



Title	Frugal innovation to customers in developed markets : a conjoint analysis
Author(s)	Lu, Zhonghua; Wirawan, Dony Dahana
Citation	大阪大学経済学. 2024, 73(4), p. 30-51
Version Type	VoR
URL	https://doi.org/10.18910/94747
rights	
Note	

The University of Osaka Institutional Knowledge Archive : OUKA

<https://ir.library.osaka-u.ac.jp/>

The University of Osaka

Frugal innovation to customers in developed markets: a conjoint analysis

Zhonghua Lu[†] and Wirawan Dony Dahana[‡]

Abstract

The onset of the twenty-first century witnessed “frugal innovation” gain prominence in the scientific and practical field. However, most studies focused on emerging markets, such as China, India, or the bottom-of-pyramid markets. A few studies focused on customers’ attitudes in developed markets towards frugal innovation. This study focuses on the representative properties of frugal innovation in emerging markets, such as substantial cost reductions, concentration on core functionalities, and optimized performance. Specifically, we addressed how customers in developed markets weigh frugal innovation properties and investigated several corporate and environmental factors that affect frugal innovation purchase decisions. A questionnaire survey was conducted among company buyers in Japan’s chemical, pharmaceutical, and food industries to collect data on how customers assess frugal innovation in emerging markets. The results reveal that customers in developed markets prefer frugal innovation properties differently. Furthermore, company buyers’ purchase intentions for frugal innovation are significantly influenced by performance (capacity and durability) and not by side function and cost reduction in emerging markets. This study provides critical insights into company buyers’ perspectives on innovation in emerging markets and hints at business strategies for introducing frugal innovations in developed markets.

JEL Classification: O33, O39

Keywords: reverse innovation, exploration, exploitation, sustainability, substantial cost reduction, function concentration, optimized performance

1. Introduction

In recent years, different types of innovation developed in emerging markets have gained significant attention in the scientific and practical literature, especially frugal innovation (Weyrauch and Herstatt, 2017). Unlike sophisticated top-down Research and Development (R&D)-driven innovation created with abundant

[†] Graduate Student, Graduate School of Economics, Osaka University

[‡] Professor, Graduate School of Economics, Osaka University

resources, frugal innovation is developed under limited consumer affordability and resource scarcity. The main idea is to develop products and services that fit the unique needs and requirements of emerging markets at low prices to enable consumption by non-affluent customers (Prahalad, 2012). In other words, instead of considerable financial and human resources, premium pricing, and abundance, innovation in emerging markets may be driven by local environmental factors, especially low consumer affordability, social problem-solving requirements, and sustainability requirements (Lu and Nakagawa, 2022). Considering these environmental factors, innovation in emerging markets should have its properties. The most widespread definition of frugal innovation includes three criteria: substantial cost reduction, concentration on core functionalities, and optimized performance levels (Weyrauch and Herstatt, 2017).

Compared to R&D-driven innovation, few resources are used throughout the life cycle of frugal innovation. Frugal innovation, complying with sustainable development, is increasingly practiced by scientists, political decision-makers, and different companies due to limited resources. Recent studies suggest that in addition to the sales potential in emerging markets, developed countries also require frugal innovation (Tiwari and Kalogerakis, 2019; Winkler et al., 2020; Wohlfart et al., 2021). For instance, portable ultrasound machines developed and initially marketed in China have been successfully introduced in Western markets. Natural ingredients used in India for centuries have been synthesized and sold as Food and Drug Administration (FDA)-approved medicines to consumers in the USA and Europe. Moreover, given the recent developments, including the financial and economic crisis (2008-2009), recession, stagnating income, rising inflation, conflicts among countries, and high unemployment (Eurostat, 2017; McCollum et al., 2018), the potential demand for frugal innovation in developed markets could increase in the future.

However, people living at the lower end of the income scale in developed countries have a significantly higher income level than those in bottom-of-pyramid (BOP) countries (Angot and Ple, 2015). The potential demand for frugal innovation may increase, and customers in developed markets may recognize frugal innovation differently; properties may differ from those in emerging markets. For example, traditional studies suggest that consumers in developed countries use prices to infer quality, as superior quality typically commands a higher price, and price signaling of quality is common for new products whose quality level is still unclear. (Gerstner, 1985; Tellis, 1986). Additionally, attributes may act as quality signals because consumers in developed countries may be particularly skeptical about quality when products originate from emerging countries. (Govindarajan and Trimble, 2012; Giannetti and Rubera, 2020). Few studies have analyzed whether and how consumers in developed markets view frugal innovation properties differently, especially regarding company buyers. However, the factors affecting consumers' viewpoints toward frugal innovation are yet to be investigated.

This study aimed to fill this gap in the literature. Specifically, we addressed how organizational buyers value frugal innovation and its properties. We aligned this with Weyrauch and Herstatt (2017) by assuming that substantial cost reduction, concentration on core functionalities, and optimized performance are the main properties of frugal innovation. In addition, corporate and environmental factors were assessed for their influence on company buyers' attitudes towards frugal innovation. At the corporate level, *sustainability practices* and ambidextrous strategy (exploitation and exploration orientations) were investigated. At the environmental level, *environmental dynamism* and *institutional distance* were assessed. Further, we developed

hypotheses on company buyers' preferences for different frugal properties and how corporate and environmental factors influence these preferences for frugal innovation properties. A survey using conjoint analysis was conducted with companies in Japan's chemical, food, pharmaceutical industries.

This study contributes to understanding how customers in developed markets value frugal innovation properties differently than those in emerging markets. This explains why some frugal innovations successfully spread to developed markets, whereas others failed. It also gives practitioners, especially from emerging markets, a direction about the frugal innovation they should provide for developed markets and the potential customers they should approach.

2. Literature review and hypothesis development

2.1 Background of frugal innovation

2.1.1 Frugal Innovation Definition

Many scholars have attempted to compare frugal innovation with other innovation types and characterize it. For example, frugal innovation differs from mainstream innovation in (1) geographical context, (2) diffusion patterns, (3) business models, and (4) distribution channels. (Zeschky et al, 2014; Herstatt & Tiwari, 2020; Weyrauch & Herstatt, 2017). Hossain (2016) compared frugal innovation with mainstream innovation in terms of input, success factors, impeding factors, and output by applying a systematic literature review approach. Agarwal et al. (2016) described frugal innovation as “good enough” and affordable products that satisfy the needs of resource-constrained consumers and have vast characteristics. Hossain (2018) offered a definition for frugal innovation as a “resource-scarce solution” where the final solution is significantly cheaper than competitive offerings and is good enough to meet basic needs. Weyrauch and Herstatt (2016) reviewed the literature and used three criteria to define frugal innovation: substantial cost reduction, concentration on core functionalities, and optimized performance. Winkler et al. (2020) argued that for frugal innovations to succeed as products in developed nations, they need to meet Weyrauch and Herstatt's (2017) optimal performance criterion by adapting to match user-specific characteristics (personal, market, or legal requirements).

2.1.2 Theoretical background for frugal innovation

Given that the concept and term frugal innovation have emerged relatively recently (the first scientific paper on frugal innovation was published in 2005), theoretical discussions are still limited. In the literature, disruptive innovation theory, institutional theory, and resource-based view are frequently cited directly and indirectly. *Disruptive innovation theory* was used to examine frugality in frugal innovation. Frugal innovation is often disruptive because it is a complex and expensive product that creates an affordable version (Soni and Krishnan, 2014; Slavova, 2014). Such disruptive innovations are intended for new or less demanding applications, primarily targeting non-mainstream customers (Ahlstrom, 2010). *Institutional theory* has been used to understand the institutional context shaping frugal innovation development. For example, scholars have discussed the role of weak innovation infrastructure or institutional voids in emerging markets in shaping frugal innovation (Bhatti, 2012; Zeschky et al., 2014a). Lu and Nakagawa (2022) applied a quantitative method to investigate consumer affordability, institutional voids, and resource availability in developing countries.

