International Institute of Social Studies

Frugal innovation by 'the small and the marginal': an alternative discourse on innovation and development

Inaugural lecture Prince Claus Chair in Development and Equity **23 May 2016 Professor Saradindu Bhaduri**

Erasmus University Rotterdam
Make it happen.

The illustration on the front page (drawn by Suranjana Bhaduri) was inspired by the Indian poem “The Invention of Shoes” written in 1897 by Rabindranath Tagore.

Frugal innovation by ‘the small and the marginal’: an alternative discourse on innovation and development

Saradindu Bhaduri

Inaugural lecture as Professor to the Prince Claus Chair in Development and Equity 2015-2017 delivered on 23 May 2016 in the Kloosterkerk, The Hague, The Netherlands

Erasmus University Rotterdam

Introduction

Since its entry into the discourse on innovation some years ago, frugal innovation has attracted keen attention from scholars and policymakers alike. The European Union, for instance, is currently exploring options for policy support to build up frugal innovation capabilities in its industry. Among academic scholars, reception of the term has been both enthusiastic and cautious. While scholars in management studies have overwhelmingly welcomed its arrival in academic discourse, scholars in the field of innovation and development have been rather sceptical about its implications. For many in this group, the term is merely 'corporate spin' or 'old wine in a new bottle'. The absence of a clear definition of the term may have contributed to this mixed response.

However, the emerging discourse on frugal innovation pushes a point that development scholars have been making for a long time – that innovations for the global North do not always satisfy the requirements of the global South. To meet the needs of the people living at the 'bottom of the pyramid', scholars propose to alter the process and organizational structure of innovative activities (Prahalad, 2012; Radjou, *et al.*, 2012). This view shares the spirit of the discourses on 'appropriate technology' (Stewart, 1978) and 'technological capability' (Lall, 1987). The appropriate technology discourse, relying heavily on Schumacher's legacy of 'small is beautiful', took a radical approach to reconfigure technological activities in the global South by breaking away from the large-scale technological projects of the North (Darrow and Pam, 1978; Capra, 1989: 219–279). The technological capability school, however, took a more reconciliatory approach. The scholars belonging to this school argue that developing economies cannot remain inactive recipients of technologies transferred from the global North. Rather, these economies must undertake well-articulated searches towards the adaptation and assimilation of the transferred technologies. These activities take place outside of the formal R&D labs and contribute significantly to the 'catch-up' process (Fransman and King, 1984; Katz, 1984; Rosenberg and Steinmueller, 1988; Lall, 1987)[1]. The subsequent literature on innovation systems shows the diversity in the trajectories of such technological catch-up processes across countries (Nelson, 1993).

[1] Evolutionary economics, in fact, argues that such minor innovations are important, even for firms in developed industrialized economies (Nelson and Winter, 1982; Lall, 1987).

These discussions have essentially focused on the 'formal sectors' of the economies in the global South. The 'informal economies' remained largely excluded, perhaps due to the belief that innovative activities by agents of the informal economy are the exception rather than the rule[2]. Such exclusion, however, becomes unsustainable in light of the expansion of informal economies in the global South. Indeed, today, informal economic activities account, on an average, for over 50 per cent of gross domestic product (GDP) and more than 70 per cent of employment in many of these countries (OECD, 2009; Schneider and Enste, 2000). What drives the competitive strength of these economies has become a valid concern for many, paving way for a scholarship keen to explore creativity and innovativeness among agents in informal economies (Daniels, 2010).

The frugal innovation discourse opens up a new possibility here by explicitly referring to the behavioural characteristics of agents and economic activities in informal economies in the discourse on innovation. In their book, *Jugaad Innovation*, Radjou *et al.* (2012), for instance, highlight the creative improvisations of individual economic actors who come up with innovative fixes or simple work-arounds, referred to as *jugaad* (in India), *zizhu chuanxin* (in China), and *gambiarra* (in Brazil); they emphasize the importance of such innovative activities for large business houses across the globe, which are increasingly taking up 'jugaad' as a management technique. Successful incorporation of such creative improvisations, according to scholars, reduce product prices, help by serving markets with higher consumer awareness, and respond to the stringent regulatory requirements of environmental sustainability (Radjou and Prabhu, 2015).

While the scholarship on frugal innovation calls for absorbing the knowledge available in the informal economy of the vast global South, it does not intend to analyse the processes through which this body of knowledge sustains itself and grows[3]. To put it differently, the existing research on frugal innovation does not aim to engage with the process of innovative activities in the informal economy. The agency and capability of actors in the informal economy, therefore, remain below the radar, and the bottom of the pyramid are only a source of 'breakthrough innovations' by being 'flexible and frugal' (Prahalad,

---

2 As Darrow and Pam (1978) point out, some variants of the discourse on appropriate technology did analyse technological activities by people without formal education. However, the demise of this discourse left this agenda unfinished.

3 Perhaps that is not the main focus of management scholars and organization theorists.

2012). Ultimately, the only way that those at the bottom of the pyramid can be *emancipated i*s by being able to enter the domain of modern market mechanisms, as consumers of cheap, 'no frills' products, produced, nonetheless, by large corporations. In this way, the contribution of frugal innovation discourse to innovation and development remains underexplored. After all, it has long been acknowledged that understanding development only through the expansion of the market is an inadequate, if not incorrect, approach[4].

The current paper aims to contribute to this debate by broadening the domain of frugal innovation research. This is achieved by bringing the innovative activities of individuals and firms in the informal economies of the global South *onto the radar* of frugal innovation scholarship. It is argued that an understanding of frugal innovation can contribute to formulating an alternative discourse on innovation and development in an important way.

It is well known that innovative activities are unequally distributed across the globe. Recent innovation surveys also bear testimony to this intercountry inequality. For instance, not a single country from the global South features in the top 20 positions in terms of innovative inputs and outputs in the survey by the Global Innovation Index 2015 (Dutta *et al.*, 2015). Only one country from the South (China) is included when the number is extended to 30. Undoubtedly, this inequality reflects unequal capacity in science and technology across countries. In addition, this inequality reflects the differential nature of activities carried out in these two categories of countries under the rubric of 'innovation', which these surveys do not adequately capture[5]. In other words, these surveys demonstrate a bias towards the type and nature of innovative activities practised in the global North – innovations that are outcomes of systematic technological activities on a large scale (e.g., Frascati Manual by OECD, 2002).

[4] See, for instance, the Prebisch Lecture by Joseph Stiglitz (1998).

[5] It is, however, not our intention to club all countries in the global South into a homogenous group. Indeed, it has been a habitual practice of international organizations to group and regroup these countries into various categories (see Ramos 2015).

Such exercises exclude many forms of novelty-generating activities of acknowledged value to the economy. Dissatisfaction with such global surveys has encouraged innovation surveys with a specific regional or development focus (e.g., Bogota Manual by Jaramillo et al. 2001; UNESCO survey by UIS, 2013). The regional indicators used in these surveys attempt to capture the pattern of innovative activities in the countries of the global South, in line with the conceptual framework of the technological capability school. However, the variation in coverage and methodologies for data collection in these surveys make comparative discussions difficult. In addition, informal economies remain outside the scope of these surveys altogether. One needs to analyse whether or not a careful construction of the discourse on frugal innovation would provide opportunities to include new domains of innovative activities in the global South. The present discussion, therefore, seeks to contribute to our understanding of inequality in innovation performances across countries. In a nutshell, this paper intends to contribute to the agenda on innovation and development in a way that is sensitive to that plurality of knowledge, focusing on the local knowledge of 'the small and the marginal'. It is well known that Prince Claus kept these concerns close to his heart throughout.

The discussion is presented in the following order. Firstly, the emerging scholarship on frugal innovation is reviewed and an attempt made to connect it to the broader discourse on frugality in the various branches of social science and economics. This discussion will help to consolidate our understanding of the emergent phenomenon of frugal innovation. This is followed by an overview of the characteristics and nuances of the informal economy – the site of the activities of the small and the marginal in this paper. What follows is a detailed analysis of the nature and pattern of innovative activities undertaken by agents in the informal economy. Finally, an attempt is made to chalk out the path for an alternative discourse on innovation and development based on the author's insights into the process, nature and pattern of frugal innovation by the small and the marginal.

Understanding 'frugal innovation' and 'frugality'

'Frugal', in a literal sense, means sparing, thrifty, 'characterized by or reflecting economy in the use of resources' (Merriam Webster, 2011), or 'simple, plain and costing little' (Oxford Dictionary, 2011). The first global appearance of the term 'frugal innovation' was in The Economist in 2010, which described frugal innovation as 'not just a matter of exploiting cheap labour (though cheap labour helps), it is a matter of redesigning products and processes to cut out unnecessary costs' (Wooldridge, 2010). Quite often, it means stripping down the 'inessential' aspects of a product or to produce products with 'no frills' (The Economist, 2015). To Bhatti (2012: 13) 'frugal innovation is not just about redesigning products; it involves rethinking entire production processes and business models. Companies need to squeeze costs so they can reach more customers, and accept thin profit margins to gain volume'. In his paper titled *What is Frugal, What is Innovation? Towards a Theory of Frugal Innovations*, Bhatti argues that frugal innovation should not be considered a new phenomenon. In a basic sense, Bhatti (2012: 13) maintains that 'frugal innovation has always occurred since the invention of Neanderthal hand tools from stones and bones to make do with what is on hand'. However, the concept became popular in the aftermath of the recent financial crisis in 2008, which made many existing ways of innovating uncompetitive in the face of tighter resource constraints[6].

For Radjou and Prabhu (2015), frugal innovation means 'doing more with less'. In their book, *Frugal Innovation: How to do More with Less,* they give many absorbing accounts of how leading multinational firms are nowadays spending billions of dollars to come up with innovations that are cheaper, environmentally sound, and scale neutral, all at the same time. Such innovations are usually dictated by changing norms in product standards, environmental concerns and consumer awareness. To introduce these innovations, firms must change their organizational structure to have a greater focus on consumer feedback, more flexibility in their R&D programmes, and enhanced emphasis on the principles of reuse and recycle. Frugal innovation according to Radjou and Prabhu (2013):

---

6 Indeed, in a lighter vein, one may claim that innovation scholars should remain indebted to crises. While the oil crises in the 1970s gave rise to the so-called evolutionary theories of technical change, the more recent financial crisis has brought the discourse on frugal innovation to prominence. The list may become longer if we note how the debates on climate change have reinvented the importance of local grass-roots innovations.

> *…is a game-changing strategy for an Age of Austerity in which firms are being compelled by cost-conscious and eco-aware consumers, employees, and governments to create offerings that are simultaneously affordable, sustainable, and of acceptable quality. Even more than a strategy, frugal innovation is a whole new mindset, a flexible approach that perceives resource constraints not as a debilitating challenge but as a growth opportunity.*

This intent is echoed by Nakata and Weidner (2012). To them, 'frugal innovation requires business to reconsider and replace existing innovation processes, strategies, finances, partnerships, research methods, business objectives and organizational learning routines' (*ibid.*: 3). Dabke (2011), in this context, insists that cheap labour does not suffice for this type of innovation and that 'It is more about redesigning products and processes, rethinking the entire production process, discarding unnecessary features and frills, negotiating with suppliers and distributors for the best deals, and finding newer cost-effective means of reaching consumers'.

