



# Can frugal go global? Diffusion patterns of frugal innovations



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## ABSTRACT

The diffusion of frugal innovation has been an uncharted territory so far. The purpose of this study is to shed light on this topic and to explore the different diffusion patterns. While practitioners have shown growing interest in scaling up frugal innovations, the extant academic literature on the diffusion topic is scarce. In this article, we identify four main diffusion patterns of frugal innovations. We label these diffusion patterns as local diffusion, proximity diffusion, distance diffusion, and global diffusion. Both proximity diffusion and distance diffusion take place predominantly in the countries where the socio-economic context is quite similar. In rare cases, frugal innovation can diffuse globally and find its ways into developed markets.

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## 1. Introduction

Over the past several years both academics' and practitioners' interest in frugal and reverse innovations has proliferated [60]. While consensus is yet to be reached, most authors would agree that frugal innovation refers to products, services or combination of them that are affordable, sustainable, easy-to-use, and have been innovated under the resource scarcity. In general, frugal innovations are developed in and for low-income market contexts and are seen to differ from innovations in developed markets. Frugal innovation comprises innovative mixtures of available knowledge and technologies to solve urgent local problems [30]. Frugal innovations are highly related with reverse innovations. The latter ones refer to those frugal innovations that migrate to wealthier markets [14].

Frugal innovations are part of the change witnessed in recent years as innovation loci and foci are changing because low-income emerging markets are increasingly becoming new sources of innovation [24]. Traditionally, the growth wave was based mainly on innovations focusing on developed markets [18] but emerging markets have started to receive growing interest due to their

growth potential and business opportunities. Many frugal innovations have emerged as disruptive for mainstream innovations [17,34]. Frugal innovations are in a formidable position to disrupt their incumbents [34].

Alongside this shift, market terminologies are in flux. Several overlapping terms such as 'emerging markets,' 'developing countries,' and 'poor countries' are often used interchangeably as are their counterparts i.e., 'industrialized countries,' 'developed countries,' and 'rich countries' [13]. We use the term low-income markets in this paper to stress that there are different markets even within one country. For instance, in any developing country there are some wealthy people, who are still part of the economy of that country. The highest upper class, however, is not typically interested in affordable solutions but luxury items, as money is not an issue for them. On the other hand, there are large groups of low-income customers in developed countries, who are looking for affordable products and services. These individuals form the low-income market in developed countries. By developed markets, we refer to the larger part of the total market in developed countries, comprising the middle and upper classes. Following the parameters set by Prahalad [29] and Hammond et al. [15]; we understand the low-income markets as being formed by individuals earning less than 5€ per day, adjusted for purchasing parity.

Although frugal innovation is becoming a topical phenomenon, academic studies of its many facets remain scarce. One of the

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uncharted topic is the diffusion of frugal innovation in different geographic regions and socio-economic contexts. The purpose of this paper is to explore the potential diffusion patterns of frugal innovations. To accomplish the objective we selected four cases, which exemplify different diffusion patterns. Using four cases is a common approach as a well-established research method in various studies (e.g., [10]).

The remainder of the paper is organized as follows. The next section provides insights on the concepts of frugal innovation and reverse innovation and their diffusion. We then explain the cases, and discuss the cross-case analysis of four frugal innovation cases. The paper concludes with a discussion on the diffusion of frugal innovations and draws conclusions for future research.

## 2. Frugal innovation and reverse innovation and their diffusion

Insights on frugal innovation and reverse innovation in the extant literature are nascent. More importantly, the knowledge on their diffusion patterns in various geographical regions is devoid of discussion. Along with highlighting frugal innovation and reverse innovation, we briefly discuss their diffusion patterns as follows.

### 2.1. Frugal innovation

As the academic research on frugal innovation is in its early stage, definitions are also in flux. Affordability, low-cost manufacturing, low-cost materials as well as design focusing on basic functionality and minimal feature sets are key aspects typically connected to frugal innovation [12,40]. Frugal innovation stems from resource scarcity: employing limited resources to meet the needs of low-income consumers [39]. It is based on the consideration of turning resource constraints – financial, material, or institutional – into advantages [62]. Frugal innovations can comprise product, service, process, and business model [40].

