The Enabling Role of IT in Frugal Innovation

Completed Research Paper

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Abstract

In this conceptual paper, we examine IT-enabled frugal innovation from the lens of absorptive capacity theory (ACAP). The practice of frugal innovation in emerging economies is rooted in low cost approaches, constrained resources, and flexible improvisation. As frugal innovation is an emergent phenomenon, there is little theoretical development and empirical investigation with respect to the enabling role of IT. We address this gap by examining the conceptual underpinnings of frugal innovation and its antecedents, such as IT leveraging capability, dynamic knowledge capabilities, and organizational learning. We develop a research model and provide testable propositions. This paper contributes to ACAP literature by providing a look inside the “black box” of the relationships between three different types of learning (according to ACAP) and their effects on the underlying dimensions of frugal innovation. Furthermore, based on our findings, implications for theory and practice are provided along with guidance for future empirical research.

Keywords: Absorptive capacity, frugal innovation, organizational learning, knowledge-based view, IT capabilities, dynamic capabilities, knowledge capabilities, IT leveraging capability, IT-enabled innovation

Introduction

“If necessity is the mother of invention, constraint is the mother of frugal innovation.”
- Terri Bresenham, President and CEO, GE Healthcare India

The practice of frugal innovation in emerging economies such as those of India, Kenya, Brazil and China, is rooted in low cost approaches, constrained resources, and flexible improvisation (Radjou, Prabhu, and Ahuja, 2012). This is very different from innovation in developed economies, which is generally based on resource richness and abundance (Prahalad and Mashelkar, 2010). Frugal innovation can be defined as “the design and development of products/services with price rather than features as the starting point, but also focusing on the end utility and value offered, rather than high-end sophistication” (Mundim, Sharma, Arora, and McManus, 2012). In emerging economies, firms that practice frugal innovation overcome severe resource constraints by developing products and services that provide extreme cost advantages compared with existing solutions (Zeschky, Widenmayer, and Gassmann, 2011). The development of affordable products and services is critical for firms operating in emerging economies because consumers in these economies are particularly conscious of price and value. Although frugal innovation is perceived to be essential for emerging economies, it may now be equally relevant for developed economies. In the wake of the recent economic crisis, U.S. personal consumption expenditure has dropped by more than three percentage points and consumers in developed markets are becoming more value oriented and are looking for simpler products and services that offer the greatest value (Zeschky et al., 2011). Furthermore, governments in developed economies are urging firms to “seek ways to boost innovation without necessarily engaging in new programme spending, primarily to meet social demands” (OECD, 2011). Therefore, in both emerging and developed economies, there is significant potential for firms to practice frugal innovation.
As firms begin to take notice of such opportunities, products and services designed for emerging markets are increasingly making their way to markets in developed economies (Govindarajan and Ramamurti, 2011). According to Gartner Research (Mesaglio, McGee, Fenn, and Nielsen, 2014), firms in developed economies are adopting a few well-chosen constraints in the innovation process to elicit more creativity in product and service design. Some examples of frugal products and services include Kenya’s extremely affordable and widely popular M-PESA mobile money transfer service which can run on text messaging and is used by 60% of the population; India’s smartphones and android tablets which cost less than $100; GE’s Vscan portable ultrasound scanner designed for rural areas in India at a third of the cost of a regular model; and China’s rapid and affordable production of solar panels to supply the growing needs of emerging economies (Blosch, 2011; Mundim et al., 2012; Radjou et al., 2012). Thus, in order to remain competitive in a dynamic and global business environment, firms may need to develop frugal innovation capabilities based on learning from emerging markets.

According to Mundim et al. (2012), firms in emerging markets, especially in the IT industry, are relatively newer and have less organizational inertia. Therefore, they tend to have fewer problems with legacy systems and processes. This enables them to rapidly progress through the usual evolution of their technology, marketing, alliances, and supply chains, to quickly develop best-in-class practices. As a result, they are able to offer state-of-the-art technology and systems to clients without incurring heavy transformation or conversion costs. According to MIT’s Center for Information Systems Research (CISR), companies in emerging economies are spending a larger percentage of revenue on digitization, are faster to market with new offerings, and perform better than peers in developed economies (Weill and Woerner, 2012). The report also emphasizes that firms in emerging economies are faster to adopt newer technologies and leverage them better, resulting in faster innovation and better performance. These firms also have lower legacy costs to consider and have learned from the experience of firms in developed economies in terms of their process of IT adoption. Nonetheless, the argument can still be made that in the frugal context, IT must be factored in as a huge cost and thus it can be counter-productive. However, this argument can be addressed with findings from MIT’s study and similar studies, which show that firms in developing economies are differentiating themselves by not making large IT infrastructure investments, but by leveraging flexible and adaptable IT systems and processes, thereby allowing them to keep costs lower than firms in developed economies.

