

An Empirical Study on the Knowledge Structure and Hotspot Mapping of Reverse Innovation Based on VOSviewer Software and Big Data

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Abstract. From the aspects of annual publications, journals and cited literatures, this paper uses content analysis and bibliometric analysis to study the papers on reverse innovation collected in Web of Science database from 2008 to 2020. Based on VOSviewer software and Big data, this paper research data processing and data visualization aiming at reverse innovation, summarizes the development status of reverse innovation research in foreign countries, and puts forward suggestions for further development of reverse innovation research in Chinese management research from two aspects of multi-factor scenario application and main role switch.

Keywords. VOSviewer, Big data, Reverse innovation, visualization.

1. Introduction

Reverse innovation is a concept proposed by GE CEO Immelt, TUCK School of Business professor V. Govindarajan, and Trimble. They illustrate the reverse innovation process using a portable imager developed by GENERAL Motors in China as an example [1]. Traditionally, a trickle down of innovation trickle down to the developing world after innovation is done in developed countries. The process of portable imaging innovation is the opposite. First in emerging markets, it trickled down to other emerging markets and even "trickling up" to developed markets [2]. After the concept was put forward, how to effectively use "reverse innovation" and break through the constraints has become the focus of attention from all walks of life. In view of this, by applying VOSviewer software and Big data, this paper research data processing and data visualization aiming at reverse innovation, the WOS database since 2008 released by the literature of reverse innovation as the research object, through literature metrology tools VOSviewer visual chart analysis, the number of published research object, research topic, and statistical analysis methods such as data source, shows the basic development of the reverse innovation research, This paper

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summarizes the frontier directions and potential research topics of reverse innovation, and provides scientific reference for the research of reverse innovation.

2. Sample Selection

The index library in the latest Web of Science core collection is selected and subject retrieval is applied. The retrieval formula is TS=(Reverse innovation), and the time span of the literature is defined. The retrieval date is 2008-01-01 to 2021-12-11. A total of 1895 valid papers were obtained.

2.1. Analysis of Overall Growth Trend

From 57 articles in 2008 to 223 in 2021, there is a small step increase in the number of articles published in 2014. In general, there is a stable trend of positive linear growth, and its R^2 of regression fitting is 0.9563, which is highly representative. The number of articles published in 2021 will maintain a rising trend, with an increase of 8% compared with that in 2020 (see figure 1).

This data illustrates the fact that the influence of reverse innovation research in the academic world is steadily increasing. The possibility of this trend lies in the influence of economic globalization, adjustment of industrial structure layout, international division of labor, scientific and technological innovation and progress, etc. Reverse innovation does not simply feed back home enterprises, as Xing et.al (2016) indicate that "Reverse innovation represents the transformation of enterprise innovation concept and mode in the new stage of globalization, and has important strategic value and significance for both multinational corporations and local enterprises" [3].

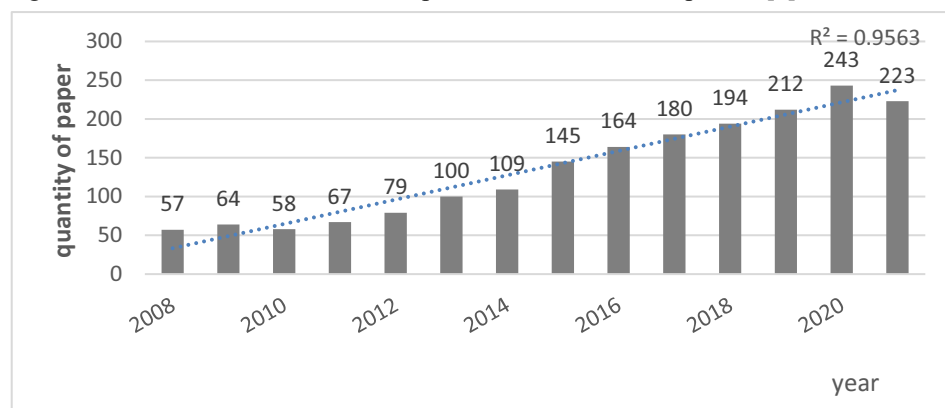


Figure 1. Statistics of the number of published literatures in each year.

