

Centre for Frugal Innovation in Africa Working Paper Series

No 1: Frugal Innovation – A Literature Review Technology, Entrepreneurship and Development in Innovation Processes

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This is a publication of the Centre for Frugal Innovation in Africa (CFIA), a research centre within the strategic alliance between Leiden University, Delft University of Technology and the Erasmus University Rotterdam in the Netherlands. The CFIA studies frugal innovations in relation to economic transformations in Africa. Our aim is to identify the conditions under which frugal innovations are more likely to improve the lives of consumers and producers at the Middle and Bottom of the Pyramid.

ISSN: 2589-5699

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CFIA Working Paper Series

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1. Introduction

In 2010, *The Economist* put a new innovation phenomenon – ‘frugal innovation’ – in the spotlight (*The Economist*, 2010). Frugal innovation involves (re)designing products, services or systems to significantly cut costs, without sacrificing user value, so as to reach a mass customer base, especially in low-income settings (Bhatti, 2012; Tiwari & Herstatt, 2012; Rao, 2013). Frugal innovation does not only have a market in developing countries in Asia, Latin America and Africa, but can equally appeal to cost-conscious consumers in Europe and North-America (Govindarajan & Ramamurti, 2011; Radjou & Prabhu, 2014). A range of products and services has resulted from frugal innovation processes, such as Tata’s Nano car, portable ultrasound devices, mobile money services (notably M-PESA in Kenya) and single-use OMO washing powder sachets suitable for cold water (Prahalad, 2012; Agarwal & Brem, 2012; van Beers, Leliveld & Knorringa, 2012). Because the low-income setting often involves institutional and resource constraints – such as limited capital resources, lack of basic provisions, weak infrastructure and poor governance – innovation has to follow a path different from the capital intensive and research and development (R&D) led process common in Western markets (Prahalad & Hall, 2002; Webb et al., 2010; Schuster & Holtbrugge, 2012). Frugal innovation involves ‘rethinking entire production processes and business models’, and it has therefore been hailed as potentially transformative (*The Economist*, 2010; Rao, 2013). Although ‘frugal’ literally means being sparing and cost-effective, frugal innovation cannot be understood solely in relation to cost-reducing aspects (Bhatti, 2012). In recent years, frugal innovation has become an emerging field of scientific interest, accompanied by fast expanding ‘business guru’ talk about the novelty of the phenomenon (Bhatti, 2012; George, McGahan & Prabhu, 2012; Tiwari & Herstatt, 2012; Radjou & Prabhu, 2014). Yet a definitive consensus on what frugal innovation is and what it means for innovation processes – in terms of technology, entrepreneurship and development – has not yet emerged (Bhatti, 2012; van Beers, Leliveld & Knorringa, 2012; Bhatti & Ventresca, 2013). This paper will present a literature review of studies on ‘frugal innovation’, assessing their strengths and weaknesses, before proposing a future research agenda. We argue that in order to understand frugal innovation, the innovation cycle has to be approached in an integrative manner, considering all aspects from design, to production, business models, marketing and consumption.

2. The ‘Emergence’ of Frugal Innovation

Although frugal innovation has become a fashionable topic, which points out that something is going on that is new to our thinking on what innovation embodies, how it is shaped and what its societal role and relevance could be, historical precedents of frugal innovation can equally be mentioned (Bhatti & Ventresca, 2013). Bhatti (2012), for example, explores the British clothing industry during the Second World War, when austerity measures were put in place to ensure that resources were focused on winning the war. A frugal mentality was applied, forbidding excessive use of materials and chemicals, whilst safeguarding the provision of quality consumer goods at reasonable prices. But earlier examples can be found as well. Prestholdt (2008) describes how the demand for affordable cloth in nineteenth century East Africa spurred the industrialisation of clothing production, first in Salem Massachusetts and then in Bombay India. Large-scale consumer demand for high-quality affordable cloth in East Africa enticed far-reaching innovations in global methods of production, forcing suppliers to customise their offerings to satisfy ever changing styles. India has a particular track record when it comes to grassroots, bottom-up and frugal innovations (Radjou, Prabhu & Ahuja, 2012). The Honeybee Network is an organisation that since 1988 has identified over 10,000 grassroots innovations all across India, of ‘entrepreneurs who have created ingenious solutions for pressing socioeconomic problems in their local communities.’ (Radjou, Prabhu & Ahuja, 2012, 1). One of these innovations is the Mitticool clay refrigerator, which operates without any electricity, is biodegradable and produces no waste. Still, frugal innovation – in its current form – is a distinct type of innovation, which combines elements of previous innovation manifestations in novel ways (Bhatti, 2012).

Innovation and innovative capacity are not spread evenly across the globe (Archibugi & Iammarino, 1999; Chataway, Hanlin & Kaplinsky, 2014). Until recently, dominant innovation processes (concentrated in Europe and North America) remained largely capital intensive, high-tech and exogenous to the low-income context (Kaplinsky, 2011). This type of innovation did not always prove suitable for a low-income context, where capital is scarce and infrastructure is often poorly developed (Pedersen & McCormick, 1999; Lee, Juma & Matthews, 2014). As a counter voice the Appropriate Technology (AT) movement developed in the 1970s. The AT movement sought to develop technologies that are appropriate for low income countries, being labour-intensive, simple to operate and repair, producing products for low income consumers at small scales and with a minimally-harmful impact on the environment (Schumacher, 1973; Kaplinsky, 2011). The message preached by the AT movement was potentially radical, yet its impact remained limited mainly to NGOs, without

disrupting dominant innovation processes (Clark et al., 2009, 19). Even though since the 1990s forms of AT and indigenous knowledge have started to find wider audiences, this still remains largely 'below-the-radar' (Clark et al., 2009; Kaplinsky, 2011). AT and frugal innovation share a focus on low income settings and technological innovation, yet the emergence of frugal innovation has been conditioned by a specific mix of factors, which relate to the current global economic, technological and innovation environment (Bhatti, 2012).