Among the ambiguities in defining a frugal innovation is which aspects comprise frugality. For instance, Zeschky et al. [61] state that “the most complex technical and organizational capabilities are required for frugal innovation”, implying technological superiority of frugal innovation compared to alternatives in the market. Radjou et al. [31] describe frugal innovation as “an innovative fix: an improvised solution born from ingenuity and cleverness”. Unlike Zeschky et al. [61]; Radjou and Prabhu [30] by no means presume technological superiority for frugal innovation. According to them, frugal innovation is the ability to do more with less – to create significantly more value by minimizing the use of resources such as energy, capital, and time.

Our approach is closer to that of Radjou and Prabhu, since we define frugal innovation as *a resource scarce solution (i.e., product, service, process, or business model) that is designed and implemented despite financial, technological, material or other resource constraints, whereby the final outcome is significantly cheaper than competitive offerings (if available) and is good enough to meet the basic needs of customers who would otherwise remain un(der)served.*

There are over a dozen of concepts that overlap with the frugal innovation concept (see Refs. [26,37] including cost innovation [54], resource-constrained innovation [35], Shanzhai in Chinese [48], and Jugaad in Hindi [31]. All of these innovation concepts represent slightly different backgrounds but bear the similarity of affordability in frugal innovation. The concept of frugal innovation also shares some ideology of disruptive innovation, in the sense that they both are categories that do not include elements of supremacy. According to Christensen [8] (p.34), disruptive innovations are “products and services that are not as good as currently available products”. The term “disruptive” rests on the

idea that these innovations can “disrupt” markets for existing solutions (products, technologies, business models).

Affordability is one of the main underlying factors affecting purchasing decisions relating to new solutions, especially in the context of low-income markets where a significant number of people live on an extremely limited income [29]. As Western multinational firms (MNCs) are encountering a downturn of revenues in their higher-end markets, they have begun to see the low-income customer base as a great opportunity for cost-efficient solutions [32,60]. Western MNCs are also facing fierce competition as firms originating from emerging markets or developing countries are increasingly offering affordable products and services with superior value at lower cost [5,23]. The rise of emerging economies as a new hub for innovation is prompting MNCs to learn more from their local counterparts in these countries [38]. Some frugal innovations have made or are about to make their way from low-income markets to wealthier markets. These innovations are labelled as reverse innovations and are discussed in the following section.

### 2.2. Reverse innovation

Reverse innovations imply low-cost innovations, which are first adopted in emerging economies and then ‘trickle up’ to developed countries [20,51,59]. Both micro- and macro-level issues are essential factors in both frugal and reverse innovations [41]. Western MNCs create successful innovations in the subsidiaries in developing countries and export these innovations to Western countries with new ways of competitive advantage [4]. Reverse diffusion is recognized as an approach for Western MNCs to boost their competitive position [9]. Zedtwitz et al. [59] found a range of ways innovation inflow into developed countries. In some circumstances, reverse innovations share great similarities with the disruptive innovation from emerging economies [16,18].

Typically, the modified and downgraded versions of innovations created for developed markets later diffuse to emerging markets or developing countries where buyers cannot afford to purchase the latest high-end versions [32,49]. Reverse innovation thereby challenges the common belief that developed countries are the hubs and origins of innovations, which then flow as stripped down versions to developing countries. This implies that developing countries are no longer merely recipients of innovations from developed countries. To understand reverse innovation and its scope we define it as follows: *Reverse innovation as a resource constrained solution (i.e., product, service, process, or business model) that has been introduced first, either successfully or not, in emerging markets or developing countries and then successfully transferred (with some modifications) to developed countries.*

Although few examples of reverse innovation do exist [19,46], the number of studies on reverse innovation in general remains limited in the extant literature [13]. While the concept sounds feasible, only a few firms have succeeded in reverse innovation, which arguably requires discarding the old organization structure and creating a new one, re-orienting product development and innovation methods, and providing the sales force with new settings [63].