2.2. Research Field Analysis

When analyzing the search data, the top ten journals with the most reverse innovation literature published in THE WOS database were selected. As can be seen from the statistical data in table 1, the top ten foreign journals only account for 13.298% of the total, which means that the literature distribution of publishing reverse innovation

literature is scattered and not stable, and the core research direction is still enterprise influence.

Table 1. The top ten journals publishing the most reverse innovation literature.

Journal name	Literature quantity	Proportion (%)
ANTIOXIDANTS REDOX SIGNALING	60	3.166
JOURNAL OF CLEANER PRODUCTION	46	2.427
SUSTAINABILITY	34	1.794
GLOBALIZATION AND HEALTH	22	1.161
ADVANCES IN SOCIAL SCIENCE EDUCATION AND HUMANITIES RESEARCH	18	0.95
TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	16	0.844
RESEARCH POLICY	15	0.792
DESALINATION	14	0.739
HARVARD BUSINESS REVIEW	14	0.739
DESALINATION AND WATER TREATMENT	13	0.686
Total	252	13.298

2.3. Analysis of Highly Cited References

This paper takes into account the influence of time on citation frequency of literature, so it adopts annual citation frequency for analysis. The citation frequency by dividing the total citation frequency by the document life, which was calculated by 2021 minus the year of publication of the document. Through the analysis of literature co-citation conducted by VOSviewer, it can be found that figure 2 and figure 3 show a strong cluster structure.

The literature of Cohen, Govindarajan and Seuring is quite a three-prong rivalry. Different colors represent different cluster relationships, and the core support of each cluster is these three literatures [4-8]. It can be seen that if you want to quickly understand the research status and theoretical basis of reverse innovation, you can start from these several studies. The complicated connection between Chinese literature also shows that the research on reverse innovation is gradually spreading out in a faceted, multidimensional development.

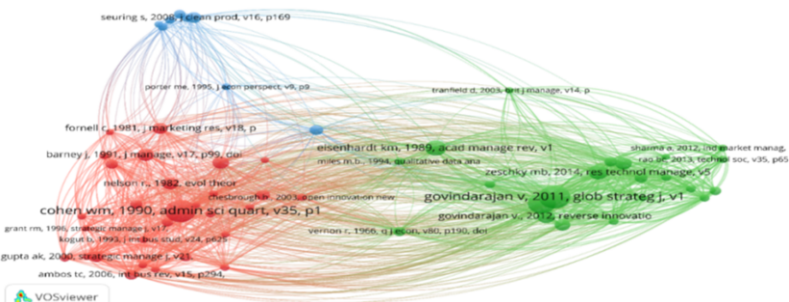


Figure 2. Correlation chart of co-citation analysis of foreign literature.

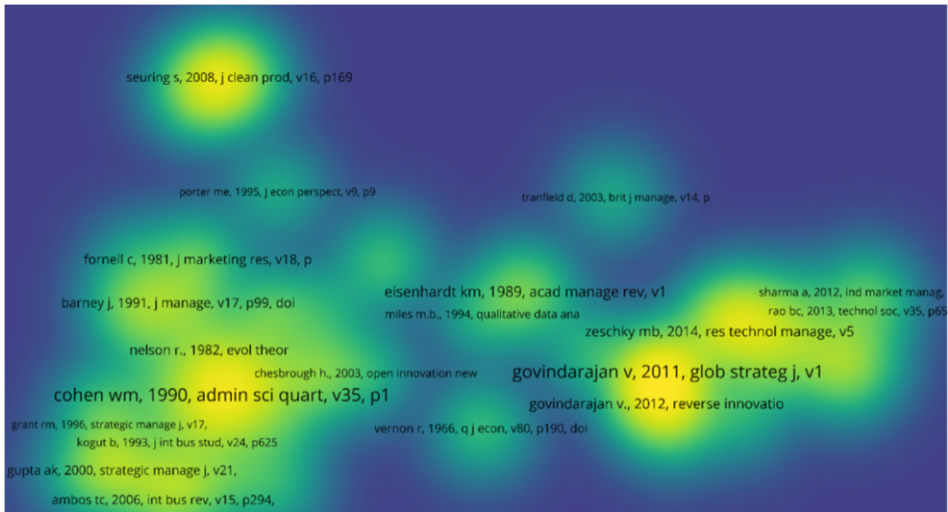


Figure 3. Density map of co-citation analysis in foreign literature.