One way of achieving frugality is through 'polycentric innovation', which aims at the co-creation of products from the very beginning. To many, polycentric innovation designates the global integration of specialized research and development capabilities across multiple regions to create novel solutions that no single region or company could have completely developed on its own (Singh *et al.,* 2011; Radjou, 2009; Bhatti et al., 2013; Kaplinsky, 2011). Indeed, multinational firms, the key actors in many such polycentric innovations, have been found to be lacking in 'local knowledge', which seriously impedes their ability to enter bottom of the pyramid contexts. Bhatti (2011) categorizes such contexts as 'institutional voids' with compelling resource constraints. Nevertheless, these institutional voids and their creative improvisations, in the forms of *jugaad, zizhu chuanxin, gambiarra* (Radjou *et al.,* 2012) or jua kali (Daniels, 2010) remain an important source of knowledge about frugal behaviour and activities (Prahalad, 2012)[7]. In this way, the entire bottom of the pyramid segment has been treated as a large reservoir of knowledge, immensely useful to large business establishments

[7] In addition to referring to such 'creative improvisations', Radjou and Prabhu (2015) repeatedly refer to features like 'sharing economy', 'circular economy' and 'reuse-all', which are commonly observed in the bottom of the pyramid economies of the global South.

for their post-crises revival. Perhaps ironically, this revival takes place by serving the same segment that now constitutes the 'bottom billion' consumers for large firms.

Unfortunately, little energy has been spent on contributing to a meaningful understanding of the way this reservoir of knowledge persists or evolves[8]. Such an understanding requires an intense engagement with the motivations behind the knowledge-generating activities, underlying mechanisms used to approach uncertainty, and affinity to solve the problems of daily life by the people at the bottom of the pyramid. All of this would enrich our understanding of the so-called institutional voids that shape frugal behaviour. In addition, with regard to polycentric innovations, an important concern for scholars on innovation and development arises from the unequal distribution of the power of related actors (or knowledge holders) (Knorringa *et al.,* 2016). The presence of this (unequal) power distribution and the motive (of the powerful) to 'achieve profitability from bottom of the pyramid consumers' have made scholars claim that the notion of frugal innovation is nothing but 'corporate spin' designed to expand the scope of the capitalist production network by inspiring the poor to shoulder the burden of global problems[9].

It is important to engage with these issues to draw a roadmap for an alternative discourse on innovation and development. For the brevity of this argument, there is a need to develop at the outset a comprehensive understanding of the term 'frugality'. Indeed, this aspect of connecting the discussions on frugal innovation with the broader notion of frugality is found to be somewhat lacking in the emerging literature on frugal innovation. This disconnect has severely limited the scope of the application of frugal innovation. It is contended that understanding frugality at some length is key to a nuanced understanding of the phenomenon of frugal innovation. A broader, and perhaps denser, understanding of frugality may also enable better connections to be made between the emerging literature on frugal innovation and other studies on technology, innovation and development to help appreciate the continuities and breaks in this emerging discourse.

---

8 In this sense, the discourse on frugal innovation has an uncanny similarity with the debates on benefit sharing in the field of traditional knowledge.

9 The promotion of smokeless stoves to reduce global carbon emissions has been cited as one such example (see also Meagher, 2015).

Frugality in the social sciences

Lastovicka *et al.* (1999), in *Lifestyle of the Tight and Frugal:* Theory and Measurement, find frugality to be entrenched in our human past. It was widely prevalent in early America. The Boston Evening Post of 1767, for example, urged readers to 'Save Your Money and You Will Save Your Country!' (Morgan, 1967). Most religions, according to the authors, promote asceticism or restraint from materialist desires. However, frugality is presented not as deprivation, but rather as 'sacrificing a series of *whims* for the sake of obtaining a *more worthy* goal' (Lastovicka *et al.,* 1999: 86, emphasis added). They argue that all major religions encourage the ethics of restraint from material desires and the seeking of satisfaction in achieving spiritual growth (*ibid.*: 86), which, to them, borders on frugality.

Going beyond religion, the authors review the use of frugality in psychology, behavioural sciences and economics. In psychology, clever and resourceful use and reuse of products and services is noted as a characteristic of being frugal. On the appropriate use of natural resources, de Young (1986: 285) defines frugality as the '*careful* use of resources and avoidance of waste' (emphasis added). From the behavioural science perspective, Lastovicka *et al.* define frugality as the 'degree to which consumers are both restrained in acquiring and in resourcefully using economic goods and services to achieve longer-term goals' (1999: 88). Such a construction of frugality emphasizes that it is not just about *what* is acquired, but also *how* something is used by embracing reduction or the elimination of waste.

A passionate early use of the terms 'frugal' and 'frugality' in economics can be traced back to Adam Smith (1776). His seminal work, *An Inquiry into the Nature and Causes of the Wealth of Nations*, uses 'frugal' or 'frugality' 37 times in its 526 pages. This is a quarter as many times as he uses the term 'wealth', the primary subject of his inquiry. In fact, the frequency of its use exceeds the frequency of the combined use of 'invention' and 'inventive'. One would also be surprised to know the variety of contexts in which Smith uses the terms. This term finds favour not only in depicting the usefulness of 'thriftiness' in contributing to 'public opulence' (*ibid.*: 5, 12), but is also mentioned when reflecting on 'sobriety' in the conduct of a borrower who used borrowed money for productive purposes (*ibid.*: 172). In an activity much closer to the modern day usage of the term innovation, frugality is observed by Smith in demonstrating the value of 'experience' in offering innovative solutions to frequently encountered problems in daily lives

(*ibid.:* 93). In addition, the use of the word frugal in conjunction with words like 'industrious', 'experience', 'attention' and 'sober' is notable and can help us locate the parameters of frugality in our research.

Although for Smith, both the rich and poor could be 'frugal' in their behaviour, he perhaps acknowledged such a trait comes more naturally to the poor – who want to become rich – than somebody who is automatically rich (*ibid.*: 53). This aspect has both interesting similarities and differences with the contemporary discourse on frugal innovation. Like Smith, the contemporary discourse emphasizes the need for frugal innovations to reach out to resource-poor settings, but unlike Smith, this discourse attempts to locate these activities (e.g., frugal innovations) almost exclusively in large private organizations of research and production[10]. Smith, however, was sceptical, about the extent that people habituated in 'prodigality' can embrace 'frugality', even when the sources that maintain such 'prodigality' have dried up (*ibid.*: 211). In more recent times, Nelson and Winter (1982) have argued that firms can rarely change their routines, which are sticky in nature, giving rise to 'path dependency' in their behaviour. It is this path dependency that, in their view, significantly determined the success and failure of firms during the oil crises in the 1970s. Combining these views, one may argue that the transition of the 'prodigal' to 'frugality' may be fraught with challenges. Indeed, in the estimation of Radjou *et al.*, (2012), only 5 per cent of the firms they surveyed have been able to adopt the changes necessary for frugal innovation after the recent financial crisis. The rise of frugal innovation may, therefore, accompany a radical process of creative destruction.

In the contemporary discourse on frugality in decision theory, Gerd Gigerenzer and his colleagues in *Gut Feeling: The Intelligence of the Unconscious* (Gigerenzer, 2008) and *Simple Heuristics that Makes us Smart* (Gigerenzer et al., 1999) attempt to draw a conceptual roadmap to help us understand frugality in the context of decision-making. According to them, we must analyse both the person who takes the decision and the environment in which the decision is taken in order to understand frugality. Frugality here refers to 'need satisfaction' (satisficing as opposed to maximizing) and the 'simple search rule' (as opposed to constraint optimization). Frugality should, therefore, underscore not only *what* is achieved, but also (and perhaps

[10] Of course, one may argue that the financial crisis may have been a major leveller, as it exposed these large firms to an unprecedented resource crunch.

more importantly) *how* it is achieved (see also de Young, 1986; Lastovicka *et al.*, 1999). If Smith is recalled here, the way to achieve frugality seems to be by being *industrious, sober, attentive and using one's skills of observation.*

This framework highlights the three main characteristics of frugality in decision theory, namely:

- a search process using simple hierarchical steps and intuitive reasoning (rather than clearly-defined rule-based decisions);
- efforts to adapt to the environmental challenges through demonstrated capacity for learning and imitation;
- emphasis on actual performance, practicability and effectiveness rather than logical/scientific validation.

Elsewhere, Gigerenzer (2008) asserts that decisions arrived at by using such rules are seldom inferior to decisions reached using logical theories and optimality-based processes by the experts. Transplanted to the frugal innovation discourse, this should be interpreted to mean that frugal innovation does not imply lower quality products. This is, however, far from unambiguous. Scholars seem to be divided on whether frugal innovation leads to the same quality or necessitates a 'stripping down' of the inessential parameters and 'frills' of a product to arrive at an 'acceptable quality'. Radjou and Prabhu (2015) maintain that frugal innovation caters to resource-poor markets and represents products with 'no frills'. This aspect has important policy implications in light of current policy, which attempts to homogenize quality standards across economies. Ray and Bhaduri (2003) note, in the context of pharmaceuticals, that quality in the post-World Trade Organization (WTO) era not only focuses on parameters like impurity profile or contamination, but also on how 'to maintain *consistency* in the specified impurity profile over all batches of production irrespective of the varying locational, climatic, technological, skill and input conditions' at different intermediate stages in the production process (*ibid.*: 2304, emphasis added). This issue will be revisited in the last section of this paper.

In so far as frugality demands adaptation to environmental challenges through learning and imitation, and insists on actual performance, the recent discourse on frugal innovation owes its intellectual debt to evolutionary economics and technological capability schools of thought. These discourses from the not so distant past highlight the need for 'incremental innovation' and stress the importance of interactions between consumers, manufacturers and researchers for successful innovation (Rosenberg and Steinmueller, 1988),

as well as emphasizing the role of 'imitation'. Nelson and Winter (1982) underline how past experience might shape the generation of knowledge, which for Nonaka and Toyama (2003) remains 'tacit'. To the extent that consumers have been identified as 'prosumers' in the literature on frugal innovation, one can also draw connections with the literature on 'user innovation'[11].

On innovation and development, as argued above, the scholarship on appropriate technology, the evolutionary economics of technological change and technological capability have all touched on many of the issues recently made popular by the frugal innovation discourse. These schools have had varying degrees of success in influencing the scholarship on innovation and development. However, the appropriate technology movement declined because it failed to reduce the role of state and donor agencies, whose policies remained focused on mainstream technologies. As Abrol (2005) puts it, developing autonomous spaces for appropriate technologies proved elusive. Kaplinsky (2011) notes that the global diffusion of technological capability has also considerably shrunk the space for appropriate technologies. For Francis Stewart, one of the pioneers in the field, the appropriate technology movement required a substantial reallocation of resources, which the elites in the governments of the countries in the global South did not allow (Stewart, 1978: Chapter 11).

Subsequently, in the decades of 1970s and 1980s, technological catch-up and learning became an important development agenda for less developed economies, in line with the predictions of the technological capability school. The rate of success in this endeavour, however, varied across

[11] In this literature, a user starts developing a solution (i.e., user innovation) when he/she experiences a problem (Franke and von Hippel, 2003; Henkel and von Hippel, 2005; von Hippel, 1986). While studying the process of user innovation, scholars have studied the characteristics of user-innovators (von Hippel, 1986), the impact of user innovation on social welfare (Henkel and von Hippel, 2005), and the user tool kit (Franke and von Hippel, 2003). The tool kit provided to a user is specific to a particular product/service and, by following a process of trial and error, the user can develop a custom product as per their requirement (e.g., integrated circuit). However, the focus of the user innovation literature has always been on developed economies. Users here include the 'well-off', hobbyists and specialists. The search costs for tools to improve upon the products remain minimal when tools are supplied along with the products. In this way, users are also legally permitted to undertake improvements on products. Recent scholarship is attempting to apply this framework to analyse grass-root innovative behaviour in the countries of the global South (Yadav and Goyal, 2015; Sinha *et al.*, 2015).

countries and sectors[12]. Perhaps the ability of firms to forge linkages with other firms and non-firm entities determined this differential success in catch-up (Nelson 1993).