As Europe struggles with recession and the USA experiences increasing levels of poverty, reverse innovation seems to be a valuable option to tackle problems in these developed countries [11]. The approach of Western MNCs such as General Electric (GE) and TATA Consultancy Services (TCS) is such that they initially use frugal innovations to address the needs of low-income consumers in emerging markets or developing countries. Thereafter, they seek to turn their frugal innovations into reverse innovations by bringing them to developed countries [48]. However, Rosca et al. [37] found

that the number of frugal innovation turned into reverse innovation is very limited with some frequently cited cases such as Ultrasound machine, vsan, ECG machine, Microwave, and Washing Machine [37,63]. This study predominantly emphasize diffusion of frugal innovation.

### 2.3. Diffusion of frugal innovation

Diffusion of frugal innovation remains a blind spot of academic research. We argue that diffusion of frugal innovation warrants investigation since their diffusion starts from low-income countries, contrary to conventional models of innovation diffusion, which presuppose high-end markets start. Diffusion refers to a process “in which an innovation is communicated through certain channels over time among the members of social system and spreads in a market [36]. Several popular models such as Rogers’ model, Moore’s crossing-the-chasm model and Bass’s model are present in the existing literature regarding diffusion of innovation [64]. However, these models are manned for conventional innovations. Therefore, they are not necessarily appropriate to understand the diffusion of frugal innovation and reverse innovation. Rogers’ diffusion model has shortcomings in developing countries as such it has been criticized by some scholars [44,45]. Zanello et al. [58] point out the characteristics which affect the diffusion of innovation in developing countries include the nature of the innovation, influence, the speed of diffusion, local needs, communication channels, weak institutional arrangements, lack of advanced and specific skills, time and social contexts. How these characteristics are different in case of frugal innovation have not been explored yet.

Customers of frugal innovations are different. According to Tiwari and Herstatt [50]; some customers for frugal product and service innovations are price sensitive; thus, affordability is an important consideration. In other words, customers interested in frugal innovations seek products that are affordable and good enough to meet their needs. While this is the case among the majority of customers in developing countries, increasing numbers of customers in developed markets are becoming price sensitive too. Thus, diffusion patterns of innovation are evolving.

It seems that all reverse innovations are also frugal innovations. However, not all frugal innovations become reverse innovations for some compelling reasons. Rosca et al. [37] found that only a few frugal innovations become reverse innovations. For instance, mobile phone based banking system M-Pesa in Kenya and Tanzania [2] can be considered a frugal innovation, but it is unlikely to diffuse as such to developed countries where the majority of people already have bank accounts, affordable banking services and access to electronic banking. Due to the special nature of problems solved by frugal innovations in developing countries, many of these local frugal innovations are not applicable or relevant in developed countries. Some however do make it: GE developed a USD 1000 handheld electrocardiogram (ECG) device in India and a USD 15,000 Ultrasound Machine in China. Both of these frugal innovations are successful in the Western market, especially in the USA [1].

Innovations created in developing countries primarily aim to solve local problems [65,66]. Faced with shortages of capital, technology, and talent, entrepreneurs in developing countries need to find solutions to their problems with scarce resources. These innovations are largely low-cost solutions addressing the needs of low-income customers. Therefore, if these kinds of innovation diffuse, they typically spread to countries with similar socio-economic conditions. To explore the diffusion patterns of frugal innovations and reverse innovations we purposefully selected four illustrative cases. Other than selecting cases from the same sector,

we selected them from different sectors and firms — small to large — to capture broad diffusion patterns of frugal innovations and reverse innovations.

## 3. Description of four cases

We employed the case study approach, which is suitable for acquiring a primary understanding of contemporary phenomena in real-life contexts [57]. We applied purposive sampling to identify four cases for this study, since our aim is not to generalize but to gain insights into the diffusion of frugal innovation (see Refs. [43]; [28]. Our sampling criteria were that an innovation should display frugality, be intended for commercialization and scalability, and that cases should represent different breadths of diffusion. We attempt to capture four possible basic patterns of diffusion of frugal innovation and exemplify how frugal innovations can diffuse in different countries. Rao et al. [34] explored a large number frugal innovation cases with a range of parameters to understand their disruptiveness. We have attempted to understand the diffusion of frugal innovation. Next, we describe four purposefully selected cases.

