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A Bibliometric Analysis of Academic Papers on Frugal Innovation

Rajnish Tiwari and Katharina Kalogerakis

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Hamburg University of Technology (TUHH)

Institute for Technology and Innovation Management

Am Schwarzenberg-Campus 4
D-21073 Hamburg, Germany

Tel.: +49 (0)40 42878 3777
Fax: +49 (0)40 42878 2867

tiwari@tuhh.de
www.tuhh.de/tim

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By:

Rajnish Tiwari and Katharina Kalogerakis

Center for Frugal Innovation

Institute for Technology and Innovation Management

Hamburg University of Technology,

Am Schwarzenberg-Campus 4, D-21073 Hamburg, Germany

tiwari@tuhh.de; katharina.kalogerakis@tuhh.de

Abstract

The term "frugal innovation" has established itself in scholarly discourse as well as in actual business practice in a short time. Nevertheless, its theoretical antecedents and underpinnings remain unclear. In this study we present results of a bibliometric analysis, which indicate that the present-day understanding of frugal innovation is shaped primarily by discourses on "bottom of the pyramid", "reverse innovation" and "disruptive innovation" and it has been targeted at "emerging economies". Even though rediscovery of frugality's virtue began in the developing world, it is spreading steadily to the economically developed world due to growing (global) demand for sustainable and affordable excellence. Frugal innovations are often associated with sustainability and development. Today, research on frugal innovations represents a very young and dynamic field: most scholarly publications and many of the references cited therein have been published in the past 5-6 years. Researchers would be, however, well-advised to incorporate insights on frugality and simplicity generated in other disciplines and other times, for example in the 1970s. Our study shows that the research on frugal innovations needs to take a calibrated, multidisciplinary approach.

Acknowledgements

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1. Introduction

The term "frugal innovation" has established itself in the scholarly discourse in a relatively fast manner. Whereas this term was almost unknown about 6 years back with only 11 entries on Google Scholar in 2009, the number of relevant entries on Google Scholar increased to 1,340 by the end of April 2016. However, so far most researchers have concentrated on understanding/defining the phenomenon while trying to identify its relevance for businesses in the context of unserved consumers in emerging economies (Tiwari and Herstatt, 2012; Radjou and Prabhu, 2015; Ramdorai and Herstatt, 2015) and sometimes also in the context of industrialized economies (Bound and Thornton, 2012; Tiwari and Herstatt, 2013; Universe Foundation, 2013). Works providing theoretical underpinnings have been limited (see, e.g., Bhatti, 2012; Tiwari and Herstatt, 2014; Zeschky, Winterhalter, and Gassmann, 2014) chiefly for two reasons: (a) the research is in a nascent stage so that there is necessarily an effort to, at first, comprehend the relevance of the phenomenon and to create a definitional framework, and (b) any attempt to assess theoretical antecedents and provide theoretical underpinnings requires a critical mass of published scholarly articles. In the absence of a deeper understanding of the root causes of frugal innovation and its underlying mechanisms there is considerable uncertainty over its novelty, partly arising from its similarity to many existing terms, such as Jugaad, low-cost innovations, or reverse innovation, to refer to (dis-)similar phenomena (Tiwari and Herstatt, 2014; Zeschky *et al*, 2014), and regarding their longevity (Bhatti and Ventresca, 2012), in the face of increasing disposable incomes in the developing world.

This study seeks to analyse the by-now-noteworthy body of scholarly publications, which enables a study of the state-of-the-art. We conduct a bibliometric analysis (van Raan, 1988; De Bellis, 2009) of the academic discussion of frugality in the specific context of innovation management, since bibliometric indicators can provide very useful and facts-based insights into "influence and specializations" of researchers and into "processes of knowledge dissemination" (van Raan, 1996: 417) going beyond peer judgement that is often subjective (Moed, Burger, Frankfort, and van Raan, 1985) and going beyond Journal Impact Factors because over-generalization and a shorter calculation period makes them a "poor measure to assess the true merit of a particular article" (Hunt, 2011: 80).

For the purpose of bibliometric analyses a database of all available, published scholarly articles in English language containing the term "frugal innovation" or "frugal innovations" was created. After filtering out irrelevant and redundant articles various bibliometric analyses were performed, including a citation analysis of peer-reviewed journal articles (Gmür, 2003), with the purpose of

identifying the most important sources of scholarly influence (cf. Nerur, Rasheed, and Natarajan, 2008; Schweisfurth, 2012; Raasch, Lee, Spaeth, and Herstatt, 2013). The combination of the two research approaches was considered useful as citation analysis is known to lead to better results when flanked by a corresponding content/discourse analysis (van Raan, 1998). Our results are potentially significant for researchers, business managers and other relevant stakeholders such as policy-makers as they reveal which aspects can influence the acceptance of frugal products and services in a given business or social context.

This paper is structured as follows: after an introduction section 1, section 2 describes the research approach. Section 3 presents the results of our bibliometric analysis of academic literature on frugal innovation. The paper concludes with a summarizing discussion in section 4.

2. Research approach

The research framework for the bibliometric analysis draws on prior works by Schweisfurth (2012) and Tiwari (2013). As a first step, a database of all published scholarly articles related to the theme of frugal innovation was created. For this purpose an extensive desk research was conducted on 4 publication catalogues, i.e. Google Scholar, Web of Science, EbscoHost and GVK Plus. Various combinations of the terms “frugal”, “frugality” and “frugal innovation” and their synonyms were used, as is described in Table 1. The search led to identification of 513 relevant, non-redundant academic publications as of April 15, 2016.