2.4. Prolific Authors and Cooperation among Authors

Co-occurrence analysis is a quantitative analysis method of information, which can reveal the content correlation and co-occurrence relationship implied by feature items of information.

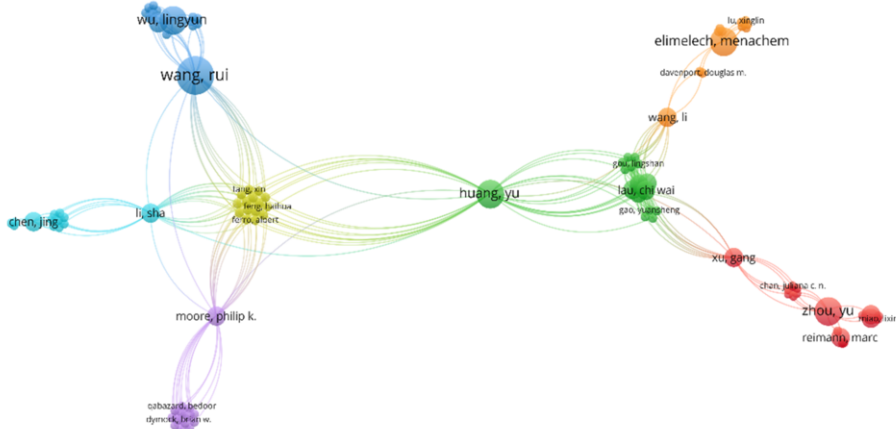


Figure 4. Co-occurrence analysis of foreign authors.

As can be seen from figure 4, researches on reverse innovation are mostly carried out in team mode, and multiple clusters represent multiple teams. Among them, Huang, Yu, Wang and Rui have a fairly close relationship network and have cooperated with many authors [9-12].

2.5. Scientific Research Institutions with the Highest Number of Publications

As can be seen from figure 5, there are a large number of reverse innovation research institutions abroad, among which Harvard, Imperial Coll, Univ, Kings Coll, Univ Southern and other institutions have nearly 100 papers, including dozens of countries or regions such as Britain, The United States and Germany. In general, it is small in size and large in quantity, and has not yet formed a very authoritative organization with a great voice. The research and development in the field of reverse innovation still needs the contention of a hundred schools of thought.

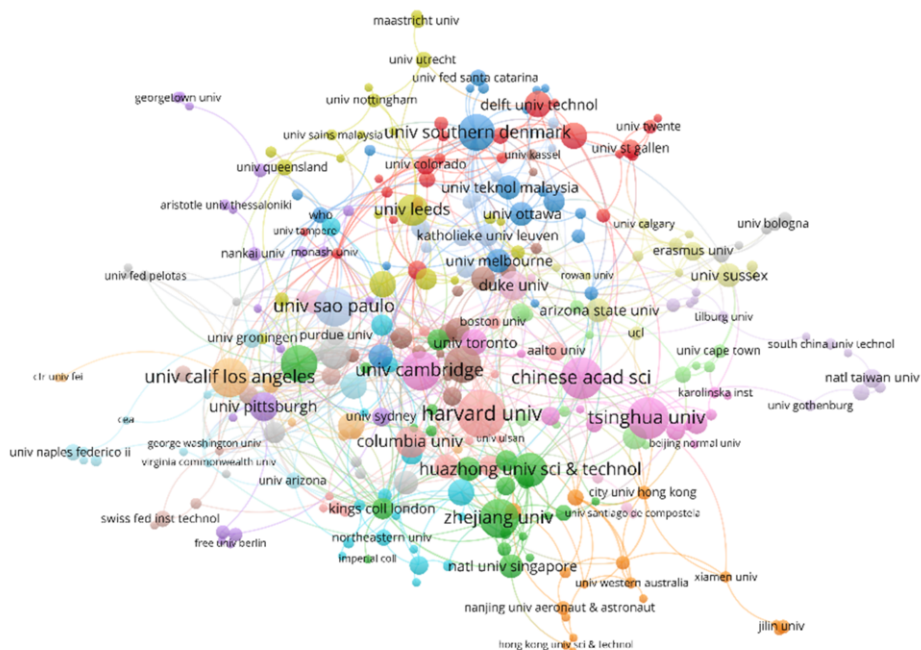


Figure 5. Co-occurrence analysis of foreign institutions.

