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Abstract

This study builds on our previous work (Tiwari and Herstatt, 2012), which had questioned the validity of certain assumptions of the lead market theory in the face of changing ground realities in a globalized world. Sustained economic growth and proven technological capabilities in some "emerging economies" like China and India call for a reassessment of the appropriateness of the "conventional wisdom" that had held true until recently. While our previous study had "re-built" a theoretical background of the lead market model by introducing some new elements, and doing away with certain others, with the help of two in-depth case studies; the purpose of the present study is to specifically assess India's potential as a lead market for cost-effective frugal innovations.

The study crystallizes the inherent characteristics of frugal innovations, their development process and market success in the domestic and overseas markets by analyzing four successful product innovations from selected industries in India. The factors identified thus are then incorporated in the theoretic model to derive propositions about India's lead market potential. Whereas affordability and economies of scale have traditionally constituted *the* primary concern for frugal innovations, an increasing shift towards "value proposition" is identified. Intensifying competition and growing customer aspirations are changing the nature of frugal innovations. The hitherto *unserved* customer demands attractive designs and modern technologies to come out of his shell of "non-consumption". Our research confirms that frugal innovations can benefit end-consumers and firms, simultaneously. Better-designed products also have positive impact on the lead market potential, creating a virtuous cycle. The study also discovered that the increasing need for sophistication coupled with continued cost pressures is shifting the product development processes into the domain of "open global innovation", which also helps reduce the negative country-of-origin effects faced by developing countries. The research would have implications for location decisions in setting up global innovation/R&D activities.

Keywords: *Lead Markets*; *Frugal Innovations*; *India*; *Bottom of the Pyramid; Global Innovation; Open Innovation; Emerging Economies*.

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1. Introduction

> "*By breaking the rules of the game and thinking of new ways to compete, a company can strategically redefine its business and catch its bigger competitors off guard. The trick is not to play the game better than the competition but to develop and play an altogether different game.*" (Markides, 1997: 9)

The necessity to play an altogether different game is rarely stronger than "when addressing the needs of large groups of potential consumers, who are shut out of a market entirely because existing solutions are either too expensive or too complicated to them" (den Ouden, 2012: 129). India, in recent years, has emerged as a fountainhead for innovations that seem to have internalized the mantra of playing an altogether different game. Prominent examples of such innovations include the low-cost versions of mobile telephones, small cars and healthcare devices especially designed to suit local needs within India's given socio-economic conditions (Immelt *et al.*, 2009; Prahalad and Mashelkar, 2010; Tiwari and Herstatt, 2012). Apart from their low costs, such disruptive innovations (cf. Christensen and Raynor, 2003) generally have some other interesting features:

- They involve a new business model that seeks to penetrate the group of price-sensitive and hitherto *unserved* consumers (den Ouden, 2012)
- They attempt to generate adequate profits with thin margins in a volume-driven business (Prahalad, 2005).
- They involve close cooperation with external partners (domestic or otherwise), who deliver crucial technical and/or market know-how and thus help reduce the innovation risk (Tiwari and Herstatt, 2012).

Many innovations emanating from India have been characterized as "frugal innovations", in that they seek to minimize the use of material and financial resources in the complete value chain (development, manufacturing, distribution, consumption, and disposal) with the objective of reducing the cost of ownership while fulfilling or even exceeding certain pre-defined criteria of acceptable quality standards.

Recent research has suggested that India is taking an increasingly active role in the innovation value chain of multinational companies (MNCs) (e.g. Bruche, 2009; Govindarajan and Ramamurti, 2011). First indicators of India's emergence as a potential lead market were delivered by Herstatt *et al.* (2008) in a study of India's National Innovation System. Notwithstanding such indicators there have been, so far, few studies of India emerging as a

"lead market" for frugal innovations. Govindarajan and Ramamurti (2011) have stated that instances of "reverse innovations" flowing from emerging economies towards developed countries, though palpable, are still not commonplace. Actual business practice, however, shows a lot of innovations flowing from India to other developing economies. This lead market function has so far remained relatively neglected (Tiwari and Herstatt, 2012).

In the present study, we address this research gap by assessing India's lead market potential for frugal innovations and build on works by Beise (2004), and Tiwari and Herstatt (2012). We undertake in-depth studies of four product innovations from India and analyze the product characteristics, development process and market success both at home and where applicable also abroad. The purpose is to identify key factors for India's lead market potential so that firms can build on these strengths.

The paper is structured on the following lines: After this introduction, section 2 introduces the concept of lead markets and their potential benefits. In section 3 we examine cases of product innovations from India. Section 4 analyzes the implications. Finally, we finish the paper with a summary in section 5.

2. Lead Markets & their Benefits

A lead market characterizes a country where an innovation is first widely accepted and adopted (Beise, 2004). The successful diffusion of the innovation ideally sends a positive signal to consumers elsewhere, thereby helping it to global success (Bartlett and Ghoshal, 1990; Beise, 2004). To elaborate the concept in a succinct manner, we can say that users in some countries, due to given socio-economic or geographic conditions, perceive greater benefits of adopting a product (a physical good or a service) at an early stage and are therefore more receptive to (technological) change than users elsewhere and that the innovation, once successful, trickles down to other regions as well (Beise, 2004). One example for such an innovation is the fax machine, which was first widely accepted in Japan and then diffused globally. Another example is provided by the Internet-based E-Commerce services, which were first pioneered in the USA before being adopted worldwide.