This specific innovation environment has been underpinned by various forms of globalisation, which have increasingly manifested themselves from the 1950s onwards (Gereffi, 2014). First of all, the development and extension of global value chains (GVCs) has played a role (Kaplinsky, 2010). GVCs have heightened international competition, reshaped global production and trade and have afforded a new role to consumers. Whereas developing countries were once mainly sources of cheap labour for northern economies, they are increasingly involved as producers and consumers in GVCs. Developing countries have shifted their strategies in GVCs from import substituting industrialisation to export oriented industrialisation and from producer-driven to buyer-driven commodity chains, which has enabled emerging economies to become new sources of demand and production competencies in the global economy (Gereffi, 2014). Secondly, and related to this, there has been a global diffusion of capabilities, witnessed by increasing numbers of university graduates, professionals and innovation hubs (Kaplinsky, 2011). Thirdly, population growth in emerging economies is challenging the dominance of the West, where population growth rates have stagnated or even reversed. African and Asian populations are rapidly increasing and they are to a large extent youthful, educated and urban (Chironga et al., 2011; Ellis, 2011). Moreover, population growth has been matched by rapid economic growth, as Africa's GDP grew by 4.7% a year over the 2000-2010 period (Roxburgh et al, 2010). Together, population growth and economic growth have caused the low income consumer base to expand significantly. Although low income markets are still hard to reach due to poor infrastructure, political instability and widespread poverty, innovation has increasingly been geared towards these low-income high-volume markets (Chikweche, 2013; Dolan & Roll, 2013). To reach the Bottom of the Pyramid (BoP), those living on less than \$2 a day, and the emerging middle classes who live just above the BoP, the dominant innovation trajectory has by necessity been challenged by new paradigms, such as frugal innovation (Kirchgeorg & Winn, 2006; Hammond, 2007). Fourthly, the great trade collapse in 2008 further accelerated the shift in end markets from the North to the South (Gereffi, 2014, 22). European and North American economies, facing saturated markets and economic decline, can no longer serve as a source of technological innovation which is simply transplanted to African and Asian localities. Instead, entrepreneurs and consumers in low-income settings have come to figure as co-creators of

innovation in polycentric innovation networks (Chironga et al., 2011; McCormick & Maalu, 2011). This relates to the fifth point, 'polycentric innovation', which designates the global integration of specialised R&D capabilities across multiple regions to create novel solutions that no single region or company could have completely developed on its own (Radjou, 2009; Singh, 2011). Greater product and technology complexity has increased costs and risks for innovators, such that these can barely be dealt with by relying on one firm's limited resources and capabilities alone. This has pushed companies to collaborate with external partners in developing innovations. Moreover, globalisation has opened up possibilities for cross-national alliances that contribute to creating competitive advantage in foreign markets (Lavie & Miller, 2008). Together, these factors give agency to low-income producers and consumers who no longer have to rely on industrial technology from developed markets, but can co-create innovations themselves. Macro-economic trends and shifting innovation paradigms have thus set the scene for the current emergence of frugal innovation, which entails a focus on low-income markets, interactive and polycentric innovation (Bhatti, 2012).

This trend to challenge established innovation paradigms has been supported by a policy shift away from state direction in innovation and industry towards an emphasis on private enterprise (Owusu, 2003; Kaplinsky, 2011). A vibrant private sector with well-functioning markets has been recognised as essential for a properly developing economy (Blowfield & Dolan, 2014). Particularly from the 1980s onwards the role of the state was cut back and international agencies promoted policies of liberalisation, including the privatisation of state-owned enterprises, the strengthening of market forces and increased competition (Banks & Hulme, 2014). The private sector was advocated as being 'more efficient, more productive and more conducive to economic dynamism' (Schulpen & Gibbon, 2002, 1) The role of business in development has become more overt from the 1990s onwards and after 2000 ideas of private sector development (PSD) have gained sway, underpinned by a valorisation of private enterprise, market efficiency, entrepreneurship and the conviction that markets can work for the poor (Schulpen & Gibbon, 2002; Sayer, 2006; Knorringa & Helmsing, 2008; Langan, 2011; Blowfield & Dolan, 2014). These trends have far-reaching consequences for developing countries, as PSD discourse holds that business might succeed where governments and aid donors have failed, namely in alleviating or even eradicating poverty (Arora & Romijn, 2011). Some assert 'a normative framework that positions poverty as a product of market failure and its alleviation as the managed integration of the poor into global finance, capital and product markets' (Blowfield & Dolan, 2014, 29-30). Promoting an alliance between international and local businesses, as well as between business, NGOs and government actors, frugal innovation fits within the current policy climate (Tiwari, Kalogerakis & Herstatt, 2014).

Frugal innovations are thus located in a specific historical, macro-economic and policy context. Frugal innovations have flourished due to globalisation, changing GVCs, demographic growth and increased economic prosperity in Asia and Africa, as well as due to increased focus in development policies on private sector development as the main motor for economic growth (Bhatti, 2012). The next section will focus on defining the meaning, potential and limitations of frugal innovation.

3. Towards a Definition of Frugal Innovation

In recent years there has been a focus on low-cost, affordable innovations that make life easier and that improve the economic, social and environmental conditions of consumers (Hanlin & Muraguri, 2009; Agarwal & Brem, 2012; Bhatti, 2012; Sesan et al., 2013). Rather than being produced in a top-down manner, these innovations are often the result of an interactive process which takes customer needs as a vantage point (Beshouri, 2006; Kirchgeorg & Winn, 2006). A variety of terms has been coined to describe similar innovation processes: *jugaad* innovation (Radjou, Prabhu & Ahuja, 2012), reverse innovation (Govindarajan & Ramamurti, 2011), cost or constraint-based innovation (George, McGahan & Prabhu, 2012; Chataway, Hanlin & Kaplinsky, 2014) and frugal innovation. Although frugal innovation encompasses some elements of the other labels, it is not effectively captured by any of them (Bhatti, 2012; Rao, 2013). This section focuses on differentiating frugal innovation from other innovation manifestations, by moving towards a definition of what frugal innovation entails.