However, the present day frugal innovation discourse makes a few important advances too. First, it visualizes innovations in a great many dimensions, rather than only focusing on technological change. The focus on products, processes, encouraging polycentrism and the development of business models for entering new markets makes it compatible with the Schumpeterian notion of innovation. Secondly, by explicitly referring to the role of the behavioural characteristics of the *jugaad* performing individuals at the bottom of the pyramid, it opens scope for bringing a whole range of creative and innovative activities, hitherto ignored, into the mainstream of innovation discourse and provokes one to look into the nature and kind of technological learning *from* (instead of *by*) the global South. In its current form, however, the frugal innovation discourse shies away from taking that emphatic step forward by confining its discussion almost exclusively to how frugality can help big business. In this sense, the current paper departs from the existing studies by engaging with the discourses on innovative activities in the informal economies in the countries of the global South.

Informal economy: understanding the site of 'the small and the marginal'

The informal economy, or what some scholars now call the 'system D' or the 'shadow economy', is certainly not a marginal component of production and distribution in the global economy[13]. It is, rather, idiosyncratically pervasive, and its share of the economy is rising. According to a study by the Organisation for Economic Co-operation and Development (OECD, 2009), half the workers in the world – close to 1.8 billion people – are working in system D, which, according to the authors, might reach two-thirds

[12] In India, for instance, the pharmaceutical industry has been a major success, while the electronics industry has remained a low performing sector in terms of technological capability. See Ray and Bhaduri (2001, 2002), Bhaduri and Ray (2004, 2006) for details.

[13] 'Systeme D' is often considered to be 'slang' in French-speaking Africa and the Caribbean. The French often use *debrouillards* to refer to particularly effective and motivated people. By being *debrouillarde* one is meant to be resourceful and ingenious. Some of the former French colonies have sculpted this word into their own socioeconomic fabric and use the term to refer to inventive, self-starting, entrepreneurial merchants who are doing business on their own, without being registering or regulated by the bureaucracy and, for the most part, without paying taxes (Neuwirth 2011: 17).

of the world's employed by the year 2020. In India, for instance, an estimated 94 per cent of livelihood generating activities fall into the category of 'informal', producing up to two-thirds of the country's GDP. The National Commission for Enterprises in the Unorganized Sector (NCEUS) estimates that around 420 million people are working in India's informal economy. Even within the organized sector, 58 per cent of the workforce are on informal contracts (Basole, 2014)[14]. According to estimates by Schneider and Enste (2000), the size of the 'shadow economy' as a percentage of GDP ranges from 2–60 per cent in Latin America and from 13–50 per cent in Asia. Today, however, the domain of the informal economy is not confined to developing economies. Schneider and Enste (2000) put the contribution of the 'shadow economy' at around 15 per cent in OECD countries and up to 30 per cent in some European countries. They estimate the total value of the informal economy globally at close to USD 10 trillion (Neuwirth, 2011: 27). This means that if all the informal economies were united in a single political structure, in the words of Neuwirth, 'it would be an economic superpower, the second-largest economy in the world' (*ibid.*: 27–28).

Like the discourse on frugal innovation, the scholarship on the informal economy also struggles with definitional ambiguities surrounding the term 'informal economy'. The 'plurality' of the concept coupled with the 'heterogeneity' attached to its activities is reflected in the wide array of terms used to analyse its content. 'Non-observed', 'irregular', 'unofficial', 'second', 'hidden', 'shadow', 'parallel', 'subterranean', 'informal', 'cash economy', 'black market', 'unmeasured', 'unrecorded', 'untaxed', 'non-structured', 'petty production' and 'unorganized' are some of the terms used to describe informal economy (Losby *et al.,* 2002; Hart 2006)[15].

[14] This study conducted by the India Staffing Federation in 2014, found that 43 per cent of the 28.8 million formal sector workforce with the Central Government are employed on a contract basis or as casual labourers. The temporary government workers are 12.3 million of which, 10.5 million are casual workers in sectors such as mining and construction (Basole, 2014).

[15] There is a growing body of literature that explores the reasons for the existence and growth of the informal economy. However, it is not important to discuss those studies here. The interested reader may refer to de Soto (2000) and Muchie *et al.* (2015). It is, however, important to note that recent studies find evidence of many people joining this sector out of 'choice' and 'want of autonomy', besides the more conventionally cited reasons of 'compulsion' and 'exit' from the formal economy.

Although the theoretical basis of the concept of the informal economy can be traced back to the dual economy model developed by Lewis (1954), it was Hart (1973) who made pioneering efforts to analyse the activities in the informal economy. Hart (1973), deviating from Lewis (1954), observed the flow of labour between informal and formal sectors of an economy as bidirectional and found that the informal economy can coexist with the formal economy (see also Guha-Khasnobis *et al.,* 2006). It is also recognized that the informal and formal are not binary, but there are degrees of informality, even within the broadly-defined 'informal sector'. These degrees of informality are measured in terms of parameters like the temporariness of an activity, tax obligations, regulatory requirements, the nature of competitors and the scale of activities (Daniels, 2010). Indeed, people seem to join this sector with multiple motives and capabilities, rather than simply to avoid tax or regulatory mechanisms, motives that have dominated the discussion of informal economy for a long time (Overa, 2007; Rivera-Huerta, 2014).

Definitional ambiguities notwithstanding, a common thread that runs through all the discourses is that informality is not about the big, powerful and most *prodigal* in the world. Rather, it is the site of the activities and livelihood issues of 'the small and the marginal'[16].

It is now being recognized that this segment of the economy is not devoid of creativity and innovation. Rather, the ability to find creative solutions to an ever-changing environment explains its sustained competitive edge in many countries (Daniels, 2010; Kumar and Bhaduri, 2014; Neuwirth, 2011). In the last few decades, we have witnessed a significant rise in interest among academic scholars in recognizing informal economic spheres as reservoirs of knowledge, skills and creativity (Daniels, 2010; Obeng-Odoom and Ameyawb 2014), besides the traditional focus on the exploitative work conditions of this sphere[17]. White (2014: 22) notes that the informal economy is not just a 'dwelling for the poor people and home to indecent work, a lot of wealth is generated, stored and circulated informally within the informal sector'.

[16] There is, however, prominent income inequality within the sector.

[17] Harris (2014) notes how skills and the ability to imitate designs 'in no time' by informal handicraft sector (furniture) firms in Nairobi, Kenya, and the consequent 'uncontrolled spillover' has a confounding impact on specialization and innovation among formal sector firms in the neighbourhood.

As the present paper intends to situate the discussion on frugal innovation in the informal economy, it is perhaps not out of place to mention that a study by Deutsche Bank observed that countries in Europe with 'robust' informal sectors fared better during the financial crisis of 2008–9 than countries with tightly-regulated economies (Neuwirth, 2011: 19). It is, therefore, a legitimate concern of innovation scholars to delve deep into the activities and processes of knowledge generation in this segment of the economy, which will be taken up in the next section.

Knowledge and innovation by the small and the marginal

The overview of the literature on frugal innovation, its connections (and disconnects) with the broader idea of frugality and the discussion on the characteristics of the informal economy prepares the ground for a thorough discussion of frugal innovation by the small and the marginal. Neuwirth (2011: 18) finds that the informal economy is a 'product of intelligence, resilience, self-organization and group solidarity and it follows a number of well-worn, though unwritten, rules'. He recognizes these economies as systems in themselves, for the way that they function within the boundaries of their own specified rules. However, the long neglect of the informal sector by the scholars of innovation and technology has indeed created a vacuum of theoretical scholarship through which one would have liked to analyse the knowledge-generating activities in this sector. It is, therefore, a challenge of the current generation of researchers (all of us) to ground our discussion in a suitable theoretical framework to meaningfully contribute to the emerging frugal innovation discourse.

However, comfort can be drawn from the work of Adam Smith that frugality is more frequently observable among less well-off people and nations who contribute to resource generating activities through their skills of observation, sobriety, engagement with the environment and experiential learning to the solve problems encountered in their daily lives. A caveat may be in order here. The innovation and knowledge-generating activities of the small and the marginal may not always completely overlap with the boundaries of the informal economy, as these activities also refer to community-level practices which are outside the definitional boundaries of the informal economy[18].

[18] These 'spaces' may fall into the category of 'substantive economy' as defined by Karl Polanyi (1944).

Gains in private property are often shown to be the major driver of innovative activities in modern day scholarship on innovation and development in formal sector firms. Joseph Schumpeter, however, did not fail to note the importance of various other forms of motivation, including the joy of creation and 'taking delight in ventures', driving innovation and research (Schumpeter, 1934: 89–94). The motivations for undertaking innovative activities in the informal economy have been explored by Bhaduri and Kumar (2011), who take the case of grass-root innovation in India[19]. Mostly, these innovators use (and reuse) locally-available raw materials to solve problems in their daily lives. For these innovations, various non-extrinsic motivations appear to be prevalent[20]. People undertake innovations for various reasons ranging from 'curious nature', 'urge to solve problems of neighbours/family members', 'sustainable use of local raw materials' and 'dissatisfaction with existing products', as well as more extrinsic forms of motivation like 'monetary gain', 'desire to find cheaper alternatives' and 'business growth'[21]. We also find evidence of shifts in motivation from intrinsic to extrinsic as an innovation progresses; a significant portion of motivations become extrinsic once the innovation becomes a certainty and ready for application[22]. Unlike innovations in the formal sector, grass-root innovations often do not have clear time line or budgetary specifications (Kumar and Bhaduri, 2014). Finances are arranged from informal sources like friends and family members. Finally, the forms of application of these technologies vary greatly, ranging from 'self-use', 'free distribution in the locality', and 'sale of technology locally'

---

19 This paper follows the categorization made by the National Innovation Foundation and characterize grass-root innovation as innovation done predominantly *by* people belonging to the lower socioeconomic strata with low levels of education. Some research groups (including the Social, Technological and Environmental Pathways to Sustainability – STEPS, at Sussex University, UK) differ from this definition and include in it all innovations *for* the poor and village people. In fact, India has a long history of technological interventions *for* the poor through both governmental and private initiatives – the Application of Science and Technology in Rural Areas (ASTRA) being one of them. The genesis of such efforts may perhaps be seen in India's freedom movement. The Rural Reconstruction Programme by Rabindranath Tagore and the establishment of the All India Village Industries Association by MK Gandhi and JC Kumarappa are key instances of such efforts. However, the analysis of innovations by the poor, in our view, is a more recent, and under-researched, phenomenon.

20 The categorization developed by Edward Deci and Richard Ryan in their various works on 'effectance motivation' (Deci and Ryan, 1985; 2000) is adapted for the purposes of this paper.

21 For these reasons, Gupta (2012) calls them 'empathetic innovators'.

22 Using the same method of data collection, taking a larger sample, Abrol and Gupta (2014) find very similar kinds of motivational dynamics at play, although they do not use the same categorization.

to 'tied up with formal sector firms for wider distribution' and 'tied up with research institutes for further development'.

