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The use of hybrid scientometric clustering for systematic literature reviews in business and economics

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Abstract

Given a substantial increase in publications over the last decades, researchers often face an insurmountable quantity of publications potentially relevant for the own research endeavors. Quantitative approaches can be used to analyze the extant scientific literature (also known as scientometrics), which may help to overcome this information overload. This article introduces a hybrid scientometric method, which is based on semantic and bibliographic indicators, for systematic literature reviews into the business and economics literature. To this end, the article provides a step-by-step analysis of the literature referring to the term 'loyalty' in the area of business and economics. The analysis reveals four research discourses associated with loyalty, which can be labeled as: 1. Brand loyalty and customer retention, 2. Economic welfare and market power through loyalty, 3. Understanding of customers and formation of loyalty in services marketing and 4. Organizational and employee loyalty. The understanding and use of loyalty is described for each research discourse. The article closes with a discussion about the overall usefulness of the quantitative approach for the review of latent constructs such as loyalty.

Keywords: loyalty, bibliometric methods, LSA, latent constructs

1. Introduction

In consideration of the steadily ongoing development of science, a review of prior, relevant literature is an essential feature of any academic project. Therefore, literature reviews play a key role for participating in scientific research. They create a foundation for advancing knowledge, facilitate theory development, close saturated areas, and uncover areas where more research is needed (Webster & Watson, 2002). However, many literature reviews submitted for publications in journals are poorly done (Randolph, 2009). One reason for flawed literature reviews may lie in the rapid increase in the amount of published information. In line with this, Garvey and Griffith stated already in 1971: “the individual scientist is […] overloaded with scientific information and [can] no longer keep up with and assimilate all the information being produced that [is] related to his primary specialty” (Garvey & Griffith, 1971, p. 350). This information overload appears to result in a narrowing of specializations and a greater reliance on literature reviews (Cooper, 1988) which in turn is becoming more difficult. Furthermore, one may assume that in times characterized by “publish or perish”, the information overload has increased even more. Another reason for flawed literature reviews may be due to the fact that qualitative reviews tend to reflect the idiosyncrasies of the reviewer as a result of a high involvement in the topic. Consequently, those reviews suffer from subjectivity, causing them to be inherently biased (Vogel & Guettel, 2013).

Reflecting these aspects leads to a dilemma: Information overload aggravates the assimilation of relevant literature, which requires a high degree of involvement of a researcher in order to provide the readership with a reasonable literature review. But a high involvement, which results from experience in the research field, may lead to a high subjective bias. Whereas an experienced researcher may overcome subjectivity through the use of certain approaches or guidelines, such as outlined in Webster and Watson (2002), the novice may perceive even more difficulties. A lack of experience in combination with information overload may lead to overextension. Correspondingly, Boote and Beile (2005, p.4) state with regard to dissertations that “the dirty secret known by those who sit on the dissertation committees is that most literature reviews are poorly conceptualized and written”. Nevertheless, even an experienced researcher may perceive rising difficulties to cope with the massive amount of papers published. This especially holds for cases where there is a highly complex topic and a vast amount of published papers available. One example for such cases could be a review of the utilization of constructs. Constructs may be regarded as conceptual abstractions of phenomena that cannot be directly observed, opposing to intervening variables, which “have no factual content surplus to the empirical functions they serve to summarize" (MacCorquodale & Meehl, 1948, p.107). Consequently, there is a high propensity for complexity, due to abstraction. This is underlined by discourses with regard to the setup and development of constructs (Churchill Jr, 1979; MacKenzie, 2003; Suddaby, 2010). Furthermore, its' potential use in everyday language increases the set of applications and papers in general. One example par excellence refers to the construct of trust. With more than 3 Million hits (Google Scholar, October 14, 2017), the amount of literature referring to this concept is immense (Aholt et al., 2009). Trust is not only a literature by itself, which has been discussed for a long time (Bullock, 1901), but the concept is also being used in sundry research fields from psychology (e.g., Rotter, 1980) over economics (e.g., Glaeser et al., 2000) and law (e.g., Pineiro, 2017) to computer science (e.g., Wang et al., 2017). One approach to this overwhelming body of literature on trust, is that experienced researchers publish bibliographies on trust with the objective to provide a compilation of trust-related literature and its relation the scholars' field of research, such as marketing (e.g., Arnott, 2007). Even though these approaches may be useful without doubt, selected bibliographies are likely incomplete (Arnott, 2007) and also prone to a subjective selection bias. As a consequence, the question remains, how to approach a literature review of, e.g., constructs, in times of intense and increasing publication activities.

One way to approach this problem may arise from the use of scientometrics, which can be defined as the "quantitative study of science, communication in science, and science policy" (Hess, 1997, p. 75). A quantitative approach provides two crucial advantages for the exploration of massive amounts of literature given the aforementioned problems. First, a quantitative approach by means of automatic computing power allows considering (or processing) of substantially more publications than one could read or even skim in an appropriate time period. Second, using quantifiable indicators allows establishing the interrelationships of documents in the literature from an objective perspective. Hence, objective indicators can be used to structure the literature and to select documents, which consequently may help to increase scientific objectivity and reproducibility in the reviewing processes.

Given the high potential of scientometric methods for literature reviews, the article takes up the idea of using scientometric methods for the literature review of constructs. To this end, we conduct a step-by-step analysis of the loyalty construct in the scientific business and economics literature over time. While the choice of the loyalty construct and research area is motivated by the researchers' expertise, the scientometric procedure is adapted from methodological research in scientometrics. Even though bibliometric and scientometric applications do exist in the broader field of the economic literature, the chosen procedure is a novelty in the field of application: The utilization of quantitative indicators based on citations in combination with quantitative indicators based on the semantics of documents has – to our knowledge – so far not been applied in fields of the economic literature (Zupic & Čater, 2015, among others). These so-called hybrid approaches were found to systematically outperform one-dimensional approaches (Boyack & Klavans, 2010; Janssens et al., 2006). Consequently, the article is thus not only supposed to provide a scientometric review of the loyalty construct in the business and economics literature, but also supposed to provide the non-specialist reader with a brief introduction to one of the latest scientometric methods, which may be imitated.

2. Scientometric principles and methods

The approach chosen for the analysis is adapted from scientometric methodological research articles, i.e., from Glanzel (2012), Glenisson et al. (2005), Janssens et al. (2006), Janssens et al. (2008) as well as Janssens (2007) among others. Conducting such a hybrid scientometric approach requires the understanding of several scientometric principles and methods, which are briefly going to be explained in this chapter.

2.1 The vector space-model and cosine-similarity measure

A basic requirement for the application of quantitative methods to scientific literature is an abstract representation of scientific documents based on its' respective quantifiable indicators, e.g., word occurrences or citations. The vector space model is a common algebraic model used in various applications such as information retrieval, document classification or clustering, which fulfils this requirement by representing a set of documents as vectors in a common vector space (Manning et al., 2008). For instance, each document in a set of documents could be identified by one or more index terms T_j. With t different index terms in the document space, each document d_i in the document space can be represented by a t-dimensional vector, $d_i = (w_{i1}, w_{i2}, \dots, w_{it})$ (Salton et al., 1975). Hence, every different term over all documents in the set of documents refers to one dimension in the vector space model. The terms or any other quantifiable indicators such as citations, co-citations, authors or the like may be unweighted with weights restricted to 0 (absence) and 1 (occurrence) or weighted according to importance. w_{ij} represents the weight of the term or any other quantifiable entity considered for the model (Glanzel, 2003; Salton et al., 1975).

The vector representation of documents in multidimensional space of quantifiable indicators allows relating the documents to each other. The most prominent approach to compare two documents based on the chosen quantifiable indicator in a set of documents is to compute indicators for the similarity between them. A common measure for similarity of documents refers to the cosine value of the angle between the vectors (Manning et al., 2008). The similarity of two documents represented by two vectors, d_1 and d_2, can thus be calculated as:

$$sim\,(d_1, d_2) = \cos(\theta) = \frac{d_1 \cdot d_2}{|d_1| \cdot |d_2|} \tag{1}$$

The numerator represents the dot product between the vectors d_1 and d_2. The dot product is divided by the product of their Euclidian lengths, which leads to a length-normalization of the vectors to unit vectors. This procedure takes into account that documents may be very similar if the relative distributions of items are similar, but not their absolute frequencies (Manning et al., 2008). The resulting similarity measure theoretically takes values between –1 (exactly opposing vectors) and +1 (parallel vectors) (Strang, 2013). Since the respective weights w_{ij} and frequencies in scientometric applications are generally non-negative, the cosine similarity of two documents ranges usually from 0 (rectangular vectors) to 1. For a broad discussion on the suitability of various similarity measures in comparison to the cosine similarity measure in scientometrics, we refer to the passionate discussion initiated by Ahlgren et al. (2003), which was taken up by Leydesdorff (2005) and Egge and Leydesdorff (2009) among others.

Given an abstract representation of documents' quantifiable indicators, which allows for the calculation of similarities between documents in a set of documents, it remains unclear, which quantifiable indicators are suitable for a substantially reflection of the documents' contexts. In the following we introduce two methods, with one measure based on the level of citations, i.e., bibliographic coupling, and one based on the semantic level, i.e., latent semantic analysis.

2.2 Bibliographic coupling

The concept of bibliographic coupling dates back to work by Kessler (1963). The main idea is that a shared reference by two documents is defined as a connection (or a unit of coupling) between these documents. The number of shared references between articles are supposed to provide a measure for the similarity between documents (Zupic & Čater, 2015), because bibliographic coupling links are based on the assumption that the strength of the linkage between documents is correlated with the subject relatedness (Glanzel & Czerwon, 1995). Vladutz and Cook (1984) were the first to validate this assumption by means of a comprehensive validation study. Nowadays, bibliographic coupling is a common method in the scientometric toolbox for establishing relationships between scientific documents (Glanzel, 2003; Zupic & Čater, 2015). Moreover, it has been found that bibliographic coupling can be used to detect "hot" research topics, which are represented by so-called "core documents" that can be identified by setting minimum numbers of common references and coupling strengths for the documents in a document space (Glanzel & Czerwon, 1995; Glanzel & Czerwon, 1996).

A common method to identify the strength of bibliographic coupling is based on the cosine value, also called the "coupling angle" (Glanzel & Czerwon, 1995; Glanzel & Czerwon, 1996; Jarneving, 2007). Boolean vectors with the dimensionality being equal to the quantity of citations in a set of documents are used to represent each document. The value for document's Boolean vector takes 1 if the document cites the respective reference and 0 if not (Glanzel & Czerwon, 1996). As presented in the previous section, the cosine similarity between two documents can then be calculated by means of the length normalized (here the length of the document's reference list) dot product.