India has received much attention in recent innovation studies (Prahalad, 2006; Agarwal & Brem, 2012; Kolk, Rivera-Santos & Rufin, 2013). *Jugaad*, a Hindi word meaning ‘an innovative fix; and improvised solution born from ingenuity and cleverness’, has become a popularised term (Radjou, Prabhu & Ahuja, 2012, 4). *Jugaad* is a ‘frugal and flexible mindset’ of ingenious entrepreneurs and enterprises bent on ‘doing more with less’ by producing cost-effective innovations (Radjou, Prabhu & Ahuja, 2012, 19-24). Different from frugal innovation, however, studies of *jugaad* innovation – spanning Brazil, China, Kenya and the USA next to India – focus on the innovation and its outcome, on good ideas, rather than on the innovation process. Although *jugaad* innovation provides several principles to guide the innovation process, it does not systematically engage with the entire innovation cycle, something which frugal innovation does attempt to do (Radjou, Prabhu & Ahuja, 2012).

Reverse innovation similarly refers to innovation processes which produce ingenious and low-cost products (Govindarajan & Trimble, 2012). Different from *jugaad*, it looks exclusively at cases ‘where an innovation is adopted first in poor (emerging) economies before ‘trickling up’ to rich countries’ (Govindarajan & Ramamurti, 2011, 191). Examples include M-PESA mobile money transfer, Nokia’s inexpensive cell phones and General Electric’s portable ultrasound device (Zeschky, Winterhalter & Gassmann, 2014). These reverse and often low-cost innovations have a substantial ‘disruptive’ potential, ‘being cheaper, smaller, simpler and convenient to use’ (Rao, 2013, 70) Low-cost innovations developed in India or Kenya might be introduced to markets in the USA or Germany, forcing large multinationals to alter their

approach to innovation – from capital-intensive and high-tech to low-cost and interactive innovation processes – in order to remain competitive (Prahalad, 2006). Moreover, products which are low in cost and make sparing use of resources increasingly appeal to value conscious consumer groups in Western countries (Rao, 2013, 66). Reverse innovation can share many features with frugal innovation, yet it focuses solely on the reverse flow, disregarding those low-cost and frugal innovations that – due to their context specificity – may never be introduced to other markets (Govindarajan & Ramamurti, 2011).

Numerous terms cover single aspects of frugal innovation, such as ‘constraint-based innovation’ (Ray & Ray, 2010) or ‘cost innovation’ (Williamson, 2010). Stressing the low-cost aspect, a ‘value-for-money’ revolution has been heralded which aims ‘to deliver high technology, variety and customisation at minimal price premiums, and to redirect niche offerings towards volume segments’ (Williamson, 2010, 343). But frugal innovation goes beyond offering ‘customers around the world dramatically more utility for less expenditure’ (Williamson, 2010, 351). We argue that frugal innovation is not confined to stripping products or cost minimisation, but instead approaches the innovation cycle in a more integrative manner, by looking at the process from idea generation, to production, marketing and consumption. This integrative approach differentiates frugal innovation from other innovation concepts, which have often been defined more narrowly (Bhatti, 2012; Tiwari, Kalogerakis & Herstatt, 2014; Zeschky, Winterhalter & Gassmann, 2014).

Besides describing phenomena closely related to frugal innovation, some authors have made attempts to define frugal innovation itself, yet existing definitions tend to focus on one aspect of frugal innovation – for example stripping, cost-efficiency or resource constraints (Bhatti, 2012; Zeschky, Winterhalter & Gassmann, 2014). Tiwari, Kalogerakis & Herstatt (2014, 18), for example, focus on cost minimisation, suggesting that frugal innovations are:

new or significantly improved products (both goods and services), processes, or marketing and organizational methods that 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 significantly reducing the total cost of ownership and/or usage while fulfilling or even exceeding certain pre-defined criteria of acceptable quality standards.

Yet in a different article, Tiwari & Herstatt (2012) admit that ‘affordable price is a *necessary* but *insufficient* condition’ for the success of a frugal innovation. Agarwal & Brem (2012, 2) define frugal innovation as ‘redesigning & developing both products and processes from

scratch at minimum cost, addressing the region specific needs.’ They stress the specific constraints faced by low-income customers: ‘Frugal products with heavy resource constraints have extreme cost advantages compared to existing solutions and are much simpler and cheaper with limited features’ (Agarwal & Brem, 2012, 2). Frugal innovations are indeed often induced by input scarcity (capital, resources, knowledge, etc.), but frugal products and services are by no means necessarily simple – neither in the sense of having only basic functionalities, nor in the sense of using merely simple technology (Bradley et al., 2012, 685). Although frugal products are designed for resource-constrained user contexts in which certain functionalities lose their added value (such as excessive safety or environmental standards), frugal innovations can be and often are technologically sophisticated (Agarwal & Brem, 2012). Zeschky, Widenmayer & Gassmann (2011, 38) define frugal innovation as “‘good-enough,” affordable products that meet the needs of resource-constrained consumers’, claiming that frugal innovation gives rise to products that are of limited functionality and are made of basic, cheaper materials. The example of M-PESA shows that this is not always the case. By means of sophisticated but accessible technology, M-PESA, a mobile financial service developed in Kenya, has extended ‘a basic form of financial access to a wide population’ (Demombynes & Thegeya, 2012, 2). M-PESA utilises mobile phone technology to innovatively circumvent the lack of bank access, showing that frugal products and services need not be of limited functionality and are often highly advanced (Zeschky, Winterhalter & Gassmann, 2014). Frugal innovation is not merely about ‘good-enough’ products. Instead, customers have to be offered an attractive alternative to existing products, services and systems. Frugal innovation, thus, has to improve the overall value proposition (user-value), by adopting innovative technology, design, business models and marketing mechanisms (Agarwal & Brem, 2012; Rao, 2013). Existing definitions of frugal innovation have tended to focus on a single aspect of the innovation cycle of frugal innovation, for example on low cost, ease of use, compact design with a no frills structure, use of limited raw materials or reuse of existing components and cutting edge technology (Bhatti, 2012). Yet no single characteristic can fully explain the phenomenon of frugal innovation and a more integrative approach is therefore needed.

