

Discovering Multiple Clusters of Second-Hand Luxury Goods to Improve the Profit of Supplier Using Network Motif

Tengfei Shao[†], Fumitoshi Teraoka[‡], Keiji Ishizaki[‡], and Reiko Hishiyama[†]

[†] Graduate School of Creative Science and Engineering, Waseda University, Shinjuku, Tokyo, 169-8555 Japan.

[‡]Gallery Rare Ltd, Maruito Minami-Horie Pharos Bldg. 1-7-4 Minami-Horie Nishi-Ku, Osaka, Japan.

1. Introduction

The market for second-hand (used) luxury goods is of great economic importance [1]. Moreover, Brand is a significant factor that affects customers to buy second-hand luxury goods [2]. Different with prior studies, this study tries to analyze the changes in profit when buying multiple second-hand luxury items of the same brand [3]. In this study, we use brand keywords to represent the brand name.

We propose an analysis model for discovering second-hand luxury trade by combining network analysis and brand keywords to try to increase the profit of suppliers. The proposed model can discover multiple clusters of second-hand luxury goods with the same brand keyword that have a possibility to improve the profit of suppliers.

2. Related Work.

Second-Hand Luxury Goods Analysis: The growth of the second-hand luxury market has raised the interest of academic researchers over the past few years. Many studies have focused on understanding the motivations of second-hand and vintage luxury consumers [4]. This study differs from prior research in that it focuses on providing some sales strategies to second-hand luxury goods suppliers.

Network Analysis: Many studies that use network analysis to study the luxury industry [5]. However, we attempted to use a complex network to discover multiple clusters of second-hand luxury goods to crease the profit based on the network motif which has never been considered by prior studies.

3. Second-Hand Luxury goods trade analysis model

The second-hand luxury goods trade analysis model (analysis model) consists of three main components: “sales data collection,” “profit complex network and subnetwork,” and “multiple clusters of second-hand luxury goods discovery” as shown in Fig. 1.

3.1. Sales Data Collection

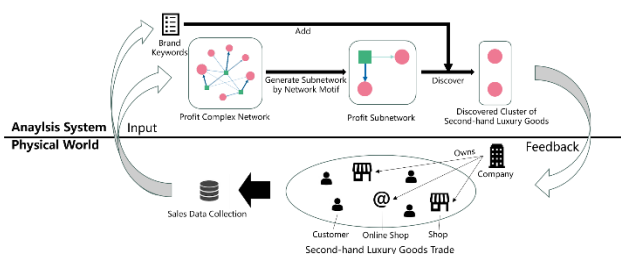


Fig.1. Second-hand luxury goods trade analysis model

As shown in Fig 1, in the physical world, a second-hand luxury goods trading company has several physical stores and online stores. Consumers use these stores to purchase second-hand luxury goods. Regarding the data acquisition, we cooperate

with the second-hand luxury goods trading company to obtain the transaction data of the company.

The collected sales data consist of second-hand luxury goods data, customer data, profit data and brand keywords data.

Therefore, we can obtain the following dataset: 1. Set of second-hand luxury goods and set of customers. 2. Relationships between second-hand luxury goods and customers, representing which second-hand luxury goods have been bought by which customers. 3. Profit of each second-hand luxury good. The above 3 data will be used to construct the profit complex network. Regarding the brand keywords data, it will be used to discover clusters of second-hand luxury goods.

3.2. Profit Complex Network and Subnetwork

The profit complex network is a network containing three types of data: second-hand luxury goods, customers, and profit of each second-hand luxury good, as shown in the analysis system section of Fig.1. In this complex network, nodes are composed of second-hand luxury goods and customers. The links between nodes represent which customer has bought which second-hand luxury goods and the weights of the links represent the profit of the trade. A network motif is an essential indicator for describing the characteristics of a network. About discovering the network motif, we chose the ESU algorithm.

3.3. Multiple Cluster of Second-Hand Luxury Goods Discovery

Discovery for Multiple clusters of second-hand luxury goods consists of two parts. The first part is the discovery preparation. In this part, we add various attributes to the nodes in cluster candidates. The second part is to filter out multiple clusters of second-hand luxury goods. The attributes added to the nodes in each cluster candidate include the number of purchases by customers, brand keywords, overall average, and partial average profit. The number of purchases by customers is not the number of times that any node in the cluster has been purchased, but the number of all second-hand luxury good nodes in the cluster.

4. Experiment

We collaborated with a company that deals in second-hand luxury goods and obtained data on the company's transactions for three years from 2018 to 2020. The data includes a total of 256,210 transactions for the company. The transactions are mainly divided into two parts, which are recycling and selling second-hand luxury goods. The data we use in this experiment is the used luxury goods sold by several physical stores and one online store for individual customers. The number of transactions is 29,021 for physical stores and 29,298 for online stores.