2.3 Latent semantic analysis

The concept of Latent Semantic Analysis (LSA) was introduced by Derwester et al. (1990) for automatic indexing and information retrieval. LSA serves basically as an improvement of the semantic Vector Space Model, which employs the occurrence of terms as quantifiable indicators for the vector space (as presented in the introduction to the vector space-model). To obtain the semantic space from the documents' natural texts usually requires intensive preprocessing. Common methods are the removal of stop words and stemming. The remaining terms are then often weighted according to the *tf-idf-* weighting scheme (Manning et al., 2008). In this scheme, the weighted term can be defined as:

$$w_{j,i} = tf_{j,i} \times \log \frac{N}{df_j} \tag{2}$$

The weight for term j in document i ($w_{j,i}$) is $tf_{j,i}$, i.e., the frequency of the term in a single document (or log of the frequency since the number of term frequencies may be very high) multiplied by the inverse document frequency (Xia & Chai, 2011), which is defined as the log of the ratio of the number of all documents in the set of documents (N) to the frequency of documents containing the term df_j. This weighting scheme leads to higher weights for document i if the term j occurs often within a small set of documents. If the term occurs fewer times in a document or in many documents, the respective weights are lower (Manning et al., 2008). A resulting weighted term-by-document matrix might then represent the semantic space, which can be used for LSA.

The substantial motivation for LSA is the fact that individual words provide unspecific and unreliable evidence for the content, because language is ambiguous. While the *tf-idf* weighting might be able to describe the relative importance of a given term in a document in relation to the terms in a set of documents, this indication could inter alia be obscured by synonyms or different styles of describing content. Moreover, the content usually arises from the ordering of words, or the context a word is used in, which is simply ignored in a term-by-document matrix, also known as the “bag of words model” (Manning et al., 2008). Given these ambiguities, the LSA approach “takes advantage of implicit higher order structure in the association of terms with documents” (Deerwester et al., 1990, p. 391) to reveal the latent semantic structure associated with a set of documents. The approach bases on singular value decomposition, which decomposes a term-by-document matrix into three matrices, i.e., a term by dimension matrix (constituting left singular vectors), a diagonal singular-value matrix (constituting singular values) and a document by dimension matrix (constituting right singular values). The number of dimensions refers to the rank of the term-by-document matrix (Kontostathis, 2007; Strang, 2013). Setting the smaller singular values in the ordered singular-value matrix to zero (keeping k singular values) and deleting the corresponding rows and columns as well as deleting the corresponding columns in the term-by-dimension and rows in the document by dimensions matrix results in a reduced or truncated term-by-document matrix (of rank k). This reduced matrix is supposed to better represent the term relationship information by reducing noise in the term-by-document matrix. Based on the truncated matrix, relationships between documents can be established, e.g., cosine similarity values. However, for this process, the choice of k is critical and the strategy for setting this value remains an open issue (Deerwester et al., 1990; Kontostathis, 2007).

2.4 Integration of the semantic and citation level

The two methods introduced above are based on two different quantifiable indicators of documents used for vector space models. While bibliographic coupling bases on the shared citations of documents, LSA is based on the higher order structure in the association of terms. Hence, these methods are two separate analyses, which result in two different matrices describing the similarities of documents given the respective level. For obtaining a hybrid measure for the similarity of documents, the two separate matrices need to be merged. Given two cosine similarity matrices, i.e., one for the bibliographic coupling (D_{BC}) and one for the LSA (D_{LSA}), an integrated or hybrid cosine similarity matrix (D_{HYB}) can be obtained by simple linear combination:

$$D_{HYB} = \alpha \cdot D_{BC} + (1 - \alpha) \cdot D_{LSA} \tag{3}$$

with α denoting the weight of the respective levels (Glanzel & Thijs, 2012; Janssens et al., 2008).[1] The choice of weight α is critical and the determination is often justified by experience (Glanzel & Thijs, 2012). Whereas linear combination of matrices may neglect different distributional characteristics and thus yielding suboptimal results by favoring one level over the other, it is an attractive and easy method. The ease of use and the computationally efficiency of simple linear combination results in the fact that "a carefully chosen weighted linear combination might be the preferred solution for integration textual and citation information" (Janssens et al., 2006, p.5). Even though other hybrid integration methods sometimes outperformed the linear combination (Janssens et al., 2008), linear combination seems still to be the a frequently preferred tool for applications in the scientometric literature (see, e.g., Glanzel, 2012).

2.5 Structuring the set of documents

A hybrid cosine similarity (or distance) matrix allows structuring of the set of documents according to the interrelationships indicated by the matrix. A common approach is the partitioning of the documents into subsets by means of clustering algorithms. Mostly cluster algorithms based on hard partitioning are used, which allocate items to a single cluster. Among the various clustering algorithms, the hard agglomerative hierarchical clustering algorithm with Ward's method (Ward Jr, 1963) plays a strong role (e.g., Glenisson et al., 2005; Janssens et al., 2008; Janssens et al., 2006). Clustering per se is only supposed to bring out features or patterns of the data, whereby the user decides which structures are relevant (Borcard et al., 2011). Additionally, in the light of the wealth of diverse clustering algorithms and its' particular characteristics, diverse and multiple representations of groups of a document space can be generated (Leydesdorff, 2005; Oberski, 1988). Hence, given a well-performing clustering algorithm, the evaluation of the obtained cluster solution, i.e., the indication whether the partition seems reasonable, is key.

[1] Note that one could also calculate distance matrices instead of similarity matrices, simply by subtracting a cosine similarity matrix from a matrix of ones with equal size (Janssens et al., 2008), which can serve as a computationally more efficient basis.

Since the clustering procedure aims at a useful representation of subgroups indicated by the association matrix, the evaluation of the cluster solution should base on the information contained in this matrix. A useful approach for the validation of a cluster analysis seems to be a combination of two complementing methods, i.e., one method evaluating the quality and one method evaluating the stability of the cluster solution. To this end, following Glenisson et al. (2005) and Janssens et al. (2008), Silhouette values (Rousseeuw, 1987) can be used to assess the quality, which can be complemented by the stability based method proposed in Ben-Hur et al. (2002).

Clustering usually aims at high between-cluster and low inner-cluster dissimilarity, and thus compact and well distinguishable clusters. The metric-independent silhouette values are supposed to describe this feature (the quality) based on the data that generated the clusters, i.e., the association matrix. Based on the corresponding distance matrix and the obtained cluster solution, the silhouette value S_{ik} for document i in cluster k can be calculated by:

$$S_{ik} = \frac{b(i) - a(i)}{\max(a(i),\ b(i))} \tag{4}$$

with $a(i)$ being the average distance of document i to all other documents in the same cluster k and $b(i)$ being the average distance of document i to the documents, which are not in the same cluster as i but in the nearest other cluster, i.e., the second best choice for document i. Given this formula, the obtained silhouette values range from -1 to +1 (Glenisson et al., 2005; Rousseeuw, 1987). S_{ik} measures how well object i has been classified, with negative values indicating a lower average distance to the objects of another cluster and consequently a potential misclassification of i. Averaging silhouette values over clusters and full cluster solutions as well as graphing silhouette profiles, i.e., silhouette values of documents in combination with the respective clusters, provides evidence for the quality of the respective cluster solution given the association matrix (Glenisson et al., 2005; Rousseeuw, 1987).

Clustering is supposed to reveal structure in data. The stability based method as proposed by Ben-Hur et al. (2002) aims to evaluate, how well the cluster solution represents an underlying structure of the data. The approach bases on the assumption that an inherent structure is "structure that is stable with respect to sub-sampling" (Ben-Hur et al., 2002, p. 9). By means of repetitive subsampling and subsequent clustering with a predetermined quantity of clusters, similarities between pairs of subsamples according to the documents allocation to clusters can be computed, which is quantified by the Jaccard coefficient. High similarities indicate relatively stable cluster solutions. For each quantity of clusters the distributions of similarities can be graphed, which allows the comparison of stability between different predetermined quantities of clusters (Ben-Hur et al., 2002; Glenisson et al., 2005).

All in all, these two methods allow to assess the proper quantity of clusters which should represent the underlying structure prevalent in the data and to assess the overall quality of the cluster solution.

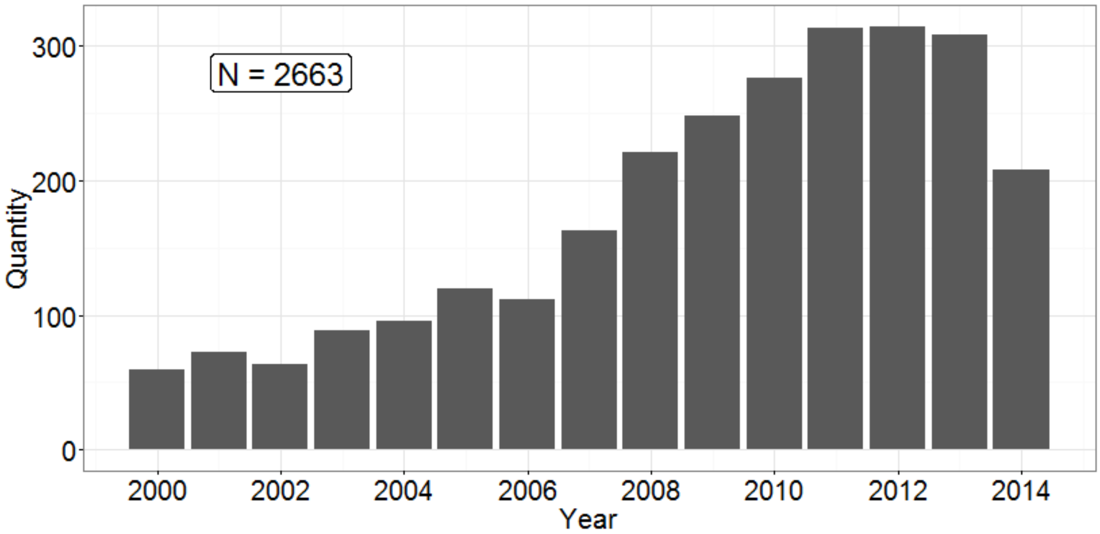
3. Implementation of the hybrid method

The principles and methods elucidated in the previous chapter provide the basis for the hybrid scientometric approach. This chapter provides a step-by-step implementation of the hybrid method to the business and economics literature associated with the loyalty construct.

3.1 Data

The data for the analyses were obtained from the database *Web of Science Core Collection (ISI Web of Knowledge)*, which is a literature and citation database owned by the corporation *Thomson Reuters*. The database is not only the oldest, but also one of the most comprehensive literature and citation databases (Aghaei Chadegani et al., 2013). Using the search terms '*loyal' or 'loyal*' on the 28. October in 2014 along with several refinements, i.e., *research areas*: 'business economics', *document types*: 'articles' and 'reviews', *language*: 'English', and *Time span*: since year 2000, resulted in a total set of 2764 documents. The selection of the base year is completely ad hoc. The obtained set of documents does consequently contain only articles published after the year 2000 and not all articles potentially relevant the loyalty construct in the research area. Due to missing bibliometric indicators 101 documents were deleted. Figure 1 depicts the distribution of publication years of the remaining 2663 documents.