3. Research Topic of the Paper

3.1. Keyword Co-occurrence Analysis

With the help of VOSviewer software analysis, 4940 frequency keywords were captured. In the screening process of VOSviewer, words with frequencies lower than 15 are eliminated, and the remaining words are regarded as high frequency words. Keywords co-occurrence network diagram is made to analyze them. In the co-occurrence network diagram, the color category adopts the clustering analysis function of VOSviewer, in which a color represents a category.

According to the set threshold value, a total of 77 keywords were obtained, and one meaningless keyword (of-the-art) was manually removed to obtain a total of 76 keywords. However, there are synonyms in the keywords, so a total of 70 co-keywords are found after the merger processing. Based on analysis by VOSviewer software, The

results show that 14 high-frequency keywords are innovations, performance, model, impact, management, research-and-development and reverse logistics se Logistics, Design, strategy, system, technology, knowledge, absorptive-capacity, industry, and growth WTH, reverse innovation, these co-occurrence keywords mean the research fields and hot spots of foreign scholars (see figure 6).

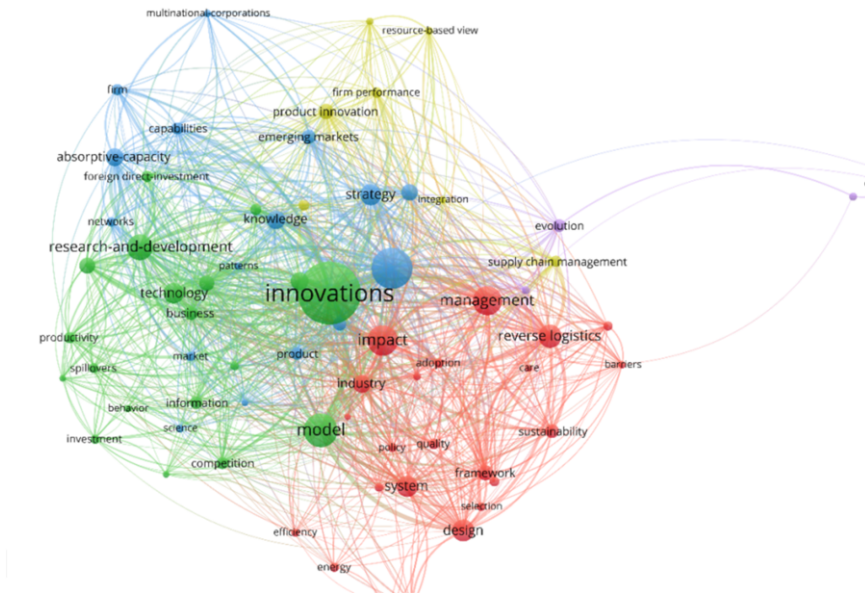


Figure 6. Co-occurrence relationship diagram of keywords in foreign research.

It can be further shown from figure 7 that most foreign studies on reverse innovation are focused on Innovations, performance, impact, model and management, namely the establishment of innovation evolution model, as well as corporate governance and performance. In the long process of trying to solve the "what" and "why" questions.



Figure 7. Co-occurrence density map of keywords in foreign research on reverse innovation field.

3.2. Research Topic

The 70 keywords were analyzed and finally divided into 5 categories. According to the keywords contained in each category, category names representing the research topics and directions of each category can be summarized, as shown in table 2.

Table 2. Categories and keywords of foreign reverse innovation research fields.