The most systematic attempt to define frugal innovation so far has been made by Bhatti (2012) and Bhatti & Ventresca (2012; 2013). They provide a literature overview of this emerging field, examining whether frugal innovation is a useful concept through which to study innovation in resource-constrained contexts. For Bhatti & Ventresca (2013, 3) frugal innovation is ‘a label that captures a range of heterogeneous activities which cut across different sectors’. Bhatti (2012, 18) proposes a multifaceted definition, arguing that frugal innovation ‘may redefine business models, reconfigure value chains and redesign products to use resources in different ways and create more inclusive markets by serving users with affordability constraints, often

in a scalable & sustainable manner.’ In line with this, we argue that for frugal innovation to have any value as an analytical concept an integrative approach is required, which goes beyond aspects of cost reduction or resource constraints, to include the innovation cycle as a whole. The definition of frugal innovation proposed here is: *The (re)design of products, services and systems to make them affordable for low-income customers without sacrificing user value.* Central to this definition are three elements: affordability, functionality and good-enough quality. This definition of frugal innovation proposes a focus not on single elements, such as the design process or the technical requirements for creating low-cost items. Instead, it takes a more integrative approach, integrating the product development cycle ((re)design) and the business model, production, distribution and marketing (Tiwari, Kalogerakis & Herstatt, 2014; Zeschly, Winterhalter & Gassmann, 2014). Furthermore, this approach pays attention to the various actors involved in frugal innovation, highlighting ‘polycentric innovation’ in which actors from various socio-economic and geographical backgrounds participate (Radjou, 2009). Thus, even if frugal innovation encompasses elements of other types of innovation – such as *jugaad* or reverse innovation – it combines these in a novel and more integrative way, resulting in a qualitatively different type of innovation (Bhatti, 2012; Zeschky, Winterhalter & Gassmann, 2014). In the next section we will explain the different aspects of such an integrative approach.

4. The Innovation Cycle of Frugal Innovation: From Idea to Product and Use

For a proper understanding of frugal innovation, it is important to consider the innovation cycle as a whole, from idea, to business model, marketing and consumption (Hansen & Birkinshaw, 2007). Frugal innovation processes challenge and change established forms of innovation in all these aspects, making frugal innovation a potentially transformative innovation manifestation (Rao, 2013). In innovation theories, innovation refers to ‘all the scientific, technological, organizational, financial and commercial activities necessary to create, implement, and market new or improved products and processes’ (Léger & Swaminathan, 2007, 2). This includes not only scientific and technological, but institutional, organisational, social and political dimensions (Hanusch & Pyka, 2007). Innovation can best be considered as a process by which ideas are transformed into practice. This does not always involve radical innovation, it can equally be an incremental process, resulting from the cumulative effect of implementing small-scale ideas and changes over a prolonged period of time (Gewald, Leliveld & Peša, 2012; Chataway, Hanlin & Kaplinsky, 2014). Because frugal innovation aims to provide total product solutions, which ‘better fit the environment of low-income markets and the characteristics and tastes of low-income consumers’, it necessitates an integrative and polycentric approach (Mendoza & Thelen, 2008, 451). Various actors play a role, not only inventors, but also producers, consumers and middlemen who transmit and operationalise innovations, making them acceptable to society. Furthermore, this type of innovation is not confined to one locality but spans geographical, technical and knowledge frontiers between countries and continents (Radjou, 2009). Frugal innovation involves collaboration between multinational corporations (MNCs), small and medium enterprises (SMEs), government, local entrepreneurs and consumers to come up with truly compatible innovations to solve local problems (Bradley et al., 2012, 686; Seelos & Mair, 2007; Webb et al., 2010; Schüster & Holtbrugge, 2012). Frugal innovation might, for example, be developed in the local subsidiaries of MNCs, merging the technical know-how of the MNC with the market knowledge of local entrepreneurs (Agarwal & Brem, 2012). Such a polycentric innovation process has the potential to play a role in local economic development, by providing a bridge between local and international knowledge and actors (Papaioannou, 2014).

In their design, production and marketing, frugal innovations attempt to meet a number of contextual challenges. Frugal innovation addresses the needs of low-income customers, who live in a resource-constrained context with a multitude of institutional voids, through design that is inexpensive, easy to use and requires minimal infrastructure (Webb et al., 2010;

Kaplinsky, 2011; Bhatti, 2012). In this respect, value sensitive design can be particularly useful: 'Value Sensitive Design is a theoretically grounded approach to the design of technology that accounts for human values in a principled and comprehensive manner throughout the design process' (Friedman, Kahn & Borning, 2002, 1). Frugal innovation aims to provide value-sensitive innovations that are truly compatible with the unique circumstances of low-income consumers in resource-constrained settings. Frugal innovation is distinctive in that it aims to be cost-effective throughout the product development cycle (Bhatti, 2012; Zeschky, Winterhalter & Gassmann, 2014). The innovation process is directed at 'doing more with less' and instead of enhancing technical functionalities by adding new attributes, frugal innovation might actually remove attributes whilst safeguarding technical functionalities and user value (Radjou, Prabhu & Ahuja, 2012; Agarwal & Brem, 2012). Some authors have described frugal innovation as "good-enough," affordable products that meet the needs of resource-constrained consumers' (Zeschky, Widenmayer & Gassmann, 2011, 38). But frugal innovation uses 'cutting edge technology to create low-cost and no frills products', involving 'the reuse of components and simpler designs that result in products without extra accessories' (Rao, 2013, 66). Whereas frugal innovation might be 'lean' compared to alternatives, frugal innovation seeks to add value to existing products and is by no means 'simple' (Rao, 2013). In order to ensure value-creation, frugal innovation further needs to adopt specific business models.

In contrast to the established innovation pattern, which relies on formal R&D driven by MNCs, frugal innovation employs a cost-efficient, appropriate, bottom-up and local approach (Bhatti, 2012, 5). Frugal innovation forces innovators to take a fresh look at their business models in order to come up with quality products at dramatically lower prices (Williamson, 2010, 348). Unlike selling differentiated products for a high profit margin to rich consumers, frugal innovation involves low-cost products sold in high-volume markets (Kaplinsky, 2011). Frugal innovation is about redesigning products and processes, rethinking the production process, discarding unnecessary features, negotiating with suppliers and distributors for the best deals and finding cost-effective means of reaching consumers (Dabke, 2011). Frugal innovation thus requires completely reconfigured business models. The aim is to solve 'customer problems and needs "better, faster and cheaper" than competitors through structural changes to a company's business system' (Simanis & Hart, 2009, 80). In order to reach low-income consumers facing serious resource constraints, businesses are 'forced to rethink the very *source, the focus, and the processes of innovation*' (Prahalad, 2012, 6). According to Prahalad & Hall (2002, 2), reaching such markets will require:

radical innovations in technology and business models. It will require MNCs to reevaluate price-performance relationships for products and services. It will demand a new level of capital efficiency and new ways of measuring financial success. Companies will be forced to transform their understanding of scale, from a “bigger is better” ideal to an ideal of highly distributed small-scale operations married to world scale capabilities.