Category		Definition
A	A1	“frugal innovation” or “frugal innovations” or both words “frugal” and “innovation” separately appear in title, abstract or keyword
	A2	“frugal engineering” or both words “frugal” and “engineering” separately appear in title, abstract or keyword
B	B1	“frugal innovation”, “frugal innovations” (or German synonym) appears in the article text, even if it is only a side topic
	B2	“frugal engineering” (or German synonym) appears in the article text, even if it is only a side topic
C		Related topics are dealt with: Innovating for emerging economies, innovating for poor/ price-sensitive customers -> “reverse innovation”, “jugaad”, “low cost innovation”
D		Further relevant topics: e.g. “frugality”, “resource constraints”…

Table 1: Categories of search terms employed for creating the literature database

The database was designed in a way to allow a bibliometric meta-analysis. Each article was assigned a unique identification code (ID). Names of the author(s), title, publication year, publication type, source, issue & page nos., availability, language and the supplied keywords were captured in the database. Two fields were created to hold yes/no values for the questions, whether the publication was published in a source that can be broadly categorized as related to the field of management/social sciences, and whether that source was a peer-reviewed medium. In a second step, the articles were assigned to one of the 4 possible categories. The first two categories had two sub-categories each to better reflect the composition of the database, see Table 1.

For the purpose of the bibliometric analysis we selected all English-language, scholarly articles (journal articles, conference papers and book chapters in non-self-edited volumes) belonging to category A1 and A2 that were peer-reviewed and published in a medium related to the field of management or social sciences. These filters narrowed down the relevant sample to 73. One of the articles could not be obtained, so that the final sample size of the relevant dataset was 72.

For all of these articles their complete list of cited references was keyed-in in a new database. This database consisted of a "Citing Source ID", a unique "Cited Source ID", and other bibliographic details (title, source and the publication year) of the cited reference. Two yes/no fields were created to keep track of publications with multiple references and their uniqueness. The final citation dataset consisted of 3.329 cited references including redundancies caused by multiple references to a single publication. For normalisation of data, obvious (mostly typographical) mistakes in citations were rectified. Varying editions of the same publication were unified to the year of the first edition, for example references to the various editions of Prahalad's book *The Fortune at the Bottom of the Pyramid* were treated as published in 2004.

3. Results of the bibliometric analysis

3.1 Descriptive Analysis

The dataset of citing sources consisted of 72 unique papers, of which 52 were journal articles, 13 conference papers, and 7 book chapters. The earliest article in the dataset was published in 2010. A majority of articles (62) was published in 2013 or later.

The 52 journal articles were published in 42 journals signalling a wide thematic spread. The journals were predominantly new or non-top ranked, therefore, probably more open to a new, emerging topic. The *Journal of Indian Business Research* had published 4 of the articles, whereas *Asia Pacific Journal of Management, Innovation and Development, Journal of Frugal Innovation,*

Journal of Technology Management for Growing Economies, *Research Technology Management*, *Sustainability*, and *Technovation* had published 2 articles each. All in all, the names of the 42 journals suggest a strong connection to issues related to the emerging economies, social development and sustainability.

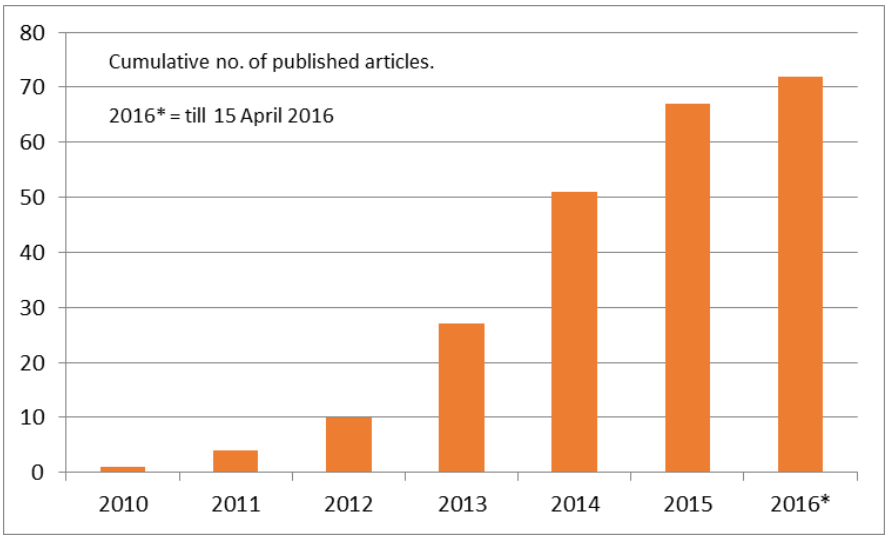

Figure 1: Cumulative number of published articles on frugal innovation

Fifty-one of the 72 papers had explicitly supplied a list of keywords with their paper. These numbered 276 including multiple listings. After condensing keywords (e.g. merging "Base of the Pyramid", "Bottom of the Pyramid" and "BOP Market" into a single "Bottom of the Pyramid") the above picture of the 10 most-often mentioned keywords emerged. The most important keywords shown in Table 2 seem to confirm the impression created by the journal titles regarding the predominant scope of research related to frugal innovations, so far.