This greatly influences three innovation properties developed by emerging markets: frugality, sociality, and technological sophistication. *The resource-based view* explains how companies develop their innovations under resource constraints. Cai et al. (2019) highlight institutional leverage and bricolage in overcoming environmental constraints and developing more affordable frugal products. By integrating with local actors to co-create products or develop collaborations with non-traditional stakeholders, companies in emerging markets managed to reduce resource dependence to fit local income markets (Schuster & Holtbrugge, 2014). Moreover, scholars suggest that frugal innovation is a source of market capability and supply chain sustainability (Shibin et al., 2018). In addition to the theories discussed in the literature, such as diffusion, resource dependency, network, and international product life cycle theories, transaction theory is quoted to explain frugal innovation.

2.2 Frugal innovation in developed markets

Frugal innovation is mostly associated with applications in the BOP or in emerging markets (Brem & Wolfram, 2014; Schleinkofer et al., 2019). However, there are also some examples of frugal innovations that have been successfully introduced to advanced economies, for example different types of frugal cars (Beetle, 2CV, old Mini, Japanese Kei) and various models of reliable, low-cost household appliances that meet with overwhelming demand, despite the availability and affordability of more fashionable solutions. Some scholars suggest demand for frugal innovation in developed nations may exist for several reasons (Govindarajan and Ramamurti, 2011; Govindarajan and Trimble, 2012).

1. Innovations developed in emerging markets may have a ready market among people with less income in rich countries.
2. Dramatic cost and price reductions of 70%-90%percent achieved to succeed in emerging markets can help expand demand in rich countries.
3. New features incorporated for emerging markets, such as sturdiness, portability, or ease of use, may create new market segments in rich countries.
4. Technology of “good enough” products developed for emerging markets may improve over time to satisfy high-end applications in rich countries.
5. Emerging markets may leapfrog to the latest technologies, especially if they have large internal demand, are unencumbered by legacy technologies, and face fewer regulatory obstacles.

Meanwhile, developments in recent years, such as the economic crisis (2008-2009), recession, stagnating income, rising inflation, conflicts among countries, and high unemployment, could increase the potential demand for frugal innovation. For example, research on consumer attitudes in the USA and Europe has indicated a growing willingness to purchase cheaper, in-house brands, which seems to have persisted even as consumer confidence has begun to return following the 2008 financial crisis (European Commission, 2016). Secondly, it is suggested that consumers are becoming increasingly ‘values-conscious’ (Radjou and Prabhu, 2015). These values include a rejection of rampant consumerism and a preference for environmentally sustainable products. Frugal innovation has significant attributes of resource scarcity, which means that few resources are used during a product’s life cycle (from production to use to disposal). In some sense, this attribute aligns with the concept of sustainable development, which is popular for global development, especially in developed countries. It is

also likely that the circular economy and sustainability considerations will play a greater role in the developed countries (Kroll, H & Gabriel, M., 2020). Given the relevance of frugal innovation to sustainable development, frugal innovation may be increasingly welcomed in developed markets.

However, frugal innovations that succeed in developed markets may have different properties, Firstly, consumers in developed markets have a much higher income level compared with consumers from emerging markets. Moreover, consumers in developed markets typically care more about product quality and functions. Consequently, customers may welcome frugal innovation differently depending on product properties. For example, frugal innovation is expected to include digital and high-tech elements. Schneider (2020) suggested that consumers in Germany weigh factors such as quality, features, and price. In addition to the price/performance ratio, consumers also consider energy efficiency or sustainability when purchasing. His most recent study verified that frugal household appliances are also relevant and accepted in industrialized countries like Germany.

If we can't have a fixed and measurable definition or criterion to define frugal innovation, it would be very difficult to investigate how customers in developed markets view frugal innovation. In this study, we will keep in line with Weyrauch and Herstatt (2017), three criteria are suggested to define frugal innovation including (1) significant cost reduction, (2) concentration on core functionalities, and (3) optimized performance level.

Substantial cost reduction is the first criterion to distinguish frugal from conventional innovation. Customers in emerging markets usually have much lower income levels than those in developed markets. In addition, manufacturers in emerging markets have limited resources for investing in new product development. Given these factors, substantial cost reduction is considered the first criterion for frugal innovation from emerging markets. Cost reduction was firstly discussed from the perspective of the manufacturer and service provider and gradually from the customer perspective, as consumers will only be satisfied when the total cost of ownership is minimized. (Bahadur & Doczi, 2016; Cappelli et al., 2010)

However, specifying the extent of cost reduction is always challenging. For example, in the literature review, descriptions such as minimum cost, much lower price, significantly lower costs, or ultra-low cost indicate that cost reduction must be significant for an innovation to be considered frugal. Rao (2013) suggests a 58%-97% cost reduction could be considered a standard. Weyrauch and Herstatt (2017) also proposed that cost reduction must be at least one-third that of comparable products but admit that the cost reduction level should depend on the user context. When it comes to developed markets, cost reduction levels may tend to be different as the user context is significantly different from that in emerging markets. In this study, we will apply the comparison approach of frugal products to alternative products originating from developed markets, so customers in developed markets can have a correct understanding of frugal innovation.

Core function concentration is seen as the second criterion for frugal innovation. Concentrating on the essential characteristics that provide the most value to customers is the concept of core function concentration (Bahadur & Doczi, 2016). In other words, streamlining a product or service places the most crucial components at the forefront, this can make the product easier to use, conserve resources, have a smaller influence on customer behavior, or match a particular lifestyle or environment (Barclay, 2014; Basu et al.2013; Flatters and Willmott 2009; Wooldridge 2010). In order to identify the core functions, unnecessary and undesired functions of a product or service, function analysis is used as a systematic approach and as a tool for determining the main

and side functions of the innovation (VDI.2010).

However, traditional research suggests that product attributes also act as quality; customers in developed countries may be particularly skeptical of quality when products come from emerging countries. (Haubl and Elrod 1999; Giannetti, V., & Rubera, G.2020). Meanwhile, some side functions may be considered as not important in emerging markets, while in developed countries, these side functions are considered important due to regulations and laws. Hence, the customers in developed markets may hold different viewpoints towards core functionalities concentration.

Optimized performance level is another criterion for frugal innovation. Fulfilling the required level of performance and quality by using appropriate, cost-effective processes should be the concept of frugal innovation (Bahadur & Doczi, 2016; Agarwal et al, 2017). Typically, engineering and functional properties, such as precision, durability, power, and speed are included in the definition of performance (Akbar & Subramaniam, 2019).

Traditional R&D-led innovations from developed markets are sometimes over-engineered. For example, Wyman (2013) provided one example showing that Western manufacturers' premium and high-priced construction equipment do not meet the requirements of the global construction equipment markets, with its growing demand for machines with technically simple and robust technologies that allow for do-it-yourself repairs. Winkler (2020) suggests that it is not enough to only focus on the technical performance (product-related performance), user-related performance should be also included. Aesthetic functions are subjectively perceptible user-related effects of an object (VDI,2019); there are less quantifiable but subjectively perceivable aspects of innovation performance. For example, consumers may not just care about the technical performance of a car, while at the same time, the performance in terms of prestige, comfort, and security could also be important. However, as user-related performance can't be quantified and differs from industry to industry, even from person to person. In this study, we will focus on product-related performance by applying a comparison approach to quantify the performance.

2.3 Research model and hypotheses

Aiming to empirically investigate the attitude of consumers (company buyers) in developed markets towards the properties of frugal innovation, and how the attitudes can be affected by corporate and environmental factors, we keep in line with Weyrauch and Herstatt (2017) and developed a model to identify customers' attitude towards substantial cost reduction, core function concentration, performance optimization. In the survey, we use a comparison approach to quantify the cost reduction level, side function reduction level, and performance optimization level. we use price level compared to alternative products from Japan to represent cost reduction level, side function level compared with alternative products from Japan to represent functional concentration level, and production capacity level and durability level compared to alternative products from Japan to represent the performance level of frugal innovation. By measuring company buyers' importance placed on specific frugal innovation properties, we could measure the attitudes of customers towards frugal innovation. In terms of corporate factors, organizational adaptation strategy, that is, exploration orientation or exploitation orientation, sustainability practice, are to be explored, while at the environmental level; environmental dynamism, and institutional distance are to be investigated. Figure 1 illustrates the conceptual model of this

study.