Yet how exactly are companies to achieve this (Karnani, 2007; Seelos & Mair, 2007; Bradley et al., 2012)? Frugal innovation can reduce the cost of product development by as much as 90%, by using ‘inventive analogies’ to increase process efficiency (Tiwari, Kalogerakis & Herstatt, 2014). No firm can do this alone, and therefore polycentric innovation is required in which multiple actors are involved, including MNCs, NGOs, government, SMEs and local entrepreneurs (Prahalad & Hall, 2002). This multiplicity of actors requires innovation in technology, business models and management processes, it requires innovation in organisational structure.

What kind of organisational collaborations foster frugal innovation? Views advocating ‘open innovation’ hold that ‘companies must open their business models by actively searching for and exploiting outside ideas and by allowing unused internal technologies to flow to the outside, where other firms can unlock their latent economic potential’ (Chesbrough & Appleyard, 2007, 22). Although partnerships might be established between a broad range of actors, there are several types of organisational frameworks within which frugal innovations are most commonly developed. First of all, frugal innovations might take place in local R&D subsidiaries of MNCs in emerging market contexts (Agarwal & Brem, 2012; Zeschky, Winterhalter & Gassmann, 2014). This type of innovation does not necessarily require a radical rethinking of business models, as it mainly aims to adapt existing products to local markets (Agarwal & Brem, 2012). Philips, for example, has established an innovation hub in Nairobi, Kenya, where the company develops frugal products through a combination of local and international expertise. Secondly, frugal innovations might arise from polycentric innovation processes in which MNCs and local entrepreneurs co-create an innovation (Prahalad & Hall, 2002). Technology networks can link actors of a different size, located in different countries, with different income levels, to create a frugal innovation (Archibugi & Iammarino, 1999; Léger & Swaminathan, 2007). Locally embedded knowledge and technology networks are important for developing frugal innovation and for successfully re-engineering high-value products for low-margin but high-volume markets (Simanis & Hart, 2009; London, Anupindi & Sheth, 2010). Frugal innovation might be driven primarily by local entrepreneurs or SMEs, or by resourceful MNCs and their R&D departments (Seelos & Mair,

2007; Govindarajan & Ramamurti, 2011; McCormick & Maalu, 2011; Cozzens & Sutz, 2014). Yet most often, frugal innovations cannot be developed by any single actor alone. MNCs, for example, use partnerships ‘with governments, large domestic corporations, and business groups to help mitigate the risks of entering foreign markets’ (Webb et al., 2010, 556). They might even co-operate ‘with non-traditional partners such as non-governmental organizations, non-profit organizations, community groups, and local authorities’ (Schüster & Holtbrugge, 2012, 827). Frugal innovation thus necessitates a truly polycentric approach of co-creation. Thirdly, frugal innovation might be developed in a more bottom-up manner, as a grassroots initiative (Meagher & Lindell, 2013; Cozzens & Sutz, 2014), sometimes in collaboration with local knowledge institutes (Tijssen & Dijksterhuis, forthcoming). Many entrepreneurs in Africa and Asia are highly innovative and have a good understanding of local markets and contextual constraints. Yet they struggle to become involved in wider technology networks that will integrate them in broader (inter)national innovation systems (Pedersen & McCormick, 1999; McCormick & Maalu, 2011; Cozzens & Sutz, 2014). Polycentric frugal innovation systems might provide a solution, by linking local entrepreneurs to international companies or local knowledge institutes, although detailed empirical studies of the dynamics of this collaboration – particularly in informal settings – are not yet available (Cozzens & Sutz, 2014; Chataway, Hanlin & Kaplinsky, 2014; Heeks, Foster & Nugroho, 2014). Apart from the idea, design and business model of frugal innovation, marketing and consumption are distinctive from existing innovation processes.

Low-income markets are characterised by a host of specific constraints and marketing challenges, with which actors intending to enter these markets might be unfamiliar (Chikweche & Fletcher, 2011, 343). These include limited purchasing power, a lack of financial services, an inefficient institutional framework and problems with market infrastructure (Schüster & Holtbrugge, 2012). Methods of distribution or marketing which work well in developed markets might need to be radically redesigned in developing markets (Chikweche & Fletcher, 2011). Such ‘differences force MNCs to develop market knowledge and consequently new products, business models, and strategies’ (Schüster & Holtbrugge, 2012, 818). Even though MNCs have much technological and managerial know-how with which they can provide affordable products and services to low-income markets, the distinct challenge is one of ‘reinventing western models of doing business to fit the local needs and requirements’, which are heterogeneous and context-specific (Chikweche & Fletcher, 2011, 344). MNCs aspiring to sell products to low-income markets need to be innovative, resourceful and willing to take risks (Burgess & Steenkamp, 2006). They need to gain knowledge on ‘how to face constraining market conditions, redesign products, services and business models, attain low prices and how to team up with non-market partners’ (Schüster & Holtbrugge, 2012, 828). A