The source of knowledge for individual frugal innovators is largely 'experiential' and, at times, 'traditional'. Recent studies on 'local knowledge' or 'people's knowledge' (called *loka-vidya* in India) emphasize that such knowledge remains largely uncodified and, therefore, embodied in individuals (Basole, 2015)[23] [24]. These individuals participate in the informal sector, either as labourers or labour entrepreneurs.

Going beyond grass-roots innovators, a survey of micro-scale lock-and-key firms in India is currently being conducted as part of research at the Centre for Frugal Innovation in India, under the Prince Claus Chair. For these firms in India[25] the pilot survey shows that designers (colloquially known as *ustaad* or *kareegar*) are the most well-paid recruits[26]. Rarely is a person with much formal education, even a vocational degree, found working as a *kareegar*. Only one entrepreneur-cum-*kareegar*, who was formally educated through a 'journeymen course' was found. However, even in his case, work experience was cited as the main site of learning. These people take pride in their skills in design and imitation. Harris (2014) found that the quick imitation of designs in the informal furniture sector in Nairobi often threatens formal sector firms. The findings of Neuwirth (2011) are along the same lines; he mentions that products by informal firms are rarely distinguishable in terms of quality from the products of the formal sector firms in many sectors in Africa and Latin America. In our study on lock-and-key firms we find that, in general,

---

[23] It would, however, be wrong to assume that such knowledge would always be possessed by an individual in its entirety. It may be held by a group of people, or the 'commons', with a high degree of indivisibility. See Nonaka et al. (2000) and Gudeman and Rivera (2001) for details.

[24] We refrain from calling them tacit knowledge. Following Witt *et al.* (2012), tacit knowledge refers to that body of knowledge that remains uncodifiable after exploiting the possibilities to codify it using *all* available codification technologies. Many of these technologies remain inaccessible to these people for a variety of reasons related to exclusion. It is, therefore, difficult to verify to what extent their knowledge remains uncodified due to the lack of access to codification technologies or because they are intrinsically uncodifiable.

[25] In India, microenterprises are firms having plant and machinery worth up to Indian rupees 2.5 million, taking into account depreciation.

[26] Two pilot surveys were conducted from February-March 2016, one in Howrah (the twin city of Kolkata in eastern India) and the other in Aligarh (around 200 km from Delhi). These surveys covered seven firms of varying sizes and degrees of informality, a marketing executive of a multinational lock company, the head of a vocational training institute, and officials from a government-sponsored training centre.

secrecy is difficult to maintain. Usually, the 'unpacking' of technologies takes place in the wholesale markets. However, in one case, an entrepreneur took pride in stating that his designs could not be copied. He reported that others had failed to 'repack' the lock after unpacking it. This bears testimony to the existence of varied layers of expertize among firms in the informal economy. In this instance, however, the innovator was found to be trained in a vocational course on engineering. Even so, the knowledge he relied on was experiential knowledge and he criticized the current engineering curricula in the country. In his view, engineers these days have become theoretical and do not know how to work on machines. As a result, indigenous machine building activities in the country have declined and firms now have to rely on imported machines. This view was confirmed by an engineer of a large, reputed public-sector oil refining firm in Kolkata. Hence, it appears that theoretical knowledge is valued more than practical knowledge, even among engineers.

In our research at the Centre for Studies in Science Policy in India we have often found a tendency among people involved in informal innovative activities to undermine the knowledge they themselves hold and the innovative efforts they undertake. During my interaction with a farmer involved in shifting cultivation in Nagaland[27], he categorically insisted that he had not introduce any changes to the cultivation method in his entire lifetime until the translator tweaked the question and asked how come he had not changed his cultivation technique when the whole world is changing so much. In reply, the farmer showcased four different types of hen-hoes used for cultivation, all bearing testimony to his awareness of changes in the local availability of raw materials and concern for efficiency. Such informal innovators learn not only by 'doing', but also by merely being there and observing others doing, which is perhaps why it is often difficult to decode their source of knowledge and precise mechanism of learning[28].

This situation is changing in certain places with the interventions of the National Innovation Foundation, which seeks to identify and facilitate social recognition of the activities of informal innovators by highlighting them in the media and giving them various awards. One needs to appreciate the fact

[27] Nagaland is situated on the far-eastern border of India. Community-based shifting cultivation remains the most widely-practised method of agriculture here.

[28] Some entrepreneurs in the lock industry claim that they can draw designs on the basis of oral descriptions.

that the recent awareness of grass-roots innovation in India, and abroad, is due to the intense efforts of the National Innovation Foundation. Such actors are often identified as 'sympathetic outsiders' in the literature on local knowledge and innovation[29]. Several such sympathetic outsiders can be found in various parts of India working for the revival of local knowledge systems at the community level (e.g., Tarun Bharat Sangh, which is an organization working for revival of local water harvesting systems in Alwar, Rajasthan), augmenting the technological capability of local people through hands-on training in modern technologies (e.g., the Barefoot College at Tilonia, Rajasthan, India) and mixing local knowledge with the codified body of 'modern' scientific knowledge. In this context, Krishnan (2014) presents an interesting historical case of collaboration between a group of 'freelance technologists' and a labour union at a public-sector coal mining unit to develop an alternative, less-automated, technology to fit the local context and labour conditions. However, these experiences are sporadic in nature and are exceptions rather than the rule. To put it differently, and perhaps more strongly, the Indian education system has failed to incorporate, and interact with, local discourses on technology and knowledge in a structurally meaningful manner.

As a result, as Basole (2014) points out, around 90 per cent of technical knowledge in India's unregistered small-scale industry sector is developed in-house. Domestic collaboration as a source of such knowledge has dropped from an already very low 5 per cent (in 2001) to a miserable 2 per cent (in 2007), and foreign collaboration remains miniscule at less than 1 per cent. During my recent survey of lock-and-key firms, however, I found some of them producing products for foreign markets as well. Despite such presence (albeit indirectly) in the export market, engaging with others for polycentric innovation seem to be a tenuous task, requiring a major change in a firm's routines. Kumar (2014) and Sheikh (2011) hint at 'trust deficits' between grass-root innovators and formal sector research institutes. In addition, it is important to point out that the more successful cases of interaction and collaboration mentioned above take place at the very site where knowledge is produced and grass-roots innovation takes place.

[29] Email correspondence in the network of Development Outcomes of Local Innovation (DOLI).

In contrast, the collaborative activities noted by Kumar (2014) and Sheikh (2011) take place ex-situ, at the laboratories of scientific institutions and the majority of these collaborations have ended in failure.

One wonders whether or not the lack of trust and respect for local knowledge by scientific institutions is an outcome of the 'contempt' for practical knowledge, mentioned above. During the pilot surveys of lock-and-key firms in Howrah and Aligarh, no interactions were observed with local academic institutes. This is despite the fact that these firms in Howrah are located within a distance of 10 kilometres of a vocational training institute and, of course, Aligarh is well known for hosting a university. Even a government training institute by the National Small Industries Corporation exclusively set up to augment this skillset finds it difficult to run their programmes successfully. While these formal sources of learning have not taken off, no official survey has yet been designed to capture data on informal sources of learning (Basole, 2014)[30].

One may then argue, with a reasonable degree of confidence, that contempt for practical knowledge leads to a difference between the scientists/engineers and the small and the marginal innovators in their worldview on what constitutes a good technology. While for the small and the marginal a good technology is one that is of 'daily use', a scientist puts more emphasis on the clarity of scientific principles[31]. This conflict is, however, not new, at least in India. Rabindranath Tagore[32], during his Rural Reconstruction

---

[30] The Department of Science and Technology in India had initiated a survey on the technological capability of formal sector firms in the mid-1990s, but discontinued it thereafter. Recently, the First Innovation Survey of Small and Medium Scale Industries has been completed. However, its details remain inaccessible to academic researchers.

[31] Kumar (2014) notes an incident where a scientist at a prestigious Indian institute of technology called an award-wining grass-root technology 'completely trash'. Sheikh (2011) gives a vivid account of the way many grass-root innovators felt suffocated when asked to collaborate with scientists to modify their innovations. Some ran away, while others persisted, only to become disappointed later. A few cases of successful patenting have come to light, however, with minimal involvement of the innovators in the process.

[32] He was the first non-European Nobel Laureate in Literature, receiving the prize in the year 1913. However, he was also active in politics and was invited to become President of the Indian National Congress in 1918. His presidential address at the Bengal Provincial Conference (later Bengal Congress Committee) in February, 1908 was his last political engagement for several years. Tagore chose to carry out his political activism through his rural reconstruction activities and framing an alternative model of education at Santiniketan and Sriniketan. For him, these activities were aimed at preparing the youth to experience 'self-reliance' in its entirety.

Programme, in which he experimented with a model of self-reliance in pre-independent India, also faced similar criticisms about the validation of rural techniques and practices. In *Rural Welfare Method*, Tagore (1932) forcefully argues that the daily utility of the devices developed by the villagers was stronger proof of science than theoretical criticism.[33] This discussion presents an opportunity to reflect on the illustration on the title page of the lecture booklet. This is an adaptation of a Bangla poem by Tagore, called *Juta Abishkar*' (The Invention of Shoes), in which a poor cobbler solves the problem of the king's feet becoming dusty by making a shoe for him, while a large group of scientists discussed large scale, theory-driven, solutions, without realizing the impracticality of their proposals. The poem is, of course, a satire. But the fact that it was written in 1897, only three years before the poet Tagore set up his alternative model of education at Visva Bharati at Santiniketan (near Kolkata), perhaps reflects his long-standing agony over the then state of higher education in India[34]. A key element of his alternative model was, in fact, to 'reconstruct rural life' through a fruitful exchange of ideas and knowledge from various sources. He, however, insisted that such exchange of knowledge must be tested at the site of its use, i.e., in the rural areas (Dasgupta, 1977). In more contemporary discourse on the philosophy of technology, Dusek (2006) provocatively refers to modern scientific knowledge as local knowledge of the West relevant only in a laboratory setting.[35]

One wonders if this emphasis on usability, overriding the criteria of logical proof, echoes the condition of frugality noted by Gerd Gigerenzer (2008), i.e., that frugality draws its credibility from 'performance in a real world environment' rather than, necessarily, being 'logically valid'. To explain the failure of the appropriate technology movement, in the 1980s, Smith *et al.*

---

[33] If Liyan (2016) is taken as a representative study, then, among developing countries, China has indeed made a great leap forward in institutionalizing interaction between university academics and local farmers/innovators.

[34] His institution went on to occupy a prestigious space in the pre-independence education scenario in India and would later become a Union government-sponsored university. Many, however, question whether or not it has been able to retain the alternative thinking that Tagore wanted to instil in it.

[35] The *universality* of laboratory science has been called into question most emphatically in the fields of agriculture, health care and the environment, due to, as Irvin and Wynne put it, their 'ceteris paribus assumptions and laboratory-controlled conditions' (1996: 220). The scholarship on science, technology and society studies is replete with evidence of how power, interest and control shapes western scientific activities, rather than rationality and objectivity.

(2014) seem to suggest a very similar reason. As the agenda of developing appropriate technology became incorporated in the mandate of many developing country governments' science and technology initiatives, it lost the essence of 'community wellbeing' and 'local context' in which the movement had emerged[36]. Sheikh (2014) shows how state intervention in the production of pashmina shawls has isolated 'local designers' by introducing computerised design-making processes.

