1. INTRODUCTION

The market for personal luxury products and services is expected to continue growing in developed and emerging countries. The market size amounted to EUR 262 billion in 2017, a three-fold increase compared to the market size in 1996 [1]. Luxury products that fascinate customers are quite different from commodity products, in terms of the tangible and intangible added value that cannot be expressed by their function and performance. Commodity production bases have been moved to emerging or developing countries from developed countries due to the rise of labor costs. It therefore lost such employment opportunities in the commodity production in the developed countries. If we consider future industry creating employment opportunities with economic growth in the developed countries, luxury products and services are obviously important issues.

Luxury products and brands have been studied from multifaceted viewpoints such as brand management [2-5], retail and distribution management [6-9] and consumer psychology [10-13]. These interdisciplinary viewpoints have included cultural backgrounds of history and heritage, aspects of product design and integrity, and elements of marketing strategy, such as positioning and pricing. In marketing research, in particular, existing frameworks designed for commodity products — emphasizing high performance and low price — were not sufficient for analyzing luxury products [2]. Quantitative analyses of consumer investigation targeting luxury brands have also been reported in behavioral science and psychology [3, 10]. Except for some papers on brand extension [4, 6, 7, 11], existing papers discussing case studies focus on specific luxury brands [7-9]. The outcomes in these papers are interesting but difficult to generalize because of limited case studies.

Figure 1 shows a framework consists of consumer–brand and qualitative–quantitative dichotomous components, which is useful to summarize previous studies on luxury products. The brand management and the consumer psychology studies mainly discussed type I and II problems in the framework. The retail and distribution management studies discussed type III problems. However, the type IV problem has not been discussed so far, due to the lack of quantitative information on brands. This study focuses on the type IV problem that have not been deeply investigated.

<table>
<thead>
<tr>
<th>Consumer</th>
<th>Brand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualitative</td>
<td>I</td>
</tr>
<tr>
<td>Quantitative</td>
<td>III</td>
</tr>
</tbody>
</table>

Figure 1: Framework summarizing previous studies on luxury products
The ready-to-wear products presented at fashion shows by luxury fashion brands have a significant impact on mass fashion products, and they lead fashion trends. This type of fashion trend propagation is regarded as “trickle-down” effect in the context of sociological aspect. Luxury fashion brands basically limit distribution channels to directly managed stores and department stores, in order to provide special purchasing experiences for customers with visual merchandising. Therefore, luxury fashion brands avoid selling their products through the distribution channel of general merchandise stores, where various brand products are mixed. Limited distribution channels allow luxury brands to strictly control price and brand image.

Distribution channels of luxury products comprise of mono-brand, specialty, department, off-price, online stores, and airport. The size of the luxury online market was estimated EUR 23.6 billion, accounting for 9% share in 2017 [1]. Moreover, high CAGR of luxury online market indicating 24% in 2017 supports the rapid growth. Online stores must be considered as a distribution channel even for luxury brands due to their large economic impact. This paper explores the attributes of luxury fashion products, such as brand and prices, extracted from the online stores. We shed light on dynamic pricing of luxury fashion products, as observed from the difference between regular and selling prices [Note 1], and we quantitatively analyze characteristics of brands and product categories.

2. METHOD

2.1 Online luxury fashion store

The online stores of luxury fashion products are categorized into flagship online stores and retail online stores. The following directly managed online stores are typical flagship online stores:
• Hermès, www.hermes.com
• CHANEL, www.chanel.com
• Louis Vuitton, www.louisvuitton.com
• 24 Sèvres managed by LVMH www.24sevres.com

In 2000, Yoox and Net-A-Porter opened their online retail stores specialized in luxury fashion products. Yoox and Net-A-Porter have a relatively long history and large revenue in the online retail stores. In this study, we have selected Yoox and Net-A-Porter, which cover various brands, as sources for the quantitative analysis.

2.2 Product attributes

An HTML file on a web page describes attributes of products sold in the online retail store. For example, a product was described in the following Javascript code in the HTML file, therefore product information can be extracted.

```
tc_vars["product_cod10"] = "34735514GR";
tc_vars["product_brand"] = "ALEXANDER MCQUEEN";
tc_vars["product_category"] = "Short dress";
tc_vars["product_macrocategry"] = "Dresses";
tc_vars["product_price"] = "1500";
tc_vars["product_discountprice"] = "975";
```

Table 1 shows the attributes of luxury fashion products sold through Yoox and Net-A-Porter. For this study, we developed a crawling application that automatically and periodically collects HTML and image files of products, which are then saved on a cloud service. We also developed a scraping program to extract the product attributes listed in Table 1.