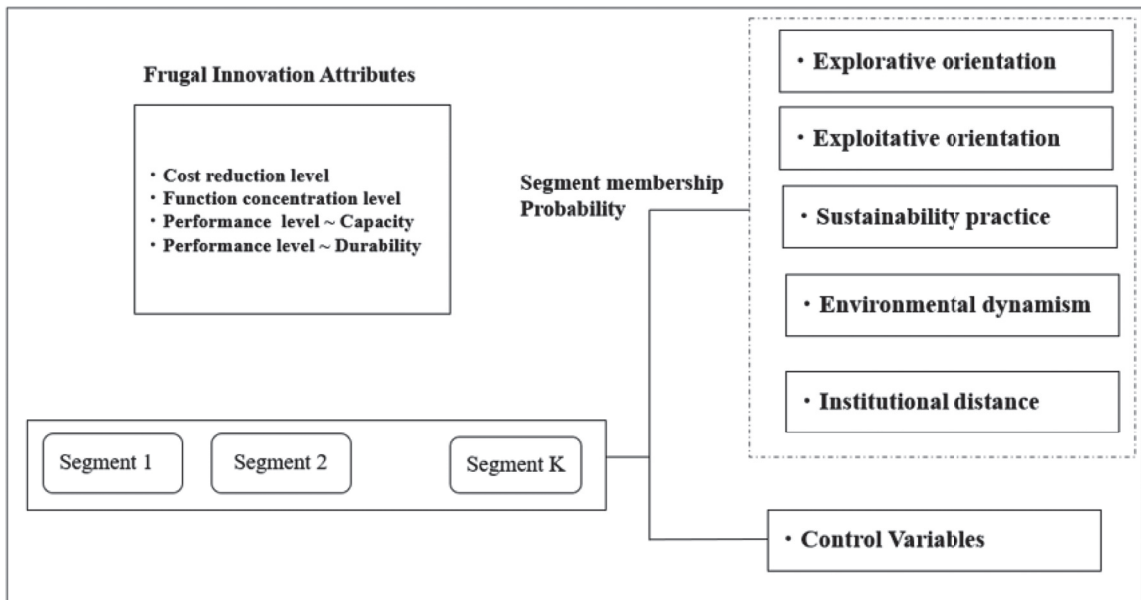


Figure 1. Conceptual model of this study

2.3.1 Exploration & exploitation orientation

March (1991) pointed out the importance of "exploration" and "exploitation" for competitive advantage and sustainable development. Exploration represents the novelty and particularity of the required knowledge. It shows the characteristics of search, discovery, high risk, experiment, and flexibility, helpful to the adaptation of the environmental changes in the new market. On the other hand, exploitation precedes the progressive adaptation of existing technology, products, and services to satisfy customer and market requirements (Jansen et al., 2006). The exploitation strategy emphasizes satisfying customer needs by improving existing knowledge, technology, products, and workmanship to enhance and expand product efficiency, production efficiency, quality, leanness, and marketization.

Exploration and exploitation strategies accomplish diverse goals and require different risk-taking behaviors. Some scholars suggest that the development of frugal innovation or the attitude towards frugal innovation could be affected and facilitated by strategic and managerial approaches. For instance, Prahalad and Mashelkar (2010) argue that firms within emerging markets have been able to develop radical business models by transforming almost every element of the value chain, thereby building disruptive business models. These firms not only hone existing capabilities but also acquire and build new capabilities to solve problems. George et al. (2012) use the term inclusive innovation for innovation within the merging market context, examining the enacting of new business models for doing such innovation as part of their exploration of organizational macro processes.

We think that the attitudes towards frugal innovation of company buyers should be influenced by the mindset, and capacity to find out new solutions for the existing problems. under the current developments such

as the economic crisis (2008~2009), recession, stagnating income, rising inflation, conflicts among developed countries, and high unemployment (Rao, 2018) world,

Firms, that apply an exploration orientation strategy may welcome the concept of frugal innovation: solve the problem and provide optimized performance by reducing side functions. Furthermore, companies applying an exploitation orientation strategy tend to emphasize the improvement of existing knowledge, technology, products, and workmanship using existing methods. In other words, these firms would not expect totally different solutions from emerging markets, even if the solution could be much cheaper, as such a frugal solution could be very risky for them. Hence, we would like to propose.

H1a. Companies applying an exploration orientation strategy are more likely to welcome function concentration and cost reduction of frugal innovation.

H1b: Companies applying an exploration orientation strategy are less likely to require the same performance level of frugal innovation compared with products from developed markets.

H2a. Companies applying an exploitation orientation strategy are less likely to welcome function concentration and cost reduction of frugal innovation.

H2b: Companies applying an exploitation orientation strategy are more likely to require the same performance level of frugal innovation compared with products from developed markets.

2.3.2 Sustainability practice

Sustainability is defined as meeting current needs without compromising the ability of future generations to meet their needs (Hahn, T& Figge, F; 2018). Corporate sustainability involves expanding the financial bottom line to a triple bottom line, which includes the environmental and social aspects of corporate performance. Driven by increasingly pressing environmental, social, and economic issues, sustainability has become a high priority for businesses in various production chains (Sancha et al., 2016). However, scholars have to find universality in the accepted understanding of corporate sustainability despite the increasing number of studies showing a positive relationship between sustainability practices and corporate performance. Two competing theories describe the impact of sustainability on corporate performance: value creation and destruction. The value-creation approach theorizes that risk can be reduced by adopting environmental and social responsibilities. In contrast, the value-destruction theory predicts that companies engaged in environmental and social responsibility lose focus on profitability and instead pursue pleasing stakeholders at the expense of shareholders.

Although some firms do not actually weigh too much on sustainability practices as they do not provide financial feedback in the short term, the influence of sustainability practices on a company in many aspects is clearer. For example, internal sustainability practices (pollution prevention and green supply chain management) can help firms reduce costs and environmental risks, creating a long-term span. External sustainability practices (green product development) can help firms meet the expectations of external stakeholders, including customers, suppliers, non-governmental organizations (NGOs), regulators, and communities, thereby improving the firm's legitimacy and reputation (Hart and Milstein, 2003).

Internal sustainability practices include waste and emission reduction in normal operations, allowing firms to lower the cost of raw materials and waste disposal in the long term, thereby increasing production efficiency (Sampath, H. R. 2015; Nishitani et al., 2011). External sustainability practices aim to minimize the product's

negative environmental impact (Shahzad et al., 2020) by introducing bio-based, recycled materials. Frugal is attributed to resource scarcity in the product cycle (from production to use to disposal). We suggest that firms that perform sustainability practices would show more interest in the concept of frugal innovation: solve the problem and provide optimized performance by reducing side functions.

H3a. Companies performing sustainability practices are more likely to welcome function concentration and cost reduction of frugal innovation.

H3b. Companies performing sustainability practices are less likely to require the same performance level of frugal innovation compared with products from developed markets.

2.3.3 Environmental dynamism

Environmental dynamism is the rate of change and the degree of instability in an industrial environment (Dess and Beard, 1984). Dynamic environments make current products and services obsolete and require the development of new ones (Jansen et al. 2005). In order to minimize this threat of obsolescence, organizational units need to develop new products and innovations consistently. In other words, understanding a dynamic environment and performing actions to adapt to it are required. However, investing in a new product or strategy entails risk, especially in a dynamic environment. Companies may try to limit resources until the expectation of return is anticipated. Under such an environment, firms may have a trend to welcome frugal products from emerging markets with much lower costs and features. Meanwhile, firms do not require the same product performance compared with products from developed markets.

H4a. Companies in a sector with higher environmental dynamism are more likely to welcome function concentration and cost reduction of frugal innovation.

H4b. Companies in a sector with higher environmental dynamism are less likely to require the same performance level of frugal innovation compared with products from developed markets.

