with a wide selection of the annual impact indicators (Web of Science) of the journals included in our sample. As a result, Table 6 confirms a significant increase in the absolute impact factor indicators together with an increase in the speed of citations of the publications in the last five years. In addition, the normalized impact measures reveal no significant differences for the 2017–2021 period versus the 2004–2016 period. These

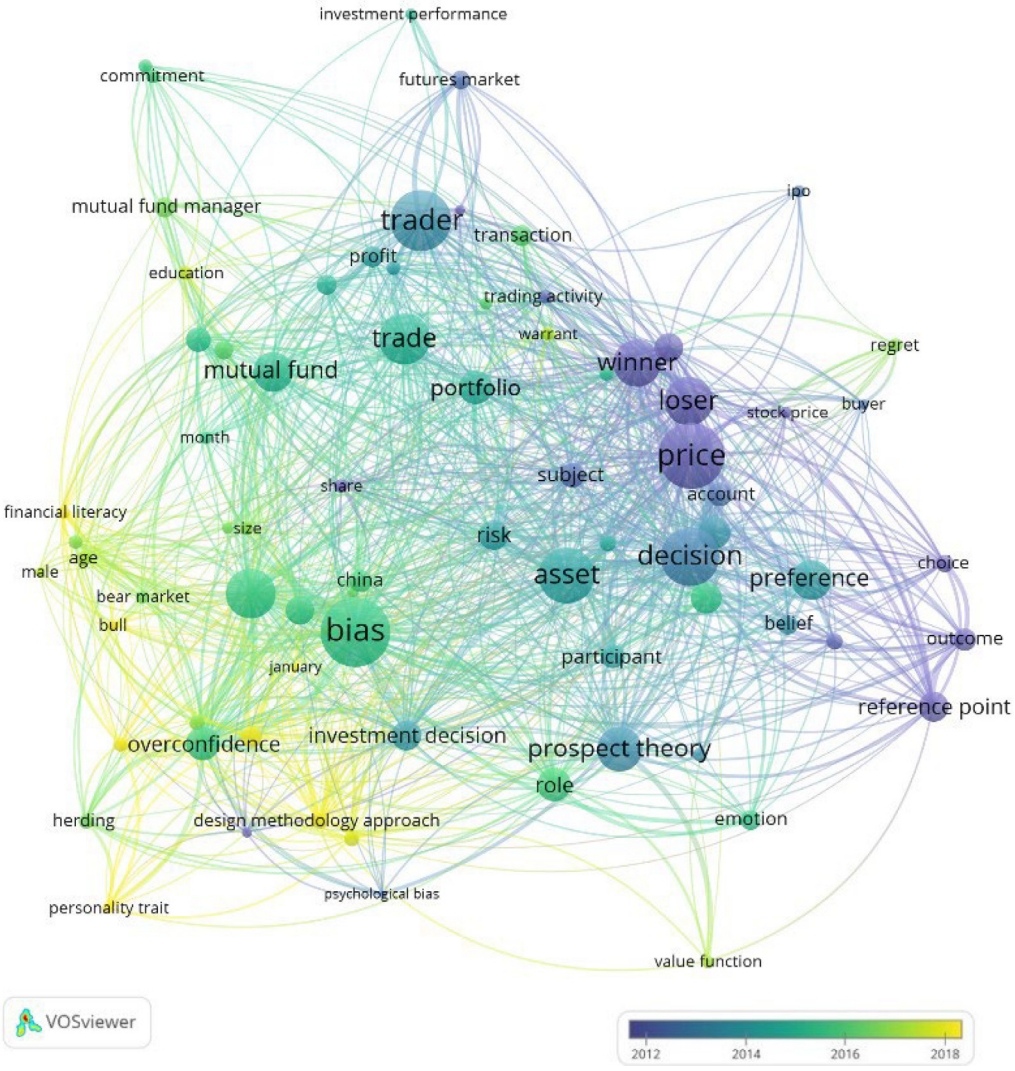

Fig. 8. Disposition Effect: Temporal Overlay Visualization of Co-Occurring Terms in publications (1985-Oct 2021).
Note: The colors range is automatized by the VOSviewer software from 2012 to 2018.

findings reject a significant decrease in the quality of the recent disposition effect papers.

Fig. 8 is similar to Fig. 5 because it analyzes the co-occurring terms that appear in the disposition effect publications. However, whereas Fig. 5 reflects the clusters of the terms, Fig. 8 shows the evolution through time by means of an overlay visualization of a map, where items are colored based on a given score; in our case, years. Even if the overlay visualization map presents multiple connections, we can interpret that the most used terms in older publications, those in purple, have to do with the initial hypotheses and development of the model (price, loser, winner, reference point…) or the proposal of experiments (subject, participant). The evolution of the research is displayed from blue to yellow nodes and links, including different types of markets or geographical areas (portfolio, mutual fund, initial public offering, trader, futures markets, China,…). More recent terms are related to the personal characteristics of managers (male, financial literacy, age, education) and other well-known behavioral finance biases (overconfidence, herding, January…), that are colored in yellow. It appears that during the foundations of the behavioral finance discipline, the disposition effect was studied alone to set the theoretical background and empirical methods in seminal papers. As the discipline evolved, the search of an advanced model of individual decision-making led researchers to study several behavioral biases jointly. Apparently, as shown in Fig. 8, during the last 5 years, the research studies have been concerned about the drivers of the disposition effect and there is an attempt to find connections among different behavioral biases.