Rank	Keyword (condensed)	Times cited	Percentage (n=51)
1	Frugal Innovation	40	78.4%
2	Innovation	14	27.5%
3	Bottom of the Pyramid	13	25.5%
4	Emerging Markets	11	21.6%
5	Sustainability	10	19.6%
6	India	9	17.7%
7	Jugaad	8	15.7%
8	Reverse Innovation	8	15.7%
9	Disruptive Innovation	5	9.8%
10	Low-cost Innovation	5	9.8%

Table 2: Most-often cited keywords in publications on frugal innovation

For a bibliometric analysis it seems interesting to look beyond the individual publications and to examine who the scholars are that have published most-widely on this theme and therefore, as a reasonable assumption, to some extent have shaped this research field. The 72 papers in the dataset were written by 130 scholars (natural persons), 21 of these were authored by a single author, and 27 by two authors. The rest had 3 or more authors. Marco Zeschky (4), Rajnish Tiwari (3), Alexander Brem (2), Nivedita Agarwal (2) and M. Pansera (2) were amongst those first or individual authors, who contributed more than one paper to the dataset. Oliver Gassmann (5), Alexander Brem (3), Cornelius Herstatt (3) and S. Winterhalter (3) contributed most often as co-authors. Involvement by a large number of researchers in this relatively new field may be interpreted as a sign of its growing appeal and attractiveness for both established as well as young scholars.

Turning our attention to the citation database, we monitored a total of 3,329 references cited by these 72 papers. Of these, 2,444 were unique entries, 325 of which were cited by more than one paper, whilst the rest was cited only once in the whole dataset. These 325 references were cited altogether 1,210 times.

Rank	Cited Source	Times Cited	Percentage (n=72)
1	(Prahalad, 2004)	29	40.3%
2	(Immelt, Govindarajan, and Trimble, 2009)	28	38.9%
3	(Prahalad and Mashelkar, 2010)	26	36.1%
4	(Radjou, Prabhu, and Ahuja, 2012)	25	34.7%
5	(Zeschky, Widenmayer, and Gassmann, 2011)	25	34.7%
6	(Govindarajan and Trimble, 2012)	19	26.4%
7	(Economist, 2010)	18	25.0%
8	(Christensen, 1997)	17	23.6%
9	(Hart and Christensen, 2002)	17	23.6%
10	(Bound and Thornton, 2012)	14	19.4%

Table 3: Top-10 cited publications in the citation database

As Table 3 shows, Prahalad's book *The Fortune at the Bottom of the Pyramid* was the most-cited publication in the citation dataset. The set is dominated by works that can be broadly categorized as the "Bottom of the Pyramid" (Prahalad, 2004; Prahalad and Mashelkar, 2010), "reverse innovation" (Immelt *et al*, 2009; Bound and Thornton, 2012; Govindarajan and Trimble, 2012), "disruptive innovation" (Christensen, 1997; Hart and Christensen, 2002; Immelt *et al*, 2009) and Jugaad (Radjou *et al*, 2012). Additionally, it shows that most works are centred on emerging economies. Bound and Thornton's work (2012) is the only one amongst the top-10 that explicitly deals with the "frugal future" of the industrialized world. Another interesting point is that with exception of Zeschky (2011) all other top-cited works were not published in an academic journal, but in business magazines, semi-academic journals or as books/reports. This is, probably, an indicator for frugal innovation being a "grassroots" phenomenon.

Since individual publications do not provide a complete overview of an author's overall contribution to a given field, we decided to check the contribution of individual scholars (natural persons) in their capacity as first authors of the cited works (see Table 4).[1]

[1] Our database did not contain the names of co-authors of cited references. Therefore, it was not possible to capture

Rank	Cited as First Author	Times Cited	Citation Frequency (per paper; n=72)
1	C.K. Prahalad	85	1.18
2	Vijay Govindarajan	61	0.85
3	Clayton M. Christensen	49	0.68
4	Anil K. Gupta[2]	44	0.61
5	Navi Radjou	40	0.56
6	Marco Zeschky	32	0.44
7	Jeffrey Immelt	28	0.39
8	Rajnish Tiwari	24	0.33
9	Ted London	23	0.32
10a	Alexander Brem	21	0.29
10b	Stuart Hart	21	0.29

Table 4: Top-10 cited first authors (natural persons) in the citation database

As Table 4 shows, the late C.K. Prahalad wields an overarching scholarly influence. In purely statistical terms, more than one of his works gets cited in every single paper on frugal innovation. Vijay Govindarajan (reverse innovation), Clayton Christensen (disruptive innovation), Anil Gupta (grassroots innovation) and Navi Radjou (Jugaad) were the most cited first authors confirming the role of BOP, reverse innovation, disruptive innovation and Jugaad as the most influential streams of thought in the development of frugal innovation research. Interesting to note is also that Marco Zeschky, Rajnish Tiwari and Alexander Brem are the only three authors among the top-10 that are represented in both the citing and the cited datasets and can be thus seen as having played an *active* role, so far, in explicitly shaping the development of research on frugal innovations; especially in the light of the fact that authors like Prahalad, Govindarajan and Christensen have not explicitly dealt with the term "frugal innovation" in their publications.

Another indicator that we investigated was the publication year of the cited sources. This investigation (Figure 2) provided a very interesting result. Close to 84% of all cited sources for

the complete picture by including co-authored works.

[2] Despite our efforts there might still be some redundancies, at this stage, in results for Anil K. Gupta due to similarity in surname with some other researchers in the dataset.

which the publication year was available (n=3288) were published since 2000. Moreover, 45.7% of all cited sources were published in the past five years since 2010. Only 25 references (0.7%) were made to publications published till the end of 1950s. This shows that this new field, in turn, is itself rather heavily influenced by recent developments in business and research, probably creating a virtuous self-reinforcing cycle.