The reason for this trickling down to other regions is that local innovations from lead markets become useful elsewhere too because the environmental characteristics that *stimulated* such innovations, in the course of time, become relevant in other parts of the world as well (Bartlett and Ghoshal, 1990; Beise, 2004). The trickling down effect is therefore rooted in the competitive advantage (e.g. anticipatory needs) enjoyed by the lead market country (Porter, 1990). In this sense we can, to some extent, compare "lead markets" with "lead users", who face needs today that most customers in the market will probably face in the future (Herstatt

and von Hippel, 1992). Anticipatory needs can therefore deliver valuable inputs for the innovation process of a firm regarding future developments and such users and markets are regarded as a precious source for innovative ideas.

2.1. The Lead Market Model

Lead markets have been traditionally thought to exist in economically highly developed nations with high levels of per capita income, customer sophistication and advanced physical and institutional infrastructure, to name but a few factors (Beise, 2004). These factors have been considered important as they often induced innovations from firms seeking (new) business opportunities. Generally, only industrialized countries were regarded to be able to finance the high costs of research & development (R&D) efforts (Tiwari and Herstatt, 2012). Of late, we can however observe an increasing pattern of innovation activities taking place in countries like India and China, especially in the domain of "frugal innovations", as described earlier (Herstatt *et al.*, 2008; Prahalad and Mashelkar, 2010). Absence of factors like high per capita income is seemingly offset by economies of scale in a large and growing market in India, whereas the supposed lack of customer sophistication is channelized into a supplier-side challenge to design cost effective and robust solutions (Tiwari and Herstatt, 2012). Figure 1 illustrates an updated model of critical advantages that shape the lead market potential of a country.

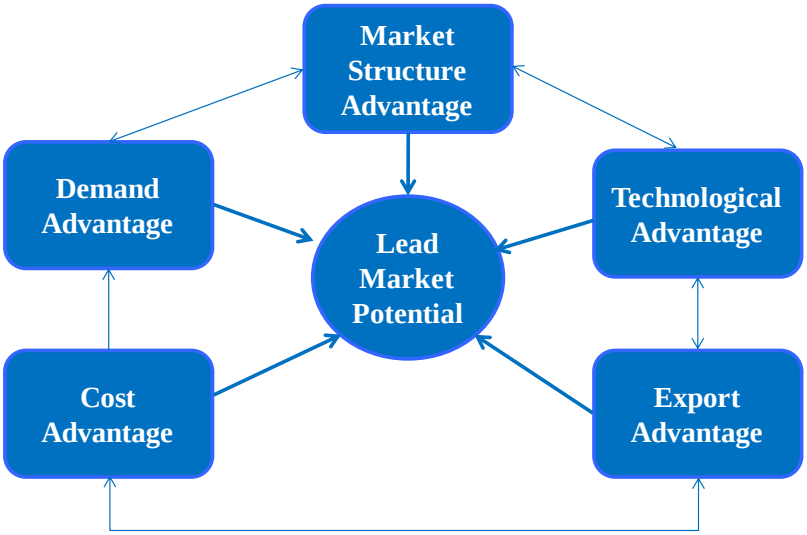

Figure 1: An updated model of lead market advantages (source: Tiwari and Herstatt, 2012)

The lead market potential, as illustrated above, is a function of five groups of national advantages originally proposed by Beise (2001, 2004) and modified by Tiwari and Herstatt (2012): Whereas "Demand Advantage" concerns market attractiveness (e.g. the number of potential customers, the expected economic growth and government procurement etc.), "Cost Advantage" relates to actual possibilities of economies of scale and the level of factor costs.

Export advantage is concerned with factors that influence the transferability of domestic products to overseas markets (e.g. export promotion policies, free trade agreements and socio-economic similarities). "Market Structure Advantage" gives information about the level of competition in the market and the resultant pressure on firms to innovate. "Technological Advantage" characterizes the favourable impact of the national and/or sectoral innovation system, e.g. the availability of skilled manpower and the presence of knowledge networks. Some scholars, e.g. Rennings and Smidt (2010), have also proposed a "Regulation Advantage". Following Michael E. Porter (1990), we consider it appropriate, not to treat regulation as a separate group since policy factors influence all other groups of advantages and are covered by them. The abovementioned advantage factors are generally interrelated, and combined together, they generate lead market potential for a country. This potential, in turn, acts as an inducement for innovation activities, thereby reinforcing the individual advantage factors and creating a virtuous cycle.

2.2. Benefits of Participating in a Lead Market

Firms can expect several benefits from participating in a lead market. For example, a lead market gives market orientation to the product development process. By incorporating the needs of local customers firms can expect to reduce the risk of market rejection for their product and simultaneously hope for better chances in comparable overseas markets. Several studies have examined the importance of lead markets for establishing locations of multinational R&D outside their home countries (e.g., Gerybadze and Reger, 1999). These studies have established that lead markets, in many instances, constitute the *primary* criterion for selection of overseas R&D location and help reduce duplication and inefficiency of R&D efforts. A study conducted on behalf of the European Commission (1998) confirmed that multinationals were increasingly concentrating their R&D capacities in select lead markets in order to establish presence on-the-spot, to ensure better learning and to adapt to the needs and wishes of sophisticated customers. It cited the semiconductor and telecom software industries as examples of industries in which product development is largely driven by select lead markets. Gassmann and von Zedtwitz (1999: 248) found evidence that international R&D in was concentrated in "a few but leading geographical areas" that stood out either by technological excellence or because of their suitability as lead markets. Studies in recent years (e.g. Sachwald, 2008; Rennings and Smidt, 2010) have continued to confirm the growing importance of market-driven considerations in the location of global R&D.