### 3.1. ChotuKool – diffusion locally in the country of origin

ChotuKool is a product that has diffused in its country of origin, India. It is able to meet its home country’s needs. It was developed by Godrej, an Indian conglomerate established in 1897 and headquartered in Mumbai with annual revenues of USD 4.1 billion (25% overseas) and 26,000 employees. Godrej is involved in more than twenty industries including appliances, electricals and electronics, real estate, and agriculture. It serves customers worldwide.

ChotuKool is a portable, small-sized fridge launched in India towards the end of 2009 and commercialised in the following year. The fridge is suitable for countries like India where erratic power supply, frequent power cuts and voltage fluctuations are commonplace. Moreover, many parts of India lack electricity supply altogether.

ChotuKool is 45 cm by 60 cm and fits into small spaces. There are two versions of the fridge. The smaller model has a capacity of 30 L and weighs 7.2 kg, while the larger model has a capacity of 43 L and weighs 8.9 kg [7]. ChotuKool’s light weight and carrying handle makes it easily portable. Instead of a compressor, ChotuKool runs on thermoelectric cooling with a cooling chip [6]. The fridge usually consumes around 60 W with a dual power supply. It is operated by battery or an inverter and has high-quality insulation that keeps its contents cool for up to 3 h without a power connection.

ChotuKool retails for approximately USD 70 [3]. To minimise costs, Godrej reduced the number of parts from 200 to 20 [42]. The fridge has become popular among low-income families, small shops, and small pharmacies to preserve drugs. The fridge is made from low-cost local materials. Features such as simplicity, portability and affordability attracted a large number of customers in rural India. Consequently, it is a vivid example of frugal innovation and serves a pressing formerly unmet local need in India. ChotuKool is distributed by villagers who are trained as salespersons on a commission of USD 3 per unit sold. This reduces distribution costs by up to 40% [6]. To date, the fridge is distributed within a number of Indian provinces such as Maharashtra, Goa, and Gujarat [47]. However, Godrej plans to expand ChotuKool’s distribution network nationwide.

### 3.2. Tata Nano – diffusion to nearby countries with similar socio-economic conditions

Tata Nano is an example of a product that diffused from its

country of origin to neighbouring and nearby countries with relatively similar socio-economic conditions; i.e., it was able to meet the needs of its home and nearby countries. Founded in 1868, Tata is a global multi-industry conglomerate headquartered in Mumbai, India. It comprises over 100 operating businesses in more than 150 countries worldwide. Its annual revenue in 2015 was USD 108.8 billion, 67% of which comes from outside India. Tata has more than 600,000 employees worldwide.

The world's cheapest car, the Tata Nano was introduced by Tata in 2009, and is the result of five years of research and development by the Nano development team ([nanocar.wordpress.com](http://nanocar.wordpress.com)). Tata Nano was launched with high expectations of changing the car industry, particularly in poor countries. It was developed with three broad criteria in mind: (1) bringing breakthrough innovation at a low cost to serve a low-income market, (2) push from headquarters and pull from potential customers, and (3) low price as a selling point.

Instead of taking an existing small car as a starting point and stripping out components and features to make a cheaper version, Tata Nano was developed via a very different approach. The design started from scratch and one of the aims was to utilize scarce resources by combining existing component technologies with modular designs suitable especially for India. Many components of the Tata Nano are made from raw materials available in India. Tata Nano is a compact, rear-wheel drive car with a petrol engine and top speed of 105 km/h. The car is sold with a price tag of USD 2500. It targets the creation of a new set of customers from those who own or are able to own motorbikes. Even though there were initially large orders for the Nano following its first launch, sales then plummeted. Some customers reported that their Nano car had caught fire [25]. Moreover, the Nano faced competition from other low-priced cars offered by, for example, Maruti. Selling a car without air conditioning in India, where temperatures can be high, created some issues. Further, Tata had a problem with land acquisition that forced it to abandon an almost completed plant, which delayed Nano production [33]. In addition, positioning the Nano as a poor man's car has promoted an uncomfortable image for potential customers [21].