2.3.4 Institutional distance

The original definition of institutional distance (Kostova, 1996) drew from the perspective of Scott's (1995) "three pillars" conceptualization of institutions: regulatory (rules and laws that exist to ensure stability and order in societies), cognitive (established cognitive structures in society that are taken for granted), and normative (domain of social values, cultures, and norms). Accordingly, institutional distance between two countries was defined as the difference between their regulatory, cognitive, and normative institutions (Kostova, 1996).

Some scholars suggest that the contextual attributes of emerging markets, such as environmental constraints (lack of institutions, infrastructure, and resources), in combination with strategic managerial decisions enable the capabilities for frugal innovation. For instance, Ernst et al. (2014) report a quantitative study undertaken to explain why the challenging environment of emerging markets with its lack of institutions can facilitate a firm's ability to develop frugal innovation. If the institutional structure of the industry is quite different, the company may be cautious about the frugal innovation concept from emerging markets.

H5a. Companies in the industry with a longer institutional distance from emerging markets are less likely to welcome function concentration and cost reduction of frugal innovation.

H5b. Companies in the industry with a longer institutional distance from emerging markets are more likely to

require the same performance level of frugal innovation compared with products from developed markets.

3. Methodology

3.1 Sample

Data was collected through a conjoint experiment in Japan from November 2022 to April 2023.

As a developed market with an aging population, Japan is seeing significant cost increases, especially in the manufacturing industry. Meanwhile, given Japan's close geographic and cultural distance from the biggest emerging market (China), frugal innovation from emerging markets to Japan could be easier. We consider Japan as an appropriate choice to collect data in this study. A database owned by a Japanese survey company, which contains purchase persons from 1,000 companies in the chemical, petrochemical, and pharmaceutical, food sectors, was used as a sampling frame. This database should be representative since it contains companies from different industries, different sizes, different establishment years.

Table 1. Descriptive statistics of the sample (n=165)

Company profile	Sample Size	Percentage	Company profile	Sample size	Percentage
Years of establishment			Annual sales		
< 5	5	3.0%	< 100 million JPY	6	3.6%
5 -- 10	9	5.5%	100 million ~ 1 billion JPY	15	9.1%
10 -- 20	11	6.7%	1 ~ 10 billion JPY	33	20.0%
20 -- 30	18	10.9%	10 ~ 50 billion JPY	22	13.3%
> 30	122	73.9%	50 ~ 100 billion JPY	12	7.3%
Employee number			100 billion ~ 1 trillion JPY	37	22.4%
1 ~ 99	28	17.0%	> 1 trillion JPY	40	24.2%
100 ~ 499	44	26.7%			
500 ~ 999	21	12.7%			
1000 ~ 3000	26	15.8%			
> 3000	46	27.9%			

3.2 Experimental design

An experiment for conjoint analysis was designed to assess the extent to which subjects welcome the frugal innovation properties. This tendency was measured by asking subjects to evaluate several centrifuge and dryer product concepts; we chose centrifuge and dryers for three reasons: Firstly, as we conduct this study to investigate corporate behavior towards frugal innovation from emerging markets, we need to find out products which are widely used in the manufacturing industry, centrifuge, and dryer is widely used in chemical, pharmaceutical and petrochemical industries. Secondly, the role of machinery is usually apparent, which means purchasing staff understand well what performance level and function will be needed. For example, a dryer's purpose is to dry powder to certain moisture levels and in some specific capacity. Finally, compared with general commodities, machinery has a larger value, which means firms will make the purchasing decision carefully and

normally conduct a comparison with brands in terms of cost, function, and performance.

We designed the experiment by presenting same pictures of centrifuge and dryer from Chinese makers, which have 4 different frugal innovation criteria to purchasing staffs' evaluation: firstly, cost reduction level compared with alternative products from developed markets (30~50% price level of alternative products from Japan; 50~70% price level of alternative products from Japan; 70~90% price level of alternative products from Japan), and side function level (except for main function, with only 30% of side functions of alternative products from Japan; except for core function, with 50% side functions of alternative products from Japan; except for main function, with 70% side function of alternative products from Japan); finally performance level which includes capacity level ((80~100% capacity level of alternative products from Japan; 60~80% capacity level of alternative products from Japan; 40~60% capacity level of alternative products from Japan), and durability level (70~90% durability level of alternative products from Japan; 50~70% durability level of alternative products from Japan; 30~50% durability level of alternative products from Japan).

3.3 Measurement model

Corporate factors and environmental factors are measured using measurement items from previous studies. For exploitation orientation and exploration orientation, we keep in line with Lubatkin (2006), taking four items for exploitation orientation measurement and four items for exploration orientation measurement. We use six items from Bansal (2005) for sustainability practice, with more items for environmental, social, and environmental sustainability measurement.










<p>Price Level: 50%~70% of close products from Japan Function level: close at main function, 50% of side functions compared with close products from Japan Capacity level: 40%~60% compared with close products from Japan Durability level: 30%~50% compared with close products from Japan</p>  <p style="text-align: right;">1</p>	<p>Price Level: 70%~90% of close products from Japan Function level: close at main function, 70% of side functions compared with close products from Japan Capacity level: 60%~80% compared with close products from Japan Durability level: 30%~50% compared with close products from Japan</p>  <p style="text-align: right;">2</p>	<p>Price Level: 30%~50 of close products from Japan Function level: close at main function, 30% of side functions compared with close products from Japan Capacity level: 80%~100% compared with close products from Japan Durability level: 30%~50% compared with close products from Japan</p>  <p style="text-align: right;">3</p>
<p>Price Level: 70%~90% of close products from Japan Function level: close at main function, 30% of side functions compared with close products from Japan Capacity level: 40%~60% compared with close product from Japan Durability level: 50%~70% compared with close product from Japan</p>  <p style="text-align: right;">4</p>	<p>Price Level: 30%~50% of close products from Japan Function level: close at main function, 50% of side functions compared with close products from Japan Capacity level: 60%~80% compared with close product from Japan Durability level: 50%~70% compared with close product from Japan</p>  <p style="text-align: right;">5</p>	<p>Price Level: 50%~70% of close product from Japan Function level: close at main function, 30% of side functions compared with close products from Japan Capacity level: 80%~100% compared with close products from Japan Durability level: 50%~70% compared with close products from Japan</p>  <p style="text-align: right;">6</p>
<p>Price Level: 30%~50% of close products from Japan Function level: close at main function, 70% of side functions compared with close products from Japan Capacity level: 40%~60% compared with close products from Japan Durability level: 70%~90% compared with close product from Japan</p>  <p style="text-align: right;">7</p>	<p>Price Level: 50%~70% level of close products from Japan Function level: close at main function, 30% of side functions compared with close products from Japan Capacity level: 60%~80% compared with close product from Japan Durability level: 70%~90% compared with close product from Japan</p>  <p style="text-align: right;">8</p>	<p>Price Level: 70%~90% of close products from Japan Function level: close at main function, 50% of side functions compared with close products from Japan Capacity level: 80%~100% compared with close products from Japan Durability level: 70%~90% compared with close products from Japan</p>  <p style="text-align: right;">9</p>

Figure 2. Illustration of the profiles presented to the experiment subjects

As for environmental factors, 4 item measurements from Li et al. (2014) were used for environmental dynamism. We measure institutional distance by using two items, asking whether business is easily influenced by government regulation and laws or industrial standards and whether the regulation, law, and industrial

standards are much different from emerging markets. We next confirmed the measures' convergent validity based on composite reliability and a variance-extracted measure, the results shows that the composite of these factors are reliable.

3.4 Segmentation method and latent class conjoint model

In the case of marketing research, researchers have used various descriptors to partition consumers into several segments, including demographic and psychographic or lifestyle (Dahana et al., 2019) variables. We assume that company buyers can also be sorted into different segments, and we aim to segment the companies on their responses to frugal innovation attributes. We try to find several segments with different attitudes towards frugal innovation from emerging markets. Companies in different segments are presumed to have different organizational traits or businesses in different environments. The relationship between attitudes towards frugal innovation from emerging markets at the segment level and these characteristics is modeled using a latent class analysis. In what follows, we describe our analytical approach in detail.