3. India as a Lead Market

As described earlier, the concept of lead markets, which are beneficial for international R&D locations and help reduce the risk of innovation activities, has been almost exclusively used in the context of industrialized nations. However, there are strong indications of lead market tendencies in India (as also in some other "emerging economies" like Brazil and China) depending on the sector. In a study carried out in India, Herstatt *et al.* (2008: 32) discovered that the "[u]nsaturated, emerging middle-class consumer market of India is growing into the role of a 'lead market' for certain products…with basic functionality, less over-engineering, durability and affordable prices". This discovery is meanwhile supported by other studies, e.g. (Govindarajan and Ramamurti, 2011; Tiwari and Herstatt, 2012), which provide evidence that some new products are first being adopted in India before diffusing to other places. To give one example from an MNC context: GE's baby warmer, known as "Lullaby", was designed and built in India targeting maternity homes and hospitals, 80% of whom use baby warmers (Bahree, 2011). The India-made frugal solution costs $3,000 in comparison to GE's high-end entry level product in the USA that starts at $12,000. The Lullaby is now reportedly sold in 62 countries, including Brazil, Russia, Egypt, Dubai and Italy (Bahree, 2011). Reportedly, there are 30-odd products in GE's Indian pipeline that are targeted at "the Indian and the emerging global markets" and would be launched by GE's Bangalore Centre within the next three years (Mahalakshmi, 2011).

In the following we present four instances of successful product innovations from India. While one example involves the automobile industry, two are related to the home appliances sector, and one is a solution from the banking industry targeted at business customers (banks). All the products can be classified as "frugal innovations" since they enabled significant reductions in price (30% and above) while concentrating on functionality (avoiding over-engineering). They can be also termed as "disruptive innovations" since they sought, and managed to, create new markets by reaching out to non-consumers. We analyze the product characteristics, its development process and market success both at home, and where applicable, also abroad. The purpose is to identify factors that influence India's lead market potential for this specific category of innovation. Before we begin with the case studies, a brief profile of India is provided to set the background.

With approximately 1.2 billion inhabitants, India is the world's second most populous country after China. The country has seen uninterrupted growth rates of 7% and above for over a decade now. India has a large middle class which has kept growing ever since economic reforms were initiated in 1991. Estimates about its size vary from 50 million to 470 million.

About 260 million people in the income group of $2-13 a day seems to be a reasonable figure. Approximately one third of the population lives below official poverty line. Close to 70% of the population lives in rural areas plagued by infrastructural deficits. Urban India is also not completely free of infrastructural hassles. It is an enormously young nation with 80% of the population below 45 years of age. For a precise and more extensive economic profile of India, see (RBI, 2011). Further references to developments, opportunities and challenges in India can be found, for example, in (Tiwari and Herstatt, 2012).

3.1. Small Commercial Vehicle: Tata Ace

Tata Motors Limited (TML), a publically-listed company of the Tata Group and known for introducing the world's cheapest car, the "Tata Nano", has another successful frugal innovation to its credit, namely the mini truck "Tata Ace", which was launched in May 2005. The Tata Ace is a small commercial vehicle (SCV) with a payload capacity of 0.75 tons (TML, 2005). Launched for a price-tag of Rs. 225,000 (approx. $5,000) the Ace cost 50% less than any other four-wheeled commercial vehicle in India (Palepu and Srinivasan, 2008).

Figure 2: Tata Ace Ex
(Photo: courtesy Tata Motors)

The need for creating a "low-cost, low-maintenance" SCV was felt by TML, which saw itself under increasing pressure from domestic and foreign competitors in the existing product segments (Khanna and Palepu, 2010). The Ace was conceived as a "cheap, nasty and rugged vehicle for India" and is regarded as ideal for India's typically narrow and crowded roads, as well as for long highway journeys (Palepu and Srinivasan, 2008; Singh and Chaudhuri, 2009). The developer team, from the very beginning, was expected to apply frugality in the development and only five people were assigned to the team. The upper limit for the total development budget was fixed at Rs. 2.2 billion ($49 million) and was not allowed to be exceeded (and was eventually met). The cost-constraint may be gauged by the fact that MNCs are generally estimated to spend close to $500 million to develop a similar platform (Palepu and Srinivasan, 2008). Moreover, market research revealed that customers were not willing to pay much more for a four-wheeled CV than for a three wheeler, restricting the possible price point in a bandwidth between $2,200 and $4,500. Even though, a low cost vehicle, the Ace was expected to meet "the highest safety standards" in keeping with the high reputation the brand name "Tata" enjoys in India. The Ace fulfils the M1/N1 class safety norms, whereas most European mini trucks are reportedly based on less stringent quadricycle norms (Palepu and Srinivasan, 2008).

The Ace has proved to be an immense success, generating a brand value of about $175 million within one year (cf. Singh and Chaudhuri, 2009). The 100,000th Ace rolled out within only 22 months of the launch (TML, 2007a). It has created a new market of SCVs that was nonexistent till then. While it originally intended to attack the three-wheeled commercial vehicles market by providing better safety and comfort to drivers at affordable prices, about 54% of customers have been actually found to be non-consumers purchasing their first commercial vehicle (Palepu and Srinivasan, 2008).

TML has introduced several variants based on this platform, e.g. the Ace EX, Super Ace and Venture. Sub-one ton mini trucks based on this platform are also being developed as electric vehicles and hybrids (TML, 2010). By the end of fiscal year (FY) 2008-09 success led by the Ace had propelled TML to command a market share of 65.4% in the encompassing light commercial vehicle (LCV) segment (TML, 2009). Its success has been so resounding that even competitors concede that "every little town and village you go to, you see a Tata Ace" (Seth and Kalesh, 2009). Even though the sales of the Ace have kept growing by double-digit figures, its success has led to the entry of several competitors in this segment (Philip and Athale, 2009; Vijayakumar, 2011) lowering TML's market share to 63.2% in FY 2010-11 (TML, 2011).