<table>
<thead>
<tr>
<th>Table 1: Product attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
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</tbody>
</table>

2.3 Brand

This study selected prominent European, American, and Japanese luxury fashion brands. Firstly, the main lines of luxury fashion brands, satisfying the condition that more than 100 products were sold on Yoox and Net-A-Porter in the US market, were selected. Secondly, diffusion lines derived from these luxury fashion brands were added for data collection. Finally, the total number of brands in this study was 73. Table 2 summarizes the number of selected luxury fashion brands by country.

<table>
<thead>
<tr>
<th>Table 2: Number of selected brands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
</tr>
<tr>
<td>Brand</td>
</tr>
</tbody>
</table>

3. PRESTIGE OF LUXURY FASHION BRANDS

3.1 Regular price and prestige

Price is the most significant indicator characterizing products. There are various prices associated with distribution processes. For example, producer price comprises production cost and producer profit. Wholesale and retail prices contain distribution margins in addition to a producer price. Regular and selling prices are used in
online stores. This paper introduced an assumption that brands definitively determine regular prices based on marketing; however, online retail stores dynamically adjust selling prices considering the balance between consumer demand and producer supply. We assumed that the regular prices reflect the brand prestige.

3.2 Regular price distribution

Figure 2 demonstrates the regular price distribution of various products by brand with a logarithmic scale. A box with a vertical line indicates the 25th, 50th, and 75th percentiles of the regular price distribution. A horizontal dotted line indicates the range between the lowest and highest prices. A diamond symbol in the chart indicates a mean regular price. N is the number of collected products in this study. Emporio Armani and Dolce & Gabbana comprised of various product lines sold more than 10,000 products in total. Meanwhile, we could collect only 7 products for Moncler Gamme Blue, which is a diffusion line of Moncler. The result of ANOVA, \( F(72, 154142) = 523, p < 0.001 \), suggests that 73 luxury fashion brands were segregated in the market, even though the price distributions overlap.

3.3 History and tradition shaping prestige

In order to analyze prestige of luxury fashion brands, this study selected main lines of luxury brands selling more than 800 items in online retail stores to ensure the reliability of the quantitative analysis. Burberry’s diffusion lines symbolize typical marketing strategy for luxury fashion brands studied by Moore & Birtwisle [7], which cannot be ignored when we consider luxury fashion brands. We therefore added Burberry Prorsum as an exception. Finally, we selected the top ten high priced luxury fashion brands in Figure 3. These brands are listed in order from the highest mean regular price. The number within parenthesis indicates founded year of the brand.

Burberry Prorsum, regarded as a high-grade line of Burberry, was ranked at the top. Except for Tom Ford and Alexander McQueen, French and Italian brands with a long history, such as Valentino, Balmain, Saint Laurent, Dior, Celine, and Gucci, appeared at a higher rank. Burberry, which was established by Thomas Burberry at Basingstoke in the UK in 1886, has a more than 160-year-old history. Burberry Prorsum, which was established in 1999, is a new brand, but it inherits the tradition of Burberry from the 19th century. Gucci was established as a leather goods manufacturer by Guccio Gucci in Florence, Italy in 1923 after World War I. Dior, which was established by Christian Dior in Paris, France in 1946 after World War II, is a core brand in the LVMH conglomerate. Valentino was established by Valentino Garavani in Rome, Italy in 1957. Saint Laurent was established by Yves Henri Donat Mathieu-Saint-Laurent with support from Pierre Bergé in Paris, France in 1962. These brands have a history of more than 50 years. This suggests that a long history and tradition, and a premium price, shape brand prestige.

Figure 2: Regular price distribution of luxury fashion brands

Figure 3: Regular price distribution of prestigious luxury fashion brands
3.4 Mobility of creative talents

Tom Ford, which ranked at the second place, was established by Thomas Carlyle Ford and Domenico De Sole in 2006. Alexander McQueen, ranked at 7th place, was established by Lee Alexander McQueen in 1992. Compared with the typical luxury brands described above, these two brands do not have a long history and tradition. It is interesting that these two brands can retain a premium cost despite a relatively short history.