Figure 1: Quantity of documents in the sample per publication year



The distribution of articles matching the search keywords and refinements increased rapidly over the course of the years. The stagnation of recorded publications over the last three years may be explained by delayed entry into the database on the download date. Consequently, the increase in documents referring to loyalty likely matches the generally accepted thesis that science is growing exponentially (Bornmann & Mutz, 2015).

Science and the scientific literature accordingly is at a constant change: Research areas emerge and decline, citation patterns change, writing habits differ, etc.. Hence, documents published many years apart differ substantially and are difficult to compare by means of objective indicators. Consequently, it is a common procedure to subdivide the documents by publishing years into time-slices (TSs) that can be assumed to consist of commensurable documents. The selection of appropriate time-spans is usually ad hoc and depends on the dynamics of the respective research areas. The documents were subdivided into five year-long TSs, i.e., years 2000–2004, 2005–2009 and 2010–2014, which is a commonly used average time-span for scientometric analyses (e.g., Glanzel & Thijs, 2012).

3.2 Data wrangling and creation of vector spaces

Scientometric analyses require ample data wrangling and cleaning efforts. For the citation level, all citations of the documents were extracted as single strings. These strings were subsequently converted into upper cases and compared to each other in order to identify whether the different documents cite the same reference. Moreover, the differences between all cited documents were calculated using the Levenshtein distance. All reference pairs characterized by a lower distance than six, i.e., that require less than six single-character edits to change one string into the other, were extracted and examined by the researcher. If these pairs indicated the same reference, the references were merged into the same string. Based on this procedure all unique citations (references) and the documents citing the references respectively could be calculated for each set of documents per TS. A document by citation matrix with an entry of 1 if the respective document cites the respective reference (and an entry of zero otherwise) is used to store this information. Table 1 shows the quantity of extracted unique citations per TS.

For the semantic-level, the title and abstracts of each document were concatenated into a large string object. Subsequently, punctuation characters were removed, all letters were converted to lower cases and all strings were split into single words with blanks indicating the separation. Duplications were removed resulting in a set of unique terms for each TS. Furthermore, numbers and stop words, i.e., words that usually have no influence for the automatic detection of content, were removed. Additionally the words were stemmed by means of the Porter-stemming-algorithm. These procedures resulted in a decrease of unique terms per TS, which is presented in Table 1. Corresponding to the citation-level, the occurrence of each term in the respective documents is stored by means of a term by document matrix. The terms in the term by document matrix are further weighted using the *tf-idf*- weighting scheme.

Table 1: Quantities of documents and dimensions of the corresponding citation- and term-vector spaces

TS	**1 (2000–2004)**	**2 (2005–2009)**	**3 (2010–2014)**
Documents	380	864	1,419
Citation-level			
Unique citations	12,114	27,655	48,684
Semantic-level			
Unique terms	5,908	8,830	10,942
Cleaned unique terms	3,292	4,787	5,898

3.3 Creation of the citation and semantic similarity matrices

Based on a Boolean document by citation matrix A, with m rows indicating the documents in the set and n columns indicating the citations in the document space, calculating the cosine similarity matrix using linear algebra is relatively straightforward. First, a document by document matrix B, which provides the number of joint references of the documents can be calculated by the product $A \times A^T$. Subsequently, the bibliographic coupling matrix D_{BC}, which provides the coupling angle between the documents indicated by the cosine similarity measure, is the product of $Diag(B)^{-1/2} \times B \times Diag(B)^{-1/2}$ (Glanzel & Czerwon, 1995).

For the semantic-level, the latent semantic analysis can be performed on the basis of the term by document matrix. However, for this process, the choice of the remaining rank k, i.e., the degree of truncation, is critical. Here, we avoid coming up with notions of setting the value due to an educated guess or the like, but follow the idea of Jannsens (2007) that the LSA serves as a tool for improving the subsequent cluster solution. Hence, by comparing the cluster quality of different similarity matrices resulting from different numbers of factors in the LSA, an appropriate number of factors for the given document set may be obtained. To allow for comparability, the silhouette value for each cluster solution is calculated from the original non-reduced weighted term by document matrix. Following Janssens (2007), we compared the cluster quality across the different cluster solutions by means of charts depicting the average silhouette widths. For all TSs the resulting cluster qualities were compared across cluster quantities from 2 to 50 based on similarity matrices obtained from LSA with the factors 5, 10, 15, 20, 30, 50, 100, 200 as well as the non-reduced weighted term by document matrix. The graphs show that especially if one is interested in structuring the set of documents into relatively few clusters, modest numbers of retained factors are associated with a better cluster performance. These findings are comparable with findings by Jannsens (2007) as well as Kontostathis (2007). The chosen factor levels for the respective TSs based on visual evaluation are depicted in Table 2. The reduced term by document matrix, also known as the latent semantic space, can be used as a basis to calculate the cosine similarities between documents. This procedure corresponds to the calculations used to obtain the bibliographic coupling matrix.

Table 2 presents the quantity of corresponding pairs per TS, i.e., the numbers of the lower or upper triangle of the respective document by document matrices, as well as descriptive statistics for the resulting similarity matrices for the citation- and semantic levels. Not surprisingly, the D_{BC} cosine matrix is characterized by high sparseness, which is indicated by the high fraction of zero elements. Additionally, the mean of similarity values is decreasing with the amount of papers, or quantity of document pairs in the set of documents.

Table 2: Document pairs and descriptive statistics for the obtained similarity matrices

TS	1 (2000–2004)	2 (2005–2009)	3 (2010–2014)
Document pairs	72,010	372,816	1,006,071
D_{BC} cosine matrix:			
Fraction of zeros (%)	85.52	74.82	72.76
Mean (SD) non-zero elements	0.043 (0.036)	0.038 (0.031)	0.032 (0.025)
D_{LSA} cosine matrix:			
Factor choice LSA (k)	20	20	30
Fraction of zeros (%)	0	0	0
Mean (SD)	0.407 (0.214)	0.389 (0.189)	0.048 (0.035)

3.4 Creation of the hybrid matrix and structuring the set of documents

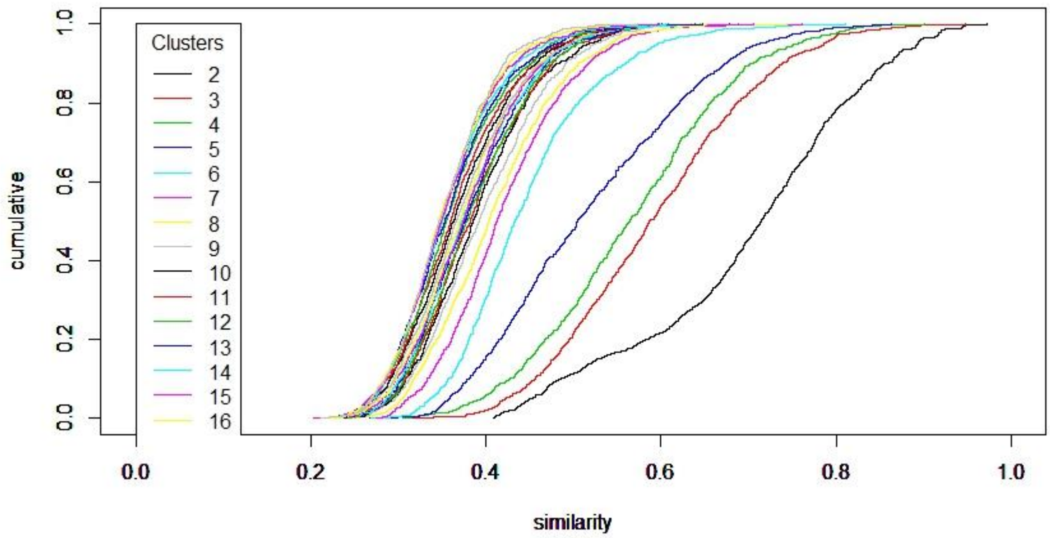
It is well-known that results from clustering based on hybrid similarities in set of documents outperform the results from one-dimensional similarities, i.e., citation or text based similarities. In case of linear combination, however, the choice of α, i.e., the relative weighting of the similarities obtained from bibliographic coupling in relation to the similarities from semantic analyses, remains a critical issue. An appropriate choice for α depends on the dataset at hand and could be determined by making trade-offs based on exploratory insights.

For the document spaces corresponding to each TS, we tested for three different α levels: 0.6, 0.7 and 0.8. Hence, for all hybrid similarity matrices resulting from these levels, the D_{BC} cosine matrix is higher weighted than the D_{LSA} cosine matrix. Since the similarity matrix obtained from bibliographic coupling is characterized by a high sparseness and relatively low cosine values in comparison to the matrix obtained from LSA, equal weighting of these two matrices may suppress the information indicated by D_{BC} in the resulting D_{HYB}. Consequently, stronger weights for the D_{BC} in relation to D_{LSA} may prevent such information loss.

As in the selection of dimensions for the LSA, we evaluate the choice of α based on the resulting cluster performance and consequently the structure we can detect in the set of documents based on the objective indicators. Following Janssens et al. (2008) we combine stability- and quality-based methods to evaluate the cluster performance resulting from the three different hybrid matrices. In the following, we elucidate the chosen procedure exemplarily for the document set in the first TS. We converted the similarity matrices into distance matrices and start with the stability-based method introduced by Ben-Hur et al. (2002) (see chapter 2.5) to get a sense for the "natural" quantity of clusters prevalent in each hybrid matrix. A value of

0.6 was chosen for the proportion of subsamples along with a clustering algorithm based on the Ward's method. Thus, the procedure repetitively draws subsamples (here 60% per cent of all documents in the TS) and subsequently subdivides these subsamples into different numbers of clusters (from two to 25 clusters in our analysis) by means of the hybrid similarity matrix. The overlap between pairs of subsamples according to the documents allocation to clusters are computed and quantified by means of the Jaccard coefficient. Figure 2 graphs the cumulative pairwise Jaccard similarities for each number of clusters from two to 25 based on a hybrid matrix with an α-level of 0.6. Each number has a single curve and the more a curve is to the right, the more stable is a cluster solution. While naturally a two cluster solution serves as the most stable cluster representation, one usually seeks for finer grained solutions. In practice this is accomplished by selecting a transition curve to the band of distributions on the left hand side of the figure (Janssens, 2007). Consequently, a five-cluster solution may serve as an appropriate representation for the underlying data structure.

Figure 2: Stability diagram for determining the number of clusters for hybrid clustering with linear combination (α=0.6)*



***Similarity measured as the Jaccard coefficient between pairs of subsampled data and clustered data.**

The graphs for the different linear combination α-levels (all graphs can be obtained from the authors) show that a five-cluster solution is not only indicated by the resulting linear combination matrix for the 0.6 α-level, but also for the 0.7 α-level. The linear combination resulting from α-level 0.8 suggests likely a four-cluster solution. However, comparing the different stability diagrams reveals that the stability diagram based on the 0.6 α-level matrix provides the clearest indication for a stable cluster-solution, due to the distinct transition curve, followed by the 0.7 and 0.8 α-level matrices. Therefore, the linear combination based on an α-level of 0.6 likely provides the most stable cluster solution.