In sum, the research on the disposition effect is an ongoing topic that not only increases in number of documents published (as shown in Fig. 2) and preserves the quality of the publications in terms of impact factor (as shown in Table 6). The evolution is also perceptible in the research lines that evolve from a description of the phenomenon and the design of experimental models to the expansion to different investment products, investor types, or markets. The disposition effect is not only tested separately, but there is a recent tendency to explain it in connection with other behavioral biases. The high number of researchers and organizations interested in the disposition bias will probably lead the field to future avenues in the behavioral finance framework.

The origins and recent trends of the disposition effect discussed in this paper shed light on new future research avenues in this topic. The interactions of the disposition effect with other behavioral issues should play a leading role in the near future. The innovation in experimental and empirical methods to identify the explanatory mechanisms of the disposition effect would also be leading the way as a result of both increasing data availability and technological improvements. All these advances should be

Table 6
Disposition effect: Quality and impact of the publications.

Panel A 2017-2021[a]	JIF	JIF without self cites	5Year JIF	Immediacy index	Average JIF percentile	Influence score	Normalized eigenfactor
Highest	8.74	7.02	11.75	2.33	98.71	12.74	226.37
Lowest	0.62	0.55	0.62	0.03	6.01	0.06	0.01
Average	2.32	2.08	2.95	0.64	54.66	1.33	4.98
Median	1.80	1.55	2.26	0.48	54.65	0.61	0.43
Panel B 2004–2016							
Highest	6.25	5.79	8.96	1.29	99.52	11.99	13.41
Lowest	0.04	0.04	0.29	0.00	2.13	0.04	0.01
Average	1.64	1.38	2.55	0.27	58.24	2.35	2.16
Median	1.30	0.92	1.89	0.17	66.17	0.80	0.67
Mann–Whitney Z-test	4.17**	4.71**	2.42*	7.11**	0.98	1.68	0.56

Note: This table shows the values of several journal impact measures extracted from the annual information of each academic journal included in Web of Science. *Journal Impact Factor (JIF)* is calculated by dividing the number of current year citations to the source items published in that journal during the previous two years; *JIF without self cites* is calculated after excluding citations from articles in the journal itself; *5 Year JIF* is calculated by dividing the number of citations in the year by the total number of articles published in the five previous years; *Immediacy Index* is the average number of times an article is cited in the year it is published and it indicates how quickly articles in a journal are cited; *Average JIF Percentile* is the journal's rank in category, determined by *JIF*, expressed as a percentile; *Influence Score* determines the average influence of a journal's articles over the first five years after publication. It is calculated by multiplying the Eigenfactor Score by 0.01 and dividing by the number of articles in the journal, normalized as a fraction of all articles in all publications. A score greater (lower) than 1 indicates that each article in the journal has above-average (below-average) influence; *Normalized Eigenfactor* is the Eigenfactor score normalized, by rescaling the total number of journals in the year, so that the average journal has a normalized score of 1. Eigenfactor Score is based on the number of times articles from the journal published in the past five years have been cited in the year, but it also considers which journals have contributed these citations so that highly cited journals will influence the network more than lesser cited journals. The influence of journal self-citation is removed. We report the highest, the lowest, the average and the median value of each measure for two time periods. Panel A shows the last 5 years period (2017–2021) and Panel B shows the previous 13 years period (2004–2016). The last row reports Mann–Whitney Z-test and its statistical significance after comparing the journal impact indicators for the two previously defined periods.

[a]As the journal impact measures are not available yet for publications in 2021, we have considered the reported values in 2020.

*Indicate statistical significance at the 5% level.

**Indicate statistical significance at the 1% level.

especially extended to markets and types of investors recently included in the literature. Finally, the search for implications of the disposition effect for policy makers and market supervisors should be an outstanding topic in the future as this behavioral effect could be playing an important role in the decision-making process of both individual and professional investors.

6. Conclusion

The investigation performed on the disposition effect contributes to the research on literature review, specifically to bibliometric reviews of behavioral finance. Moreover, the research is complemented with a deep empirical analysis of the evolution of the impact factor of the academic journals and the overlay visualization of co-occurring terms that, as far as we know, have not been applied before in the field of behavioral finance. This tool allows the detection of the origins and recent research trends of the disposition effect.

We show that the chronology of the research interests has evolved since the seminal papers related to psychological aspects and the definition of the model to the recent investigations that attempt to relate the disposition effect with other behavioral cognitive biases.

The progressive increase in the number of papers, the opening of new lines of research during the last years and the preservation of the quality of the journals in terms of impact factor lead to our main conclusion that the disposition effect may be an outstanding topic in the future behavioral finance literature.

Further research on the disposition effect should benefit from the increasing data availability and technological improvements to draw more accurate evidence of the reasons and consequences of this investor behavior and its connection with other behavioral effects documented in the previous literature. The near future should also fill the gap in the literature of some underrepresented markets and types of investors to provide an overall background of this influential topic on the decision-making process of investors. This contribution would be really useful for supervisors and policy makers to evaluate the impact of behavioral finance issues on market dynamics.

CRediT authorship contribution statement

Begoña Gutiérrez-Nieto: Methodology, Software, Funding acquisition. **Cristina Ortiz:** Formal analysis, Writing – review & editing, Funding acquisition. **Luis Vicente:** Conceptualization, Writing – original draft, Funding acquisition.

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