We assume that attitude towards frugal innovation varies among company segments. Although we do not directly observe the segments, we consider the existence of several "latent" segments whose members have different propensities to purchase frugal innovation from emerging markets. The membership of each consumer in every segment is unknown, but we can make statistical inferences about it based on available company information. In our analysis, we assume that the membership probability of companies to a particular segment can be explained by their organizational characteristics and operating environmental variables. Let i ($i=1,2, \dots, n$) denote the suffix of a company, where n represents the number of companies. Further, let us assume that K company segments are in the market. Denoting the probability that customer i belongs to segment $K \in \{1,2, \dots, K\}$ by P_{ik} , we use a logit-link function to allow the influence of organizational characteristics and environmental variables on this probability as follows.

$$P_{ik} = \frac{\exp(Z_{ik})}{1 + \sum_{l=2}^K \exp(Z_{il})} \quad (1)$$

It can be verified that P_{ik} takes a value between 0 and 1, where a higher value represents a higher probability of belonging to the respective segment. Equation (1) implies that this probability depends Z_{ik} , which is defined as follows.

$$Z_{ik} = \lambda_{0k} + \lambda_{1k}Epra_i + \lambda_{2k}Epit_i + \lambda_{3k}Sust_i + \lambda_{4k}Envi_i + \lambda_{5k}Inst_i + \lambda_{6k}Fsize_i + \lambda_{7k}Fage_i + \lambda_{8k}Sale_i + \lambda_{9k}Hist_i. \quad (2)$$

Here, We *Epra*, *Epit*, *Sust* are company trait variables for exploration orientation, exploitation orientation, sustainability practice. Meanwhile, *Envi* and *Inst* are the environmental variables for environmental dynamism and institutional distance. Finally, *Fsize* is the firm size shown by employee numbers. *Fage* means years of establishment, *Sale* means the company's annual sales, and *Hist* is years since the company's establishment. The effect of these variables is captured by the parameter λ_s , where a higher (lower) value of λ implies that membership probability increases (decreases) with the respective variable. For identification purposes, we fix these parameters with respect to the first segment at a zero value (Gupta and Chintagunta, 1994). Thus, this segment serves as a baseline segment to which the results for the remaining segments are compared and

interpreted.

As described in the above paragraph, we consider a situation where different companies evaluate a set of products or profiles. (machinery from emerging markets). Let J be the number of products and assume that company i belongs to segment k . One company’s evaluation of the product j ($j=1, 2, \dots, J$), denoted by y_{ij} , is given by:

$$y_{ij} = \beta_{0k} + \beta_{1k}Cost_j + \beta_{2k}Function_j + \beta_{3k}Capacity_j + \beta_{4k}Durability_j + \varepsilon_{ijk} \quad (3)$$

Where $Cost_j$ is a dummy variable taking a value of -1 if product j has a 30~50% price level compared with the alternative product from Japan, and equals 0 if product j has a 50~70% price level compared with product from Japan, equals 1 if product j has a 70~90% price level compared with products from Japan? Similarly, $Function_j$, $Capacity_j$, and $Durability_j$ are operationalized relative to their levels. In this specification, the degree of customers’ attitude is captured by the part-worth β_{1k} , where a higher value of the parameter implies a higher importance placed on the attributes, and consequently, a higher likelihood of acceptance of the frugal innovation from developing markets. (Eastman and Eastman, 2011). Finally, ε_{ijk} denotes a random error representing the influence of other factors not included in the analysis. We assume that ε_{ijk} follows a normal distribution with a mean of 0. Conditional on the membership of company i in segment k , we can define the company’s likelihood function in the model described in Equation (3); that is, the probability of obtaining the consumer data under the model’s assumption. The likelihood function is given by:

$$y_i(\beta_k, \sigma_k^2 | y_{ik}) = \prod_i \frac{1}{\sqrt{2\pi\sigma_k^2}} \exp\left(-\frac{(y_{ik}-\beta'_k x_j)^2}{2\sigma_k^2}\right). \quad (4)$$

Here $\beta'_k x_j$ is the deterministic part of the right-hand side of Equation (3). The estimation of model parameters for all segments is conducted based on the unconditional likelihood function. To obtain the unconditional likelihood function, we must marginalize the likelihood function over the distribution of segment membership. This can be done by weight-averaging the conditional likelihood function in Equation (4) using the membership probability p_{ik} as follows:

$$\ell(\beta, \sigma, \lambda | data) = \prod_i \sum_k p_{ik} l_i(\beta_k, \gamma_k, \sigma_k^2 | d_i, x_i), \quad (5)$$

Where $\beta = (\beta_k, \beta_k, \beta_k, \dots, \beta_k)$, $\sigma = (\sigma_k^2, \sigma_k^2, \dots, \sigma_k^2)$ and $\lambda = (\lambda_{02}, \dots, \lambda_{9k})$, Model estimation is implemented by finding the parameters’ value that maximizes Equation (5). Here, we used the expectation-maximization algorithm to obtain the estimates of the parameters, which can be easily implemented using the flexmix package in R software. Finally, using the estimates of $\hat{\beta}$, $\hat{\sigma}$, $\hat{\lambda}$, we can predict companies’ posterior membership probability in each segment using the following identity.

$$\frac{P_{ik} | data = \hat{p}_{ik} l_i(\hat{\beta}_k, \hat{\sigma}_k^2 | y_{ij})}{\sum_{l=1}^k \hat{p}_{il} l_i(\hat{\beta}_l, \hat{\sigma}_l^2 | y_{ij})}. \quad (6)$$

3.5 Segment number

As the number of segments is unknown prior to the analysis, we estimated multiple models imposing different numbers of segments and subsequently chose the one with the best explanatory power. We use a

Bayesian information criterion (BIC) to assess model accuracy. Figure 3 depicts the results of the models with one to six segments. The BIC decreases when we move from the model with one segment to two segments, suggesting a significant improvement in model accuracy. However, when we add the number of segments, from three to six segments, the BIC increases, showing that two segments should be the best choice. Accordingly, we selected the model with two segments and will use its results hereafter to examine the proposed hypotheses' validity.