We calculated network motifs by setting size to three which means the selected numbers of motif nodes were three. Then we found multiple clusters of second-hand luxury goods by the second-hand luxury goods trade analysis model.

5. Result and Discussion

After we compiled 3 years of sales data, we identified 325 brand keywords in the physical store sales data and 305 brand keywords in the online store. The brand keywords include "Rolex", "Louis Vuitton", and "Chanel", etc.

Table 1. Examples of discovered clusters.

Examples	Second-hand luxury goods	Common keyword	Customer number
Physical stores	Hermès clothing Hermès handbags	Hermès	518
Online store	Louis Vuitton accessories, wallet	Louis Vuitton	237

For the analysis model, we first constructed two complex networks (one uses physical store data and the other uses online store data). We then calculated network motifs based on size, three and four (numbers of nodes in the network motifs). Since this study examines the impact of purchasing the same brand of used luxury goods, we mainly use the first structure of the size-3 network motif for our discussion. Regarding the size-4 motif network, we do not discuss it because there are no clusters with the same brand keywords. As a result, we discovered multiple clusters of second-hand luxury goods and their numbers were 56 (physical store), 38 (online store). Two examples of clusters are presented in **Table 1**.

Table 2. Summary of Result.

Store Type	Physical stores		Online store	
Number of all combinations	3169		1069	
Number of combinations when customers > 3	659		157	
Changes of profit*	>0	<0	>0	<0
Number of combinations of common keywords for all second-hand luxury goods	56	4	38	1
Proportion of combinations of common keywords for all second-hand luxury goods	11.14 5%	3.738 %	26.389 %	7.143 %

Next, we calculated the proportions of clusters of second-hand luxury goods for changes of profit (> 0 and < 0) in all subnetworks (all combinations) of the same size. "Changes of profit" in **Table 2** represents the partial profit average of a second-hand luxury good in a cluster minus its overall profit average as we described above. There are 659 combinations in which each second-hand luxury good has been bought more than 3 times. 3 is the average number of times each cluster of second-hand luxury goods is purchased. "Number of combinations of common keywords for all second-hand luxury goods" represents the number of clusters of second-hand luxury goods with the same brand keyword that meets the above conditions (customers > 3 and changes of profit). "Proportion of combinations of common keywords for all second-hand luxury goods" represent the percentage of "Number of combinations of common keywords for all second-hand luxury goods" in combinations (include clusters with no common keyword) that meet the above two conditions.

It is apparent that for both stores, the proportion of combinations of common keywords for all second-hand luxury goods when the profit change is greater than zero is greater than that when the profit change is less than zero. In other words, after customers have fully bought all second-hand luxury goods in a cluster, the profit of each second-hand luxury good is more than those second-hand luxury goods bought by customers who have not purchased all second-hand luxury goods in a cluster. Therefore, the significance of multiple clusters of second-hand luxury goods is that customers who shop based on these clusters can collect second-hand luxury goods with the same brand keywords, so they are more willing to pay more to buy multiple clusters of second-hand luxury goods than customers who have not bought all the second-hand luxury goods in a cluster. To verify the effectiveness of our data, we performed an analysis of variance based on sampling experiments.

Based on these results, we can conclude that the changes in the proportion of combinations of common keywords for all second-hand luxury goods under different conditions are significant. The changing trends under different conditions also verified our hypothesis that if customers bought second-hand luxury goods with a common brand keyword, they may be more willing to pay more money. Therefore, we identified these types of second-hand luxury goods as clusters with the potential to increase the profit of the supplier. Additionally, it is expected that the high quality of the brand will bring consumers a sense of pleasure, and when a consumer identifies with a brand, the consumer will be more likely to accept the price of other products of the brand (less bargaining). Through second-hand luxury consumption, consumers may gain the emotional benefits associated with treasure hunting. This could also be a side note that collecting two treasures of the same brand increases the emotional gain of consumption. Therefore, it can be considered that brand keywords play a vital role in profit improvement. As a result, it is conceivable that one could improve the profit of second-hand luxury goods by guiding customers to buy two second-hand luxury goods with a common brand as a cluster. Or set up some discounts for customers who buy two second-hand luxury goods of the same brand to improve the overall profit of the company.

6. Conclusion

We proposed an analysis model for discovering multiple clusters of second-hand luxury goods. Customers who bought these discovered clusters of second-hand luxury goods were more willing to pay more money. To determine the validity of multiple clusters of second-hand luxury goods we identified.

In the future, we plan to work with second-hand luxury companies to develop some strategies that use the multiple clusters of second-hand luxury goods that we have found.

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