Additionally, we explored the different α-levels and cluster quantities by means of the average silhouette values obtained from the respective cluster quantities based on the different hybrid matrices. To this end, we first obtained the different cluster solutions by means of the Ward's method for 2 – 50 clusters based on the different hybrid matrices as well as the matrix describing the LSA-based and bibliographic coupling based similarities between the documents in the set. These different cluster solutions based on the different similarity matrices enables to calculate average silhouette values given a distance matrix. Here, the distance matrix may refer to the distance matrix which served as the basis for the cluster solution or to another distance matrix. Hence, one may not only check the quality of the different quantities of cluster given the matrix that served as the basis for the cluster-algorithm, but also compare how, e.g., the cluster solutions from a hybrid matrix behaves in terms of quality given an LSA-based similarity matrix. Graphing the average silhouette values against the cluster quantities measured in terms of a distance matrix (LSA: latent semantic analysis based distance matrix, BC: bibliographic coupling based distance matrix, Hybrid: linear combination of LSA and BC based distance matrix) provides a means to explore the best quantity of clusters as well as the best α-level given a set of documents.

Exploring the different graphs depicting the average silhouette values for the different cluster quantities based on the different hybrid matrices given the respective hybrid matrix shows a local maximum at the cluster quantity of five for all different α-levels. This provides further evidence that a five-cluster-solution is not only indicated by a relatively high stability (α-levels 0.6 and 0.7) but also by a relatively high cluster quality (α-levels 0.6, 0.7 and 0.8). The mismatch associated with the hybrid solution based on the 0.8 α-level in terms of cluster stability (four clusters) and quality (five clusters) might suggest that the results of the other linear combinations outperform the results of the 0.8 α-level hybrid matrix in terms of consistency given the evaluation criteria. The comparison of silhouette values obtained by the different cluster solutions across the different similarity matrices provides further evidence for the best linear combination, i.e., the α-level. Figure 3 depicts the average silhouette values for the cluster solutions based on the different hybrid matrices (linco_06_LSA, linco_07_LSA, linco_08_LSA), the LSA similarity matrix (LSA_s_average) and the bibliographic coupling based similarity matrix (BC_s_average) measured on the basis of the LSA similarity/distance matrix. This gives an indication for how the hybrid cluster solutions take up the semantic information and consequently compete "in the semantic world". Surprisingly the hybrid solutions based on the linear combinations with α-levels 0.6 and 0.8 perform similar in terms of quality to the pure LSA based solutions in the range of a few clusters. This information provides evidence for the choice of the best α-level.

Figure 3: Average silhouette values per cluster quantity for the different cluster solutions given the LSA based distance matrix

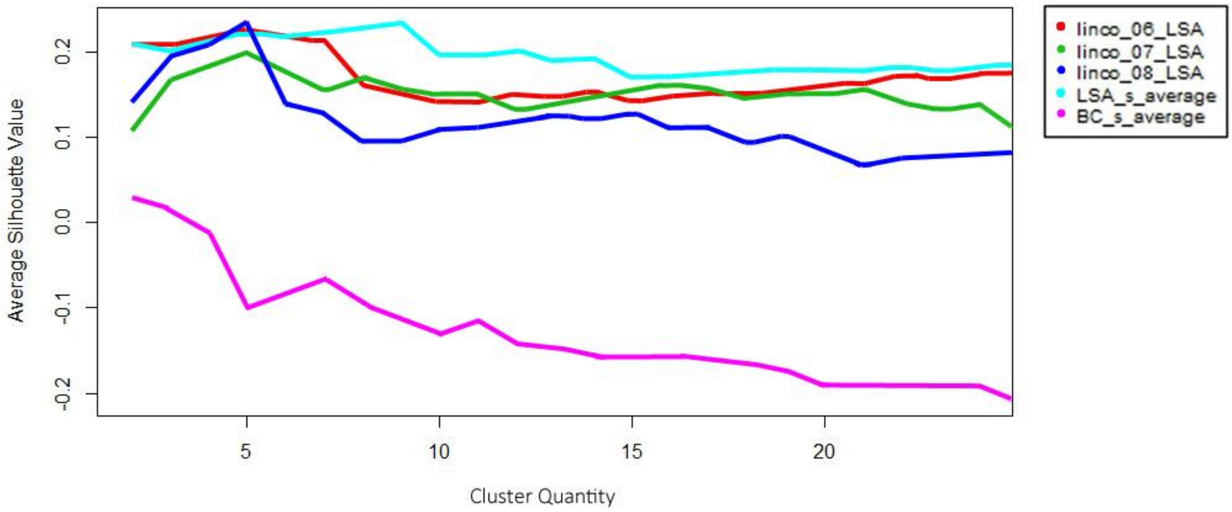


Table 3 summarizes information gained by the exploratory analyses for the documents in the first TS. The hybrid solution based on the 0.6 α-level is characterized by the highest clarity of the stability based method for five clusters, which is also a local maximum for the average silhouette values of all hybrid matrices. Moreover, it performs similar to the LSA-based solution in the "semantic world" and even outperforms the citation based solution in the "citation world" given an optimal five-cluster solution. Hence, for the three different α-levels, the linear combination based on the α-level of 0.6 seems to be the best solution given the chosen criteria.

Table 3: Information gained by the exploratory analysis of the hybrid similarity matrix for TS1 (2000-2004), which serves as evidence for the best α-level and optimal number of clusters

α-levels	**0.6**	**0.7**	**0.8**
Stability based method			
Best cluster quantity	5	5	4
Clarity of optimal quantity (rank)	1	2	3
Quality based method			
Performance in semantic world	Similar to LSA	Worse than LSA	Similar to LSA
(rank)	1	2	
Performance in citation world	Outperforms BC	Outperforms BC	Similar to BC
(rank)	1	2	
Performance in hybrid world	Slightly outperforms others	Performs worse than LSA	Slightly outperforms others

Applying the same exploratory procedure to the other TSs resulted in "best" alpha-levels for each TS as well as an optimal quantity of clusters. Table 4 displays the features of the resulting best hybrid cluster solutions.

Table 4: Weighting, cluster quantity and descriptive indicators of the hybrid cosine matrices ($\boldsymbol{D_{HYB}}$)

TS	1 (2000–2004)	2 (2005–2009)	3 (2010–2014)
Weight α	0.6	0.8	0.7
Cluster Quantity	5	4	3
Mean (SD)	0.166 (0.090)	0.086 (0.048)	0.106 (0.056)

4. Reviewing the results

The obtained cluster solutions allow the analysis of the document space in a systematic manner. The allocation of documents to certain clusters structures the document space and might reveal certain patterns in the scientific economic literature analyzing or at least containing the loyalty construct to some extent. The analysis aims for a holistic understanding of the utilization of the loyalty construct in the business and economics literature. To this end, we try to answer the questions what kind of research streams (discourses) are associated with the loyalty construct and how loyalty is used and understood in this matter. We explore the obtained clusters by means of objective indicators, i.e., representative terms, journals and clustering indicators, and a content analysis of objectively selected documents. We try to reveal the research discourses before we review the respective measurement of the loyalty construct. In both cases, we more extensively review the first TS in the document space and briefly summarize and compare our findings for the subsequent TSs.

4.1 Research discourses

The elaborations in the previous section revealed a five-cluster solution for the first TS, a four-cluster solution for the second TS and a three-cluster solution for the third TS as the appropriate choice for the document set. Table 5 provides some descriptive indicators for each cluster solution, i.e., the cluster-sizes, an indicator for the quality (the clusters' average silhouette values) and the so-called best terms (the ten terms per cluster, which exhibit the highest average *tf-idf*-weight). The best terms are displayed, because terms characterized by high weights in combination with a frequent appearance in the cluster seem representative for each cluster. If one of the ten terms appeared in multiple clusters, the terms were removed from the list in order to provide cluster-characteristic terms.

In the first TS, each of the 380 documents has been assigned to one of five clusters. The cluster sizes range from 45 (cluster 2) to 132 (cluster 3). The silhouette values range from 0.03 (cluster 2 and 5) to 0.11 (cluster 3). Consequently, cluster 3 is characterized by the highest quality in terms of tightness and separation. Note that the levels of the silhouette-values are comparable to the silhouette values in other hybrid scientometric clustering approaches (e.g., Janssens et al., 2008). In the second TS, the hybrid scientometric approach resulted in a cluster solution with four clusters for the 864 documents. The cluster sizes range from 115 in the first cluster to 383 in the third cluster. The silhouette values range from a negative value of -0.007 in the fourth cluster to a maximum value of 0.04 (for cluster 1 and cluster 4). The third TS contains with 1419 documents in total the most documents. Here, the three-cluster solution resulted in clusters sizes ranging from 178 to 870 documents. The silhouette values are comparable to the previous TSs.

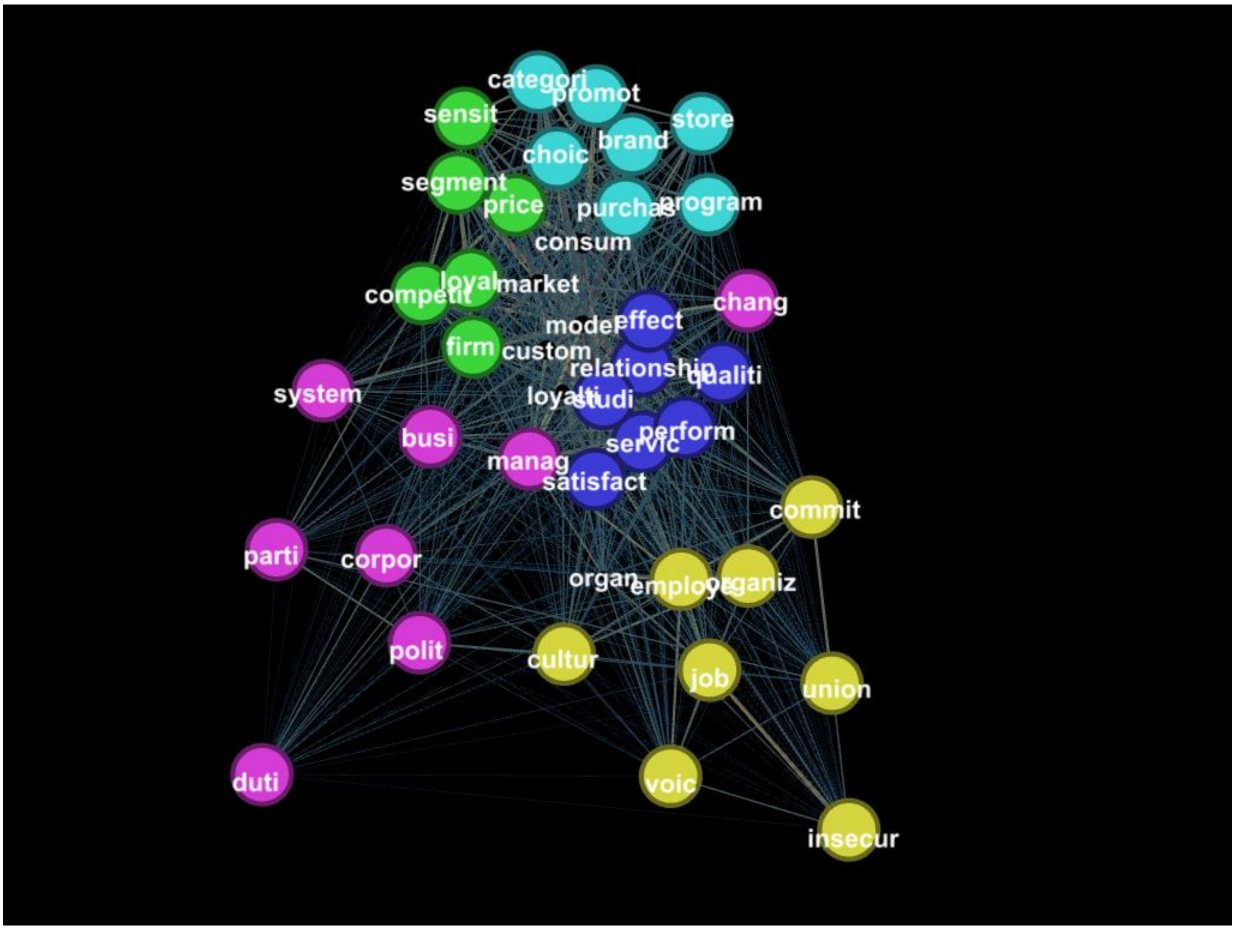
Table 5: Descriptive indicators for each cluster per TS