Serial number	Category name	Keywords included
1	Concept of analytical	Impact, management, and reverse logistics Logistics, Design, System, Industry, Framework, Sustainability, quality, Future, Energy, implementation (IMP Lementation, adaptation, reverse-osmosis, challenges, selection, efficiency, diffusion, and barriers (b) Arriers), Optimization, United States
2	Strategy formulation	Innovations, models, technology, Growth, firms, Determinants, Busines S), information, competition, dynamics, foreign direct investment Direct-investment, productivity, spillovers, investment, empirical evidence, behavior, economic-g Rowth), panel-data
3	The evaluation index	Performance, strategy, knowledge, absorptive-capacity, reverse innovation, emerging markets Markets, perspective, product, capabilities, networks, science, rent-co Rporations), patterns, collaboration
4	Corporate governance	Product innovation, Supply chain Management, Governance, resource-based perspective View, Integration,
5	Development trend	Evolution, Expression, China, Identification, activation

4. Conclusion

In this paper, VOSviewer, a bibliometric software, is used to visually analyze 1895 relevant literatures in the Web of Science database, mainly through quantitative analysis of the annual publications, journals, cited literatures, keywords, high-yield authors and scientific research institutions in this field. In order to provide reference for future research on reverse innovation, the research status and hot spots in the field of international reverse innovation are presented more intuitively.

4.1. Main Conclusions of This Paper

(1) Through VOSviewer software and Big data,in terms of the characteristics of external literature, the annual number of foreign reverse innovation research papers shows an upward trend through the analysis of the annual number of papers; Through the journal analysis, it can be found that the research of reverse innovation is mainly concentrated in the field of economics and management, and gradually develops to other engineering fields, showing the characteristics of interdisciplinary, wide perspective and wide field. Through the cited literature analysis, it can be found that the

research of reverse innovation mainly focuses on evaluation indicators, corporate governance and other categories.

(2) Through the coword analysis of VOSviewer, a bibliometrics software, this paper finds that "innovation path" and "evolution path" are still hot spots of academic attention, and the focus is gradually shifted to corporate strategic practice and national strategic practice. This shows that foreign scholars gradually shift their perspective to the field outside the discipline.

(3) Through VOSviewer, a bibliometric software, this paper conducts a long-term, wide-field and multi-level analysis on the research status of reverse innovation, and finds that the current research is still in the academic development stage where a hundred flowers bloom and a hundred schools of thought argue. At present, there is not a complete development logic chain of reverse innovation, only the upstream of innovation, that is, its generation and status quo have a full understanding, but the application and impact of reverse innovation is still lacking. Especially in the multi-role context, what positive effects does reverse innovation have on local enterprises? What is the impact on the advancement of technological progress in the country? How to draw lessons from the management of multinational corporations? These questions still need further study.

4.2. Deficiencies of Current Research

(1) Current research methods mainly adopt quantitative analysis methods such as case sketch, case analysis and bibliometrics, which need to be improved in terms of persuasion and validity of conclusions. Many research literatures have not adopted three-level grounded method to analyze cases, and case analysis without double-blind test may have subjective bias of analysts, which will also reduce the validity of research conclusions. Quantitative methods, such as structural equation and regression analysis, should be adopted as far as possible to make a more systematic.

(2) The current research has not jumped out of the scope of firm strategy either in industry heterogeneity or in region difference. From the perspective of the subject, we can also examine the relationship between other stakeholders from the perspective of entrepreneurs themselves and the government. From the perspective of innovation value chain, we should re-examine the whole process of innovation and pay attention to the important position of process innovation.

4.3. Future Outlook

The author provides two suggestions for further research in the field of reverse innovation:

(1) In terms of the content and scope of research, we should pay more attention to multi-level and all-round research and exploration and avoid blindly chasing hot spots.

The research on reverse innovation needs to be further deepened. Regional differences among different regions and industry heterogeneity among different industries may become the leading factors of reverse innovation. At present, the research on the influencing factors of reverse innovation is still limited to "intellectual property rights" and "market opportunities", and the application logic of reverse innovation is still confined to the application of manufacturing industry. Then, what effect will other industries have on other factors? These problems need to be further explored and analyzed.

(2) At the level of theoretical application, more attention should be paid to the applicability exploration under multiple scenarios. The attention to reverse innovation should not be confined to the donor country or OFDI side. For example, in the case of GE, most scholars focus on the US side that obtains innovation and narrow the beneficiaries as the more developed side. However, when the innovation value chain is upgraded, the place where the upgrade takes place, i.e. the recipient, can also obtain the innovation spillover effect. So for these countries, how to grasp the innovation spillover effect in reverse innovation? How to grasp the dilemma brought by role transformation? These questions need to be supplemented in the future.

Acknowledgments

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