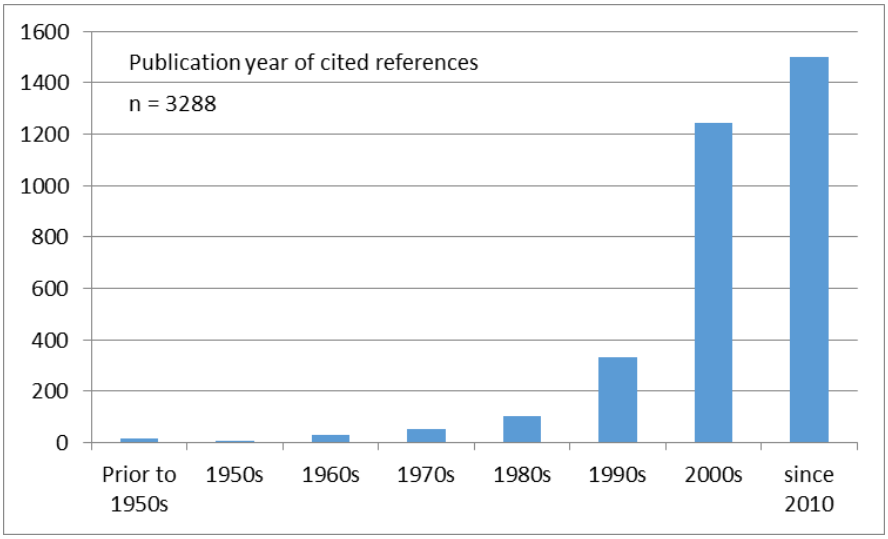

Figure 2: Publication year of cited references

3.2 Co-Citation Analysis

Only those articles that were cited at least 3 times within the sample were included in the co-citation analysis. This left us with 142 often-cited references ("nodes") and 9,134 links interconnecting these nodes.

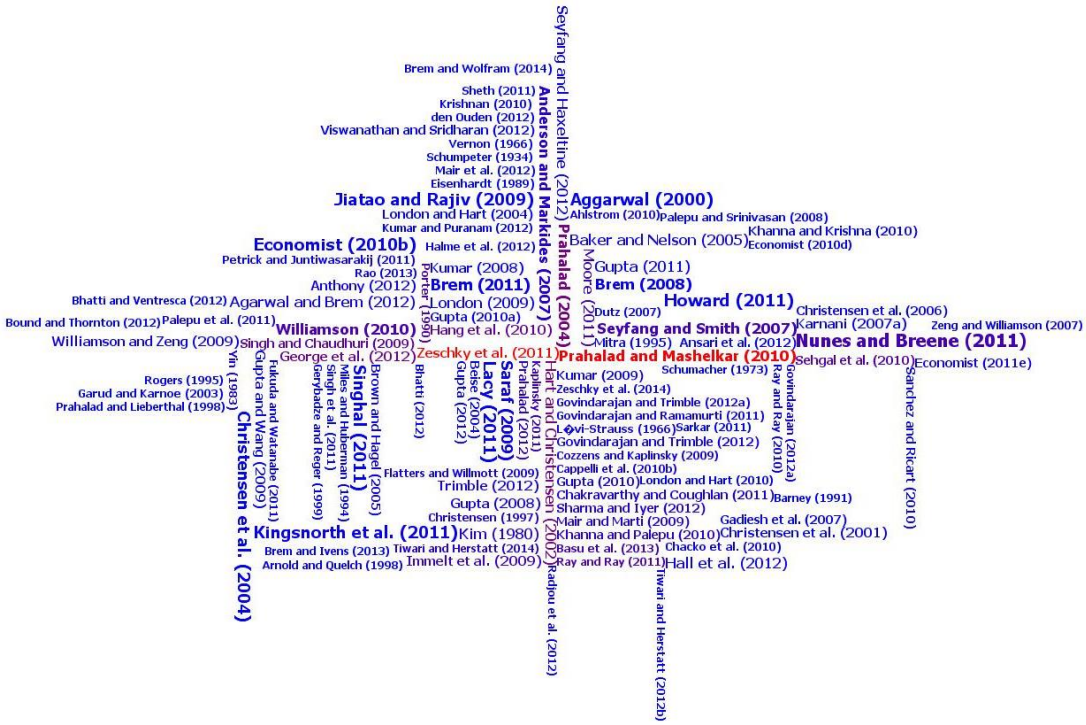

Figure 3: A "node cloud" of the co-citation network

The co-citation analysis was run on the basis of the CoCit-Score that "sets the co-citation count in relation to the minimum and mean counts of the two individual citations" and is generally evaluated as a robust measure (Gmür, 2003). The resulting 142x142 CoCit-Score matrix provided the input for further software-based visualization and analysis with a test-version of ORA-NetScenes (Carley, 2016). We applied a CoCit threshold of 0.3 to identify relationships within the network. Once the option "Recursively Hide Pendants and Isolates" was chosen for visualization purpose, the meta-network was left with 114 nodes and 960 interconnecting links (see Figure 3). The analysis, unless specified, remains based on 142 nodes.

We applied CONCOR algorithm (Breiger, Boorman, and Arabie, 1975; Riviera, 2012: 80 p.) to identify structural similarity amongst papers and to visualize these groups by different colours. The CONCOR function in ORA groups nodes together "if they are connected to similar nodes"(Carley, 2016). This algorithm has been often used in social sciences, especially with the purpose of conducting content/discourse analysis (see, Almeida and Jorge, 2013).The number of "CONCOR splits" (n) was set at 2, restricting the number of maximum possible groups at 2^n = 4. The following picture consisting of 4 groups emerged, once these measures were applied:

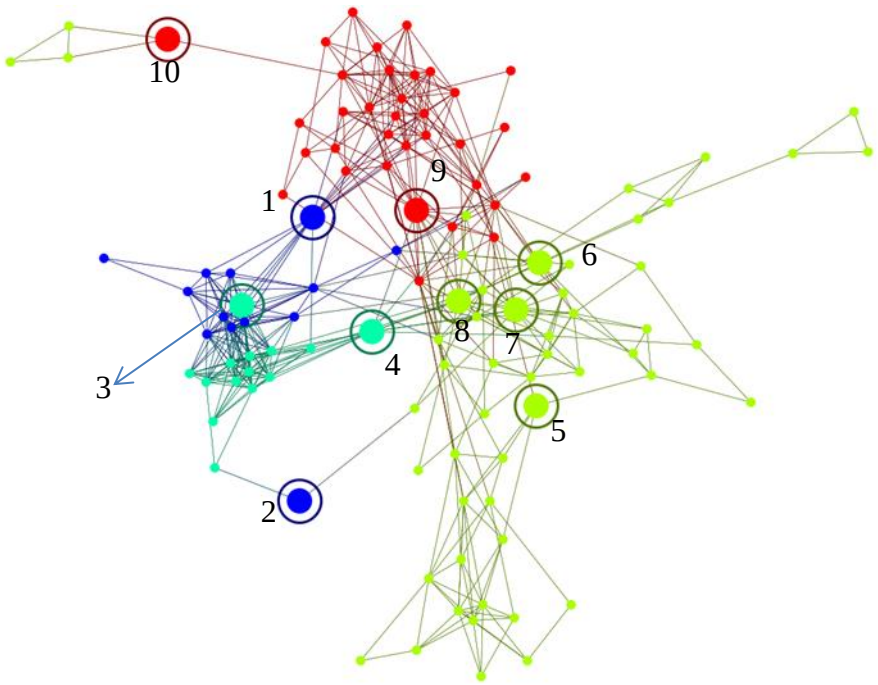

Figure 4: Co-citation meta-network of academic literature

The blue-colored group (Group 1; CONCOR = 1) consists of 13 nodes. Two notable publications in this group are depicted by Circles 1 (Seyfang and Smith, 2007) and 2 (Brem and Ivens, 2013) that provide important connection to other groups. The bright-green colored group (Group 2; CONCOR = 2) consists of 14 nodes and is closely connected to Group 1. Two important connections to other groups are characterized by circled nodes 3 (Brem, 2009) and 4 (Hang, Chen, and Subramian, 2010). The largest, light-green-colored group (Group 3; CONCOR = 3), has 54 elements (nodes). The circled node 5 (Palepu, Anand, and Tahilyani, 2011) represents an interlinkage between sub-clusters of this large group; whereas node 6 (Ray and Ray, 2011) is the interlinkage within this group to the boundary spanners. Circles nodes 7 (Immelt *et al*, 2009) and 8 (Williamson, 2010) provide valuable intra- and inter-cluster links. Finally, the red colored group (Group 4; CONCOR = 4) has 34 nodes. Two notable publications here seem to be circled nodes 9 (Prahalad, 2004) and 10 (Kaplinsky, 2011). While node 9 connects Group 3 to Group 4, node 10 depicts a boundary spanner to the discourse on "appropriate technologies". In the following, we briefly outline some further interesting results of the citation analysis.

Top-ranked Publications

The analysis identified 10 top-ranked publications. Figure 5 shows the nodeset that was repeatedly top-ranked in 45 different node-level measures. The value shown is the percentage of

measures for which the respective node was ranked in the top-3. There are some surprising results, like the best-ranked Aggarwal (2000), who was not visible earlier.

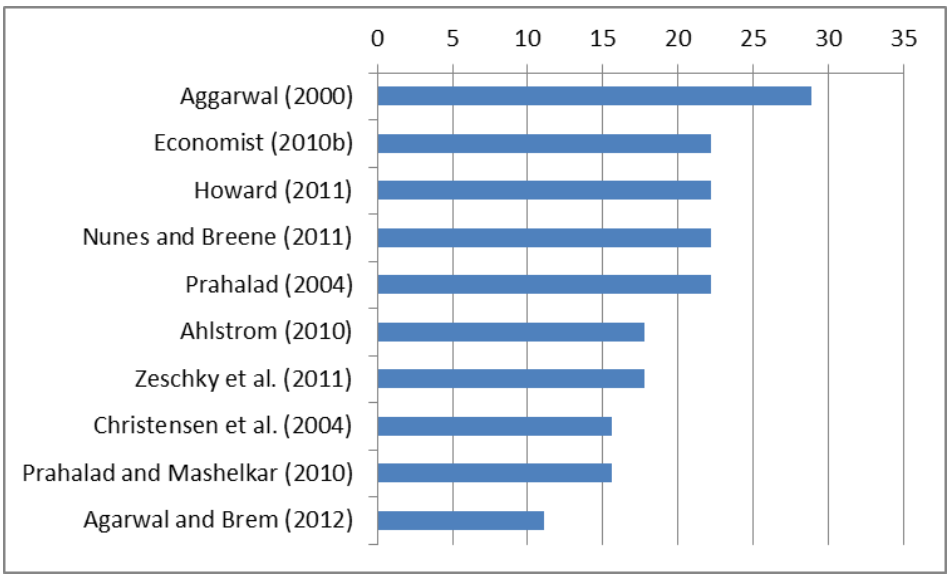

Figure 5: Bibliometrically top ranked co-citation nodeset

Structural Holes

Structural holes connect nodes that would otherwise remain disconnected (see, e.g. node D3 in Figure 6); and thus enable access to knowledge and resources from diverse fields (Tan, Mookerjee, and Singh, 2007).