This paper discusses how emerging luxury brands acquire a prestigious position in the market in the short term. Thomas Carlyle Ford had previously worked as a creative director of Gucci and Yves Saint Laurent Rive Gauche. When he joined Gucci in 1994, Gucci had been fundamentally restructuring its historical brand to stay relevant. During this period, therefore, Mr. Ford gained experience in establishing prestigious brands. Lee Alexander McQueen had also worked as a designer for well-known brands such as Givenchy. Despite the comparatively short history of Tom Ford and Alexander McQueen, the mobility of creative talents allowed them to inherit brand equity of traditional and prestigious brand such as Gucci and Givenchy. Indirect inheritance of DNA from traditional and prestigious brands is a significant factor for emerging luxury fashion brands to succeed in the market.

4. PRICING STRATEGY IN DIFFUSION LINES

4.1 Diffusion lines

Existing luxury fashion brands often create a new line with a lower price level in order to supply inexpensive products [7, 13]. A new branched line is called a diffusion or second line. A diffusion line intends to supply inexpensive products that share a prestigious brand image with the main line for young consumers who have a lower disposable income.

4.2 Regular and selling price distribution

Figure 4 shows the regular and selling price distributions of brands operating diffusion lines. The white and gray boxes illustrate the distributions of regular and selling prices, respectively. Main and diffusion lines tend to be separated into high and low prices. This tendency clearly appears in Armani, Chloé, and Valentino. In terms of brands (main and diffusion lines) and prices (regular and selling), we applied two-way ANOVA for each brand group. In the case of Giorgio Armani, Emporio Armani, and Armani Exchange, for main and diffusion lines, $F(2, 26291) = 4071, p<0.001$, for regular and selling prices, $F(2, 26291) = 4071, p<0.001$. These two-way ANOVA confirmed the difference between the main and diffusion lines as well as the difference between regular and selling prices for all brand groups. Although Miu Miu is a diffusion line of Prada, the mean regular and selling prices of Miu Miu were both higher than those of Prada. The mean regular and selling prices of Junya Watanabe Comme des Garçons were both higher than those of Comme des Garçons.

4.3 Classification of diffusion lines

Table 3 classifies these brand groups into five types based on brand operations, in addition to the price relationship between main and diffusion lines. The brands classified into the “divided price lines” type clearly separated the main and diffusion lines into high and low prices. The brands classified into “multiple high price lines” have a high-priced diffusion line, like Prada – Miu Miu and Comme des Garçons – Junya Watanabe Comme des Garçons. In these brand groups, the diffusion line has established a strong position and is regarded as an independent brand in the market. Other brand groups that discontinued diffusion lines were subdivided into discontinuance of high or low price lines and integration.

Figure 4: Regular and selling price distribution by brand group
Table 3: Classification of brand groups comprised of main and diffusion lines

<table>
<thead>
<tr>
<th>Type</th>
<th>Main line</th>
<th>Diffusion lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Divided price lines</td>
<td>Giorgio Armani</td>
<td>Emporio Armani</td>
</tr>
<tr>
<td></td>
<td>Chloé</td>
<td>See by Chloé</td>
</tr>
<tr>
<td></td>
<td>Jil Sander</td>
<td>Jil Sander Navy</td>
</tr>
<tr>
<td></td>
<td>Valentino</td>
<td>Red Valentino</td>
</tr>
<tr>
<td></td>
<td>Alexander Wang</td>
<td>T by Alexander Wang</td>
</tr>
<tr>
<td></td>
<td>Maison Margiela</td>
<td>MM6 by Maison Margiela</td>
</tr>
<tr>
<td>Multiple high price</td>
<td>Prada</td>
<td>Miu Miu</td>
</tr>
<tr>
<td>lines</td>
<td>Comme des Garçons</td>
<td>Junya Watanabe Comme des Garçons</td>
</tr>
<tr>
<td>Discontinuance of low price line</td>
<td>Dolce &amp; Gabbana</td>
<td>D&amp;G</td>
</tr>
<tr>
<td></td>
<td>Marc Jacobs</td>
<td>Marc by Marc Jacobs</td>
</tr>
<tr>
<td>Discontinuance of high price line</td>
<td>Moncler</td>
<td>Moncler Gamme Rouge</td>
</tr>
<tr>
<td></td>
<td>Donna Karan</td>
<td>Moncler Gamme Bleu</td>
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<td></td>
<td></td>
<td>Moncler Grenoble</td>
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<td></td>
<td></td>
<td>DKNY</td>
</tr>
<tr>
<td>Integration</td>
<td>Burberry</td>
<td>Burberry Prosum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Burberry London</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Burberry Brit</td>
</tr>
</tbody>
</table>

5. DYNAMIC PRICING BY PRODUCT CATEGORY

5.1 Brand category extension
Brand extension is a well-known marketing strategy, that reuses established brand name to other product categories considering brand equity [14-16]. Launching a new brand requires a large amount of investment for advertisement and publicity with risk of business failure. However, brand extension reusing an existing brand name can suppress such investment cost and reduce the risk of business failure. In brand category extension of luxury fashion products, haute couture products are located at the top price level, followed by ready-to-wear products, bags, watches, shoes, fragrance, and cosmetics. Low priced products are expected to attract young consumers who have a lower disposable income for the customers of luxury brands.