deep understanding of consumption patterns in low-income markets is thus required to develop successful frugal innovations. Yet consumption and consumer preferences in low-income markets remain poorly understood (Banerjee & Duflo, 2007; Karnani, 2007; Subrahmanyam & Gomez-Arias, 2008). In order to serve the mass market segment of poor consumers, who are resource constrained and extremely price sensitive, actors need to adopt 'imaginative strategies – selling products in small quantities; offering credit, hire purchase, and layaway plans; and (...) developing innovative, low-priced consumer products and services' (Chironga et al., 2011, 121). Even though low-income 'consumers engage in a deliberation process' when buying goods, which given their constraints might be more complex than in high-income markets, low-income consumers by no means automatically prefer low-price or low-quality goods (Chikweche, Stanton & Fletcher, 2012, 208-9). To the contrary, low-income consumers are willing to spend money, especially in return for 'quality, reliability, and value' (Nakata & Weidner, 2012, 21-5). Frugal innovations are thus not judged solely on the basis of cost. Instead, frugal innovations should provide an attractive value proposition and higher user value than existing alternatives (Bradley et al., 2012). Nakata & Weidner (2012, 23) rightly argue that: 'How a product is designed in terms of features, or new product attributes, is critical to its acceptance.' Because low-income markets are extremely diverse in terms of ethnicity, culture and preferences, products have to be tailor-made to suit such markets (Prahalad, 2006). Producers might have to redesign the shape, size or usage of existing products in order to appeal to specific markets. Reaching low-income markets through frugal innovation requires not only innovative ideas and business models, but marketing strategies as well. Companies might have to engage in 'mobilizing community efforts, creative pricing methods, innovative product designs, tapping into cultural and locally prevalent ways of communicating' (Subrahmanyam & Gomez-Arias, 2009, 410). An intimate understanding of consumptive behaviour could serve to make business models, marketing and distribution strategies of frugal innovation better suited to diverse low- and middle-income markets.

Finally, the institutional context in which frugal innovation takes place should be scrutinised. Frugal innovations are highly context-specific, each setting brings certain opportunities and constraints (Bhatti, 2012; George, MacGahan & Prabhu, 2012). Institutional theory plays a role in understanding the resource choices of firms and the context in which innovation is created, and furthermore institutions are fundamental to social and economic development outcomes (Banks & Hulme, 2014, 185). Inefficient institutions might 'contribute to high transaction costs that discourage or preclude productive transactions', whereas 'without competitive markets and the rule of law to protect property rights, there is no incentive for entrepreneurs to innovate and no spillover of the technological advancements that produce

economic growth' (McMullen, 2011, 205-6). Frugal innovation predominantly occurs in a context of resource constraints and institutional voids (Mendoza & Thelen, 2008; Webb et al., 2010). But instead of being an impediment to innovation, the large low-income consumer segment might pose an opportunity to provide affordable solutions that help mitigate poverty:

resource-poor settings can actually drive innovation, demanding ingenious product designs that are less expensive, and easier to use, and require less infrastructure. It is also easier to disrupt the technological status quo in the absence of entrenched commercial interests organised around existing products. (Elias, 2006; Quoted in Bhatti, 2012)

Existing studies of frugal innovation have not paid much attention to this institutional context, suggesting that frugal innovation provides a 'one size fits all' solution which can be implemented in any locality across the globe (Bhatti, 2012). Yet the innovation cycle should be adapted to suit the specific institutional context and therefore this local institutional context has to be better understood.

An integrative approach to frugal innovation follows a partly parallel development process in which all the stages of the innovation cycle are considered jointly, from idea to production, business model and entrepreneurship, to marketing, consumption and institutional context. Value sensitive design has to take consumer preferences into account, whereas an innovative idea cannot succeed without an appropriate business model (Kaplinsky, 2011). Previous attempts to define frugal innovation have focused on one aspect, such as cost reduction, largely overlooking the interrelationship between the various aspects of the innovation cycle (Bhatti, 2012). An integrative approach towards frugal innovation does not only propose a fresh look at the innovation cycle, but enables a better understanding of the societal and economic impact of frugal innovation. An important question in this respect, both for academics and policymakers, is whether and under what conditions frugal innovation can be(come) inclusive innovation.

5. Frugal Innovation as Inclusive Innovation?

As emphasised by Schumpeter, innovations are a dominant force in economically transforming societies. Schumpeter (1912) argued that the introduction of new (innovative) products might disrupt existing production processes ('creative destruction') and that this drives economic transformation in capitalist societies. In reaction to this, it has been argued that innovation can play an important role in reorienting economic growth in more developmentally satisfactory ways (Chataway, Hanlin & Kaplinsky, 2014, 50). Yet whilst innovation might help address poverty challenges, 'mainstream innovation is associated with increasing inequality' (Heeks, Foster & Nugroho, 2014, 176; Santiago, 2014, 1). Formal science and technology rarely target the needs of the poor, which has led to the increased decoupling of socio-economic growth and development due to the use of capital-intensive, large-scale and environmentally damaging technologies (Kaplinsky, 2011; Chataway, Hanlin & Kaplinsky, 2014). Frugal innovations might prove to be examples of Schumpeterian creative destruction, disrupting mainstream innovation processes and having the potential to boost local economic development in low-income settings (Rao, 2013). More so than conventional types of innovation and technology networks, frugal innovation may allow the incorporation of Asian and African producers and consumers in the design, production, marketing and distribution of frugal products, systems and services (Chataway, Hanlin & Kaplinsky, 2014). Although frugal innovation might prove to be a form of 'inclusive innovation', it remains to be empirically ascertained whether it will be able to fulfill this role (Heeks, Foster & Nugroho, 2014; Papaioannou, 2014). Will frugal innovation lead to sustained and equitable economic growth, or will it merely benefit a privileged few whilst exploiting others (George, MacGahan & Prabhu, 2012; Dolan & Roll, 2013; Cozzens & Sutz, 2014)?

Inclusive innovation can be defined as 'the development and implementation of new ideas which aspire to create opportunities that enhance social and economic wellbeing for disenfranchised members of society' (George, MacGahan & Prabhu, 2012, 663). It might be the case that top-down innovations, developed in the headquarters of MNCs in London or New York before being transplanted to Bombay or Dar es Salaam without local linkages, are not likely to result in equitable and sustainable economic growth (Sesan et al., 2013, 137). Instead, bottom-up approaches and informal sector studies propose that 'innovation in the informal sector' can 'be more sustainable with wider impacts on productivity, livelihoods and welfare of the marginalized populations' (Santiago, 2014, 2). Yet it should be questioned whether 'ideas that emerge from and integrate with the local context have better chances of adoption or success than those planned elsewhere and subsequently imported into a resource-limited

setting' (George, MacGahan & Prabhu, 2012, 664). By providing a polycentric alternative, which links actors in the formal and informal sectors across different countries, frugal innovation might play a role in creating sustainable economic growth and inclusive development (Papaioannou, 2014). Inclusive and pro-poor innovations have been described as 'a multi-stakeholder social learning process, that generates and puts to use new knowledge and which expands the capabilities and opportunities of the poor' (Berdegué, 2005, 15). The poor themselves should equally be involved: 'Inclusive innovation policy presupposes a change in institutional culture and mandates the involvement of the poor in identifying their development priorities and in providing incentives for various actors to serve their needs more effectively' (World Bank, 2010, 338). This entails a collaborative effort among 'public R&D entities, industry, universities, nongovernmental organizations NGOs, donors, and global networks' (World Bank, 2010, 338). Frugal innovation contributes to establishing exactly this type of polycentric collaboration between actors, and therefore frugal innovation might prove to be a form of inclusive innovation (Radjou & Prabhu, 2014).