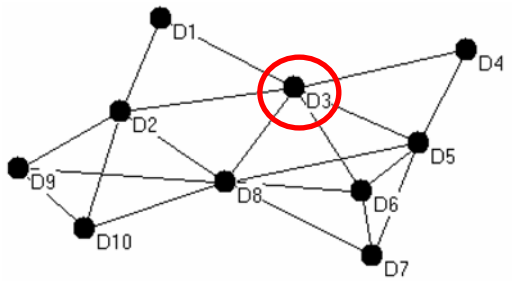

Figure 6: Depiction of a "structural hole" in a social network[3]

"The structural holes view", according to Tan *et al* (2007: 2), "emphasizes a team member's abilities to access a wide range of information, resources or perspectives as a key factor for efficient

[3] Source: Tan *et al* (2007: 4)

team performance". In our case structural holes depict those works that have connected different streams of research and channelized them into the scholarly discourse on frugal innovation. Two works by the late C.K. Prahalad (Prahalad, 2004; Prahalad and Mashelkar, 2010) emerged as the most valuable sources of interlinkages. Both of these works have emerged as the foremost connections between themes as diverse as BOP, corporate strategy, international business, and innovation management with frugal innovations. The top-10 structural holes are shown in Table 5 and Figure 7.

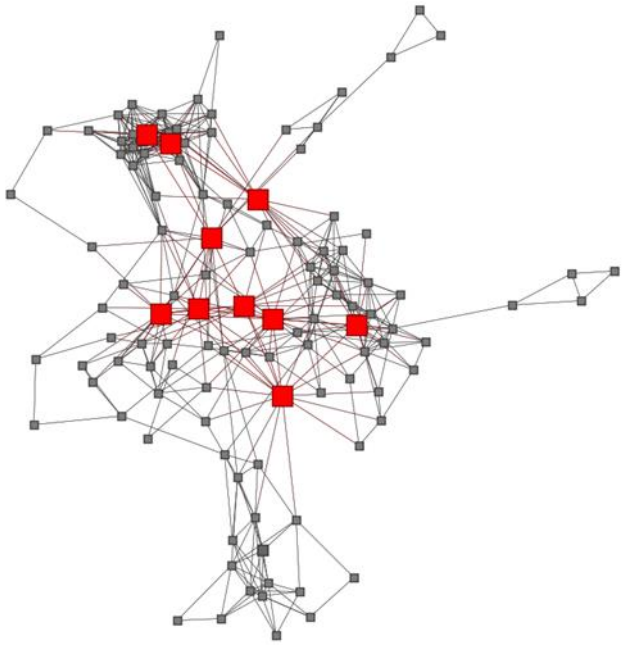

Figure 7: Depiction of actual Structural Holes in the visualized network

As against brokers, they do not necessarily connect complete clusters but only nodes (compare Figure 7 and Figure 8). However, individual nodes can also have both functions. For example Zeschky et al (2011) has been identified as top-3 structural hole and top-9 Broker in this analysis.

Serial No.	Key Publication(s)	Achieved Value
1	(Prahalad, 2004)	15.855
2	(Prahalad and Mashelkar, 2010)	15.562
3	(Zeschky *et al*, 2011)	13.486
4	(Anderson and Markides, 2007)	13.042
5	(Williamson, 2010)	12.711
6	(Hart and Christensen, 2002)	12.408
7	(Seyfang and Smith, 2007)	11.761
8	(Nunes and Breene, 2011)	11.252
9	(Immelt *et al*, 2009)	10.659
10	(Howard, 2011)	10.628

Table 5: Top-10 publications as "Structural Holes"

(Measures for "Structural Holes – Effective Network Size";
overall values: Min: 1; Mean: 5.628; Max: 15.855; Std.dev: 3.393)

Brokerage

Brokers can be understood as those individuals that provide linkage to different *clusters* and can help transfer knowledge from one domain to other (Burt, 2005; Nerur *et al*, 2008; Kalogerakis, 2010). Brokerage, therefore, "brings different research communities together, spurring cross-fertilization of ideas and theoretical innovation" (Nerur *et al*, 2008: 332). Table 6 shows the top-10 publications with brokerage functions, while Figure 8 depicts these "Brokers" in the actually visualized network.

Serial No.	Key Publication(s)	Achieved Value
1	(Ahlstrom, 2010)	1.000
2	(Arnold and Quelch, 1998)	1.000
3	(Barney, 1991)	1.000
4	(Brem and Ivens, 2013)	1.000
5	(Prahalad and Lieberthal, 1998)	1.000
6	(Porter, 1990)	0.933
7	(Ray and Ray, 2011)	0.900
8	(Yin, 1983)	0.900
9	(Zeschky *et al*, 2011)	0.857
10	(Ray and Ray, 2010)	0.833

Table 6: Top-10 publications with "brokerage" function

(Overall values: Min: 0; Mean: 0.500; Max: 1; Std.dev: 0.254)

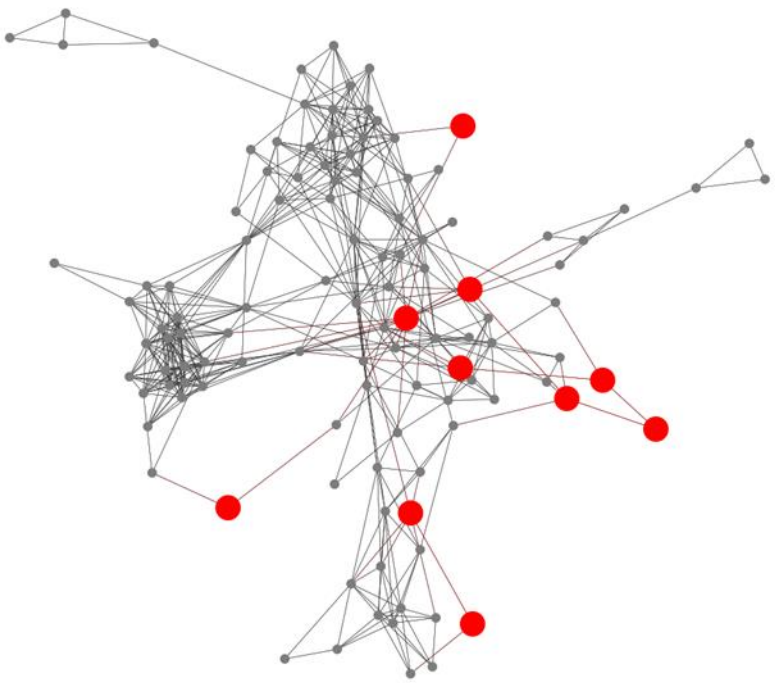

Figure 8: Depiction of Brokers in the visualized network

Clusters and schools of thought

Successively increasing the CoCit-threshold to display interrelated links leads to identification of clusters within the meta-network and thus to revelation of schools of thought (Schweisfurth, 2012). At a threshold of 0.5 and after blending away isolates and pendants the following picture of 4 clusters consisting of 37 nodes emerged:

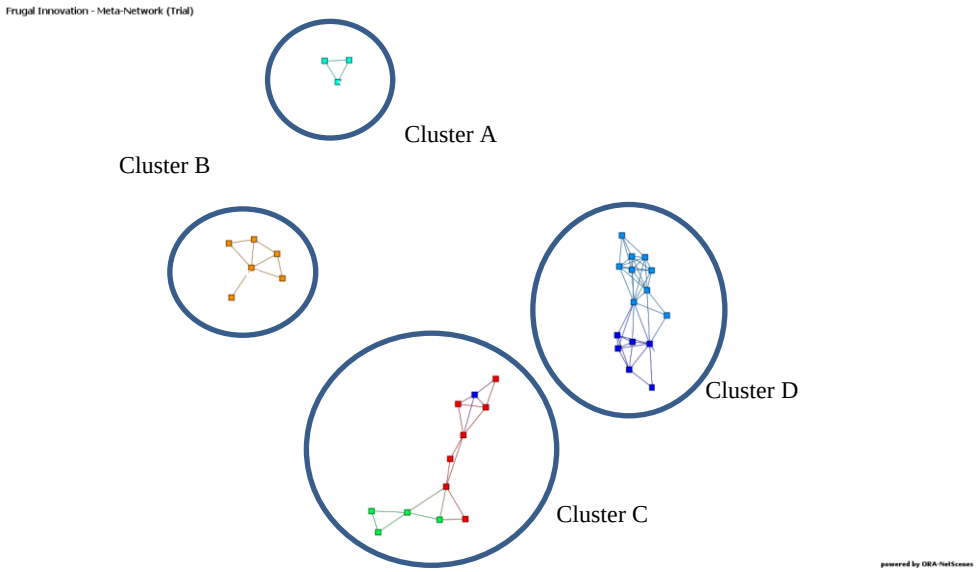

Figure 9: Identified clusters and schools of thought

The composition of the clusters and their preliminary attributes, based on an analysis of publication titles, are described in Table 7. Also these results help us get a differentiated view of the antecedents of frugal innovation.

Cluster A "Emerging Markets as Lead Markets"	**Cluster B** "Value creation in low-income markets"	**Cluster C** "Innovations in emerging economies"	**Cluster D** "Innovations for BOP markets & social change"
(Beise, 2004)	(Gadiesh, Leung, and Vestring, 2007)	(Anderson and Markides, 2007)	(Agarwal and Brem, 2012)
(Chakravarthy and Coughlan, 2011)	(Miles and Huberman, 1994)	(Ansari, Munir, and Gregg, 2012)	(Aggarwal, 2000)
(Singh and Chaudhuri, 2009)	(Sánchez and Ricart, 2010)	(Baker and Nelson, 2005)	(Brem, 2011)
	(Vernon, 1966)	(Christensen, Craig, and Hart, 2001)	(Brown and Hagel, 2005)
	(Williamson, 2010)	(Christensen, Baumann, Ruggles, and Sadtler, 2006)	(Christensen, Anthony, and Roth, 2004)
	(Williamson and Zeng, 2009)	(Gupta, 2012)	(Economist, 2010b)
		(Hall, Matos, Sheehan, and Silvestre, 2012)	(Gupta, 2011)
		(Kim, 1980)	(Howard, 2011)
		(Levi-Strauss, 1966)	(Jiatao and Kozhikode, 2009)
		(London and Hart, 2004)	(Kingsnorth, Tongaonkar, and Awojobi, 2011)
		(Seyfang and Haxeltine, 2012)	(Kumar, 2008)
		(Seyfang and Smith, 2007)	(Lacy, 2011)
			(Moore, 2011)
			(Nunes and Breene, 2011)
			(Saraf, 2009)
			(Singhal, 2011)

Table 7: Composition of the identified clusters

Boundary spanners

The analysis identified five boundary spanners: Basu et al. (2013), George et al. (2012), Kaplinsky (2011), Tiwari and Herstatt (2014) and Zeschky et al. (2011) as depicted in Figure 10.