One may round up this discussion with insights from *The Wealth of the Nations*, once again (Smith, 1776). We have already noted that Smith's magnum opus mentioned 'frugal' and 'frugality' 37 times (compare to 31 mentions of 'invention' and 'inventive'). On page 93, he depicts the story of a verdict by Democritus, a philosopher well known for writing extensively on ancient animal husbandry in Rome, about the fruitfulness of hedging the then very valuable activity of kitchen gardens. It is reported that Democritus dismissed the idea of enclosing these gardens, because the cost of a stone wall or a 'brick mouldered with the rains and the winter storm, and the required continual repairs' well exceeded the expected profit from such activities. Columella, a practitioner of farming, while not dismissing this view, suggested 'enclosing with a hedge of brambles and briars', which in his experience was 'a lasting and an impenetrable fence', but which, Smith argues, 'was not commonly known in the time of Democritus'. For Smith, this solution was 'a very *frugal* method of enclosing' a kitchen garden. To elaborate on this a little further, Smith explicitly recognized the importance of labour embodied, experiential learning, even in a factory set up. He writes 'All the improvements in machinery, however, have by no means been the inventions of those who had occasion to use the machines. Many improvements have been made by the ingenuity of the makers of the machines' and some by those who are called philosophers or men of speculation, whose trade is not to do anything, but to observe everything (Smith, 1776: 11). Needless to say, he was referring to the advantages of the 'division of labour'. Using his views on the proposal by Columella, we argue that the mechanism by which the division of labour brings specialization involves a significant amount of frugality. Therefore, Gigerenzer may find a supporter in Smith, and the poet Tagore was also not too off the mark in putting the knowledge of the cobbler in solving a real life problem on a higher pedestal than that of many scientists. Indeed, Mokyr (2005) notes

[36] It seems that micro financing also suffered when large banks entered into it.

that the Wright brothers flew well before physics explained the mechanism of wings.

The appropriation of 'useful knowledge' (a la Mokyr, 2005) is always the concern of economists. In current times, a discussion on innovation, frugal albeit, is not complete without a fitting discussion on the appropriation of knowledge. We focus only on its most popular form, namely, the patent. While the patent was indeed designed, in the words of Abraham Lincoln, 'to add fuel to the fire of genius', it is widely recognized that, over time, it has become an instrument used by large corporations to protect knowledge monopolies, often at the cost of individual scientists (Noble, 1977) and that small individual innovators derive much less value, per patent, than large firms (Bessen and Meurer, 2008). However, it remains contested whether or not small innovators are better off with a patent than without.
For the National Innovation Foundation in India, patents have remained an important tool to help appropriate grass-roots innovation. Sharma and Kumar (2016) report spending of over Indian rupees 20 million by the National Innovation Foundation during the last 10 years on patents for grass-roots innovations. In their survey, Sharma and Kumar (2016) find that the National Innovation Foundation has, till date, filed 742 patent applications. Among these, 707 applications were filed in India, 8 with the US Patent Office and 27 with the Patent Cooperation Treaty. The Centre's interactions with innovators in the initial years of intervention by the National Innovation Foundation presented a very different picture. We observe a near complete ignorance and lack of enthusiasm among innovators about any formal intellectual property protection mechanism. Although, over time, they have been made aware of the significance of such protection, many still remain ignorant of the ways in which such intellectual property is used (Sharma and Kumar, 2016)[37]. Given that a patent is a legal right extended to protect the interest of the innovator, one wonders how much protection such patents offer unaware individuals in the case of disputes[38]. Noble (1977) vividly discusses the failure of individual scientists in the USA to protect their

[37] In the lock-and-key industry, we find some innovators filing patents to gain status in the eyes of their consumers. However, one individual declined to apply for patents, even if he had a patentable innovation, because of his past experience with a costly legal battle and his lack of confidence in the 'non-imitability' of his innovations.

[38] Nevertheless, in so far as patents reveal 'non-obviousness' in novelty, we find many instances of innovations by the small and the marginal bringing novelty in the national, and even, international body of codified knowledge.

patented rights due to the high cost of legal action, even though they were more aware of such rights and their implications than today's grass-roots innovators.

From a utilitarian perspective, patents can bring benefits if innovations are commercialized on a large scale, which is not automatic, at least, for many grass-roots innovations, leaving such property devoid of much use. In addition, putting undue trust in the scaling up or large-scale commercialization by the National Innovation Foundation seems to have had a demotivating effect on some innovators by inculcating a belief that large-scale commercialization is more important than solving local problems. Kumar and Bhaduri (2014) discuss how large-scale commercialization may depend on modifying the various aspects of an innovation (e.g., packaging, various product standards, advertisement) to fulfil the preferences of consumers in different settings. This is beyond the capacity of an individual, or even small communities, and calls for a comprehensive system of diverse economic agents.[39] The growing interest in polycentric forms of innovation may be worthwhile in this direction. However, its success in sustaining frugality would depend on the way polycentrism deals with the unequal power of the various knowledge holders (Knorringa *et al.*, 2016). Particularly when a large body of knowledge of the small and the marginal remains uncodified, and they remain ignorant about the possibility of codification, the likelihood of that knowledge being misappropriated cannot be ruled out. One may, once again, invoke the poem of Tagore, here. Immediately after the poor cobbler made the shoe, the minister sharply responded: 'this was in *my* head, but how could the blighter have guessed?' (see translation by Chaudhuri, 2002)[40].

Moreover, as we found in earlier research (Kumar and Bhaduri, 2014), market transaction is not the main motivation and many of these innovations are diffused without a clear market exchange. So, to invoke Marx (1978), these innovations can generate substantial 'social use value', which cannot be captured through the lens of 'exchange value', as the mode of diffusion is embedded in social relations and does not take the market route. Duty and relatedness to social commons (mentioned earlier) remain an important

[39] Many efforts by the National Innovation Foundation are, however, in place to encourage the building up of such a system. See Kumar (2014) for details. However, the contours of such a system remains difficult to draw.

[40] Alternatively, for an online version, see http://www.boloji.com/index.cfm?md=Content&sd=Poem&PoemID=8461 (translation by Kumud Biswas) (accessed 30 April 2016).

motivation behind grass-root innovations. To refer to Tagore's poem, once again, the motivation to invent shoes was not market exchange, but to solve the king's problem in a self-motivated manner. The poor cobbler, after all, was not asked (or was not thought of as important enough to be asked) to solve the problem until the scientists of the court failed to deliver a practical solution. But how these motivations play out for micro enterprises and the *kareegar* working on a problem is a more complex question, calling for empirical research.

Quite often, the scaling up or large-scale commercialization of these innovations aims at making them available to urban consumers in the metropolis. This is despite the fact that the contexts in which these innovations are made differ greatly from the urban contexts in many developing countries. It is, therefore, unlikely that these technologies would meet the quality considerations or needs of people in the urban metropolis without significant alterations to the product design and the addition of what the frugal innovation scholars refer to as 'non-essential' components to match the 'prodigal' preferences of urban consumers. In addition, current research by STEPS points out other complex context specificities (like control and ownership of technology, and local power relations), which might become diluted in the process of scaling up. As a result, many attempts to scale up have been opposed by the communities which developed these technologies (Smith 2014).

Despite the recent surge in research on innovations in the informal economy, two aspects have not received adequate attention. These are the financing of informal sector innovations and the role of gender in knowledge-generating activities in the informal economy. On the issue of financing, self-financing and financial assistance from friends and relations has a substantive presence[41]. The advantage of such funding is their pro-social nature, which does not come with specific repayment dates and criteria.

[41] A panel of leading public sector banks at a conference organized by the Bengal Chamber of Commerce in Kolkata openly admitted that they (the banks) in India 'are not mature enough to fund R&D'.

While Adam Smith hails such socially-embedded credit flows as 'frugal' and capable of ensuring the productive use of money, the stories of exploitative moneylenders in rural areas of India have become legendary[42].

Joshi (2015) documents the lived experiences of grass-roots innovators to reveal how two of them had, at one point, thought of committing suicide after failing in their projects. There is no substantive evidence of people complaining about the non-availability of finance for their innovation projects. It is unclear, however, whether or not their non-demand is a reflection of their non-expectation of any help for their work, which, by many in the neighbourhood, is considered wasteful effort anyway. Such a social environment may make them conservative in articulating demands for external funding and more resilient in facing hardships. But a situation of non-demand should not necessarily be interpreted to mean that financial assistance is not needed. Rather, one might argue that it is necessary to develop a socially-conducive environment in which innovative efforts are valued and rewarded. Indeed, innovators recognized by, and in touch with, the National Innovation Foundation in India are more vocal about their financial requirements[43]. Undoubtedly, this issue requires more empirical investigation.

Some scholars note, and correctly so, that the informal sector in many countries has over-representation of women, in contrast to women's participation in the formal sector (Chen, 2001). However, to what extent this over-representation manifests in their participation in knowledge-generating activities remains an under-researched area. Sheikh (2012) and Singh (2015), in their pre-doctoral dissertations, find evidence of women's role in knowledge-generating activities being shaped by wider social customs and marriage rules, as well as the nature of activities. These rules often restrict unmarried women from engaging in core knowledge-generating activities, but allow them to participate in peripheral acts, arguably to prevent the leakage of knowledge outside families/communities following their marriage.

---

[42] See, for instance, the Gazetteer of Maharastra, http://ahmednagar.gov.in/gazetteer/bank_money_lenders.html (accessed 29 April 2016). Such (mal-)practices constituted a major reason for the nationalization of banks in India in 1969. A very similar argument is often put forward in support of bank nationalization in South Africa. The implications of nationalism for such frugal innovations has, however, remained suspect.

[43] In relation to health, Amartya Sen (2002) pointed out that the perception of illness can be higher in societies that are more educated and have access to better health care.

Even for married women, participation depends on broader social norms. In family-based vinegar making, for instance, women are prohibited from participating during menstruation. These forms of gender-based division of labour (involuntary, of course), are observed in activities that are more socially organized, either within a family (e.g., vinegar making in villages of western Uttar Pradesh) or within communities (e.g., pashmina shawl making in Kashmir). We find more evidence of participation by women in agricultural communities, for instance, in reconstructing water harvesting systems. However, even here, their participation in searching for suitable areas and the measurement of land slopes for the catchment area is almost non-existent (Singh 2011). These rules may not apply to individual acts of innovation to the same extent, and many examples of women innovators are observed in India and elsewhere. However, many more studies are needed in this area for a better understanding of the challenges they face, precisely on account of being women.

Towards an alternative discourse on innovation and development

The informal economy is here to stay and is a hub for a diverse set of knowledge-generating activities, some of which can eventually generate novelty, even at the global level. However, this segment of the economy remains both small and marginal in the debate on innovation and development. While it is true that there have been attempts to emphasize inclusion in these segments in the mainstream development discourse, rarely have such development narratives appreciated the knowledge base of these segments and their capability to generate innovative solutions. The participation of this group has remained limited to 'identifying their needs' or 'articulating their problems' to scientists and technologists. Even though the appropriate technology movement was sympathetic to the possibility of building upon these bodies of knowledge, their operationalization in many countries, by states and development corporations alike, favoured a 'top-down' approach. Scientists and technologists retained the task of *solving* the problems of the poor, almost unilaterally. The participation of the small and the marginal mostly remained confined to the identification of need and articulating the constraints (see, for instance, Rajan, 2009).

We know the reservation Prince Claus had against such an approach, which does not provide enough scope to local people to exercise their knowledge and decision-making ability[44].