TML has a long history of technical capabilities. The company, earlier known as Tata Engineering and Locomotive Company (TELCO), had set up a R&D centre as early as 1959. In 1969, the company started in-house designing of CVs as the then Government, pursuing a policy of technological self-reliance and faced with foreign exchange crunch, did not approve the continuance of a technical collaboration with Daimler Benz of Germany (Palepu and Srinivasan, 2008; Tiwari *et al.*, 2011). But apart from substantial in-house facilities, product development at TML often involves stakeholders from within and outside the Tata Group (Mishra, 2012). For example, gas injection technology for Tata Ace was procured from Alternative Fuel Systems Inc. (AFS) of Canada (TML, 2010). In order to reduce costs, TML has opted for the strategy of parts sharing and adapted the Indica engine for the Ace (Palepu and Srinivasan, 2008). Overall, 40% of the components of the Ace are shared with other TML products to generate additional savings through bulk purchasing. In production too, unusually high 81.5% of contents were outsourced with the objective "to convert the fixed cost of production facilities into variable costs" (Palepu and Srinivasan, 2008: 11).

Sri Lanka was the first overseas market to import Tata Ace, where it is sold under the brand name "DIMO Batta" (Economic Times, 2007). Diffusion in Nepal followed next (TML, 2007b). In FY 2010-11 the Super Ace was introduced in Thailand (TML, 2011). Recently,

TML has announced assembly plans for the Ace in Indonesia. Commercial vehicles produced by TML are sold, in principle, across all continents except in North America (TML, 2012).

3.2. Water Purifier: Tata Swach

Following closely on the heels of Tata Motors launching the world's cheapest car the Tata Nano, another Tata Group company, Tata Chemicals Ltd. (TCL) introduced the "Tata Swach" the world's cheapest household water purification system in December 2009 (Economic Times, 2009). The objective, declared in TCL's Annual Report for FY 2009-10, was "to reduce the incidence of water borne diseases by making safe drinking water accessible to all" (TCL, 2010: 9). The expression "Swach" is a variant of Hindi word "Swachchh" and means "clean". It has been developed by TCL's Innovation Centre and is based on "natural materials and cutting edge nanotechnology" (TCL, 2010: 9). While the combination of "locally sourced materials with nano-silver particles for the filters" helps enhance performance and eliminates 90% of the contaminants and almost all of the most serious pathogens that can cause serious diseases like diarrhoea, cholera or typhoid (Ahlstrom, 2010; Singh *et al.*, 2011). The Swach does not use any harmful chemicals such as chlorine (TCL, 2012).

Figure 3: Tata Swach
(Photo: courtesy Tata Chemicals)

The Swach is targeted at households, predominantly poor and/or located in rural or semi-urban areas with poor access to electricity or running water (Lamont, 2010). Tata Group Chairman Ratan Tata, speaking at the launch, stressed that the quest was not to create the *cheapest* products but to reach the *largest* number of people (Economic Times, 2009). Nonetheless, with a price tag of Rs. 999 (approx. $21 in then exchange rates) Tata Swach became the world's most inexpensive water purifier enabling 50% saving against its nearest competitor, "Pureit" of Hindustan Lever (Kinetz, 2009). Today, Pureit costs Rs. 2,200 (approx. $44) for the classic version (HLL, 2012), whereas Tata Swach Smart, the entry level product, costs Rs. 899 (approx. $18). Tata Swach also became the world's "lowest cost" purifier, providing safe drinking water at Re. 0.10 per litre (TCL, 2010), which amounts to approx $0.002 ($1=INR 50). The purifier consists of upper and lower storage containers that have a maximum capacity of 9 litres each. Swach can purify between 3 and 4 litres of drinking water per hour. It is designed to give up to 3,000 litres of purified drinking water, after which the "bulb" needs to be replaced. At present, the replacement bulb costs Rs. 349 (approx. $7) (TCL, 2012).

Tata Swach was reportedly designed by Design Directions, an external company (Bhosale, 2010) and involved concerted R&D efforts spanning multiple years (Kinetz, 2009). The R&D involved, apart from TCL, two more Tata group companies, Tata Consultancy Services (TCS) and Titan (Economic Times, 2009; Economist, 2011). By March 2010 the company had filed 14 patents involving Tata Swach (TCL, 2010). The innovation has won several awards (Lavallee and Veach, 2010; TCL, 2011). The water purifier is a disruptive "good enough" product that reportedly complies with the U.S. Environmental Protection Agency standards (Kinetz, 2009). Confusingly though, another report suggests that it does not yet fully satisfy the requirements set by the World Health Organization (Ahlstrom, 2010).

TCL expected to sell one million units in 2010, the first full year after its launch (Lavallee and Veach, 2010). Early analysis by the company showed that the product was principally purchased by hitherto non-consumers and confirmed that the new and affordable price point for water purifiers had succeeded in creating a new market (TCL, 2010). At the end of FY 2010-11, Tata Swach was being sold in more than 12 states of India, up from 2 (Maharashtra and Karnataka) the previous fiscal. Around 35% of the sales take place in rural area (Maiti, 2012b). Even though TCL has not disclosed the sales figures, it has announced that the product "has been received exceptionally well by the market" and termed the demand to be "extremely encouraging" and "in line with expectations" (TCL, 2011: 26, 34). Swach's success might be, however, gauged by the fact that the manufacturing capacity of the Haldia plant in West Bengal was ramped up from 1 million units in FY 2009-10 (TCL, 2010) to 1.8 million units in FY 2010-11. An additional plant was being commissioned in Nanded, Maharashtra, "to meet growing demand in existing and new markets" (TCL, 2011: 38). TCL hopes to sell 5 million units within next 3 years and reach 200 million households (Maiti, 2012b). With increasing purchasing power the market for water purifiers in India is expected to grow exponentially and is heavily fought between players like Hindustan Lever, Eureka Forbes and TCL (Vijayraghavan, 2010; Maiti, 2012a).