Tata made some strategic decisions to boost the Nano's sales: a TV ad, a revised financial scheme whereby banks provided a loan and customers did not need to pay the full price, an extended warranty and low-cost service, an extended sales network, and exports to neighbouring countries. As of January 2015, Tata had sold 263,619 units. The car was even expected to become successful in Western countries like the way Henry Ford's Model T did in the USA in the early days of automobile history [55]. In 2010, a redesigned version of the Nano was planned for markets in Europe and the USA [27]. It was anticipated that Nano and its emulators would undermine the European automotive industry [53]. Nano could not however satisfy the recently tightened emission and crash security norms in Europe for new passenger cars. At present, a team is improving the Nano to meet the requirements of European and other Western markets. Tata Nano is now positioned to meet the needs of many previously unserved customers and is an example of a frugal innovation that serves not only its home country but also some neighbouring countries such as Bangladesh, Nepal and Sri Lanka.

### 3.3. Vortex Gramateller – diffusion to distant countries with similar socio-economic conditions

Vortex Gramateller (VG) is an example of a product that meets the needs of the home as well as some distant countries. Similarity in socio-economic conditions between the countries in question is a major catalyst for distance diffusion. VG is developed by Vortex

Engineering Pvt. Ltd, a start-up based in Chennai, India. VG emerged after five years (2004–2008) of experimentation to design Automatic Teller Machines (ATMs) for rural India. As of May 2014, the firm had installed 1500 ATMs in 17 states across India. Vortex Engineering posted a turnover of USD 3.4 million in fiscal year 2014. Recently, the firm has raised USD 7.8 million in venture capital yielding 80% ownership to the investors. It started deploying ATMs in India in 2008 and in foreign markets in 2011. Vortex Engineering is mainly involved in ATM installation and associated services for banks. Currently, it has service centres in 35 different locations across India and a production capacity of over 12,000 ATMs per year.

VG was invented based on an idea to extend banking services to customers who were unserved. In India, the power supply is erratic or in some places there is no mainline power supply. Therefore, solar-generated electricity is often the most feasible power option. Vortex's ATMs are run by solar energy and consume one-tenth of a traditional ATM's total energy requirement; thus, the cost associated with power for the VG is lower than for conventional ATMs. VG operates in temperatures ranging from 0 to 50 Celsius while conventional ATMs need air conditioners in the hot Asian climate. VG runs on 72 units of power supply, whereas conventional ATMs require 1800 units [52].

The literacy rate is extremely low in rural India in particular. VGs have an in-built fingerprint identification system that has eliminated the need for customers to enter an identity code, which makes the ATMs easy-to-use for illiterate customers. VGs also cost 50% less than conventional ATMs. VG is an example of a frugal innovation that has diffused not only to neighbouring countries but also to other countries with similar socio-economic conditions. The firm has partnerships in various neighbouring countries such as Bangladesh, Bhutan and Nepal, and some distant countries such as Djibouti and Madagascar. Vortex has been exported to eight countries in South Asia, the Middle East and Africa. Thus, this frugal innovation initially diffused in its home country, India, then reached neighbouring countries and, finally, gained a foothold in distant countries.

### 3.4. GE's ultrasound machine – diffusion to multiple countries with similar and different socio-economic conditions

General Electric's (GE) Ultrasound Machine was able to meet needs in emerging markets and developed countries. It serves the needs of users from different socio-economic contexts. It is an example of frugal innovation that has become reverse innovation. Founded in 1892, GE is an American conglomerate headquartered in Connecticut, USA. According to GE's Annual Report (2014), it has USD 148.5 billion in annual revenues and 307,000 employees worldwide. Over the years, it has acquired and sold off numerous businesses. GE has an R&D budget of over USD 4.3 billion and R&D sites in various parts of the world. Its R&D operation employs more than 2800 people of whom 1000 have PhDs. In 1979, GE successfully launched its high-end Ultrasound Machine in the USA. After several decades, GE considered expanding its market for the Ultrasound Machine and examined various foreign markets. China was assessed as a country with enormous potential. However, after a long presence there, GE's growth was exceedingly slow until the late 1990s when it changed its perspective on capturing market share in the country. GE found the market in China remarkably different from those in which it had traditionally operated. For instance, in Western countries, product quality and performance are prime sales arguments for high-end medical devices, whereas in China, as in other emerging markets, a product's price is the most considered buying point.