The discourse on frugal innovation can provide an alternative approach to this debate. On the positive side, this discourse has explicitly acknowledged the knowledge and behavioural features of the small and the marginal, as well as their importance for innovation. Being a latecomer in the field, the discourse on frugal innovation has the advantage of drawing strength from the conceptual contributions of the appropriate technology movement and the technological capability school of thought in the field of innovation. To elaborate, the notions of 'minor innovation' and 'incremental innovations' are nowadays more accepted among scholars, practitioners and policy-makers in the field of development, primarily due to the ground laid by these two schools of thought. Frugal innovation can, therefore, legitimately claim a place in the discourse on innovation, easily. However, this discourse will have to go beyond large business organizations and explore the nuances and challenges of innovative behaviour among the individuals and communities at the bottom of the pyramid. Once this is done, it will have the advantage of the new developments in the field of development theories, due to Amartya Sen, to reshape the discourse on innovation and development by analysing capability, agency and the freedom of *individuals*. The use of capability theories in innovation remains sub-optimal till date, which the frugal innovation discourse may attempt to rectify (Papaioannou, 2014).

Indeed, studying *individual* behaviour has remained an underexplored area in innovation research. As Basalla (1988) notes, innovation research would benefit from focusing on the individual and social dimensions of innovative processes. Our previous research on motivation has made an attempt in this direction by analysing the preferences for autonomy, control, relatedness and duty to social commons by grass-root innovators. However, more research needs to be undertaken in this area. Moreover, our research only covers independent individual innovators. Within firms in the informal

[44] Microcredit has made an important contribution in this direction. But the focus on timely repayment has often obstructed individuals from investing in ventures where the market is small or non-existent. Also, microcredit always inspires the integration of poor people with the market, while many frugal innovations at the bottom of the pyramid are not driven by market needs and are embedded in social relations or individual need satisfaction.

economy, what motivates artisan-employees (the *kareegar*) to innovate, even when payments are paltry, remains underexplored and a theme of ongoing research at the Centre for Frugal Innovation.

More appreciation and recognition of local, uncodified, experiential, labour-embodied knowledge can be an important policy tool to support such creative endeavours and forms part of the emerging innovation policies of countries in the global South[45]. However, such an approach may not come automatically. More empirical research, bringing out how local knowledge and innovations contribute to the economic and social emancipation of people, is a prerequisite for generating more support for such a policy approach. As much of these activities, especially those by individuals and communities, remain strongly embedded in solving livelihood issues, a connection between innovation policies and poverty alleviation policies needs to be explored[46]. Appreciation for such innovative activities would also open new avenues of financial support for these innovators (individuals, communities and firms). Currently, much of the finances are informally arranged, through friends, families or (in the case of firms) customers[47]. Banks, at least in India, have been particularly reluctant to support such innovative activities. If the confession of the chief of a major public sector bank is to be believed, banks in India 'are not yet mature enough to fund research'. To a large extent, this reflects the undervaluation of 'peoples' knowledge', calling, once again, for the need for wider recognition of these forms of knowledge-generating activities. In this regard, the approach of the National Innovation Foundation in India should be studied for its replicability. It may also be emphasized here that recognition of these acts by innovation policymakers will pave the way for their inclusion in global surveys on innovation.

This action plan, however, has to overcome the challenges arising out of contempt for the experiential labour-embodied knowledge of common people. Increasing evidence is surfacing, both in historical and

---

45 Recognition was indeed an integral part of post-Industrial Revolution England. Mokyr (2005: 65) recounts the story of a 'self-taught' dyeist from Lancashire, who was given membership of the Royal Society of Science in recognition of his inventive genius.

46 de Beer *et al.*, 2013 in this context finds evidence of using procurement as a tool to incentivise innovations and traditional knowledge-based activities in some African countries. See also http://www.merit.unu.edu/innovation-for-africa-series-deip-kenya-2014/ (accessed 29 April 2016).

47 Often these customers are big merchants, the final sellers of goods (Sheikh, 2014).

contemporary settings, that shows that the hierarchies between different kinds of knowledge (theoretical vis-à-vis practical, codified vis-à-vis experiential/tacit, universal vis-à-vis local, prescriptive vis-à-vis propositional, and even scientific-vis-à-vis technological) are rather misplaced (Nonaka *et al.,* 2000; Dusek, 2006; Rosenberg, 1976; Mokyr, 2005; Gigerenzer *et al.,* 1999; Gigerenzer, 2008), justifying their assimilation. It is important to bring this cutting-edge discourse on the plurality of knowledge into the discourse on development. Frugal innovation, in its more inclusive avatar, could offer an appropriate entry point. Mokyr (2005) affirms that much of the success behind the first industrial revolution was due to the successful, non-hierarchical feedback between different forms of 'useful knowledge' (prescriptive knowledge [how] and propositional knowledge [what]) at that time. In his words, this co-existence of two different forms of knowledge led to 'virtuous cycles much more powerful than can be explained by technological progress or scientific progress separately' (*ibid.*: 21). It may be important to reiterate here that the reduced access costs to the diverse kinds of knowledge also hold importance for frugal innovation.

Frugal innovation literature emphasizes 'reuse' and 'repair', once again, explicitly acknowledging its intellectual debt to the behavioural features of the small and the marginal. Quite importantly, this emphasis also firmly puts the innovation discourse back on its etymological roots, where the meaning of innovation included activities like 'repair'. Research on grass-roots innovations and community innovations are exposing the wide prevalence of such actions. These forms of innovative efforts contribute to sustainability in a major way by reducing waste and delaying technological obsolescence (Kumar and Bhaduri, 2014; Sheikh, 2014)[48]. More empirical research is needed in this direction. As highlighted by Nath and Arora (2015), the customization and reuse of machines remains the single most prevalent in-firm technological activity among microenterprises in India. The research of the Centre for Frugal Innovation on the lock-and-key industry is poised to examine this aspect further in India and Africa.

The discourse on frugal innovation highlights the diverse designs and products developed for different markets. This approach can open up new avenues for further research around automation and standardization.

[48] See, for an illustration, http://steps-centre.org/2014/blog/urban-infrastructure-day-argentinas-street-engineers/ (accessed 18 April 2016).

The former is an outcome of the second industrial revolution towards mass production, while the latter is globally spread and can safely be linked to the WTO-led globalization. Both, however, aspire to achieve consistency in production and quality in diverse manufacturing setups, by minimizing the need for human touch and the effect of environmental variations (Ray and Bhaduri, 2003), as mentioned earlier. The technological capability school, for instance, Katz (1984), emphasized the need to reduce the degree of automation (continuous flow production in the North vis-à-vis the discontinuous batch system in the South) in response to low market demand and major supply bottlenecks. They, however, do not emphasize differentiation in design and product qualities across markets. Frugal innovation does precisely that. This proposal has the potential to undermine a 'one-size-fits-all' approach to product characteristics and quality. *Consistency* in quality, across markets, through automation, therefore, may become problematic in the era of frugal innovation.

The research in India and Africa on grass-roots innovation reveals how quality is endogenously constructed by the producers and consumers of these technologies, in both informal settings and local market places. These results challenge the claims by Kaplinsky (2011) that developing countries will engage in a 'race to the bottom' if not made to adhere to global standards. Rather, it is argued that the absence of a globally-homogenized standard may open up the possibility for more endogenously determined standards, agreeable to consumers and producers, and, therefore, may become 'market determined' in a truer sense, without the 'frills' they incorporate now. The present level of standardization with these 'frills' is making products inaccessible to the 'bottom billion' consumers at the margin. For the pioneer of modern-day bioequivalence standards, KK Midha, 'quality without accessibility is meaningless' (Midha 2013). Once again, we need more empirical research. The Centre's proposed research on lock-and-key industries in India and Africa may give us new insights into how standards and innovations co-evolve at local levels.

I would like to round up this discussion by returning to Adam Smith. His ideational influence on technological change is often measured through his analysis of the division of labour. We have noted in an earlier section that labour-embodied experiential knowledge was for him a crucial dimension, not only of frugality, but also of the division of labour. To put it differently, his notion of division of labour embodies an early understanding of frugality in the process of knowledge generation. In fact, his early enthusiasm for

division of labour as a tool for economic progress turned to despair later in *The Wealth of Nations*. In Part V, he seems to be disappointed with the deleterious effect of division of labour, as 'those who live by labour, that is, of the great body of the people, comes to be confined to a few very simple operations, frequently to one or two' (Smith, 1776). He notes (*ibid.*: 428–9) that the:

> *...man whose whole life is spent in performing a few simple operations, of which the effects are perhaps always the same, or very nearly the same, has no occasion to exert his understanding or to exercise his invention in finding out expediments for removing difficulties which never occur. [...] He [...] becomes stupid [...].*

Through a careful interpretation of Smith's writings, Rosenberg (1965) argues that these situations occur in technologically-advanced societies, where, unlike less-advanced societies, labourers no longer invent. The task of invention is completely taken over by scientists and philosophers, and this process is the outcome of division of labour and the growth of specialization. However, technological progress continues in these societies, although isolated from the labour force. This was, for Rosenberg, a typical situation in advanced societies producing complex technologies. Therefore, with technological progress, technological changes, while becoming more complex, become progressively more detached from labour.

Does this process become satiated at any point? The recent financial crisis in the west and the consequent rise of the frugal innovation discourse gives us an opportunity to reflect on this question. Radjou and Prabhu's (2015) seminal book on this topic presents the case study of the car manufacturer, Renault, which set up a firm in Romania to manufacture their frugal car model, the Dacia. Having a plant in Romania facilitated this process by enabling the local engineers, 'who had grown up in harsh communist environment' (*ibid.*: 2), to instil frugality in the design of the car. This car, as the story continues, played an important role in turning the fortunes of the company around after the crisis. Using this example, it is argued, perhaps at the risk of sounding naïve, that specialization through division of labour leading to the separation of labour from knowledge has a limit, beyond which technological progress becomes embodied in labour and experience. Of course, this is only rough conjecture, but interesting enough to mention. To conclude, I wish to note that a carefully-constructed discourse on frugal innovation has the potential to significantly alter the debates on innovation

and development. It can make global innovation surveys more inclusive by qualifying a broader range of activities as innovation. Further, I believe that this discourse can also lead to sustained innovation and economic wellbeing, even in the global North, if the emphasis shifts to value informally-acquired, labour-embodied, uncodified knowledge, which is pervasive in the informal economies of the global South. Moreover, understanding the relevance of accessing different forms of knowledge, spread across countries and communities, the discourse on frugal innovation can bring more equity to the North-South innovation relationship. It is well known that what made the United Kingdom a fore runner in industrialization was not its capacity to do fundamental research, for which it relied heavily on France, but its capacity to absorb, assimilate and apply the knowledge acquired from multiple sources in practical situations. Today, many economies, particularly in the global South, are deprived of that opportunity, due to the high access costs imposed by strict forms of intellectual property rights and the stifling stringency of quality standards. The discourse on frugal innovation, if reconfigured, can restore the legitimacy of experimentation with diverse forms of knowledge and put it back in the discussion on innovation policymaking. All of this would be essential to realize the dream of Prince Claus to bring more equity into the North-South innovation relationship. For this to happen, the North-South innovation relationship will have to be shaped within a narrative of 'exchange', and not 'transfer' or 'catch-up', of knowledge and technology. A correctly visualized frugal innovation discourse can indeed facilitate this.

References

Abrol, D. (2005) 'Embedding technology in community based production systems through people's technology initiatives: lessons from the Indian experience', *International Journal of Technology Management and Sustainable Development* 4(1): 3–20.

Abrol, D. and A. Gupta (2014) 'Understanding the diffusion modes of grassroots innovations in India: a study of Honey Bee Network supported innovators', *African Journal of Science, Technology, Innovation and Development* 6 (6): 541–552.