TCL has overseas presence in Kenya, England and the USA and intends to take the Swach to other developing country markets, such as Africa, Southeast Asia and Latin America within next few years (Lavallee and Veach, 2010; Maiti, 2012b). A market for low-cost water purifier seems to exist as about 894 million people worldwide lack access to clean water and close to 90% of all deaths from diarrhoea are due to lack of sanitation and water-borne diseases (Independent, 2010). In India alone currently about 1,000 children die every day due to unsafe drinking water (Independent, 2010), which indicates towards the need for such a product.

3.3. Solar-powered ATMs: Vortex

Vortex Engineering Private Limited ("Vortex") is a company headquartered in Chennai in the Southern Indian state of Tamil Nadu. It was set-up in 2001 as an incubation project of the Indian Institute of Technology Madras (IIT-M) (Leena, 2011). The company develops and manufactures Automated Teller Machines (ATMs) that are "highly reliable, rugged, easy to use and eco-friendly" (Vortex, 2012). The solutions are specially designed to suit conditions prevalent in rural and semi-urban areas, e.g. unreliable power supply and higher illiteracy levels of end users. Vortex ATMs have an in-built fingerprint identification system so that the user does not need to key in a personal identification number, a feature that has apparently proved very popular in rural areas (Varadarajan, 2010).

Vortex's ATMs can be run by solar energy and one such ATM consumes only about 10% of the total energy requirement of a conventional ATM (Vortex, 2012). Whereas conventional ATMs require about 1,800 units of electricity per month, a "Gramateller" of Vortex requires only 72 units (Shivapriya, 2010). While conventional ATMs work on temperatures around 35°C (Simhan, n.d.), the rugged ATMs of Vortex do not require air conditioning and are able to cope with temperatures ranging between 0°C and 50°C. This enables reduction in CO_2 emissions by at least 18,500 kg. per annum (IBEF, n.d.). The ATMs come equipped with in-built systems of uninterrupted power supply (UPS) and "bring down monthly electricity bills to less than Rs. 600" (approx. $12) (Vortex, 2012). The total cost of ownership for Vortex machines works out to be 50% less than for conventional ATMs (Mittal, 2012; Simhan, n.d.). Whilst conventional ATMs generally require fresh and crisp notes to function without hassles, Vortex's ATMs are reportedly the only ones able to dispense soiled notes, which is a critical requirement in remote areas owing to limited supply of fresh notes (IBEF, n.d.). Collaboration with IIT-M has played a key role in developing different technologies that have enabled this solution (IBEF, n.d.). The fully indigenous development of its "Gramateller Duo" ATM has enabled 5 patents (Vortex, 2012). Prohibitive costs of setting up new bank branches coupled with "low transaction volumes, and the inability of conventional ATMs to serve rural locations" have in the past acted as a formidable barrier in setting up formal banking systems in India's hinterland (IBEF, n.d.: 66). Vortex's ATMs, depending on configuration, cost between Rs. 200,000 to 300,000 (approx.

Figure 4: A Gramateller ATM
(Photo: courtesy Vortex Engineering)

$4,000–5,000) are significantly cheaper (~50%) than conventional ATMs (Ghosh, 2011). Vortex has, therefore, been able to penetrate a market of non-consumers (banks) and create a niche for itself. It could also count on some institutional support: around 50 ATMs in remote areas were used by Government authorities to distribute wages under the National Rural Employment Guarantee scheme (Varadarajan, 2010).

Since 2007 Vortex has installed 500 "low-cost, low-maintenance" ATMs, of them 300 solar-powered, for reputed banks in India including State Bank of India (cf. Leena, 2011). It is now linking up with local banks in India with an ambitious United Nations backed proposal to install 10,000 solar-powered ATMs by 2015 (UNDP, 2011). Funding does not seem to be a major problem. Recently, Tata Capital Innovations Fund and some other private sector investors have acquired a minority stake in Vortex by infusing a total sum of Rs. 500 million (approx. $10 million). International Finance Corp. (IFC), belonging to the World Bank group, has also announced plans to invest $3 million (Leena, 2011; Vortex, 2011). It is estimated that, in the long-run, India alone would require at least half a million such ATMs to serve its vast hinterland consisting of about 640,000 villages (IBEF, n.d.), where about 70% of India's population lives. At present, not even 25% of India's only 45,000 ATMs are deployed in rural and semi-urban areas (Leena, 2011). Developed countries usually have a ratio of one ATM per 1,000 inhabitants, going by that yardstick, India's requirement could cross one million (Banerjee, 2010).

The company has export partners in Bangladesh, Nepal, Bhutan, Africa (for Madagascar, Benin, Burkina Faso, Ivory Coast & Gabon) and Middle East (Vortex, 2012). In December 2011, it signed an agreement with South Africa's WIZZIT Bank as part of a United Nations programme to provide banking services to "30 million low-income people in India and South Africa by 2015" (UNDP, 2011). It is reportedly the only Indian company to have been featured in the Time magazine's 2011 list of "10 start-ups that will change your life" and was honoured as a "Technology Pioneer" by the World Economic Forum (Economic Times, 2012).

3.4. Battery-powered Refrigerator: ChotuKool

"ChotuKool", according to its manufacturer Godrej & Boyce, is "a top-loading, compact and portable cooling solution" (Godrej, 2012). It was first inaugurated towards the end of 2009 (Kumar, 2009) and commercially launched the next year (Economic Times, 2011). The product name itself is a marketing innovation combining cute-sounding variations of Hindi word "Chhotu" (affectionately used for referring to a little boy) and English word "cool". The

actual brand name is written as "chotuKool", thus emphasizing the smallness of size and the supposedly big cooling effect.