5.2 Regular and selling prices by product category
Figure 5 illustrates regular and selling price distribution by product category extracted from the collected product attributes. Product categories are listed in order from the highest mean regular price in Figure 5. Since expensive coats often use high priced materials such as fur and leather with expensive production cost, the mean regular price of coat was the highest in these product categories. The bags, ranked at the second place, use high priced animal skins such as crocodile, python, and ostrich. Even in the lowest place, mean regular price of T-shirt exceeded $US 200. This price distribution of T-shirt suggests that luxury brands added large marginal cost to the production cost.

5.3 Normalized selling price
We define normalized selling price by $x_{NSP} = x_{SP}/x_{RP}$, where $x_{SP}$ and $x_{RP}$ denote selling price and regular price, respectively. For a product without markdown, $x_{NSP} = 1$. Markdown ratio is given by $1−x_{NSP}$.

Figure 6 shows histograms of normalized selling prices for dresses, coats, shoes, and bags, where $N$ and $x_{NSP}$ indicate the number of samples and mean normalized selling price. In Figure 6(a), dresses sold at regular price without markdown accounted for 32.6%. Remained dresses with markdown accounted for 67.4%. The mean normalized price 0.658 indicates that the mean markdown ratio was 34.2%, including dresses without markdown. Normalized selling price for discounted dresses ranged from 0.2 to 0.9. Dresses whose markdown ratio exceeds 50% accounted for a certain amount.

Normalized selling price distribution of coats in Figure 6(b) shows that 46.5% of products were sold at regular price without discount and remained 53.5% of products were discounted. The mean normalized price 0.744 indicates that the mean markdown ratio was 25.6%. The markdown ratio of coats was lower than that of dress.
Normalized selling price for discounted coats also ranged from 0.2 to 0.9.

Normalized selling price distribution of bags in Figure 6(c) shows that 69.1% of products were sold at regular price without markdown and remained 30.9% of products were discounted. For bags, percentage of products without markdown was remarkably higher than those of dresses and coats. The mean normalized price 0.878 indicates that the mean markdown ratio was 12.2%.

Normalized selling price distribution of shoes in Figure 6(d) shows that 48.4% of products were sold at regular price without markdown and remained 51.6% of products were discounted. The mean normalized price 0.790 indicates that the mean markdown ratio was 21.0%. Normalized selling price distribution of shoes was similar to that of coats. For other product categories, result of wallets was close to that of bags. Results of trousers, formal dresses, skirts were close to that of dresses.

6. DYNAMIC PRICING AND SELLING DURATION

6.1 Relationship between selling duration and normalized selling price

This paper discusses the relationship between selling duration and dynamic pricing. In this study, selling duration is the duration from a day that a product appeared on the web page for a day that the product disappeared from the web page. Figure 7 shows the relationship between selling duration and normalized selling price. In Figure 7, horizontal and vertical axes indicate selling duration for almost two years and normalized selling price. A color point corresponds to a product sold in the online stores, in which a regular price is reflected in the color shown in legend. Dotted horizontal and vertical lines indicate mean selling duration and mean normalized selling price. Slant line is a linear regression relating selling duration and normalized selling price, respectively.

Figure 7 (a) shows relationship between selling duration and normalized selling price of dresses (N=20,221). Mean selling duration was 121.3 days corresponding to about four months. The mean normalized selling price was 0.658, in which markdown ratio was 34.2%. Many dresses were discounted during a short-term. Nevertheless, 32.6% of dresses were sold at a regular price even if selling duration was extended. Vertically distributing high concentration areas seem clearance sales.

Figure 7 (b) shows the relationship between selling duration and normalized selling price of the bags (N=10,040). Mean selling duration was 92.9 days corresponding to almost three months. Mean selling duration was one month short compared with the result of dresses. The mean normalized selling price was 0.877, in which markdown ratio was 12.3%. 69.1% of bags were sold at regular price without markdown. From a viewpoint of retail business, bag is an excellent product which can be sold within short-term without the discount.
6.2 Relationship between selling duration and normalized selling price

The mean markdown ratio of dresses was remarkably larger than that of bags. At the same time, mean selling duration of the dresses was longer than that of bags. We shed light on product lifecycle depending on fashion trends in the market, which does not intend physical product lifecycle reflecting durability nor production processes. This paper discusses a time fluctuation model of product value to describe the product lifecycle in the market.