For these reasons, we examine the enabling role of IT in frugal innovation in this study. In addition, although the topic of frugal innovation is gaining increased attention in the academic and practitioner literature (Castro, Montoro-Sanchez, and Ortiz-De-Urbina-Criado, 2011; Govindarajan and Ramamurti, 2011; Helpman, 1992; Johnson, Christensen and Kagermann, 2008; Prahalad and Ramaswamy, 2002), because frugal innovation is an emergent phenomenon, there is little established theory and empirical research to guide both academics and practitioners (George, McGahan, and Prabhu, 2012). This paper attempts to fill this gap by 1) investigating the conceptual underpinnings of frugal innovation along with its antecedents; 2) studying the role of IT in enabling frugal innovation; 3) using the theoretical lens of absorptive capacity theory (Cohen and Levinthal, 1989, 1990; Zahra and George, 2002, 2002a) to examine frugal innovation; and 4) providing propositions and guidance for future research.

This paper is of relevance for both academia and practitioners. From an academic perspective, frugal innovation can be theoretically linked to several literature sources such as the Resource Based View (RBV) of the firm, the Knowledge Based View (KBV), alliance networks, Corporate Social Responsibility (CSR), business model innovation and dynamic capabilities (Ahuja and Chan, 2014; George et al., 2012). Studies also show that the principal components of frugal innovation, including social, business model and technological innovation components, may overlap with existing theoretical constructs (Ahuja and Chan, 2014). In order to continuously innovate, firms are reliant on their knowledge capabilities (Cohen and Levinthal 1990). Information Technology (IT) and Information Systems (IS) are critical for supporting knowledge management initiatives and nurturing innovation (Alavi and Leidner 2001). Absorptive capacity (ACAP) is often viewed as a dynamic capability for processing knowledge that enhances firm innovation (Zahra and George 2002). To specifically investigate the role of IT in frugal innovation from a knowledge and capabilities standpoint, it is important to use an appropriate theoretical lens. ACAP theory states that the ability of a firm to recognize the value of new information, assimilate it, and apply it to commercial ends is critical to its innovative capabilities (Cohen and Levinthal, 1990). Furthermore, ACAP theory uses an “input-process-output” approach that aligns well with process-based investigation of firm innovation. ACAP is increasingly important for knowledge-intensive firms as they use knowledge
management capabilities and organizational learning for improved innovation, coordination and communication and rapid commercialization of new products/services (Gold, Malhotra, and Segars, 2001). In addition, due to increased global competition, the ability of firms to anticipate surprises, respond to market changes, and reduce redundancy of information by using their knowledge and learning capabilities can be critical for sustained competitive advantage (Gold et al., 2001). ACAP theory has been previously used and recommended for IT and innovation-based studies (Cohen and Levinthal, 1989, 1990; Heeks, 2012; Oh, 2009; Zahra and George, 2002, 2002a; Zeschky et al., 2011). Relying on the rich theoretical foundation of ACAP, this paper attempts to extend the current literature on both ACAP and frugal innovation (within an IT context), by incorporating IT capabilities, specifically IT leveraging capabilities (Pavlou and El Sawy, 2010), as an antecedent of frugal innovation.

In terms of practitioner implications, this paper aims to provide firms with insights regarding their choice, deployment, and usage of IT systems for innovation in resource-constrained settings and for development of highly affordable products and services. This may be of particular interest to start-ups in developed economies as they try to balance their costs and resources, while at the same time trying to deliver higher value for their investors and customers. Furthermore, small and medium sized enterprises (SMEs) can learn frugal innovation mechanisms and incorporate social, business model, and technological innovation practices into their existing innovation programs, thereby enhancing their innovation profiles. The sections that follow provide a literature review, theoretical background, research model and propositions, limitations, future research, and conclusions.

**Literature Review**

First, it is important to distinguish frugal innovation from other existing innovation paradigms. The major innovation paradigms adjacent to frugal are: 1) Reverse Innovation, which refers to the case where an innovation is adopted first in poor (emerging) economies before “trickling up” to rich countries (Govindarajan and Ramamurti, 2011); 2) Inclusive Innovation, which is defined as knowledge creation and absorption efforts that are most relevant to the needs of the poor (Utz and Dahlman, 2007); and 3) Frugal Engineering, which is an overarching philosophy that enables product development where cost discipline is an intrinsic part of the process; however, rather than simply cutting existing costs, frugal engineering seeks to avoid needless costs in the first place (Tiwari and Herstatt, 2012). Furthermore, studies also show the distinction between frugal innovation and other cost and efficiency based mechanisms such as lean and agile approaches, primarily used in the IT and software development industries (Ahuja and Chan, 2014).