In the literature so far there have been two quite different assessments of whether frugal innovation will be able to contribute to inclusive innovation and development (Cross & Street, 2009; Dolan, 2013). On the one hand, there has been celebratory discourse of the ability of international business to serve the needs of the 'Bottom of the Pyramid' (BoP), creating a 'win-win' situation by generating profits and simultaneously alleviating poverty (Prahalad, 2006). The BoP discourse suggests that business can find fortune by serving 'the billions of *aspiring poor* who are joining the market economy for the first time' (Prahalad & Hart, 2002, 1). Those living on less than \$2 a day constitute a 'mega market' of 'micro consumers', amounting to 4 billion people worldwide (Hammond et al., 2007; Critiqued by Crabtree, 2007; Landrum, 2007). The BoP rhetoric suggests that these consumers are underserved by existing products and services, and that businesses can therefore profitably introduce frugal innovations to this market. Through mutual value creation, the BoP might thus stimulate corporate profits and alleviate poverty (London, Anupindi & Sheth, 2010). In this sense, poverty eradication would be 'reconcilable with a profit-maximizing objective within an enterprise-based market system' (Ansari, Munir & Gregg, 2012, 814). Increasingly, private sector actors have been targeting inclusive innovation for poor consumers as a source of sales and profit (Schulpen & Gibbon, 2002; Blowfield & Dolan, 2014). Ideas of 'inclusive business for the poor' (alternatively 'social business', 'pro-poor business' or 'inclusive capitalism') have sought to marry profits with social aims, assuming that 'business activities can contribute to the long-term goal of poverty alleviation by embedding the neglected poor parts of the world population into efficient value chains and market structures' (Hahn, 2012, 51).

On the other hand, this business view of a ‘win-win’ scenario resulting in inclusive development has been heavily critiqued (Schwittay, 2011; Dolan, 2012). Opponents argue in favour of a focus on the informal economy, a hitherto neglected field in innovation studies (Meagher & Lindell, 2013; Cozzens & Sutz, 2014). Critical approaches to the BoP literature suggest that there is insufficient understanding of how the search for corporate profit and the needs of the poor can be combined (Cross & Street, 2009; Arora & Romijn, 2011). BoP discourse might even aggravate poverty, by reconstituting the poor as ‘modern’ and value-conscious consumers, with unmet needs and wants which can only be satisfied through capitalist enterprise and market involvement (Dolan, 2012). MNCs might crowd out local resources, enhance dependency and transfer inappropriate technologies and practices to a local context (Hansen & Schaumburg-Muller, 2010). It is doubtful whether ‘poor people can escape chronic poverty through better access to a wide range of cheap, high-quality products and services’ (Arora & Romijn, 2008, 4). Admittedly, consumption alone cannot change the structural features of poverty and the unequal power relations between MNCs and poor consumers have to be acknowledged (Karnani, 2007; Ansari, Munir & Gregg, 2012; Dolan, 2012). More so than MNCs, the informal economy might be suited to enable responsiveness to shifting demand, skills development, participation in global value chains, facilitate the role of intermediary organisations and to provide knowledge of the societal and political context (Cozzens & Sutz, 2014, 13). Due to its open employment structure, ideas diffuse rapidly in the informal sector (Meagher & Lindell, 2013; Cozzens & Sutz, 2014). It should be questioned to what extent ‘incorporating the informal economy into global business models and participatory systems of service provision empower[s] Africa’s [and Asia’s] informal entrepreneurs and workers, or does it capture their energies to cut costs and increase profits for others? (Meagher & Lindell, 2013, 59)’

Although frugal innovation has the potential to be inclusive, it is not inherently so (Papaioannou, 2014). Frugal innovation might involve low-income producers in the design, production and marketing process, yet it might equally be that MNCs design, produce and market frugal innovations which end up jeopardising local entrepreneurs (Ansari, Munir & Gregg, 2012; Varman, Skalen & Belk, 2012). Despite the aim of frugal innovations to provide ‘total product solutions’ that better fit the environment and tastes of low-income consumers, this does not always succeed (Mendoza & Thelen, 2008, 451). After all, ‘introducing new markets may create new vulnerabilities and disrupt rather than enhance social harmony’ (Ansari, Munir & Gregg, 2012, 817). Critics argue that business-led frugal innovations cannot address ‘the root structural causes of poverty and inequality’ (Banks & Hulme, 2014, 193). Indeed, ‘inclusiveness is a multi-dimensional concept that cannot be realized if people are offered low-quality products’ (Papaioannou, 2014, 195). Development should be seen as ‘an

economic *and* social process that also facilitates redistributions of power, representation and accountability, and more inclusive social, economic and political institutions' (Banks & Hulme, 2014, 189). For a structural solution to the problem of poverty, multiple actors will have to be involved: 'addressing poverty on a global scale requires participation of all sectors of society, including corporations' (Badiane & Berdish, 2011, 581). The polycentric approach, advocated by frugal innovation, might thus enable more inclusive forms of innovation and development (Heeks, Foster, Nugroho, 2014).