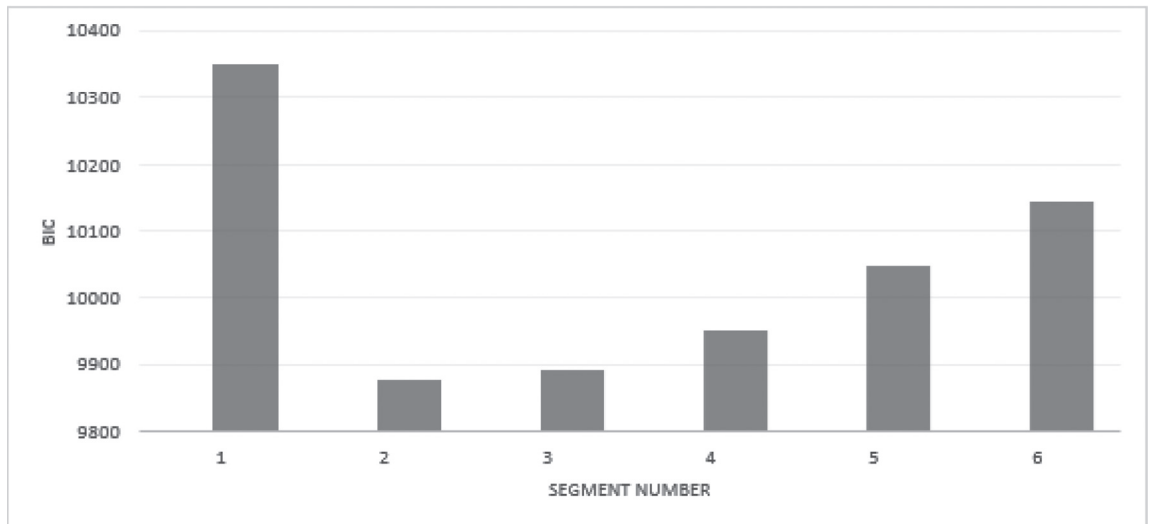


Figure 3. Segment number selection using BIC

3.6 Part-worth estimates and segment interpretation.

Next, we report the estimation results of part-worth utilities for each segment (Table 4). At first, we computed the segments' size using the posterior membership probability given in Equation (6). Segment 1 is the larger segment, with 95 companies (57%). The part-worth utility of Low cost ($\beta_{11} = -0.53$; $P=0.71$); Middle cost ($\beta_{21} = -0.37$; $P=0.80$); Low functionality ($\beta_{31} = -2.03$; $P=0.17$), Middle functionality ($\beta_{41} = 0.64$; $P=0.66$) are insignificant, suggesting that these companies do take cost and side attributes as important parameters. Traditional research suggests that consumers in developed countries use price to infer quality, as superior quality typically commands a higher price. The price-signaling of quality is common for new products whose quality level is still unclear. (Gerstner 1985; Tellis 1986). Functionality may also act as a signal of quality as well, as consumers in developed countries may be particularly skeptical of quality when products come from emerging countries. (Govindarajan and Trimble, 2012; Giannetti, V., & Rubera, G.2020). Suppose customers in developed markets still suspect product quality and performance of frugal products from emerging markets. In that case, they may not take cost reduction and side attributes reduction as a reference factor when deciding whether to accept the products.

On the other hand, the part-worth estimates of Low capacity ($\beta_{51} = -6.33$; $P<0.01$), Middle capacity ($\beta_{61} = -3.23$; $P=0.05$); Low durability ($\beta_{71} = -13.07$; $P<0.01$), Middle durability ($\beta_{81} = -6.61$; $P<0.01$) turns out to

be significant and negative, suggesting that customers in developed nations firstly value the performance of the frugal products from developed markets if the performance of the products is much worse than alternative products from developed markets. They will not accept the products even with much lower cost.

Segment 2 is the smaller segment, with 70 companies (43%). The part estimate showed almost the same trends. Firstly, Low cost ($\beta_{12} = -0.58$; $P=0.78$); Middle cost ($\beta_{22} = -1.05$; $P=0.62$); Low functionality ($\beta_{32} = -2.64$; $P=0.17$) and middle functionality ($\beta_{42} = 0.58$; $P=0.66$) are insignificant, suggesting that these companies take cost reduction and side attributes reduction level as a factor when deciding whether to accept frugal innovation or not because they suspect the performance. Moreover, the part-worth estimates of Low capacity ($\beta_{52} = -8.91$; $P<0.05$), Middle capacity ($\beta_{62} = -8.27$; $P=0.05$); Low durability ($\beta_{72} = -24.92$; $P<0.01$), Middle durability ($\beta_{82} = -21.49$; $P<0.01$) turns out to be significant and negative. Compared with Segment 1, customers in Segment 2 are more negative over lower performance levels such as capacity and durability.

Table 2. Estimation results of segment-level part-worth utilities (n=165)

	Segment 1 (n = 95)		Segment 2 (n = 70)	
	Estimate	P-value	Estimate	P-value
Intercept	65.88	0.00 ***	41.59	0.00 ***
Low cost	-0.53	0.71	-0.58	0.78
Medium cost	-0.37	0.80	-1.05	0.62
Low functionality	-2.03	0.17	-2.64	0.22
Medium functionality	0.64	0.66	0.58	0.78
Low capacity	-6.33	0.00 ***	-8.91	0.02 *
Medium capacity	-3.23	0.03 *	-8.27	0.04 *
Low durability	-13.07	0.00 ***	-24.92	0.00 ***
Medium durability	-6.61	0.00 ***	-21.49	0.00 ***

Note (s): * $P<0.01$, ** $p<0.05$, * $P<0.1$**

3.7 Segment membership and hypothesis testing

Table (5) displays the estimation results of segment membership parameters or λ . As described in the methodology section, the parameters of the baseline segment are fixed at zero for identification purposes. Hence, the effect of the covariates on the segment membership probability in each segment is interpreted relative to the baseline segment's value. As the results show that companies in both segments 1 and 2 do not take cost reduction and side attributes reduction as an important factor for their acceptance of frugal innovation, our hypotheses 1a, 2a, 3a, 4a, 5a are not supported. Explorative orientation' effect on membership in Segment 2 is negative and significant ($\lambda = -0.078$, $p<0.05$). Therefore, companies applying an explorative orientation strategy are less likely to belong to Segment 2. On the other hand, customers in Segment 2 are more negative over lower performance levels, so companies applying an exploration orientation strategy are less likely to ask for the same performance level of frugal innovation. Hence, our *Hypothesis 1b* is supported. On the other hand, the Exploitative orientation' effect on membership in Segment 2 is positive and significant ($\lambda = -0.088$, $p<0.01$). Therefore, companies applying an exploitative orientation strategy are more likely to belong to segment 2,

which means companies applying an exploitative orientation strategy are more likely to ask for the same performance level of frugal innovation from emerging markets. Hence *Hypothesis 2b* is supported.

Sustainable practice’ effect on membership in Segment 2 is negative and significant ($\lambda = -0.95, p < 0.1$). Therefore, companies applying sustainable practices are less likely to belong to Segment 2. In other words, companies applying sustainable practices are less likely to ask for the same performance level of frugal innovation to products in developed markets; hence *Hypothesis 3b* is supported.

Table 3. Segment membership parameters (n=165)

	Segment 1 (n= 95)		Segment 2 (n= 70)	
	Estimate	P-value	Estimate	P-value
Intercept	0	Fixed	-4.21	0.02 *
Explorative orientation	0	Fixed	-7.87	0.05 .
Exploitative orientation	0	Fixed	8.88	0.01 *
Sustainable practice	0	Fixed	-0.95	0.07
Environmental dynamism	0	Fixed	6.24	0.03 *
Institutional distance	0	Fixed	-10.3	0.04 *
Company size	0	Fixed	-0.22	0.04 *
Company age	0	Fixed	-0.28	0.11
Annual sales	0	Fixed	0.00	0.96

Note (s): The parameters in Segment 1 are normilized to zero for identification purposes
*****p < 0.01, **p < 0.05, *P < 0.1**

Environmental dynamism’ effect on membership in Segment 2 is positive and significant ($\lambda = 6.24, p < 0.1$). Therefore, companies facing great competition are more likely to ask for the same performance of frugal innovation from emerging markets. Hence *Hypothesis 4b* is rejected. As machinery is normally a big amount investment, and it is the essential part for whole product lines, maybe within a high competition environment, companies can’t afford risk over production line. Consequently, companies in such an environment would likely ask for close or similar performance levels of frugal products, especially products with great investment. Institutional distance’ effect on membership in Segment 2 is positive and significant ($\lambda = -10.3, p = 0.04$), therefore, companies in an institutional environment that is far from emerging markets are more likely to ask for a higher performance level of frugal products, consequently *Hypothesis 5b* is supported.

3.8 The demographic variables’ results

Finally, we examined how demographic variables affect the tendency toward customer perceptions of frugal innovation properties. First, the effect of company age and annual sales on membership in Segment 2 is insignificant, indicating that age and annual sales do not influence companies’ viewpoints on frugal products. However, the effect of company size on membership in segment 2 is negative and significant, suggesting that larger companies are less likely to demand the same performance level of frugal innovation from emerging markets. Therefore, small companies are less likely to take risks, especially for machinery that requires significant investment.

4. Discussion and conclusion

This study examines customers' attitudes toward frugal innovation properties in developed markets, company strategies, and environmental factors that impact these perspectives. By implementing a conjoint experiment (industrial machinery), we confirmed and verified company buyers' viewpoints on frugal innovation properties in developed markets (Japan) and how these viewpoints are affected by company strategies and environmental factors.