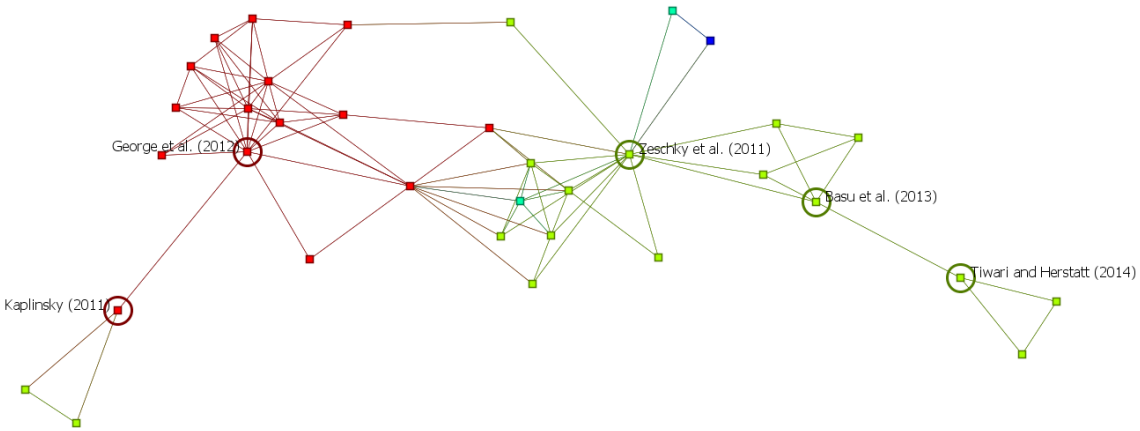

Figure 10: Boundary Spanners

Boundary spanners are sometimes also called gate keepers and link different research streams (Schweisfurth, 2012). If a boundary spanner is removed from the network, new components would be created (Carley, 2016). The presence of 5 boundary spanners suggests that this research field is still very dynamic and new streams are being added. For example, Tiwari and Herstatt (2014) look into the emergence of lead markets in developing countries leading to spread of frugal innovations into developed economies. Together with the two associated nodes Bound and Thornton (2012) and Rogers (1995), they represent "pushing the envelope" beyond emerging economies. Similarly, Kaplinsky (2011) can be seen as reconnecting the frugal innovation literature with the discourse on "appropriate technologies" propagated by Schumacher (1973), which has surprisingly been rather neglected in the discussion of frugal innovation so far.

3.3 Discussion of Results

The bibliometric analysis has helped in generation of some very useful insights about the phenomenon of frugal innovations. It has, first of all, demonstrated that it is not only a new and emerging, but also an intensely dynamic, field of research involving a large body of both young and established researchers. The articles are being published in thematically wide-spread journals, suggesting a possible megatrend in the offing.

Within management sciences the frugal innovation phenomenon has its key-roots in 3 different

and relatively recent streams of scholarly discourse, i.e. “bottom of the (economic) pyramid”, “reverse innovation”, and “disruptive innovation”. Not surprisingly, the top-3 most-cited authors in the collected data sample were C.K. Prahalad, Vijay Govindarajan, and Clayton Christensen. The analysis also shows that research on frugal innovation has been predominantly contextualized for emerging economies, especially India.

This, however, seems to be changing as new clusters of intellectual influences involving young researchers are emerging that see the relevance of frugal innovation extending beyond merely selling to the poor or low-income consumers in the developing world. The analysis on boundary spanners showed that the emphasis on appropriateness of solutions in conjunction with resource-efficiency and effectiveness is increasing. This is a good sign because, so far, as the analysis revealed, the research had taken little note of the valuable work by scholars such as Ernst Friedrich Schumacher in the 1970s: only 7 papers explicitly referred to his seminal work *Small is Beautiful* (1973) on the need for “appropriate” solutions.

3.3 Limitations and further research

Certain limitations arise for the present study because the phenomenon under investigation is still under formation. Most publications in our sample date between 2013 and 2016. Distinct research clusters are still evolving and the available dataset is rather small. In addition, bibliometric analyses are ex-post enquiries and their ability to predict the future must be regarded as limited. A co-citation analysis, even though undoubtedly very useful in tracing theoretical antecedents and in identifying schools of thought, does not capture the intensity of the interrelation between two works, e.g. how many times a reference was cited within a work; nor does it take into account whether the reference was used as a positive source of influence or rather for a critique.

Nevertheless, the effects of these limitations could be mitigated to some extent by incorporating the literature review on frugality, so that the results could be juxtaposed. Since the findings of the two subsets are essentially in alignment with each other, we may reasonably presume the overall findings to be largely free of serious errors. One area, where there is a notable difference between findings of the literature review and the descriptive analysis on the one hand and of the co-citation analysis on the other is the issue of top-ranked publications. In future research we hope to find out the reasons underlying this difference. We also intend to conduct more research to analyse and better comprehend the 4 clusters of influence that have been crystallised by the citation analysis and to comprehend their connection to the 4 groups of influences identified in the CONCOR analysis. At this juncture, it also seems promising to increase the number of groups within the CONCOR

analysis from current 4 to the next possible level (2^3=8), as at present 2 of the groups are very large and at least Group 4 shows signs of encompassing sub-clusters.

4. Conclusion

The aim of this study was to investigate the theoretical base and antecedents of frugal innovations in the mirror of scholarly discourse. For this purpose, we conducted a literature review to examine the role of frugality in the field of political economy and other disciplines connected to innovation management. One objective was to examine how frugality was regarded in the past so as to assess its prospects for longevity. This review was supplemented by bibliometric analyses including a co-citation analysis. The investigation has revealed that frugal innovations represent a new, emerging field of research; most publications have been published since 2013 and an overwhelming majority of the cited references have been published since the turn of the millennium.

So far, the discourse on frugal innovations has been predominantly shaped by research in the context of emerging economies. As the co-citation analysis revealed, frugal innovations have been often seen as disruptive innovations, targeted at the bottom of the pyramid or low-income consumers. It is only slowly that their potential in the markets of the economically developed world is being recognized. But the impressively growing body of literature and the enjoinment of various, new streams indicate that frugal innovations are poised to get into a bigger role in the future. They offer a measure against unnecessary technological complexity and reduce utilization of precious resources. This means, there is an in-built sustainability component in frugal innovations, which turns them into “responsible innovations”. The study also shows that research on frugal innovations needs to take a multidisciplinary approach by incorporating elements from other related streams such as sociology, psychology and engineering sciences. Only an integrated framework can help in working out critical success factors for frugal innovations (a) during implementation in new product development processes in firms, (b) for acceptance by consumers and business customers, and (c) for ensuring the requisite support by other relevant societal stakeholders.

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