Basalla G. (1988) *The evolution of technology.* Cambridge, New York: Cambridge University Press.

Basole, A. (2014) 'The informal sector from a knowledge perspective', *Yojana* 58: 8–13.

Basole, A. (2015) *Lokavidya perspectives: a philosophy of political imagination for the knowledge age.* New Delhi: Aakar Books.

Bessen, J. and **M.J. Meurer** (2008) *Patent failure: how judges, bureaucrats, and lawyers put innovators at risk.* Princeton: Princeton University Press.

Bhaduri, S. and **A.S Ray** (2004) 'Exporting through technological capability', *Oxford Development Studies* 32(1): 87–100.

Bhaduri, S. and **A.S Ray** (2006) 'A game theoretic model of drug launch in India', *Health Economics, Policy and Law* 1(1): 23–39.

Bhaduri, S. and **H. Kumar** (2011) 'Extrinsic and intrinsic motivations to innovate: tracing the motivation of 'grassroot' innovators in India', *Mind & Society* 10(1): 27–55.

Bhatti, Y. (2011) *Response to The Economist*, http://www.frugal-innovation.com/tag/frugal-innovation/ (accessed 29 April 2016).

Bhatti, Y. (2012) *What is frugal? What is innovation? Towards a theory of frugal innovation*. SSRN Working Paper Series.

Bhatti, Y., S. Khilji and **R. Basu** (2013) 'Frugal innovation', in S. Khilji and C. Rowley (eds) *Globalization, Change and Learning in South Asia*. UK: Oxford.

Capra, F. (1989) *Uncommon wisdom: conversation with remarkable people*. London: Flamingo.

Chen, M. (2001) 'Women in the informal sector: a global picture, the global movement', *SAIS Review* 21(1).

Chaudhuri, S (ed.) (2002) *Rabindranath Tagore: selected writings for children*. New Delhi: Oxford University Press.

Dabke, S. (2011) Emerging markets – *The epicentre for creativity and innovation*. http://www.docstoc.com/docs/82388590/Emerging-markets---The-Epicentre-for-Creativity-and-Innovation (accessed 15 March 2013).

Daniels S (2010) Making do: *innovation in Kenya's informal economy*. San Francisco: Creative Commons.

Darrow, K. and **R. Pam** (1978) *Appropriate technology sourcebook: for tools and techniques that use local skills, local resources, and renewable sources of energy* 1. Stanford: Volunteers in Asia Publication.

Dasgupta, U. (1977) *Santiniketan and Sriniketan: a historical introduction*. A Visva-Bharti Quarterly Booklet. Santiniketan: Visva-Bharti University.
de Beer, J., K. Fu and **S. Wunsch-Vincent** (2013) *The informal economy, innovation and intellectual property: concepts, metrics and policy considerations*. WIPO Economic Research Working Paper No. 10, July, pp. 1–76, www.wipo.int/export/sites/www/econ_stat/en/economics/pdf/wp10.pdf (accessed 30 July 2013).
de Soto, H. (2000) *The mystery of capital: why capitalism triumphs in the West and fails everywhere else*. New York: Bantam Press.
de Young, R. (1986) 'Encouraging environmentally appropriate behavior: the role of intrinsic motivation', *Journal of Environmental Systems* 15 (4): 281–291.
Deci, E.L. and **R. Ryan** (1985) *Intrinsic motivation and self-determination in human behaviour*. New York: Plenum Press.
Deci, E.L. and **R. Ryan** (2000) 'Intrinsic and extrinsic motivations: classic definitions and new directions', *Contemporary Educational Psychology* 25: 54-67.
Dusek, V. (2006) *Philosophy of technology: an introduction*. Wiley-Blackwell.
Dutta, S., B. Lanvin, and **S. Wunsch-Vincent** (2015) *The Global Innovation Index (2015): effective innovation policies for development*. Fontainebleau, Ithaca, and Geneva: OAS.
The Economist (2015) *Cheap and cheerful: after some teething troubles, frugal innovation is on the rise*, 24 January 2015, http://www.economist.com/news/business/21640330-after-some-teething-troubles-frugal-innovation-rise-cheap-and-cheerful (accessed 4 May 2016)
Franke, N. and **E. Von Hippel** (2003) 'Satisfying heterogeneous user needs via innovation toolkits: the case of Apache security software', *Research Policy* 32(7): 1199–1215.
Fransman, M. and **K. King** (ed.) (1984) *Technological capability in the third world (introduction)*. London: Macmillan Press Ltd.
Gigerenzer, G. (2008) *Gut feelings: the intelligence of the unconscious*. Penguin Books.
Gigerenzer, G., P.M. Todd and **ABC Research Group** (eds) (1999) *Simple heuristics that make us smart*. New York: Oxford University Press.
Gudeman, S. and **A. Rivera** (2001) 'Sustaining the community, resisting the market: Guatemalan perspectives', in J.F. Richards (eds) *Land, property and the environment*. Oxford: Blackwell, pp 359–381.
Guha-Khasnobis, B., R. Kanbur and **E. Ostrom** (eds) (2006) *Linking the formal and informal economy: concepts and policies*. Oxford: Oxford University Press.
Gupta, A. (2012) 'Innovations for the poor by the poor', *International Journal of Technological Learning, Innovation and Development* 5 (1/2): 28–39.
Harris, C.J. (2014) 'The confounding influence of urban informality on innovation and production specialisation in production clusters: evidence from Nairobi', *African Journal of Science, Technology, Innovation and Development* 6 (6): 529–539.
Hart, K. (1973) 'Informal income opportunities and urban employment in Ghana', *Journal of Modern African Studies* 11(1): 61–89.

Hart, K. (2006) 'Bureaucratic form and the informal economy', in B. Guha-Khasnobis, R. Kanbur and E. Ostrom (eds) *Linking the formal and informal economy: concepts and policies*. Oxford: Oxford University Press: 21–35.
Henkel, J. and **E. von Hippel** (2005) 'Welfare implications of user innovation', *The Journal of Technology Transfer* 30 (1): 73–87.
Irvin, A. and **B. Wynne** (1996) *Misunderstanding science? The public reconstruction of science and technology*. UK: Cambridge University Press.
Jaramillo, H., G. Lugones and **M. Salazar** (2001) *Standardisation of indicators of technological innovation in Latin American and Caribbean Countries*. Bogota Manual. Bogota: OAS.
Joshi, R. (2015) *The essence of lived experiences of grassroots innovators: a phenomenological study*. PhD dissertation, University of Technology Sydney, Australia.
Kaplinsky, R. (2011) 'Schumacher meets Schumpeter: appropriate technology below the radar', *Research Policy* 40: 193–203.
Katz, J.M. (1984) 'Domestic technology generation in ldcs: A review of research findings', in J.M. Katz (ed.) *Technology generation in Latin American manufacturing industries: theory and case-studies concerning its nature, magnitude and consequences.* London: Macmillan, pp 13–56.
Knorringaa, P., I. Peša, A. Leliveldb and **C. Beersc** (2016) 'Frugal innovation and development: aides or adversaries?', *European Journal of Development Research* 28: 143–153.
Krishnan, R. (2014) 'Rethinking technological choices and knowledge production in the mines and on the factory floor: Chhatisgarh Mukti Morcha's experiences in central India', *African Journal of Science, Technology, Innovation and Development* 6 (3): 213–221.
Kumar, H. (2014) 'Dynamic networks of grassroots innovators in India', *African Journal of Science, Technology, Innovation and Development*, 6 (3): 193–20.
Kumar, H. and **S. Bhaduri** (2014) 'Jugaad to grassroot innovations: understanding the landscape of the informal sector innovations in India', *African Journal of Science, Technology, Innovation and Development* 6 (1): 13–22.
Lall, S. (1987) *Learning to industrialize: the acquisition of technological capability by India*. London: Macmillan.
Lastovicka, J.L., L.A. Bettencour, R.S. Hughner and **R.J. Kuntze** (1999) 'Lifestyle of the tight and frugal: theory and measurement', *Journal of Consumer Research* 26(1): 85–98.
Lewis, W.A. (1954) 'Economic development with unlimited supplies of labour', *Manchester School* 22: 139–191.
Liyan, Z. (2016) 'University intermediation of grassroots innovation incubation: a case study in China', Paper presented at Indialics CDS, Trivandrum 2016.
Losby, J.L., J.F. Else, M.E. Kingslow, E.L. Edgcomb, E.T. Malam and **V. Kao** (2002) *Informal economy literature review*. Santa Fe: Institute for Social and Economic Development (ISED) and Microenterprise Fund for Innovation, Effectiveness, Learning and Dissemination (FIELD).
Marx, K. (1978) *Capital, Volume I*. Moscow: Progress Publishers.

Meagher, K. (2015) 'Cannibalising the informal economy: frugal innovation and economic inclusion.' Keynote address, CFIA workshop, 25 November 2015, ISS, The Hague.
Merriam Webster Dictionary (2011) http://www.merriam-webster.com/dictionary/frugal (accessed 26 December 2012).
Midha, K.K. (2013) 'Venkateswaralu Memorial Lecture', presented at the Annual Conference of the Indian Pharmacists Association, 8–10 April 2013, Goa, India.
Mokyr, J. (2005) *The gifts of Athena: historical origins of the knowledge economy*. Princeton, NJ: Princeton University Press.
Morgan, ES (1967) 'The puritan ethic and the American revolution', *William and Mary Quarterly* 24 (10): 3–43.
Muchie, M., S. Bhaduri, A. Baskaran and **F.A. Sheikh** (eds) (2015) *Informal sector innovations: insights from the global South*. UK: Routledge, Taylor and Francis.
Nakata, C.K. and **K. Weidner** (2012) 'Enhancing new product adoption at the base of the pyramid: a contextualized model', *Journal of Production Innovation Management* 29(1): 21–32.
Nath, P. and **P. Arora** (2015) 'Indian industries: insights from the first national innovation survey', *Asian Journal of Innovation & Policy* 4 (3): 360–380.
Nelson, R. (ed.) (1993) *National innovation systems: a comparative analysis*. New York: Oxford University Press.
Nelson, R. and **S.G. Winter** (1982) *An evolutionary theory of economic change*. Cambridge, MA and London: Belknap Press.
Neuwirth, R. (2011) *Stealth of nations: the global rise of the informal economy*. New York: First Anchor Books.
Noble, D. (1977) *America by design: science, technology, and the rise of corporate capitalism.* New York: Alfred A. Knopf.
Nonaka, I. and **R. Toyama** (2003) 'The knowledge-creating theory revisited: knowledge creation as a synthesizing process', *Knowledge Management Research and Practice* 1: 2–10.
Nonaka, I., R. Toyama and **A. Nagata** (2000) 'A firm as a knowledge creating entity: A new perspective on the theory of the firm', *Industrial and Corporate Change* 9(1): 1–20.
NIF (2001) *First national grassroots technological innovation and traditional knowledge awards*. Ahmedabad: National Innovation Foundation.
NIF (2002) *Second national grassroots technological innovation and traditional knowledge awards*. Ahmedabad: National Innovation Foundation.
Obeng-Odooma, F. and **S. Ameyawb** (2014) 'A new informal economy in Africa: the case of Ghana', *African Journal of Science, Technology, Innovation and Development* 6(3): 223–230.
OECD (2002) *Frascati Manual 2002: proposed standard practice for surveys on research and experimental development, the measurement of scientific and technological activities*. Paris: OECD Publishing, Paris.
OECD (2009) *Competition policy and the informal economy.* Policy Roundtables. OECD.