First, Previous study suggests lower-income consumers or company buyers require frugal innovation for substantial cost reduction. For example, Govindarajan (2011, 2012) suggested that substantial cost reductions may help expand demand in developed countries because some customers in developed countries may require frugal innovations;

In our study, the results show the trend that customers (company buyers) in developed markets may use price and attributes to infer quality and performance (Gerstner, 1985; Tellis, 1986; Giannetti, and Rubera, 2020). If customers are uncertain about the performance and quality level of frugal innovation, they do not decide whether to accept frugal innovation from emerging markets based on substantial cost reduction and core function concentration.

Second, the results support our hypothesis that companies applying different strategies would have different attitudes towards the performance level of frugal innovation from emerging markets. Although company buyers in developed markets are negative toward lower performance levels, companies applying an explorative orientation strategy are less likely to demand the same performance level of frugal innovation compared with alternative products from developed markets. In contrast, companies applying an exploitative orientation strategy are more likely to ask for same performance level. Previous studies suggest that exploration-oriented companies are more open to novelty, experiments, and risk-taking, whereas exploitation-oriented companies prefer a progressive adaptation to existing products (Jansen et al. 2006). Our results are consistent with the opinion.

Our results also suggest that companies applying sustainable practices are less likely to seek the same level of frugal innovation in developed markets. As frugal innovation has the property of resource scarcity in the life cycle of a product from production to disposal (Sampath, 2015), this property is realized by deleting unnecessary side functions and having a customized performance level. Consequently, companies applying sustainable practices are less likely to ask for same performance levels of frugal innovation compared with alternative products from developed markets.

Finally, we propose and confirm that environmental factors influence customers' perspectives of frugal innovation properties. Although we propose that companies with businesses in a dynamic industry would be less likely to require the same performance level of frugal innovation, they would try to limit or reduce resources invested in contending with technology updates and competition. However, the results suggest that companies are more likely to seek same performance level of frugal innovation performance. This is because companies do not prefer to take risks when faced with severe competition in the industry. Finally, for institutional distance, we propose and confirm that companies operating in an industry, where the regulatory, cognitive, and normative distance (Scott and Bruce, 1995) are far from the same in emerging markets, are more likely to demand the same

performance level of frugal innovation compared with alternative products from developed markets.

5. Implication and limitation

Frugal innovation is seen as a significant approach to fit emerging markets with special needs and requirements so that non-affluent customers in developing markets can have opportunities for consumption (Pralhad, 2012). Some scholars suggest that frugal innovation can also find its market in developed countries, as some customers in developed markets with lower income levels welcome frugal innovation. Moreover, scholars suggest that frugal innovation can help expand the original market in developed markets (Govindarajan, 2012).

However, our results suggest that customers in developed markets have different perspectives towards the properties of frugal innovation. Firstly, a substantial cost reduction through core function concentration is critical for frugal innovation in BOP markets. However, customers (company buyers) in developed markets do not consider cost reduction as an important factor to judge frugal innovation because they typically use price and functionality to infer quality and performance; a much lower cost level makes customers suspect the performance and quality of frugal innovation in developed markets. This result suggests that companies should adopt a different strategy instead of just focusing on cost reduction if they want to promote frugal products to developed markets. In addition, our results show that company buyers are generally negative about the lower performance levels of frugal innovation compared to alternative products from developed markets. Optimized performance at least getting close to alternative products from developed markets may be needed.

Finally, different company strategies and business environments can influence customers' attitudes towards lower performance levels. Consequently, finding suitable targets would be the second step or challenge for frugal innovation to be sold to developed markets.

Few scholars focused on frugal innovation research in developed markets, and most of these studies are based on case analysis, as a well-recognized definition of frugal innovation was proposed only a few years ago. This study follows the definition of frugal innovation proposed by Weyrauch and Herstatt (2017), empirically analyzed how customers in developed markets view frugal innovation properties. The totally different results compared with frugal innovation studies in developing markets may give us a hint that why most frugal innovations can't succeed in developed markets. Our study also contributes to the practical field by suggesting that if firms in emerging markets want to promote their frugal products to developed markets, a different strategy should be considered.

However, this study has some limitations. First, we investigated company buyers over machinery products, this may be a reason for some bias as machinery products typically require huge investments. Further studies targeting general consumers and general commodities should be conducted to verify these results. Moreover, a comparative study on frugal innovation in different emerging markets should be done, totally different results are expected so we can have a clear image over the diffusion patterns of frugal innovations in global markets.

Reference

- Agarwal, N., Grottke, M., Mishra, S., & Brem, A. (2016). A systematic literature review of constraint-based innovations: State of the art and future perspectives. *IEEE Transactions on Engineering Management*, 64(1), 3-15.
- Ahlstrom, D. (2010). Innovation and growth: How business contributes to society. *Academy of management perspectives*, 24(3), 11-24.
- Akbar, S., & Subramaniam, N. (2019). Linking frugal innovation and sustainable development: Leveraging corporate accountability mechanisms. *Frugal Innovation: A Global Research Companion*, Routledge, 196-211.
- Angot, J., & Plé, L. (2015). Serving poor people in rich countries: the bottom-of-the-pyramid business model solution. *Journal of Business Strategy*, 36(2), 3-15.
- Bahadur, A., & Doczi, J. (2016). Unlocking resilience through autonomous innovation. *London: Overseas Development Institute*.
- Bansal, P. (2005). Evolving sustainably: A longitudinal study of corporate sustainable development. *Strategic management journal*, 26(3), 197-218.
- Barclay, C. (2014). Using frugal innovations to support cybercrime legislations in small developing states: introducing the cyber-legislation development and implementation process model (CyberLeg-DPM). *Information Technology for Development*, 20(2), 165-195.
- Basu, R. R., Banerjee, P. M., & Sweeny, E. G. (2013). FRUGAL INNOVATION. *Journal of Management for Global sustainability*, 1(2).
- Bhatti, Y. A. (2012). What is frugal, what is innovation? Towards a theory of frugal innovation. *Towards a Theory of Frugal Innovation (February 1, 2012)*.
- Brem, A., & Wolfram, P. (2014). Research and development from the bottom up-introduction of terminologies for new product development in emerging markets. *Journal of Innovation and Entrepreneurship*, 3(1), 1-22.
- Cai, Q., Ying, Y., Liu, Y., & Wu, W. (2019). Innovating with limited resources: The antecedents and consequences of frugal innovation. *Sustainability*, 11(20), 5789.
- Cappelli, P. (2010). *The India way: How India's top business leaders are revolutionizing management*. Harvard Business Press.
- Chuang, T. T., Nakatani, K., & Zhou, D. (2009). An exploratory study of the extent of information technology adoption in SMEs: an application of upper echelon theory. *Journal of Enterprise information management*, 22(1/2), 183-196.
- Dahana, W. D., Miwa, Y., & Morisada, M. (2019). Linking lifestyle to customer lifetime value: An exploratory study in an online fashion retail market. *Journal of Business Research*, 99, 319-331.
- Dess, G. G., & Beard, D. W. (1984). Dimensions of organizational task environments. *Administrative science quarterly*, 52-73.
- Ernst, A., Alkass, K., Bernard, S., Salehpour, M., Perl, S., Tisdale, J., ... & Frisé, J. (2014). Neurogenesis in the striatum of the adult human brain. *Cell*, 156(5), 1072-1083.