GE ultimately invented a very low cost Ultrasound Machine in

China after encountering stringent challenges to serve customers there. The majority of people in China are treated in poorly equipped hospitals. Due to China's unorganised transportation system, getting a patient to a nearby healthcare centre is difficult. Hence, taking healthcare equipment to a patient's location is a highly practical solution. Thus, price and portability are two crucial factors for selling equipment such as the Ultrasound Machine. GE was unable to deliver products that satisfied these two factors, and so partnered with a Chinese firm, Haiying, to produce an ultrasound machine. With the local engineering partner onboard, GE finally launched its first compact Ultrasound Machine in 2002. GE supplied local engineers with access to its global resource pool and involved three experts from other countries [13]. The price of the machine is USD 15,000, much lower than conventional ultrasound machines. Over the first six years following its launch, the device generated USD 278 million in revenues [13]. Initially, the Ultrasound Machine was used in China and other emerging markets. Finally, it has found market potential in the developed countries. In the USA, for example, it is usually deployed in emergency units, operating theatres, and ambulances. This Ultrasound Machine is now a global product with 50% global annual growth.

#### 4. Cross-case analysis

The findings illustrate four patterns through which frugal innovation can diffuse. The ChotuKool case can be termed a *local frugal innovation*. India as a whole, however, is a large market in which ChotuKool has realised only a fraction of its total potential – unable to diffuse to every state in India. Tata Nano on the other hand has diffused into some neighbouring countries, which have relatively similar socio-economic conditions to its home country. We therefore term it a *proximity diffusion* of frugal innovation. Vortex Gramateller has spread not only to nearby countries but also into other continents such as Africa. However, it has not yet diffused to developed countries. We therefore term it *distance diffusion* of frugal innovation. The last case – Ultrasound Machine – has diffused in its country of origin, China, and neighbouring and distant countries including developed economies, due to which its diffusion can be termed *global diffusion*, and it is thus a reverse innovation too. A number of factors influence the diffusion patterns: the need for the innovation (such as cool-storage for food, mobility, access to finance, and health services), functional and technological qualities of the innovation, marketing channels and logistics, and capabilities of innovating firms.

Although the need to keep food edible for longer, i.e. the need for cool storage, and that for mobility are both pressing unmet needs throughout low-income populations, neither ChotuKool nor Tata Nano have been able to diffuse very widely. Aside from need, our analysis points to the importance of marketing channels and logistics, suggesting that frugal innovations where one product constitutes a platform for providing services to many customers (e.g., Vortex Gramateller and Ultrasound Machine) have a better chance to diffuse faster than frugal innovations sold to consumers as physical products (e.g., ChotuKool and Tata Nano). The first type can be sold to business-to-business (B2B) customers, for whom these products offer a platform for the provision of innovative, competitive services (getting cash more easily through biometric recognition; getting ultrasound services close to home or in emergency settings). Building business-to-consumer (B2C) marketing channels and production facilities (or exporting logistics) to offer goods to a large number of low-income consumers is more costly and time consuming than building marketing relationships with a smaller number of business customers, who in turn use the innovation (product) to provide services to consumers. In addition, creating trust and brand reputation among selected B2B customers

is relatively easy in comparison with efforts required to reach out to end-users in distant areas where local firms are better positioned to apply the underlying platform via local knowledge, and networks.

Further, the functional and technological qualities of an innovation play a significant role in diffusion. Often cheap, local, simple, and/or used materials are considered for local frugal innovation. Our findings imply frugal innovation using high-end materials and state-of-the-art technologies may be a condition for global diffusion. GE's Ultrasound Machine and Vortex Gramateller manifest these characteristics while Tata Nano has been found to compromise on safety and ChotuKool represents lower-end technology.

#### 5. Discussion

Our aim is to improve understanding of diffusion patterns of frugal innovation as this topic is largely absent from the literature despite the interest in scaling up frugal innovations. Next, we discuss the implications of our findings, and suggest a simple framework to understand various likely and less likely diffusion patterns of frugal innovation (Fig. 1).