Overa, R. (2007) 'When men do women's work: structural adjustments, unemployment and changing gender relationship in the informal economy of Accra, Ghana', *Journal of Modern African Studies* 45 (4): 539–63.
Oxford Dictionary (2011) http://oxforddictionaries.com/definition/frugal (accessed 26 December 2012).
Papaioannou, T. (2014) 'How inclusive can innovation and development be in the twenty-first century?' *Innovation and Development* 4: 187–202.
Polanyi, K. (1944) *The great transformation: the political and economic origins of our time*. New York: Farrar and Rinehart.
Prahalad, C. (2012) 'Bottom of the pyramid as a source of breakthrough innovations', *Journal of Product Innovation Management* 29 (1): 6–12.
Radjou, N. (2009) 'Polycentric innovation: The new global innovation agenda for MNCs', *Harvard Business Review* 5 November 2009.
Radjou, N. and **J. Prabhu** (2013) *Frugal innovation: a new business paradigm*. Insead Education. http://knowledge.insead.edu/innovation/frugal-innovation-a-new-business-paradigm-2375#t2lALpyvKmbFZqM8.99 (accessed 25 April 2016).
Radjou, N. and **J. Prabhu** (2015) *Frugal innovation: how to do more with less*. London: Profile Books.
Radjou, N., and J. Prabhu and **S. Ahuja** (2012) *Jugaad innovation: a frugal and flexible approach to innovation for the 21st Century*. India: Random House.
Rajan, R. (2009) *Amulya Reddy: citizen scientist*. Hyderabad: Orient Blackswan.
Ramos, D.N.F. (2015) 'Slicing up the developing world: differentiation in the special treatment of developing countries.' PhD dissertation, ISS, The Hague.
Ray, A.S. and **S. Bhaduri** (2001) 'R&D and technological learning in Indian industry: econometric estimation of the research production function.' *Oxford Development Studies* 29 (2).
Ray, A.S. and **S. Bhaduri** (2002) 'Technology development in Indian industry: challenges and options after the East Asian crises', in R. Hooley and J.H. Yoo (eds) *The post-financial crises challenges for Asian industrialization*. UK: JAI, Elsevier Science Ltd.
Ray, A.S. and **S. Bhaduri** (2003) 'The political economy of drug quality: changing perceptions and implications for the Indian pharmaceutical industry', *Economic and Political Weekly* 38(23).
Rivera-Huertaa, R. (2014) 'Rational agent-based understanding of the informal sector: a critical assessment', *African Journal of Science, Technology, Innovation and Development* 6 (3): 165–173.
Rosenberg, N. (1965) 'Adam Smith on the division of labour: two views or one?', *Economica* 32(126): 127–139.
Rosenberg, N. (1976) *Perspectives on technology*. Cambridge: Cambridge.
Rosenberg, N. and **W.W. Steinmueller** (1988) 'Why are Americans such poor imitators?' *American Economic Review* 78 (2): 229–235.
Schneider, F and **D.H. Enste** (2000) 'Shadow economies: size, causes and consequences', *Journal of Economic Literature* 38 (1): 77–114.

Schumpeter, J. (1934) *The theory of economic development: an inquiry into profits, capital, credit, interest and the business cycle*. New York: A Galaxy Book, OUP.
Sen, A. (2002) 'Health: perception versus observation', *British Medical Journal* 324: 660–661.
Sharma, G. and **H. Kumar** (2016) 'Patents and grassroots innovations: rethinking intellectual property rights in the informal sector.' Paper presented in Indialics CDS, Trivandrum 2016.
Sheikh, F.A. (2011) *Unsung innovators of Kashmir*. Srinagar: Gulshan Books.
Sheikh, F.A. (2012) 'Exploring community innovations in the informal sector: a study of Kashmiri pashmina shawls.' MPhil dissertation, CSSP-JNU.
Sheikh, F.A (2014) 'Exploring informal sector community innovations and knowledge appropriation: a study of Kashmiri pashmina shawls', *African Journal of Science, Technology, Innovation and Development* 6 (3): 203–212.
Singh, A. (2011) 'Understanding the 'revival' of rainwater harvesting system in India: the case of Johad in Alwar, Rajasthan.' MPhil dissertation, CSSP-JNU.
Singh, B. (2015) 'Knowledge and innovation in informal economy: a case of vinegar making in western Uttar Pradesh.' MPhil dissertation submitted at CSSP-JNU.
Singh, S., G.D. Sharma and **M. Mahendru** (2011) 'The Jugaad Technology (indigenous innovations): a case study of Indian origin', *Asia Pacific Journal of Research in Business Management* 2(4). http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1827622 (accessed 3 12 2012)
Sinha, K.M., P. Adams and **F. Malerba** (2015) *Intermediate users as a source of innovation in a development context: empirical evidence and theory*. No. 2015-14, Globelics-Global Network for Economics of Learning, Innovation, and Competence Building Systems, Aalborg University, Department of Business and Management.
Smith, A. (1776) *An inquiry into the nature and causes of the wealth of nations*. http:// en.wikisource.org (accessed 29 April 2016).
Smith, A. (2014) *Scaling-up inclusive innovation: asking the right questions?* STEPS Centre [blog]. http://steps-centre.org/2014/blog/scaling-up-inclusive-innovation (accessed on 18 April 2016)
Smith, A., M. Fressoli and **H. Thomas** (2014) 'Grassroots innovation movements: challenges and contributions', *Journal of Cleaner Production* 63: 114–124.
Stewart, F. (1978) *Technology and underdevelopment*. London: Macmillan Press.
Stiglitz , J.E. (1998) 'Towards a new paradigm for development: strategies, policies, and processes', Paper
presented as Prebisch Lecture at UNCTAD, Geneva, 19 October.
Tagore, R.N. (1932) 'Rural welfare methods', in Ghosh, N (ed.) (2007) *The English writings of Rabindranath Tagore*', Vol.4. New Delhi: Sahitya Akademi.
UIS (2013) Survey on innovation statistics. Paris: UNESCO.
von Hippel, E. (1986) 'Lead users: a source of novel product concepts', *Management Science* 32(7): 791–805.

von Hippel, E. (2001) 'User toolkits for innovation', *Journal of Product Innovation Management*, 18 (4): 247–257.
White, B.H. (2014) 'The role of India's informal economy', *Yojana* 58: 21–28.
Witt, U., T. Brokel and **T. Brenner** (2012) 'Knowledge and its economic characteristics – a conceptual clarification', in R. Arena, A. Festre and N. Lazaric (eds) *Handbook of Knowledge and Economics*. Paris: Edward Elgar.
Wooldridge, A. (2010) 'The world turned upside down. a special report on innovation in emerging markets', *The Economist*, 15 April 2010, http://www.economist.com/node/15879369
Yadav, V and **P. Goyal** (2015) 'User innovation and entrepreneurship: case studies from rural India', *Journal of Innovation and Entrepreneurship*: 1–20.

A word of thanks

I would like to thank the Curatorium of the Prince Claus Chair for nominating me for this prestigious Chair and the Executive Board of the Board of Deans of Erasmus University of Rotterdam for approving my appointment. I am also very grateful to NWO-WOTRO for co-funding a postdoctoral fellowship to support the research agenda of the Prince Claus Chair 2015-2017.

Peter Knorringa, the Chair of the Search Committee, my mentor and colleague at the Centre for Frugal Innovation in Africa, has done everything to ensure smooth passage for me throughout my tenure here at ISS. With his pleasant personality he made me feel at home on the first day of my association with the Centre. His 'inclusive' approach generates enthusiasm in others and encourages them to participate. He has introduced me to his loving family and together they ensured I was not deprived of delicious home-cooked multi-ethnic food while being away from home. Thank you, Peter.

I also thank Leo de Haan, the previous Rector of ISS, for his interest in frugal innovation and sharp observations on my research. I also thank Inge Hutter, Rector of ISS, for her continued support and kindness. The Secretary of the Curatorium and Executive Secretary of ISS, Linda Johnson, and her colleagues Jose van dar Starre, Femke van der Vilet, and John Sinjorgo have made every effort to make my stay at ISS pleasant. Linda has been active in introducing me to many members of the ISS community and, of course, to Dutch classical music. All this has contributed to me being able to get to know this beautiful place better.

My colleagues at the Centre for Frugal Innovation in Africa, Cees van Beers and Andre Leliveld, together with Peter, have given me every opportunity to express my views on important academic matters at the Centre from the beginning. The Prince Claus Chair Post-Doctoral Fellow Kinsuk Mani Sinha's confident and enthusiastic involvement in this research agenda is noteworthy. Tom Harmsen, the anchor-person of the Centre for Frugal Innovation in Africa, deserves a special mention for his commitment and sincerity, with a human touch. You have been indispensable, Tom!

In more ways than one, this speech is co-owned by all the members of the Centre for Frugal Innovation in Africa for those valuable comments and insights they gave during its conceptualization, and their comments on earlier drafts. My thanks to our post-doctoral fellow Haye Hazenberg for enticing me to go back to Adam Smith to prepare this paper. The quasi-insider of the Centre for Frugal Innovation in Africa, Georgina Gomez, gave valuable comments on an earlier draft.

My students, back in Delhi, have been my greatest strength throughout my academic life. From running errands for me, to keeping me engaged in

stimulating intellectual exchange – they have phenomenally contributed to my academic journey. In fact, it is their commitment that has enabled me to explore the field of frugal innovation by 'the small and the marginal'.
Hemant Kumar and, more recently, Fayaz Ahmad Sheikh have substantially enriched my understanding of this issue. The other line of thought that complemented my research on frugal innovation is the discourse on the plurality of knowledge. I started this line of research with Abhinandan Saikia and Aviram Sharma. Several discussions with my colleagues at the Centre for Studies in Science Policy, particularly Rohan D'Souza, Madhav Govind and, more recently, Mathieu Quet, have enriched my understanding of this issue. Fayaz also gave excellent research support for preparing this draft. Noklenyangla gave invaluable editorial support at short notice. A chance discussion with Mammo Muchie a couple of years ago helped me appreciate the nuances of replacing the current 'transfer-based narratives' in development discourse with a less hierarchical 'exchange-based narrative'.
Amit Shovon Ray introduced me to the discourses on technological capability and development precisely 18 years ago. Since then, he has suffered all my raw ideas. He has rejected a few of them, accepted some, and reshaped many other.
My father-in-law, while being a practitioner of alternative medicine, has been an informal innovator himself. His life stories have helped me develop a clearer perspective on these innovation processes. My schoolmates, Suman, Apurba and Parichoy, have shared their invaluable insights on the world of small business at different points in time.
I cannot express my indebtedness to my parents in words. However, I must mention that my mother has always prodded me to dream big. She left no stone unturned to ensure that I received the best possible academic exposure since my childhood. My father's politics has shaped my research agenda in a profound manner. My sister is a quiet, but firm, supporter of whatever I do. Our two sons, Bhasvar and Maitreesh, train me how to be frugal, and perhaps better, every day, with their unstoppable energy and inquisitiveness. My wife Suranjana has been firmly there, with her immense care and love. Her motto of putting family first greatly helped me choose the career path I wanted. It has been a perfect case of free ridership (with her indulgence) on my part, I must confess.

Thank you all for giving me an opportunity to share my views with you.

International Institute of Social Studies (ISS)
Erasmus University Rotterdam

Kortenaerkade 12
2518 AX The Hague
The Netherlands

+31 70 426 04 60
femke.vandervliet@eur.nl
www.iss.nl