To cope with the erratic power supply in many parts of India (e.g. voltage fluctuation, frequent power cuts, or occasionally a complete lack of electrification in some remote areas), it is equipped to operate on battery or an inverter (Godrej, 2012). The product uses high-end insulation to stay cool for 2-3 hours without power. ChotuKool's small size (1.5 X 2 feet) caters to constraints of small living spaces. It is available in two variants: (a) internal capacity 30 litres (weight 7.2 Kg.), and (b) internal capacity 43 litres (weight 8.9 Kg.). Its low weight is intended to ensure portability since (a) many of ChotuKool's potential owners live in small one-room dwellings so that household items have to be shifted every evening to make sleeping space, and (b) ChotuKool's typical customers frequently change homes looking for jobs and/or due to financial constraints (Whitney, 2010). The fridge, therefore, is fitted with "handles to make it portable for the migrant workers" (Bellman *et al.*, 2009).

Ethnographic research had revealed that the targeted customers didn't need full-scale refrigerators (Innosight, 2011). They only required limited storage (Whitney, 2010), which would save milk, vegetables and leftovers from spoilage for a day or two (Eyring *et al.*, 2011; Innosight, 2011). This purpose is well-served by ChotuKool that can keep foodstuff 20°C below outside temperature (Godrej, 2012). Additionally, the 30-litre variant seeks to target more prosperous customers in regions faced with power cuts as a backup cooling instrument (Eyring *et al.*, 2011) or by enabling applications such as "Travel Companion" for use in a car (Godrej, 2012), which can be attractive in a hot country like India. The fridge is not only targeted at private households. Small street-side shopkeepers and the local hospitality sector in rural and semi-urban India with financial, infrastructural and/or space constraints could be its prospective customers too. Overseas markets with similar socio-geographic conditions are also potential customers (cf. Singh *et al.*, 2011). The company hopes to generate some demand even in developed countries, once the technology has further improved (Eyring *et al.*, 2011).

Figure 5: ChotuKool
(Photo: courtesy Godrej & Boyce)

To cut down costs, Godrej has reduced the number of product parts from 200 to 20 and eliminated the deep freezer (Singh *et al.*, 2011) ChotuKool employs thermoelectric cooling, which runs on a cooling chip along with a fan similar to those used to cool computers, instead of using compressors, the regular cooling method for refrigerators (Chakravarthy and

Coughlan, 2011; Subramanian, n.d.). Interestingly, thermoelectric cooling has existed for long and has been used in Western countries for "keeping beer cold at barbecues" but was never employed to serve a low-cost cooling solution (Subramanian, n.d.). ChotuKool carries a price-tag between Rs. 3,500 and Rs. 3,800 (Economic Times, 2011). This works out to approx. $70-76. At launch, ChotuKool was about 50% cheaper than the next entry-level fridge available in the market costing about Rs. 7,000 with much greater storage capacity that was however not required by the targeted customer group (Bellman *et al.*, 2009; Kumar, 2009; Chakravarthy and Coughlan, 2011).

The operational cost of ChotuKool is kept low as it requires about half the power consumed by regular refrigerators (Eyring *et al.*, 2011). The unconventional top-opening (instead of the usual front-opening) ensures that cold air can settle down in the cabinet and power does not dissipate when the door is opened (Anthony, 2012). The fridge, depending on the variant, consumes between 55 and 62 Watt power and runs on dual power supply (230V AC & 12V DC). The laptop-style converter reduces energy consumption (Subramanian, n.d.). Furthermore, it has hardly any moving parts reducing the need for maintenance (Godrej, 2012).

ChotuKool is a product of "co-creation". The idea of a small-sized, battery-powered and affordable means of refrigeration for a vast majority of non-consumers was created by Godrej in collaboration with Innosight (Anthony, 2012; Godrej, 2012), a global innovation and strategy consulting firm located in Boston (USA), Singapore and Bangalore (India) and co-founded by Prof. Clayton M. Christensen (Innosight, 2012). While designing ChotuKool much care was taken to ensure that the overall cost of ownership remains affordable (Anthony, 2012). It was developed in close interaction with the targeted customer groups "to get insights on their needs, desired solutions and barriers to consumption" (Godrej, 2012). ChotuKool is distributed by villagers (and other social entrepreneurs) who have been trained as salespersons (Kumar, 2009; Godrej, 2012). They earn a commission of roughly $3 per fridge sold, while enabling Godrej to cut down its marketing and distribution costs by 40% (Chakravarthy and Coughlan, 2011: 31).

The Indian refrigerator market is estimated to stand at 8.5 million units a year and is growing at 18% per annum (Economic Times, 2011). However, less than 18% of all households in India possess a refrigerator (Whitney, 2010). Some studies put the percentage of households with a refrigerator at just 8% (cf. Singh *et al.*, 2011). The penetration level, especially in rural and semi-urban areas, is even lower. On the other hand, the need for refrigeration owing to weather conditions is high. According to India's Consumer Electronics and Appliances

Manufacturers Association, 90% of India faces hot and humid weather for more than 8 months a year (CEAMA, 2012) and an estimated "one third of India's food is lost to spoilage because of a combination of frequent power cuts, heat, and high humidity" (Chakravarthy and Coughlan, 2011: 31).

For reasons cited above, it seems plausible that a large market of non-consumers exists for refrigeration products. Even though the manufacturer has not issued official sales figures for ChotuKool so far, the available information suggests that the product has received enthusiastic response. Godrej & Boyce was reportedly "on pace to sell 100,000 ChotuKools in only its second full year on the market" (Innosight, 2011). While ChotuKool was first sold in rural and semi-urban areas of Western Indian states of Maharashtra and Goa (Economic Times, 2011), now it is also available in Gujarat (Saiyed, 2011) and Karnataka (Godrej, 2012). The company intends to prepare its distribution network carefully before going for a nation-wide launch (Economic Times, 2011). Through collaboration with the Indian Postal Department, e.g. in Gujarat state, the fridge can be ordered at the local post office and is then shipped within one week directly to the customer's doorstep even in far-flung areas reducing the need for the customer to go to the city (Saiyed, 2011). The early success of ChotuKool has led to many awards for its manufacturer Godrej (Innosight, 2011).