From a different angle, authors who write about the role of standards in innovation processes contribute to the debate on inclusive innovation. On the one hand, some authors argue that large established firms use product and process standards to entrench their market position, to increase barriers to entry and thus standards can function as a line of defence against being swept away by the next wave of creative destruction. Established firms claim that these standards guarantee consumers high-quality, safe, hygienic, and socially responsible products, in short that these standards protect consumers against dangerous, environmentally destructive and humanly exploitative products and processes (van Beers, Knorringa & Leliveld, 2013). Because standards are increasingly recognised as a key global governance mechanism, which co-determines access markets and opportunities for price differentiation (Blowfield, 2007; Knorringa, 2011), market access for new firms becomes increasingly difficult. If such standards are applied to frugal innovations these may prevent small and medium enterprises operating in BoP markets and in the informal sector from joining the co-design, production, marketing and distribution of frugal innovations, because these actors do not have the means to comply with imposed standards. On the other hand, standards can indeed play an important role in ensuring relatively high-quality, safe, hygienic and socially responsible products. This major achievement might get lost if frugal innovation strategies focus on reducing costs and stripping products of all attributes that do not influence usage and/or cannot be deduced, as in the case of credence goods. An often implicit coalition of major Western brand-name companies, Western governments, trade unions and Western consumers activists lobby against allowing firms to ignore standards. However, in less regulated markets in emerging economies they might be swept aside by indigenous firms and new MNCs from China, India and Brazil. While some analysts predict that this will lead to a 'race to the bottom' (Kaplinsky & Farooki, 2010), it remains an empirically open question to what extent frugal innovations will undercut existing standards (van Beers, Knorringa & Leliveld, 2013).

Existing views on the inclusive effects of frugal innovation are overtly polarising, juxtaposing a business view of a 'win-win' scenario with a critical view of capitalist exploitation of the

informal sector (Dolan, 2012). Yet frugal innovation might offer a more nuanced middle ground. To what extent do bottom-up innovations have more potential for generating equitable economic growth than top-down innovations? It might be the case that 'both top-down and bottom-up processes are crucial in the sourcing and driving forward of inclusive innovation initiatives' (George, MacGahan & Prabhu, 2012, 677). Exactly because of their polycentric nature in which top-down and bottom-up innovation processes and different actors are in dialogue, frugal innovations might offer prospects for more inclusive forms of innovation. Such a stance would escape the 'development vs. exploitation' debate, by suggesting that frugal innovation seeks to combine local knowledge and ideas with international knowledge and expertise in inclusive value chains to develop low-cost products that enjoy maximum user value (Bhatti, 2012). Still, detailed empirical studies are required to ascertain whether frugal innovation will lead to equitable economic growth, or whether it will merely sustain existing inequalities (Arora & Romijn, 2011).

6. Conclusion: Towards a Research Agenda

This paper has aimed to introduce the concept of frugal innovation, by sketching its historical, macro-economic and policy background. Based on a literature review, it has defined frugal innovation and differentiated the concept from other types of innovation. The various aspects of the innovation cycle have been analysed in an integrative manner, arguing that frugal innovation only becomes an analytically useful concept if and when the design, production and marketing of a frugal innovation are viewed in conjunction. Previous studies of frugal innovation have focused too much on single aspects, such as cost reduction or the resource-constrained environment (Radjou & Prabhu, 2014). Finally, the socio-economic and developmental impact of frugal innovation has been explored, in order to tackle the question whether frugal innovation is indeed transformative (Rao, 2013). Although frugal innovation can be(come) inclusive innovation, this remains an empirical question, as the outcome might differ from case to case (Heeks, Foster & Nugroho, 2014). This paper has argued that frugal innovation is a new and potentially transformative concept, which has to be understood in a broader context, taking aspects of technology, entrepreneurship and development into account. Detailed empirical studies are much needed, as existing studies have mainly engaged in theoretical debates about the potentials and limitations of frugal innovation. Because frugal innovation is still an emerging field of scientific interest, some avenues for future research will be proposed.

First of all, detailed empirical studies are much needed, as existing studies have mainly engaged in discussions about the potentials and limitations of frugal innovation (Bhatti, 2012; Zeschky, Winterhalter & Gassmann, 2014). Or they have reached grand conclusions on the basis of a single case study – mainly in Western MNCs (Agarwal & Brem, 2012; Rao, 2013). A ‘glocal’ perspective is needed. A main aim of empirical studies should be to look at frugal innovation through the lens of local economic development, but at the same time to relate local processes to national and global levels. Such empirical studies can generate a better understanding of which actors play a role in frugal innovation, both internationally and locally. For example, can differences be observed between actors in terms of market segments served, type of frugal products and services designed, produced and marketed, technologies used, business models, enterprise form (MNCs, SMEs, micro-entrepreneurs), participation in and organisation of innovation and technology networks, compliance to safety and sustainability standards, governance, legal frameworks, etc.? And can these different manifestations inform us about the effects of different kinds of frugal innovations on local economic development? Empirical studies can also contribute to further insights on the

technical conditions for frugal innovation to take place. A relevant question here is how (high) technology solutions can be redesigned through frugal engineering so that they can be used in a low technology environment. Empirical studies can further generate better insights into the appropriate social and institutional (pre)conditions for frugal innovations. The main question here is to what extent and how the environment in which actors operate is enabling for frugal innovations which benefit local economic development. Governance issues, such as the legal dimensions of innovation, the availability of and access to financial institutions, the role of knowledge centres (universities, think tanks, laboratories, vocational training institutes), governmental policies on innovation and industrial development, all need to be better understood. For this, it is important to conduct empirical studies that can take frugal innovation out of the Indian and Asian context, to introduce the concept to the African and Latin American context, where it has barely been applied so far (Kolk, Rivera-Santos & Rufin, 2013). Although some studies have been conducted in Africa, there remains much to be explored there (Sesan et al., 2013). Does frugal innovation in Latin America and Africa enjoy the same dynamics as in Asia and does it have similar effects?

Secondly, frugal innovation can make several important contributions to theoretical debates, which follow the innovation cycle: 1) the ethical literature focusing on early engagements in new technologies (Doorn et al., 2013) 2) the socio-technical systems approach which takes both design and use of technical innovations into account (Geels, 2004) 3) the entrepreneurship literature (Schumpeter, 1912; Baumol, 1990) 4) the literature on inclusive business models (Lem et al., 2013) and local economic development (Helmsing, 2001) 5) the emerging literature on patterns of consumption at the BoP (Subrahmanyam & Gomez-Arias, 2008; Panda, 2014). Due to the increasing attention paid to the concept of frugal innovation, it is safe to assume that frugal innovation has both empirical and analytical value, yet it remains to be ascertained what its dynamics and effects will be in each specific case.

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