Through our empirical cases we outlined four patterns of diffusion for frugal innovation: local, proximity, distance, and global diffusions. While the selected cases represent four patterns, we do not claim they are the only possible patterns. Below we outline these diffusion patterns of frugal innovation, some of which are more likely than the others. In Fig. 1, the solid lines indicate likely paths and dotted lines unlikely paths of diffusion. Each path is designated with a number referenced in the text.

Local diffusion may extend to proximity diffusion (path 1). Tata Nano is an example of this. If the innovation continues to diffuse further, it can travel to more remote countries with similar socio-economic conditions, i.e. in our terminology attain the status of distance diffusion, like Vortex Gramateller (path 2). Occasionally, distance diffusion may lead to reverse innovation: the innovation diffuses globally, i.e. spreads to developed countries (path 3). GE's Ultrasound Machine exemplifies this development. In some, probably rarer, cases frugal innovation may become reverse innovation directly after the proximity diffusion phase (path 6).

As to the unlikely diffusion options, after local diffusion an innovation may bypass neighbouring countries and diffuse directly to distant locations (path 4). In a similarly unlikely manner, local diffusion may become reverse innovation without passing the two intermediary stages – proximity diffusion and distance diffusion (path 5). However, we postulate that this is an extremely rare development.

The kind of diffusion indicated on paths 4 and 5 is, however, plausible in theory due to the rapid flow of information via the Internet. It is worth noting that in this study we have primarily focused on frugal innovations that are natural targets for commerce. We have intentionally omitted so-called grassroots or make-shift innovations, i.e. various quick fixes that can help individuals via small hacks and can actually be distributed quite quickly from one community to another (Gupta, 2006). In addition, thanks to social media channels, these innovations can rapidly traverse long distances from country to country; and, thus, can not be expected to function according to the logic of our framework.

It is commonly assumed that large firms can enter new markets faster because they possess the necessary resources [29]; [23]. Our findings imply it is not always that straightforward. Both Godrej and Tata failed to capture expected market share despite their size and well-established sales and marketing capabilities. On the other hand, Vortex Engineering, a start-up firm, was able to diffuse its innovation to distant countries with similar socio-economic conditions; but unlike Tata Nano and ChotuKool, Vortex Gramateller was marketed through B2B channels. This suggests that frugal

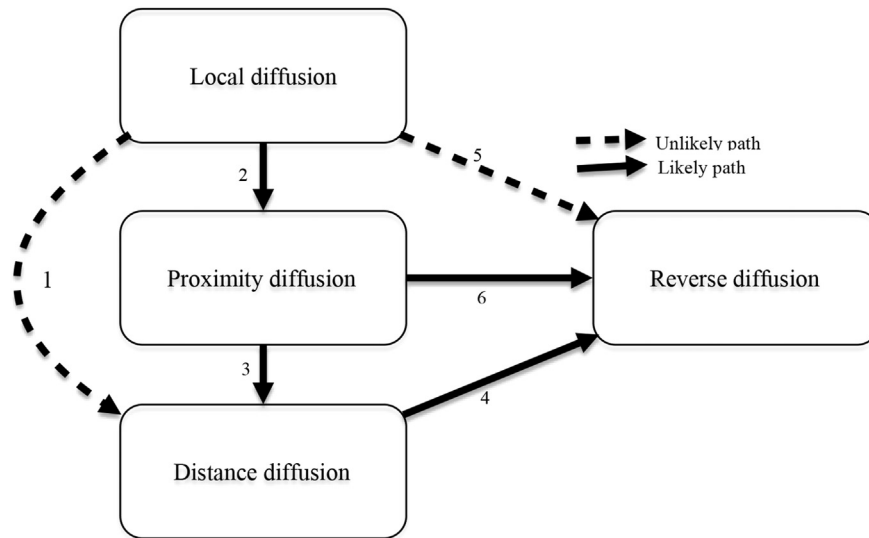


Fig. 1. Diffusion patterns of frugal innovation.

innovation where the underlying product provides a platform for service provision is capable of serving unmet needs at ultra-low cost and thereby diffuse rapidly.