Table 1 summarizes the principal features of the product innovations discussed above from the perspective of the lead market model. It illustrates why India is an attractive "hotbed" for frugal innovations and why companies can hope to bring these products to (comparable) overseas markets. It also impressively illustrates the connection to the lead market model, as discussed in section 2. Many prospective users in India, due to their given socio-economic and/or geographic conditions, perceive significant benefits in adopting such frugal products, as analyzed above, since these enable the prospective users to "flee" a non-volunteered state of "non-consumption" and to improve their standards of living. They are therefore more receptive to technological change even if it is a disruptive innovation, not yet having full-fledged functional performance. Similarity of socio-economic and geographic conditions in many other developing countries provides an ideal opportunity for exporting such products. At least in some instances, the products are also suitable for developed country markets. Indian firms have been quick to sense this opportunity and have established overseas presence, thereby emerging as an important source of outward FDI (Pradhan, 2008; Sauvant *et al.*, 2010).

	Tata Ace	Tata Swach	Vortex Gramateller	Godrej ChotuKool
Cost Advantage	Development costs ($49 million) less than 1/10th of costs in developed countries In-house synergies by parts sharing Competitive supplier industries enabled outsourcing of 81.5% components (turning a sizeable share of fixed costs into variable costs)	Generally low costs of development & production Presence of a highly-skilled industry of service providers: Designing was outsourced, cutting cost while getting access to creative talents	Generally low costs of development & production	Generally low costs of production Social entrepreneurship led to 40% reduction in marketing & distribution costs
Demand Advantage	Targeted the world's largest 3 wheeler market Infrastructural deficits, e.g. narrow roads, policy factors, restricting entry of heavy CVs in cities created demand for a SCV	Waterborne diseases encourage use of water purifiers Over 80% of Indian population without access to safe drinking water	Govt. support for bringing formal banking system to Indian hinterland Extremely low penetration of ATMs at present owing to infrastructural problems and high costs	Climatic conditions encourage usage of refrigeration (one third of food stuff lost to spoilage) Less than 18% of over 250 million households currently own a fridge
Technological Advantage	Long established domestic in-house R&D capacities, partly owing to govt. policies Access to global know-how via own foreign affiliates & third party providers	In-house capabilities for nanotechnology & access to complementary knowledge in group firms Govt. initiatives for nano-technology	Access to cutting-edge technology at the premium Indian Institute of Technology in Madras (Chennai)	Co-creation with Innosight, a firm specializing in disruptive innovations Access to pre-existing thermoelectric cooling technology
Export Advantage	Similarity to market conditions in other developing countries (e.g. Sri Lanka and Nepal) Vast overseas network in 4 continents (except North America)	Similarity to market conditions in other developing countries Tata's overseas network Safe water on global development agenda	Similarity to market conditions in other developing countries Banking access to the "unbanked" part of global development agenda (backed by the UNO)	Similarity to market conditions in other developing countries Parent Godrej group internationally active (e.g. in Africa, Southeast Asia, and Middle East)
Market Structure Advantage	Intense competition forced TML to look for new sources of revenue	Intense competition with existing and new competitors acts as a pressure to innovate	No significant challenger in the low cost segment despite attractive market opportunities	No significant challenger in the low cost segment despite attractive market opportunities

Table 1: Positive Impact of Lead Market Factors on Individual Product Innovations

4. Discussion & Implications

The four case studies presented above reveal an interesting pattern of characteristics for which India has emerged as a hotbed for innovations:

- Value Proposition: All examples discussed in the previous section have illustrated that the value proposition plays an even greater role than otherwise for product innovations in an emerging country like India. The potential customer should not only actually

possess the means to pay for the product. Rather, he should be also *willing* to spend his scarce resources on that particular product. Because the company is mostly competing against non-consumption. If a prospective customer perceives the price to be too high for the value-proposition, he or she might simply decide to *remain* a non-consumer. In all examples discussed here the innovator reduced the price by close to 50% in comparison to the standard entry-level product.

- Volume opportunities: All innovations discussed in this paper were aimed at addressing large customer segments. It did not matter whether they were targeted at end-consumers (e.g. Tata Swach, or ChotuKool) or at business users (Vortex, Tata Ace). Economies of scale play a critical role in compensating the low profit margins per unit.
- Robustness: Products being created for voluminous markets of rural and semi-urban hinterlands in a country like India must be able to cope with infrastructure deficiencies such as voltage fluctuation, abrupt power-cuts, dust, and extreme temperatures.
- Fault resistance: Since companies, unlike in the developed countries, cannot presume the hitherto non-consumers to have some first-hand experience of a similar product, the product must be designed in a way that is easy-to-use *and* fault-resistant for first-time users.
- Cost of Ownership: Not just the purchase price but also the low costs of usage, maintenance and repair spanning across the complete product life span from acquisition till disposal needs to match the financial situation of the prospective customers. All examples in our study showed that successful companies enabled significant reductions in the cost of ownership.

Having characterized the main features of innovations, we can turn our attention to the lead market potential of India for frugal innovations. Table 2 shows some key factors that impact the lead market potential of a country (Tiwari and Herstatt, 2012) applied to the context of frugal innovations in India.