The difference from the latest fashion trend to the fashion trend when a product begun to be sold increases over time. Therefore, product value gradually decreases with the expansion of the fashion trend difference. We denote this time fluctuation of product value by an exponential function \( f_A(t) \) as a trend model shown in Figure 8(a).

\[
f_A(t) = e^{-\alpha t}
\]

where constant \( \alpha \) satisfies \( \alpha > 0 \).

We also consider seasonal fluctuation of product value observed in spring/summer and fall/winter clothes. In this case, product value cyclically changes with the seasons. We denote this time fluctuation of product value by a cosine function \( f_B(t) \) as the seasonal model shown in Figure 8(b).

\[
f_B(t) = \beta \cos 2\pi t + 1 - \beta
\]

where constant \( \beta \) satisfies \( \beta > 0 \). To describe time fluctuation of product value, we introduce a unified model that combines trend and seasonal models in equations (1) and (2).

\[
f(t) = e^{-\alpha t}(\beta \cos 2\pi t + 1 - \beta)
\]

By using this time fluctuation model of product value in equation (3), we discuss the difference between dress-type and bag-type models. Constants \( \alpha \) and \( \beta \) adjust balance between trend and seasonal models. If \( \alpha \) is relatively large and \( \beta \) is relatively small, trend model is

![Figure 7: Relationship between selling duration and normalized selling price](image-url)
dominant compared with seasonal model. On the contrary, if $\alpha$ is relatively small and $\beta$ is relatively large, seasonal model is dominant compared with trend model.

Large markdown ratio observed from dresses means drastic decrease of product value over time, so that trend model is dominant as shown in Figure 8(c). The drastic decrease of product value causes many discounted products with large markdown ratio. Meanwhile, the small markdown ratio observed from bags explains that product value does not decrease over time, so that trend model is not dominant as shown in Figure 8(d). These dress-type and bag-type models of time fluctuation of product value are useful to understand the differences of dynamic pricing of luxury fashion products.

7. CONCLUSION

Luxury products and services are important issues when we consider future industry creating employment opportunities with economic growth. Luxury products and brands have been multifaceted viewpoints such as brand management, retail and distribution management, and consumer psychology. Previous studies were categorized by the framework consists of consumer–brand and qualitative–quantitative dichotomous components. It showed the lack of quantitative analysis focusing on luxury fashion brands, therefore this paper revealed the characteristics of luxury fashion brands from price information extracted from online retail stores.

Firstly, the regular price distribution quantitatively indicated prestigious brands. It suggests that emerging luxury fashion brands, such as Tom Ford and Alexander McQueen, have inherited brand equity from historical and prestigious brands through the mobility of creative talent. It will be a vital matter to create a prestigious luxury fashion brand. Secondly, the brand groups were classified into five types based on brand operations as well as the price relationship between the main and diffusion lines. Thirdly, this paper analyzed dynamic pricing in luxury fashion products by category. The results revealed the following characteristics; 67.4% of dresses were discounted with the large markdown ratio even for online luxury fashion stores. Meanwhile, 30.9% of bags were discounted though remained 69.1% of bags were sold at regular price. To elucidate the factor of this difference, we investigated the relationship between selling duration and sold price. Consequently, the mean selling duration of dresses was one month longer than that of bags. Finally, based on these analyses, we proposed a time fluctuation model of product value to interpret dynamical price differences between dress and bag.

Large markdown ratio observed in apparel products would be a serious problem when we consider wholesome industry and the sustainable development. The proposed time fluctuation model of product value suggests that product design maintaining the tangible and intangible values for a long time would be a key solution for the problem, where affective engineering plays significant roles.

In this study, we analyzed a large amount of data, though high-end luxury brands, e.g. Hermés and CHANEL, were not contained in the data collected from the retail online stores in the United States. This is a limitation of this study to reveal the actual situation of luxury fashion products in the market. It is required to combine the data collected from flagship online stores to enlarge coverage. Detailed analysis focusing on product design is also another issue to be resolved in the next step.
NOTES
1. An earlier version of this study describing methods and several results were presented at ISASE 2019 [17].

ACKNOWLEDGEMENTS
This work was supported by Grant-in-Aid from the Centre for Interdisciplinary Studies of Science and Culture, Kyoritsu Women’s University.

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