- European Commission (2016) A conceptual analysis of foundations, trends and relevant potentials in the field of Frugal Innovation (for Europe)
- Eurostat. (2017). *Sustainable development in the European Union: monitoring report on progress towards the SDGS in an EU context*. Publications office of the European Union.
- Flatters, P., & Willmott, M. (2009). Understanding the post-recession consumer. *Harvard Business Review*, 87(7/8), 106-112.
- George, G., McGahan, A. M., & Prabhu, J. (2012). Innovation for inclusive growth: Towards a theoretical framework and a research agenda. *Journal of management studies*, 49(4), 661-683.
- Gerstner, E. (1985). Do higher prices signal higher quality?. *Journal of marketing research*, 22(2), 209-215.
- Giannetti, V., & Rubera, G. (2020). Innovation for and from emerging countries: a closer look at the antecedents of trickle-down and reverse innovation. *Journal of the Academy of Marketing Science*, 48, 987-1008
- Govindarajan, V., & Ramamurti, R. (2011). Reverse innovation, emerging markets, and global strategy. *Global strategy journal*, 1(3-4), 191-205.
- Govindarajan, V., & Trimble, C. (2012). Reverse innovation: a global growth strategy that could pre-empt disruption at home. *Strategy & Leadership*, 40(5), 5-11.
- Gupta, S., & Chintagunta, P. K. (1994). On using demographic variables to determine segment membership in logit mixture models. *Journal of Marketing Research*, 31(1), 128-136.
- Hahn, T., Figge, F., Pinkse, J., & Preuss, L. (2018). A paradox perspective on corporate sustainability: Descriptive, instrumental, and normative aspects. *Journal of Business Ethics*, 148, 235-248.
- Hart, S. L., & Milstein, M. B. (2003). Creating sustainable value. *Academy of Management Perspectives*, 17(2), 56-67.
- Häubl, G., & Elrod, T. (1999). The impact of congruity between brand name and country of production on consumers' product quality judgments. *International Journal of research in Marketing*, 16(3), 199-215.
- Herstatt, C., & Tiwari, R. (2020). Opportunities of frugality in the post-corona era. *International Journal of Technology Management*, 83(1-3), 15-33.
- Hossain, M. (2016). Frugal innovation: a systematic literature review. Available at SSRN 2768254.
- Hossain, M. (2018). Frugal innovation: A review and research agenda. *Journal of cleaner production*, 182, 926-936.
- Jansen, J. J., Van Den Bosch, F. A., & Volberda, H. W. (2005). Managing potential and realized absorptive capacity: how do organizational antecedents matter?. *Academy of management journal*, 48(6), 999-1015.
- Jansen, J. J., Van Den Bosch, F. A., & Volberda, H. W. (2006). Exploratory innovation, exploitative innovation, and performance: Effects of organizational antecedents and environmental moderators. *Management science*, 52(11), 1661-1674.
- Kostova, T. (1996). *Success of the transnational transfer of organizational practices within multinational companies*. University of Minnesota.
- Kroll, H., & Gabriel, M. (2020). Frugal innovation in, by and for Europe. *International Journal of Technology Management*, 83(1-3), 34-54.
- Lu, Z., & Nakagawa, K. (2022). The Influence of Environmental Factors on Product Innovations in Emerging Markets: The Institutional Theory Perspective. *International Business Research*, 15(9), 1-1.

- Li, D. Y., & Liu, J. (2014). Dynamic capabilities, environmental dynamism, and competitive advantage: Evidence from China. *Journal of business research*, 67(1), 2793-2799.
- Lubatkin, M. H., Simsek, Z., Ling, Y., & Veiga, J. F. (2006). Ambidexterity and performance in small-to medium-sized firms: The pivotal role of top management team behavioral integration. *Journal of management*, 32(5), 646-672.
- March, J. G. (1991). Exploration and exploitation in organizational learning. *Organization science*, 2(1), 71-87.
- McCollum, D. L., Zhou, W., Bertram, C., De Boer, H. S., Bosetti, V., Busch, S., ... & Riahi, K. (2018). Energy investment needs for fulfilling the Paris Agreement and achieving the Sustainable Development Goals. *Nature Energy*, 3(7), 589-599.
- Nishitani, K. (2011). An empirical analysis of the effects on firms' economic performance of implementing environmental management systems. *Environmental and Resource Economics*, 48, 569-586.
- Prahalad, C. K., & Mashelkar, R. A. (2010). Innovation's holy grail. *Harvard Business Review*, 88(7/8), 132-141.
- Prahalad, C. K. (2012). Bottom of the pyramid as a source of breakthrough innovations. *Journal of product innovation management*, 29(1), 6-12.
- Rao, B. C. (2013). How disruptive is frugal?. *Technology in society*, 35(1), 65-73.
- Rao, B. C. (2018). Science is indispensable to frugal innovations. *Technology Innovation Management Review*, 8(4).
- Sampath, H. R. (2015). Effect of corporate social responsibility on share prices.
- Sancha, C., Gimenez, C., & Sierra, V. (2016). Achieving a socially responsible supply chain through assessment and collaboration. *Journal of Cleaner Production*, 112, 1934-1947.
- Schleinkofer, U., Herrmann, T., Maier, I., Bauernhansl, T., Roth, D., & Spath, D. (2019). Development and evaluation of a design thinking process adapted to frugal production systems for emerging markets. *Procedia Manufacturing*, 39, 609-617.
- Schneider, S. (2020). Combining the characteristics of sustainability, frugal innovations and washing machines in the industrial nations-A literature-based analysis of the common features for future sustainable developments. *Journal of Economic Development, Environment and People*, 9(2), 50-59.
- Schuster, T., & Holtbrügge, D. (2014). Resource dependency, innovative strategies, and firm performance in BOP markets. *Journal of Product Innovation Management*, 31, 43-59.
- Scott, S. G., & Bruce, R. A. (1995). Decision-making style: The development and assessment of a new measure. *Educational and psychological measurement*, 55(5), 818-831.
- Shahab, Y., Ntim, C. G., Chen, Y., Ullah, F., Li, H. X., & Ye, Z. (2020). Chief executive officer attributes, sustainable performance, environmental performance, and environmental reporting: New insights from upper echelons perspective. *Business Strategy and the Environment*, 29(1), 1-16.
- Shahzad, M., Qu, Y., Zafar, A. U., Rehman, S. U., & Islam, T. (2020). Exploring the influence of knowledge management process on corporate sustainable performance through green innovation. *Journal of Knowledge Management*, 24(9), 2079-2106.
- Shibin, K. T., Dubey, R., Gunasekaran, A., Luo, Z., Papadopoulos, T., & Roubaud, D. (2018). Frugal innovation for supply chain sustainability in SMEs: multi-method research design. *Production Planning & Control*,

29(11), 908-927.

- Slavova, M. (2014). Consumerism as a source for innovation and product development.
- Soni, P., & T. Krishnan, R. (2014). Frugal innovation: aligning theory, practice, and public policy. *Journal of Indian Business Research*, 6(1), 29-47.
- Tellis, G. J. (1986). Beyond the many faces of price: an integration of pricing strategies. *Journal of marketing*, 50(4), 146-160.
- Tiwari, R., & Herstatt, C. (2012). Assessing India's lead market potential for cost-effective innovations. *Journal of Indian Business Research*, 4(2), 97-115.
- Tiwari, R., & Kalogerakis, K. (2019). What drives frugal innovation in an economically developed economy. *Frugal Innovation: A Global Research Companion*.
- VDI (2019). Function analysis: Fundamentals and methode. In VDI 2803 part 1. Berlin: Beuth Verlag GmbH.
- Weyrauch, T., & Herstatt, C. (2017). What is frugal innovation? Three defining criteria. *Journal of frugal innovation*, 2(1), 1-17.
- Winkler, T., Ulz, A., Knöbl, W., & Lercher, H. (2020). Frugal innovation in developed markets-Adaption of a criteria-based evaluation model. *Journal of Innovation & Knowledge*, 5(4), 251-259.
- Wohlfart, L., Groganz, J., Manefeld, S., & Fröhlich, F. (2021). Frugal Innovation for Developed Markets: Target Customers, Characteristics, Success Factors. In *Frugal Innovation and Its Implementation: Leveraging Constraints to Drive Innovations on a Global Scale* (pp. 141-164). Cham: Springer International Publishing.
- Wooldridge, A. (2010). The world turned upside down. *The Economist*, 15, 12.
- Wyman, O. (2013). Global construction equipment market: Chinese companies set the pace. *New York, Oliver Wyman Group*.
- Zeschky, M. B., Winterhalter, S., & Gassmann, O. (2014). From cost to frugal and reverse innovation: Mapping the field and implications for global competitiveness. *Research-Technology Management*, 57(4), 20-27.