TS1 (2000–2004)					
Cluster	**1**	**2**	**3**	**4**	**5**
N (Documents)	85	45	132	66	52
Silhouette-value	0.05	0.03	0.11	0.09	0.03
Best terms	brand, purchas, choic, promot, program, store, categori	price, competit, firm, loyal, segment, sensit	service, satisfact, relationship, quality, effect, studi, perform	employe, job, union, commit, culture, organiz, voic, insecure	manag, corpor, busi, polit, system, parti, chang, duti
TS2 (2005–2009)					
Cluster	**1**	**2**	**3**	**4**	
N (Documents)	115	150	383	216	
Silhouette-value	0.04	0.03	0.04	-0.007	
Best terms	price, promot, product, firm, competit, retail	employe, organiz, organ, contract, union, commit, job, employ, psycholog	service, satisfact, relationship, quality, effect	valu, perform, manag	

TS3 (2010–2014)			
Cluster	**1**	**2**	**3**
N (Documents)	371	870	178
Silhouette-value	0.02	0.03	0.05
Best terms	brand, consum, market, price, product, retail, corpor, equity, destin	custom, service, satisfact, relationship, studi, quality, research, valu, effect	employe, organiz, union, employ, organ, worker, commit, job, leadership

The best terms might already provide a first understanding of the content associated with each cluster. Another perspective on the best terms can be provided by means of network visualization. To this end, we calculated a term-by-term cosine similarity matrix using all terms in the TS. Subsequently, we deleted all terms which did not appear amongst the overall 50 (40 and 30) best terms for the clusters, which obtained a best-term similarity matrix. The best term similarity matrix can then be depicted as a network map by means of network visualization tools. Figure 4 shows a visual representation of the best term similarity matrix for the first TS using the open source software package Gephi (Bastian et al., 2009). The corresponding visualizations for the second and the third TS can be found in the appendix (A1 and A2). In the visualization, the terms are arranged according to their similarity, i.e., the closer the terms the more they are interrelated according to the similarity matrix. Every term is connected to every other term, whereby the thickness of the edges (the lines between the terms) represents the respective degree of similarity. The underlying color of the nodes represents the terms' cluster memberships with the small black nodes (or the nodes are invisible) being the aforementioned terms that appeared in multiple clusters. The consideration of the term network map can provide a better understanding on how the best terms are interrelated, and how this is related to the terms' cluster membership.

Figure 4: Term network map for TS1*



***Cluster 1 in cyan, cluster 2 in green, cluster 3 in blue, cluster 4 in yellow and cluster 5 in pink**

Another objective perspective on the structure in the document set is provided by the distribution of journals in which the documents were published. Here, we assume that a journal's name provides some information on the content of the documents, since journals usually publish articles in the scope of a certain research area. Hence, the distribution of journals across the different clusters can provide some indication on the content or research streams associated with the structure. To this end, we calculated the absolute frequency of a journal in a cluster and the share to which each journal appeared in each cluster. Subsequently, we ranked the journals according to their frequency and selected the ten most often occurring journals per cluster. Out of these ten journals we selected (up to) six journals where the share exceeded 0.5, i.e., where more than half of the publications in that journal appeared in that very cluster. The share provides an indication for the representativeness of a journal for a cluster. If fewer than six journals are displayed, fewer than six journals out of the ten most frequent journals were characterized by shares larger than 0.5. Table 6 provides an overview of the six most frequent journals per cluster, where each journal's share per cluster exceeded 0.5 for the first TS. The corresponding tables for the second and third TS can be found in the appendix (A3 and A4).

Table 6: Representative journals per cluster*

Cluster 1	**Absolute**	**Share**
JOURNAL OF MARKETING RESEARCH	12	0.86
JOURNAL OF MARKETING	7	0.54
JOURNAL OF ADVERTISING RESEARCH	6	0.75
JOURNAL OF CONSUMER PSYCHOLOGY	5	1
INTERNATIONAL JOURNAL OF MARKET RESEARCH	4	0.8
ADVANCES IN CONSUMER RESEARCH VOLUME XXXI	3	0.75
Cluster 2	**Absolute**	**Share**
MARKETING SCIENCE	9	0.69
JOURNAL OF ECONOMIC BEHAVIOR & ORGANIZATION	2	0.67
JOURNAL OF CONSUMER AFFAIRS	2	0.67
JOURNAL OF ECONOMIC DYNAMICS & CONTROL	2	1
JOURNAL OF ECONOMIC THEORY	2	1
INFORMATION ECONOMICS AND POLICY	2	1
Cluster 3	**Absolute**	**Share**
INTERNATIONAL JOURNAL OF SERVICE INDUSTRY MANAGEMENT	19	0.95
JOURNAL OF RETAILING	12	0.63
TOTAL QUALITY MANAGEMENT	12	0.92
JOURNAL OF THE ACADEMY OF MARKETING SCIENCE	10	0.71
TOTAL QUALITY MANAGEMENT & BUSINESS EXCELLENCE	7	0.78
PSYCHOLOGY & MARKETING	7	0.88
Cluster 4	**Absolute**	**Share**
HUMAN RELATIONS	5	1
INTERNATIONAL JOURNAL OF HUMAN RESOURCE MANAGEMENT	5	1
JOURNAL OF APPLIED PSYCHOLOGY	5	1
JOURNAL OF ORGANIZATIONAL BEHAVIOR	4	0.67
JOURNAL OF MANAGEMENT STUDIES	4	1
PUBLIC PERSONNEL MANAGEMENT	4	1
Cluster 5	**Absolute**	**Share**
JOURNAL OF BUSINESS ETHICS	6	0.6
BUSINESS ETHICS QUARTERLY	4	0.8
PUBLIC CHOICE	3	1
TOURISM MANAGEMENT	2	0.5
WORLD DEVELOPMENT	2	1
RESEARCH POLICY	2	1

* Representativeness indicated by the absolute frequency of the journal in the cluster as well as the relative frequency, i.e., the share of the journal's appearance in the cluster (TS1).

The combination of best terms and representative journals might already provoke connotations for the different research streams associated with each cluster. However, it seems reasonable to complement these objective indicators with content analysis, since the indications provided could be misleading. An author's selection of papers for the content analysis may be prone to a subjective selection bias. Consequently, it seems reasonable and consistent to select the documents for the content analysis based on objective measures. Since we aim to describe the content of the structure in the TS, we target representative documents for this very structure, i.e., each cluster. To this end, we calculated for each cluster, the average hybrid similarity of a document to the other documents in that cluster. Exemplarily, we selected the 10 documents per cluster, which ranked highest in terms of average similarity. Hence, we assume that a high average similarity reflects a substantial representativeness for the cluster. The references for the selected documents per cluster and TS can be found in the appendix (A5). Reviewing these documents' titles and abstracts in combination with the previously presented indicators provides a profound picture of the research discourses associated with each cluster, which we are going to elucidate for TS1 in the following:

TS1 cluster 1

Cluster 1 contains many documents from the marketing side of the business and economics literature, which is also reflected by the cluster's high share of the documents from the *Journal of Marketing Research* as well as the *Journal of Marketing*. While marketing is a rather broad research field, the dominance of the *Journal of Advertising Research* and the *Journal of Consumer Psychology* enhances the profile of the cluster into a consumer- and/ or customer-related direction. This perspective is complemented by the key terms, e.g., *purchas*, *choic* or *promot*, which hints at research streams associated with a customer's purchase intention and its determinants. Reviewing the selected documents' titles we observe generic articles in this scope, such as *The Economics of Consumer Knowledge* by Ratchford (2001) or the *Entrenched Knowledge Structures and Consumer Response to New Products* by Moreau et al. (2001). Nevertheless, the vast majority of titles add more profile to the clusters, especially in combination with the obtained key terms. *Brand* seems to play a crucial role in many titles, e.g., in *Why Brands Grow* by Baldinger et al. (2002) and *The chain of effects from brand trust and brand affect to brand performance: The role of brand loyalty* by Chaudhuri and Holbrook (2001), as well as the key term *program*, e.g., in *Spatial diffusion of a new loyalty program through a retail market* by Allaway et al. (2003) or *The Influence of Loyalty Programs and Short-Term Promotions on Customer Retention* by Lewis (2004). The examination of the respective abstracts reveals a clearer picture of the utilization of the loyalty construct in association with consumer- and/ or customer-related research. The loyalty of customers towards a brand, i.e., the brand loyalty seems to play a crucial role (e.g., Baldinger et al., 2002; Chaudhuri & Holbrook, 2001; Hem & Iversen, 2003) as well as the effect of loyalty related marketing-programs or promotional techniques on the customers (e.g., Allaway et al., 2003; Laroche et al., 2003; Lewis, 2004). Given these observations, we label cluster 1 as b*rand loyalty and customer retention*.