Western MNCs can speed up the global diffusion of frugal innovation by bringing a product from developing countries to developed countries, as the GE case illustrates. In reality, a frugal innovation may take many years to become a mainstream innovation in the developed countries. Yet, a frugal innovation can capture value if it appeals to cost-conscious customers or is convenient for some new types of user in the developed countries, as was the case with GE's Ultrasound Machine. The number of innovations flowing from developing to developed countries is still limited. One reason for this is, apparently, the difficulty of operating in a different business context. According to a study by Yang et al. [56]; there are issues relating to the pressures and challenges faced by firms that operate in different institutional business environments in general. Thus, it is quite likely that there are extra challenges when a firm attempts to commercialise an idea originating from a very different market.

It seems that small firms (e.g., Vortex Gramateller) from developing countries are good at capturing a niche market with an ingenious frugal innovation, but find difficult to reach developed markets. Moreover, frugal innovations such as ChotuKool and Tata Nano, developed by MNCs of developing countries, have challenge to trickle up in Western countries due to their local embeddedness. Western MNCs on the other hand are good at innovating for rich customers, but find innovating sufficiently affordable products for low-income markets where price is the main buying point. Firms from emerging markets are also increasingly capturing market share not only in their local markets but also in countries with similar socio-economic conditions. Thus, they are emerging as challenging competitors for the Western MNCs.

To capture market share for a frugal innovation, firms can consider several options depending on the innovation, business model, firm size and where it is headquartered, distribution channel, and so on. For instance, a joint venture may be useful when high investment is necessary. Tata Nano, for example, requires huge investment in building manufacturing facilities, whereas the platform-type B2B Vortex Gramateller does not need huge investment to diffuse even in distant regions. Frugal innovations that diffuse through B2B channels can expand if a well-fitted strategy is adopted. Large Western MNCs such as GE have a

strong global presence, which helps them diffusing their innovations (e.g., GE's Ultrasound Machine) rapidly. Furthermore, MNCs headquartered in emerging markets mainly aim to release good-enough products (e.g., Tata Nano) that are below global standard. Western MNCs also develop frugal innovations to a global standard, which may still be expensive for developing countries but cheaper in developed countries. Low-cost but high-quality product (e.g., GE's Ultrasound Machine) may cannibalize existing high-end products to some extent because customers will prefer to buy the cheaper models as long as they meet the same purpose.

Even though Western MNCs have competitive advantage, they also face some challenges in global diffusions. Radjou [32] argues that there are some crucial factors that hinder firms in developed countries from creating innovations for price-sensitive customer segments in low-income markets: the Western approach to innovation is too expensive and resource consuming, elitist, non-inclusive, and inflexible. There are often some differences of opinion between local operations and headquarters.

## 6. Conclusions and outlook

The global landscape of innovation is in flux, and the same is true for the diffusion routes of innovation. Frugal innovation is important not only in developing countries, but also increasingly for developed countries, whose economies are stagnating, while global population growth, the spectre of global warming, and growing demand for sustainability creates pressure for more efficient resource utilisation. Frugal innovations increase competition resulting in lower prices, shift a share of R&D sites to developing countries, and engage completely new groups of customers. Moreover, they contribute for sustainable development in many ways [22]. Reverse innovations, despite being still few in number, are providing new possibilities for firms originating from low-income markets to enter new markets in developed countries. This special mode of frugal innovation promotes entirely new diffusion patterns, which warrant increasing attention in academia and practice.

As to future research, there are many opportunities to explore the topic as we have only started to open the discussion on diffusion patterns of frugal innovations, with four purposefully selected cases here. How start-ups in developing countries can collaborate with MNCs or vice-versa to scale up frugal innovation is an

interesting avenue for future studies. Funding start-ups is challenging because sources such as venture capital and state support are limited. How these sources of funding can be established and what alternative sources can be utilised in developing countries to stimulate frugal innovation merits close attention from academics, practitioners, and policy makers. Hence, exploring frugal innovation through the policy perspective is pivotal.

Scholars may employ higher number cases to provide deeper and more compelling insights, and to refine knowledge of frugal innovation diffusion patterns and the factors that condition the patterns. Moreover, rigorous analysis using the single in-depth case method may be useful to study factors that accelerate or enervate the diffusion of frugal innovation in various regions.

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