(A)	(B)	(C)
Lead Market Factors		**India's Advantages**
Group	**Factor**	
Cost Advantage	Economies of scale	High volumes can enable significant reduction in cost per unit
	Growth of demand	High growth in most sectors
	Factor costs	Low costs for production factors
Demand Advantage	Size of demand	Large, untapped groups of multi million potential consumers
	Anticipatory needs faced by prospective customers	Yet-unserved, innovation friendly customers receptive to disruptive innovations (good enough performance may suffice)
Technological Advantage	Availability of skilled labour	Large pool of young & skilled workforce with first-hand knowledge of living situation
	Access to open knowledge networks	Public institutions, many domestic firms & MNCs with R&D capabilities
Export Advantage	International demonstration effects	Increasing integration of India into global mainstream causes positive effects
	Similarity of local demand to foreign market conditions	Many developing countries face similar challenges; in some case global chances
	Multinational firms and mobile users	Integration of India into global economy (inward / outward FDI; large diaspora)
	Export incentives	Govt. Schemes, e.g. Special Economic Zones (SEZs); Free Trade Agreements with many countries, e.g. in South Asia and Africa
	Cross-national policy convergence	Signatory to all important multilateral treaties enabling policy convergence on standards
Market Structure Advantage	Market competition	Large & dynamic market economy with intense competition; mature financial sector, competitive ancillary industries

Table 2: Assessment of India's Lead Market Potential

As can be seen above, India seems to be endowed with several factors that positively affect its potential as a lead market for cost-effective frugal innovations. Even the low per-capita income can act as an incentive for firms to come up with solutions that can satisfy "demanding" customers, who would otherwise remain non-consumers "quasi-boycotting" the product. Nonetheless, as the examples have shown, "Made in India" products do not only have a large potential for exports, but they are rather actually being purchased abroad in increasingly large numbers, as also the export data for India confirms.

Region	FY 1999-00	FY 2010-2011	CAGR (%)
OECD countries	21,106.6	84,600.6	13.5%
Eastern Europe	1,292.9	2,973.3	7.9%
Developing Asia	8,205.5	78,545.3	22.8%
Africa	1,554.6	16,635.8	24.0%
Latin America	699.8	10,512.1	27.9%
Total exports	**36,822.4**	**254,402.1**	**19.2%**

Table 3: India's Exports to Selected World Regions in million US$, based on RBI (2011) data

As a matter of fact, India's exports, as of 2009, had a higher *intensity* of high-technology products than an average member state of the European Union (EU average: 16.9%), as a study by the European Statistical Office revealed (Loschky and Triebskorn, 2011).

Furthermore, frugal products, as shown by the examples above, may require complex and concerted R&D efforts to design an easy-to-use, low-cost solution to a complex problem. The innovators operate under extreme cost constraints and as a consequence are much more open to external ideas while developing affordable solutions. They seem to be less prone to the so-called "not invented here" syndrome. All the examples discussed in this paper have seen contribution from various external knowledge sources, domestic or otherwise. We can, therefore, state that the innovations are increasingly taking place in an atmosphere of "open global innovation".

5. Summary & Conclusions

Frugal innovations emanating from India seem to be singularly suitable to tap into the hitherto non-consuming segments of the society. They increase the market-size and help raise the living standards of people. Even though customers are price-sensitive and affordability is extremely important, acceptable quality levels and attractive designs play an increasingly crucial role in a demanding, market-driven economy characterized by intense competition. Merely stripped-down versions of existing products fail to satisfy customer *aspirations* for a nearly high-end product.

As illustrated by the case studies, products "Developed in India" possess strong chances for overseas diffusion not only in other developing countries with similar socio-economic conditions but, in some instances, also in the industrialized world. With its large volumes, dynamic markets, cost advantage, strong technical capabilities, extensive global linkages, and finally, a young and aspiring population, India is endowed with an enormous lead market potential. Companies, both domestic and MNCs, would be well advised to make use of India as a test-bed for frugal, disruptive innovations and to early identify emerging needs. Furthermore, India is fast emerging as a hub of knowledge-based innovation and not mere offshore implementation of tasks defined elsewhere. Participating in this lead market can be advantageous to firms seeking access to tomorrow's affluent consumers. Management scholars, too, could find interesting research avenues in relation to strategies to overcome country-of-origin barriers faced by a developing country lead market.

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About Institute for Technology and Innovation Management

The Institute for Technology and Innovation Management at the Hamburg University of Technology (TUHH) was founded in 1998 and is headed by Prof. Cornelius Herstatt PhD, MBA. Prof. Herstatt has worked for many years in managerial positions in both Industry and Consulting. Before joining TUHH, he was teaching at the University of Zurich and St. Gall (Switzerland). The department is still in the building-up phase, and we cooperate with a number of research institutes in and outside of Germany as well as with a number of companies and federal/private institutions.

At our institute we take care of both, education in various fields of business administration (e.g. Innovation Management, Marketing and Sales, Project Management, etc.), and dedicated research in the field of Technology and Innovation Management.

We see ourselves as an open institute that develops and later transfers knowledge, mostly in close cooperation with companies and institutions. In our research, we focus on the management of the innovation process in both the classical ("old") economy and the service sector. The product-creation process, its organizational and instrumental aspects are the umbrella of our various research projects. The underlying goal of all these projects is the identification and analysis of strategic and operational issues which have a major influence on the eventual success of innovation. Through co-operations with companies we carry out research projects or market studies. We offer advice through consulting projects and develop seminars, workshops and trainings.

Webpage: www.tuhh.de/tim

About Research Project Global Innovation

'Global Innovation' is a research project of the Institute of Technology & Innovation Management (TIM) at Hamburg University of Technology (TUHH). A primary aim of this project is to observe, analyze and forecast developments in the field of globalization of innovations. It also aims to provide decision-makers from selected industry sectors with useful instruments while deciding on whether or not to internationalize their innovation / R&D activities and to which locations.

Even though not exclusively focussed on a single region, the research project pays special attention to emerging R&D locations such as China and India.

Webpage: www.global-innovation.net

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