TS1 cluster 2

The most frequent journal in cluster 2 is again a marketing oriented journal, i.e., *Marketing Science*. However, the other journals sharpen the cluster's profile, since these journals are in contrast to the journals in the other clusters devoted to a more economic-oriented research, e.g., the *Journal of Economic Behavior and Organization* or the *Journal of Economic Theory*. This observation corresponds relatively clearly with the obtained best terms, e.g., *price*, *competit*, *firm* or *segment*, which represent typical subject-specific vocabulary. Interestingly, *loyalty* is even a best term in cluster 2. Reviewing the selected documents titles and abstracts, we find that the consumer and/ or the customer is (again) the entity, which is subject to loyalty. In contrast to cluster 1, the loyalty of the consumer is mainly not devoted to a brand, but more generally to a product which is considered to determine the customers' behavior and/ or preferences. This view is for instance utilized in order to understand consumers' behavior in marketplaces with certain consumers' behavioral patterns, e.g. viscous demand (e.g., Radner, 2003; Radner & Richardson, 2003) and its effect on market power and firms' behavior. The focus lies on the market mechanisms and how loyalty effects these markets and ,e.g., the firms market shares (e.g., Villas-Boas, 2004). Consequently, we label cluster 2 as *economic welfare and market power through loyalty*.

TS1 cluster 3

The leading journal in cluster 3 is the *International Journal of Service Industry Management* followed by *Total Quality Management* and the *Journal of Retailing*. Hence, the documents in the cluster seem to have an orientation towards customer-interaction in the scope of the services marketing literature. This is further underlined by the best terms *service, satisfact* and *relationship*, which seem to match such research discourses. Reviewing the selected documents` titles and abstracts further support this observation and adds more profile to the cluster, since the focus of the research in the cluster seems to be on the understanding of the customer. Titles such as *The antecedents of consumers' loyalty toward Internet Service Providers* by Chiou (2004) or *Understanding the Customer Base of Service Providers: An Examination of the Differences Between Switchers and Stayers* by Ganesh et al. (2000) underline this perception. In contrast to cluster 2, the loyalty construct does not seem to be considered as a phenomenon, which simply exists and influences economic interaction on markets, but as the phenomenon which is in the focus of interest and which has to be understood. We label cluster 3 as *understanding of customers and formation of loyalty in services marketing*.

TS1 cluster 4

Cluster 4 lists several journals exclusively. Examples refer to the journals *Human Relations* and *Public Personnel Management*. In combination with the best terms, e.g., *employe*, *job*, *culture* or *organiz,* the cluster relatively clearly seems to comprise documents related to loyalty in an organizational and job-related context. Titles like *The Influence of Empowerment and Job Enrichment on Employee Loyalty in a Downsizing Environment* by Niehoff et al. (2001) or *What kind of voice do loyal Employees use?* by Luchak (2003) underline this view. We label cluster 4 correspondingly as *organizational and employee loyalty*. Reviewing the selected documents confirmed this view, because all documents approach the loyalty of employees.

TS1 cluster 5

The most frequently used journals in cluster 5 are the *Journal of Business Ethics* and *Business Ethics Quarterly*. Several documents' titles such as *Loyalty, harm and duty: PBL in a media ethics course* by (Slattery, 2002) or *Professional Ethics - a Managerial Opportunity in Emerging Organizations* by (Hoivik, 2002) refer to ethical research discourses as well. In combination with best terms such as *manag, corpor* and *busi* it seems reasonable to label cluster 5 as *ethics in organizational context*. However, the content analysis of the selected documents revealed that most of the documents do not actually focus on loyalty as a research object, but rather incorporate it as part of the everyday language. Consequently, we cannot disentangle an actual loyalty discourse in this cluster and consider it as a *noise cluster*.

TS2 (2005–2009)

In the second TS, we observe that the silhouette-values are relatively low compared to the first TS. Consequently, the clusters in the cluster solution seem to be characterized by a relatively low intra-homogeneity in relation to the documents of the other clusters according to the objective indicators. This holds especially for cluster 4, which is characterized by a silhouette-value close to zero. Many key words appear in multiple clusters, which underlines the perception of a relatively “unclear” cluster-solution as well. This view is complemented by the distribution of best terms, because relatively many best terms appear in multiple clusters. Cluster 4 seems to be not clearly separated from the other clusters, since only three unique terms can be assigned to that cluster. Moreover, cluster 4 is only characterized by three “typical” journals, since the remaining six most frequent journals were accompanied with shares below 0.5.

Reviewing the clusters’ objective indicators and the selected “representative” documents revealed several similarities and differences in comparison to the first TS. Cluster 1 shows generic similarities to cluster 2 *economic welfare and market power through loyalty* in the first TS. The key terms, e.g., *price*, *firm* and *competit,* and typical journals such as the *Journal of Economics & Management Strategy* point also at an economic-oriented research discourse. But, while the selected documents in the cluster *economic welfare and market power through loyalty* seem to focus on the general relationship between consumers and products (and the influence of pricing on the two), the focus of some documents in cluster 1 seems to lie on brand loyalty measured as, e.g., a consumer’s brand share (Lim et al., 2005). Hence, cluster 1 seems to entail some similarities to cluster 1 (*Brand Loyalty and Customer Retention*) in the first TS, which is also reflected by the best term *promot,* which might indicate that cluster 1 takes up questions of pricing such as promotion programs on purchasing patterns (e.g., Lim et al., 2005), which would have been likely allocated to the *Brand Loyalty and Customer Retention* cluster in the first TS. Cluster 2, however, seems to resemble the research discourse from cluster 4 (*organizational and employee loyalty)* from the first TS surprisingly well. Not only the best terms and journals, but also the selected documents’ contents match the observations that the cluster is devoted to *organizational and employee loyalty.* Cluster 3 substantially resembles cluster 3 (*understanding of customers and formation of loyalty in services marketing*) from the first TS. Surprisingly, all of the best terms for cluster 3 in the second TS appear in the corresponding cluster in the first TS. The characteristic journals (e.g., The Journal of Retailing) seem to cover similar research interests, for instance, the service industry. While the first three clusters seem to represent a certain research stream with a more or less homogeneous understanding of the loyalty construct, cluster 4 does not show any homogeneous and characteristic features. The content analysis confirmed this perception already indicated by the objective indicators. Therefore, the cluster can be labeled as a noise cluster.

TS3 (2009–2014)

The third TS contains with 1419 documents in the set the most documents. The hybrid scientometric procedure resulted in a cluster solution with only three clusters. The cluster sizes range from 178 to 870 documents and the silhouette values are comparable to the previous TS except the silhouette value close to zero as in the second TS. Reviewing the best terms and the corresponding best term matrix seems to indicate, that the cluster-solution for this TS provides the cleanest results based on this objective indicators. All but one best term are unique to each cluster and describe the clusters reasonable well. The remaining best term that is shared by all clusters refers surprisingly to *loyalty*.

The best terms associated with cluster 1 are again vastly a combination of the best terms from cluster 1 and cluster 2 from the first TS. However, reviewing the selected documents showed that, in contrast to the second TS, the focus of the research discourse (as indicated by the representative documents) is focused on brand loyalty. Hence, cluster 1 seems to be a descendant of cluster 1 from the first TS, i.e., *Brand Loyalty and Customer Retention*, which may incorporate economic research devoted to customer loyalty as well. Reviewing the remaining two clusters' best terms, journals and selected documents reveal a clear profile regarding the research discourse associated with each cluster. Cluster 2 is similar to cluster 3 (*understanding of customers and formation of loyalty in services marketing)* and cluster 3 is similar to cluster 4 (*organizational and employee loyalty*) from the first TS.

4.2 Measurement of the loyalty construct

The orientation of the clusters in the first TS seems to draw a relatively clear picture. Nevertheless, it remains unclear how the loyalty construct in each research area is understood and operationalized. Consequently, we analyzed the content of the selected documents articles for a deeper understanding of loyalty in research discourse.

TS1 cluster 1 (Brand loyalty and customer retention)

While the orientation of cluster 1 in TS1 in consumer and/ or customer research towards loyalty seems to draw a relatively clear picture, it remains unclear how the loyalty construct in the *Brand loyalty and customer retention* area is understood and operationalized, i.e., which scales are used. Consequently, we analyzed the content of the whole articles for a deeper insight into loyalty in that cluster. Eight out of ten articles use an empirical approach to answer their research question. The remaining two articles by Ratchford (2001) and Morgan (2000) are conceptual contributions. Interestingly, the document by Morgan (2000) is even a conceptual review on the loyalty term in the branding literature, which is according to the author one of “the most abused words in the English marketing lexicon” (Morgan, 2000, p. 65). Morgan (2000), inter alia, describe two different views on loyalty towards a brand: the emotional attachment towards a brand, i.e., the feeling towards a brand, and loyalty as repeated purchase of a brand, i.e., a pure behavioral view. Reviewing the selected documents, however, we find a clear dominance for the behavioral view on loyalty in the empirical papers with loyalty defined and measured as the share of purchases attributed to a brand (purchase patterns) (Baldinger et al., 2002), brand loyalty nested in buying frequency (Bawa & Shoemaker, 2004) or statements regarding a customer’s usual buying behavior (Laroche et al., 2003). An exception refers to Chaudhuri and Holbrook (2001), who differentiate between behavioral and attitudinal brand loyalty.

TS1 cluster 2 (Economic welfare and market power through loyalty)

The selected documents are mainly theoretical and inhibit a behavioral view on the loyalty construct. Loyalty is mainly just a preference for a product or firm, and is not the focus of the research approaches. Loyal customers are, e.g., viewed as customers that do not take price differences into account (Kocas, 2002; Lommerud & Sorgard, 2003). Overall, the focus lies more on the effect of the presence of loyal customers on markets, which may hinder customer switching (Ciarreta & Kuo, 2002; Rodriguez-Ibeas, 2000) and not on the formation or measurement of loyalty per se.

TS1 cluster 3 (Understanding of customers and formation of loyalty in services marketing)

All documents pursue an empirical approach to their research question. The view of Ganesh et al. (2000), who “conceptualize customer loyalty as a combination of both commitment to the relationship and other overt loyalty behaviors” (Ganesh et al., 2000, p. 69) seems to be characteristically for the perception of loyalty in that cluster. The “overt behavior” usually seems to be understood as the customers intention to repurchase a product (e.g., Homburg & Giering, 2001) or simply to stay with the current business partner (e.g., Colgate & Danaher, 2000). The affective component, e.g., the commitment to the business-relationship, is measured and understood differently. But one indicator seems to be crucial for the attitude of a customer in that cluster, i.e., whether the customer would recommend the partner or product to its peers (e.g., Colgate & Danaher, 2000; Ganesh et al., 2000; Guenzi & Pelloni, 2004) also known as word of mouth behavior. From this perspective, loyalty has a crucial impact on the behavior of customers not only regarding a business-relationship, but also on other (potential) clients.

TS1 cluster 4 (Organizational and employee loyalty)

While all but one document (Khatri & Tsang, 2003) empirically approach their research question, we observe diverse perceptions of loyalty. Loyalty is viewed as employees' active behavioral patterns (e.g., Niehoff et al., 2001) or attitudes and behavioral responses (e.g., Thomas & Au, 2002). Employees defending their organization is often viewed as typical loyal behavior (or response) (e.g., Niehoff et al., 2001; Olson-Buchanan & Boswell, 2002). In this context, loyal employees might be even described as "good soldiers" (Vigoda, 2001). Overall, cultural aspects seem to play an important role for the understanding of loyalty (Culpepper et al., 2004; Khatri & Tsang, 2003) and the Hirschman's model (Hirschman, 1970) is often used in this cluster (e.g., Luchak, 2003; Thomas & Au, 2002).

TS2 and TS3

Reviewing the remaining TSs supports the aforementioned view on loyalty and its measurements in the respective research areas. According to the objective indicators cluster 1 in the second TS seems to be strongly related to cluster 2 from the first TS (*Economic welfare and market power through loyalty*) comprising elements related to cluster 1 from the first TS (*Brand loyalty and customer retention*). Similar to cluster 2 from the first TS, most articles are conceptual whereby loyalty serves as a behavioral assumption that describes the purchasing behavior of buyer segments (e.g., Jing & Wen, 2008; Kocas & Kiyak, 2006) and the interest does not lie on the formation of loyalty as well. Many articles discuss the effect of price changes on purchasing behavior and classify a certain behavior as being brand loyal (e.g., Anderson & Kumar, 2007; Jing & Wen, 2008), which might explain the relation to the *Brand loyalty and customer retention* cluster. Cluster 1 from the third TS was found to be more strongly related to the cluster *Brand loyalty and customer retention* cluster than the *Economic welfare and market power through loyalty* cluster based on the objective indicators. In fact, most of the selected documents are empirical and are devoted to brand loyalty. However, whereas the documents in *Brand loyalty and customer retention* mainly analyzed purchasing behavior, the documents in this cluster show all kinds of approaches to the loyalty construct, e.g., purchase frequencies and shares (e.g., Romaniuk & Nenycz-Thiel, 2013) or purchasing intentions and attitudinal loyalty (e.g., Leischnig & Enke, 2011).

Reviewing the clusters corresponding to *Understanding of customers and formation of loyalty in services marketing* and *Organizational and employee loyalty* in the first TS confirm the respective perceptions of the loyalty construct. Regarding *Understanding of customers and formation of loyalty in services marketing*, we observe a crucial role of the intention of staying with and recommending a business partner or service (e.g., Caceres & Paparoidamis, 2007; Dimitriadis & Koritos, 2014; Liang et al., 2008). Moreover, similar to cluster 3 in in the first TS, authors mainly combine an attitudinal with a behavioral view on the loyalty construct. For this research discourse, the article by Caceres and Paparoidamis (2007) provides a great overview of the loyalty construct. Overall, the work by Zeithaml et al. (1996) seems to have greatly influenced the operationalization of the loyalty construct in this research area.

For the clusters related to *Organizational and employee loyalty* we observe again that Hirschman's model is used frequently (e.g., Si et al., 2008). Note that a thorough overview of employee loyalty in the literature is provided by Hart and Thompson (2007), which is one of the selected documents.

5. Discussion

The introduced scientometric method is adapted from Glanzel (2012), Glenisson et al. (2005), Janssens et al. (2006), Janssens et al. (2008) as well as Janssens (2007), among others. All those articles refer to research endeavors in the scientometric research discourse, which implies that those articles rather take a methodological perspective. This article seeks to translate such methodological research into an empirical field of research by providing as step-by-step illustration to the hybrid clustering of a research field. This process provides several insights into the specifics of such approaches.

Initially, the researcher has to make crucial decisions regarding the selection of dimensions in the LSA, the selection of the alpha level for the linear combination as well as the selection of the quantity of clusters. Following the above mentioned research, in particular Janssens (2007) and Janssens et al. (2008), we approached these questions by means of exploratory approaches based on the potentially resulting cluster-solutions. One may argue that given the high degrees of freedom for the choice of objective indicators, the combination procedure and the clustering algorithm, that there is no actual solution or pattern, but all kinds of different solutions (see e.g., Oberski, 1988). Nevertheless, we argue that the introduced approach still fulfills its purpose of investigating the research discourse from an objective standpoint. The choices are made based on an exploratory data analysis and follow a transparent decision-framework. Hence, the researcher does not directly interact with the content, which helps to prevent subjective biases. Moreover, it seems likely that the selection procedures do not crucially influence the insights obtained from the analysis. For example, the stability measures proposed for alpha values of 0.8 in the first and the second TS one less cluster. Given that one would have chosen these alternate cluster numbers, the documents from the "noise clusters" would have probably been allocated to the remaining clusters. Since these documents would likely have contributed to the periphery of theses research discourses, the characteristics of the actual research discourses and consequently the obtained insights would not have changed substantially. This view is supported by the relatively low silhouette-values of the respective "noise clusters", which indicates a low homogeneity of these clusters.

The objective indicators obtained from the analysis, i.e., the best terms, the best term maps and the characteristic journals provides the researcher with a first impression of the research discourses. Nonetheless, there is a point in time, where the researcher has to review some documents' content. To prevent a potential subjective selection bias, we decided to select the documents for the content analysis depending on the average cosine-similarity of a document in a cluster. These documents are supposed to exhibit characteristic features of the research discourses associated with a cluster, since they are supposed to have the highest similarity to the remaining documents. However, while this approach prevents a subjective selection bias, it is associated with certain weaknesses. For instance, the mean might be affected by outliers, which means that if two or more documents are indicated by an exceptional high cosine similarity, these documents are more likely to appear amongst the selected documents, even though these documents might only represent a small fraction of the overall cluster. Additionally, assuming that a cluster contains several sub-discourses, these selected documents might only represent the largest discourse amongst those sub-discourses. These problems can be overcome statistically, e.g., through outlier removal or smoothing procedures, by cross-checking the characteristic documents with randomly selected documents, or by analyzing a cluster for sub-discourses by means of an additional cluster analysis solely based on the documents in a cluster.

Despite these weaknesses, the selected documents in combination with the objective indicators enabled a categorization of the research discourses. Across all three TSs we found two stable research discourses labeled as the *understanding of customers and formation of loyalty in services marketing* and *organizational and employee loyalty*. The other two research discourses from the first TS, i.e., *brand loyalty and customer retention* and *economic welfare* *and market power through loyalty*, however, do only appear in the first TS and seem to flow into a joint cluster with different manifestations of the supposedly preceding discourses. A reason for the merger of these supposedly distinct research discourses may lie in the fact that research tends to branch out over time. Hence, one discourse might take up, e.g., jargon, from the other or vice versa, which would lead to blurred boundaries (based on objective indicators) between the two. Another reason might lay in the fact that research discourses do not necessarily grow likewise. For instance, it could be the case that loyalty from an economic perspective does not seek as much attention from economic scholars as from marketing or branding scholars, which would lead to a shift in the relative fraction given the total loyalty discourse. Consequently, the supposedly economic consideration, which treated loyalty rather as a behavioral assumption for their mainly conceptual work, may have simply become a sub-discourse of another discourse, due to an increased likelihood of similarities due to a larger set of documents in the latter. Increasing the set of objective indicators, e.g., by using full texts and not only abstracts for the analysis may help to improve the potential to reveal structure.

The content analysis regarding the understanding and operationalization of the loyalty construct revealed a mixed picture. Surprisingly, for some research discourses, e.g., the *economic welfare and market power through loyalty* discourse, the insights were relatively clear. However, we only find a tendency towards some mutual understanding or operationalization of the loyalty construct for other discourses. This likely represents the simple nature of the mixed understanding (or "abuse") of loyalty even in supposedly relatively homogeneous research streams. While the hybrid approach may function well to structure the documents into discourses, the discourses are likely still fragmented regarding this relatively small aspect of a research paper. One solution would be to use more objective indicators, e.g., full text bodies, and to assign different weights according to indicators supposedly associated with the loyalty construct.

6. Conclusion

Publications, which are the main tool for scientific communication, are accumulating exponentially. A researcher, who seeks to contribute something valuable to the scientific world, needs to have a basic understanding of the extant knowledge in that respective research field. Since publications document this knowledge, researchers are increasingly facing information overload, which might hinder expedient research efforts and efficient communication among researchers. Consequently, there is a growing need for methods that provide assistance to the researcher for apprehending scientific discourses. Literature reviews, however, suffer from subjective biases and delayed publication. Scientometric methods might overcome these weaknesses and complement review processes by using computational power for the analysis of articles' objective indicators. But despite this potential, scientometric approaches by applied researchers are scarce and we argue that applied researchers are lagging behind the progress in the scientometric research field. Hence, we try to transfer knowledge from the methodological discourse to the applied (non-scientometric) researcher by providing a step-by-step analysis of loyalty in the business and economics literature. To our knowledge, we even provide the first hybrid scientometric approach in the economics literature.

The hybrid approach to the loyalty literature revealed that the researcher has to take several important decisions in the course of the analysis. However, by means of exploratory data analysis and decision frameworks, these decisions can be fully taken based on objective indicators. To combine objective indicators with the content, we selected documents given the detected structure and based on objective indicators. Even though this process may suffer from several limitations, we are able to detect certain research discourses associated with the loyalty construct, with two discourses being even stable over time. Moreover, we detect certain tendencies of the utilization of the loyalty construct associated with the different discourses. However, while we are able to detect discourses, the utilization of constructs still shows a substantial heterogeneity. Nevertheless the applied researcher might still crucially benefit from this approach because of multiple factors: The applied researcher gets a holistic overview of a literature discourse, can label research discourses based on objective indicators and is facing documents, which the researcher might not ever have considered in a regular subjective review process.

We conclude there should be more applied research endeavors for a better exploitation of the extant scientometric knowledge. Furthermore, there should be more methodological research, not only on how a set of documents can be structured, but also on how a research discourse can be analyzed from a certain perspective, e.g., the loyalty construct. This requires, however, full text approaches and probably a different weighting procedure.

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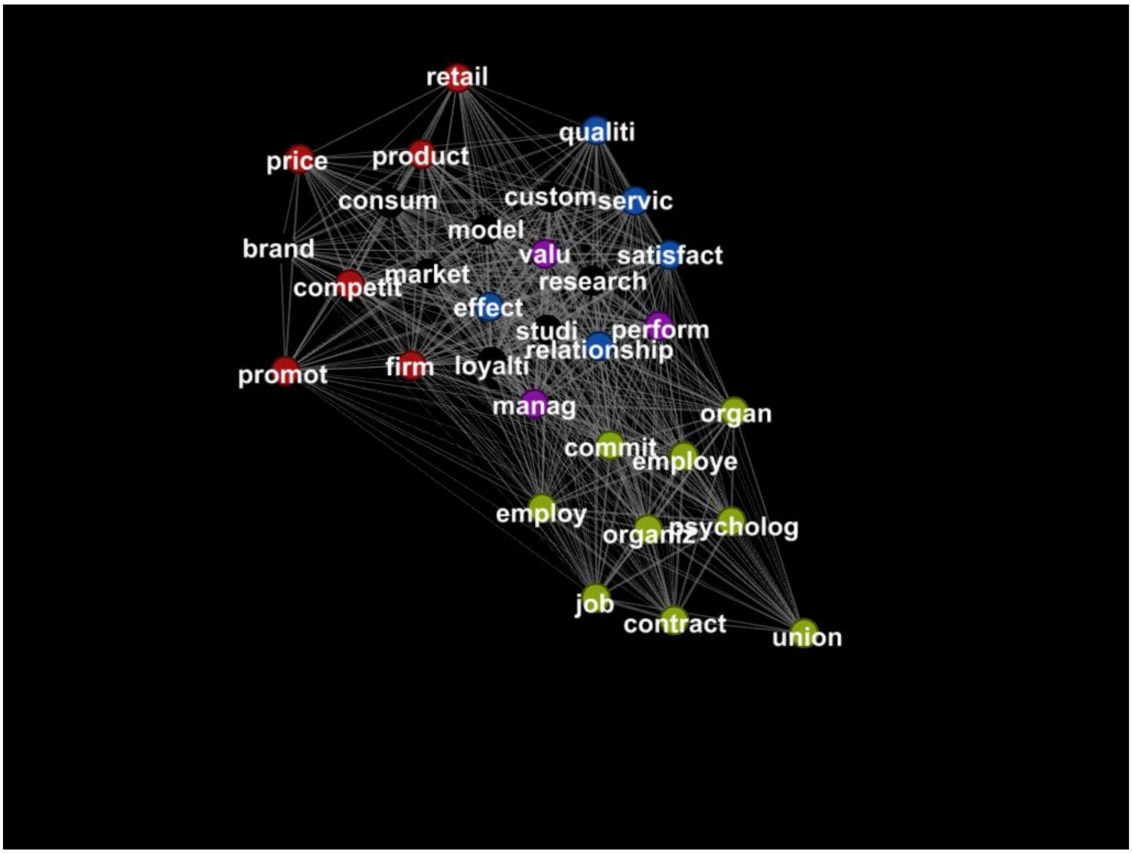
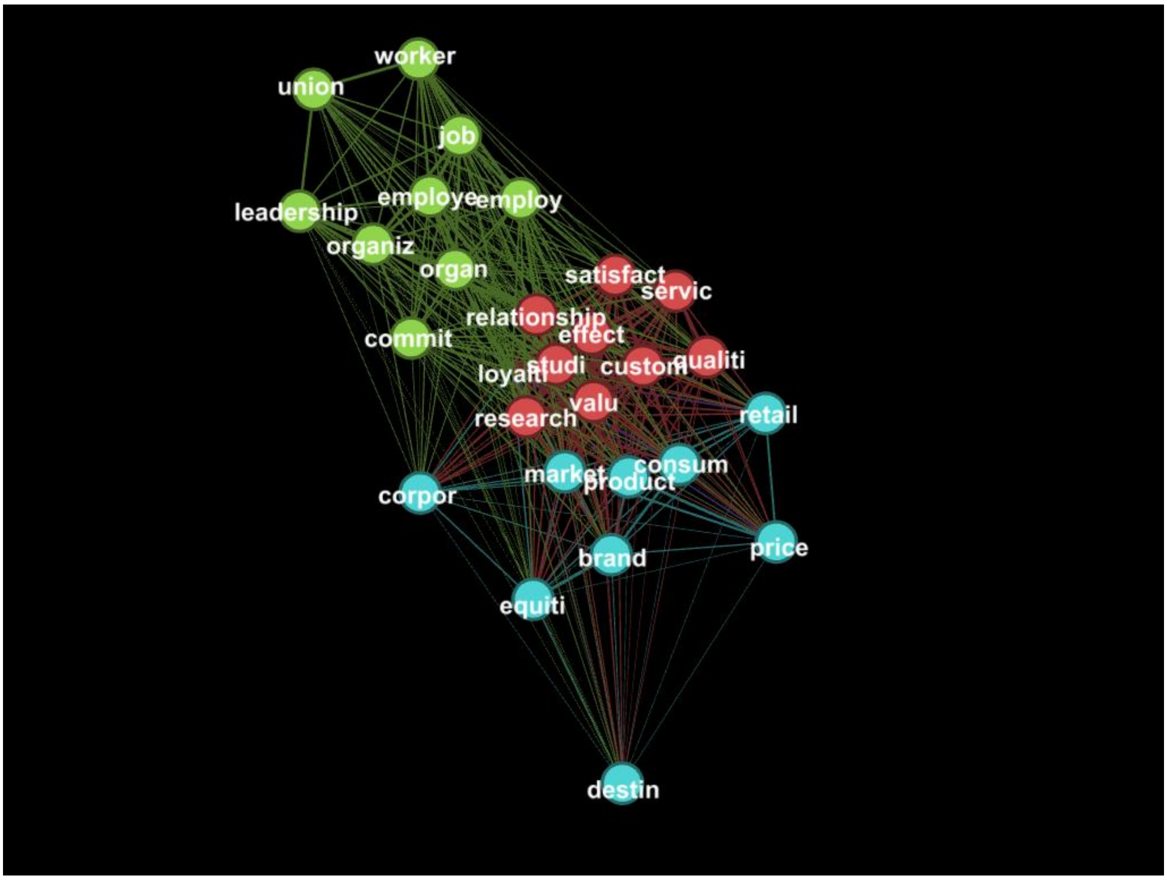
Appendix

A1: Term network map for TS2 with cluster 1 in red, cluster 2 in green, cluster 3 in blue and cluster 4 in pink



A2: Term network map for TS3 with cluster 1 in cyan, cluster 2 in red and cluster 3 in green



A3: Representative journals per cluster indicated by the absolute frequency of the journal in the cluster as well as the relative frequency, i.e., the share of the journal's appearance in the cluster (TS2)

Cluster 1	Absolute	Share
MARKETING SCIENCE	12	0.57
JOURNAL OF MARKETING RESEARCH	10	0.59
JOURNAL OF ECONOMICS & MANAGEMENT STRATEGY	6	1
MANAGEMENT SCIENCE	6	0.75
INTERNATIONAL JOURNAL OF INDUSTRIAL ORGANIZATION	5	1
QME-QUANTITATIVE MARKETING AND ECONOMICS	5	1
Cluster 2	**Absolute**	**Share**
JOURNAL OF BUSINESS ETHICS	19	0.73
INTERNATIONAL JOURNAL OF HUMAN RESOURCE MAN-AGEMENT	9	1
JOURNAL OF APPLIED PSYCHOLOGY	8	0.8
PUBLIC CHOICE	7	1
HUMAN RELATIONS	5	1
BRITISH JOURNAL OF INDUSTRIAL RELATIONS	4	1
Cluster 3	**Absolute**	**Share**
SERVICE INDUSTRIES JOURNAL	36	0.92
JOURNAL OF SERVICE RESEARCH	28	0.85
JOURNAL OF BUSINESS RESEARCH	24	0.57
TOTAL QUALITY MANAGEMENT & BUSINESS EXCELLENCE	20	0.69
EUROPEAN JOURNAL OF MARKETING	19	0.54
JOURNAL OF RETAILING	16	0.57
Cluster 4	**Absolute**	**Share**
TOURISM MANAGEMENT	15	0.65
JOURNAL OF SPORT MANAGEMENT	8	0.89
INTERNATIONAL JOURNAL OF MARKET RESEARCH	7	0.54

A4: Representative journals per cluster indicated by the absolute frequency of the journal in the cluster as well as the relative frequency, i.e., the share of the journal's appearance in the cluster (TS3)

Cluster 1	**Absolute**	**Share**
TOURISM MANAGEMENT	33	0.67
TOURISM ECONOMICS	12	0.8
ACTUAL PROBLEMS OF ECONOMICS	9	0.56
Cluster 2	**Absolute**	**Share**
JOURNAL OF SERVICES MARKETING	60	0.91
JOURNAL OF BUSINESS RESEARCH	53	0.60
AFRICAN JOURNAL OF BUSINESS MANAGEMENT	47	0.68
SERVICE INDUSTRIES JOURNAL	45	0.76
EUROPEAN JOURNAL OF MARKETING	36	0.63
MANAGING SERVICE QUALITY	34	0.97
Cluster 3	**Absolute**	**Share**
INTERNATIONAL JOURNAL OF HUMAN RESOURCE MANAGEMENT	13	0.81
PUBLIC CHOICE	8	1
EUROPE-ASIA STUDIES	5	1
LABOUR HISTORY	4	1
EUROPEAN JOURNAL OF WORK AND ORGANIZATIONAL PSYCHOLOGY	4	1

A5: Selected Documents per TS and Cluster

TS1 Cluster 1

Allaway, A.W., Berkowitz, D., & D'Souza, G. (2003). Spatial diffusion of a new loyalty program through a retail market. Journal of Retailing, 79(3), 137-151.

Baldinger, A.L., Blair, E., & Echambadi, R. (2002). Why brands grow. Journal of Advertising Research, 42(1), 7-14.

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TS1 Cluster 2

Adachi, M.M. (2000). Product market competition in transition economies: Increasing varieties and consumer loyalty. Journal of Comparative Economics, 28(4), 700-715.

Ciarreta, A., & Kuo, C.K. (2002). A supergame-theoretic model with consumer loyalty. Economics Letters, 74(2), 211-217.

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Villas-Boas, J.M. (2004). Consumer learning, brand loyalty, and competition. Marketing Science, 23(1), 134-145.

TS1 Cluster 3

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Die Wurzeln der **Fakultät für Agrarwissenschaften** reichen in das 19. Jahrhundert zurück. Mit Ausgang des Wintersemesters 1951/52 wurde sie als siebente Fakultät an der Georgia-Augusta-Universität durch Ausgliederung bereits existierender landwirtschaftlicher Disziplinen aus der Mathematisch-Naturwissenschaftlichen Fakultät etabliert.

1969/70 wurde durch Zusammenschluss mehrerer bis dahin selbständiger Institute das **Institut für Agrarökonomie** gegründet. Im Jahr 2006 wurden das Institut für Agrarökonomie und das Institut für Rurale Entwicklung zum heutigen **Department für Agrarökonomie und Rurale Entwicklung** zusammengeführt.

Das Department für Agrarökonomie und Rurale Entwicklung besteht aus insgesamt neun Lehrstühlen zu den folgenden Themenschwerpunkten:

- Agrarpolitik
- Betriebswirtschaftslehre des Agribusiness
- Internationale Agrarökonomie
- Landwirtschaftliche Betriebslehre
- Landwirtschaftliche Marktlehre
- Marketing für Lebensmittel und Agrarprodukte
- Soziologie Ländlicher Räume
- Umwelt- und Ressourcenökonomik
- Welternährung und rurale Entwicklung

In der Lehre ist das Department für Agrarökonomie und Rurale Entwicklung führend für die Studienrichtung Wirtschafts- und Sozialwissenschaften des Landbaus sowie maßgeblich eingebunden in die Studienrichtungen Agribusiness und Ressourcenmanagement. Das Forschungsspektrum des Departments ist breit gefächert. Schwerpunkte liegen sowohl in der Grundlagenforschung als auch in angewandten Forschungsbereichen. Das Department bildet heute eine schlagkräftige Einheit mit international beachteten Forschungsleistungen.

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