Second, it is important to define frugal innovation and state its underlying principles. Bhatti (2012) provides a very comprehensive definition of frugal innovation as “innovation that redefines business models, reconfigures value chains and redesigns products to use resources in different ways and create more inclusive markets by serving users with affordability constraints, often in a scalable and sustainable manner”. Based on this definition, frugal innovation is currently conceptualized as a combination of social, business and technology innovation. Each of these is described next. Figure 1 diagrammatically represents the conceptualization of frugal innovation.

According to The Center for Social Innovation at Stanford University (2014), “social innovation is a novel solution to a social problem that is more effective, efficient, sustainable, or just than present solutions and for which the value created accrues primarily to society as a whole rather than private individuals.” Kanter (1999) argues that “the primary business justification for the sustained commitment of resources to social innovation is the new knowledge and capabilities that will stem from innovation – the lessons learned from the tough problems solved”. Kanter (1999) also provides an example of social innovation leading to benefits for the firm – “IBM began its Reinventing Education program in 1994 under the personal leadership of CEO Louis V. Gerstner, Jr. Today the program, designed to develop new tools and solutions for systemic change in public K-12 schools, operates in 21 U.S. sites and in four other countries. Many product innovations, which benefit both IBM and the schools, have resulted from this initiative”. If we consider the above discussion logically, any firm which seeks to optimize its human and financial resources, while at the same time building its innovation and learning capabilities, would likely engage in social innovation practices (Austin, Stevenson and Wei-Skillern, 2006).
Business innovation is related to redefining new business models and reinventing value chains. Business model innovation is defined as reconfiguration of the underlying components of business models i.e., processes, profit formulas, value propositions, and resources, in order to grow, expand or establish new revenue streams (Chesbrough, 2010; Eagar, van Oene, Boulton, Roos, and Dekeyser, 2012; Hwang and Christensen, 2008). An example of business model innovation can be found in Tencent, which is a mobile software development firm in China, famous for its WeChat and QQ messenger apps. Instead of following the business model of its competitors, which is based on advertising revenue, Tencent built a new, innovative business model by using micro-transactions (typically less than a dollar in price), such as charging consumers to upgrade the look of the avatar that appears on their chat service. This resulted in much higher revenues and greater customer growth than that experienced by some of its rivals in the US and Europe. Unsurprisingly, Tencent currently gains 80% of its approximately $7 billion revenue from value-added services (Scott, 2013).

The classical economics of Adam Smith, David Ricardo, and their followers focuses on physical resources in defining its factors of production, i.e., land, labor and capital stock. Solow (1956) argued that technological change had a significant impact on the production function of an economy. Since then, much attention has been focused on the technological changes that shape the firm, its markets, and the larger economy (Burns and Stalker, 1961). Technological innovation represents advancement in technologies that enhance the production of goods and services. Christensen (2003, p. 221) states that disruptive technologies are simpler, cheaper, more reliable, and convenient than existing ones. It is within this framework that most of the frugal technology innovations take place. It is also important to note that frugal technology innovations are generally not about creating the next radical technology product or service, but instead the goal is to find the right fit between the needs of the market and the technical specifications of the product (Heeks, 2012). An example of this type of frugal technology innovation can be found in Nokia’s basic cell phone, the Nokia 1100. It is arguably the world’s best-selling phone and is a classic example of closing the gap between IT design and resource-constraints. In order to make it highly affordable, Nokia reduced its elements to the basic features required for low-income consumers and included a much-valued flashlight component (Heeks, 2012).

Thus far, we have only discussed examples of each of the underlying components of frugal innovation. An example of the integration of all three underlying components of frugal innovation (business model, technology, and social innovation) can be observed in the strategies used by Micromax, India’s second-largest selling mobile phone brand. The founder of Micromax recognized the opportunity for launching his business in India after he saw a payphone being charged by a truck battery in a rural area in India (Dharmakumar, 2010). Micromax developed mobile phones that do not need to be recharged for a month.
or longer (technology innovation) and focused on being frugal with costs such that the firm could target rural customers (business innovation). In doing so, Micromax developed the capability (either in-house or via partnerships) for longer-lasting batteries and for sourcing cheap components for its products, thereby offering its first flagship phone with 30 days of standby time for approximately 45 US dollars. It also established a dependable network of distributors in rural areas (social innovation) and set up manufacturing facilities in northern India, being the first mobile hardware company to do so (social innovation, business innovation). Today, Micromax is present in 12 countries and sells over a million handsets a month (Dharmakumar, 2010).

Third, the role of IT in enabling and supporting frugal innovation must be investigated. Previous studies show that IT capabilities are important for supporting frugal innovation (Ahuja and Chan, 2014; Bhatti, and Ventresca, 2012; Eagar, et al., 2012; Heeks, 2012). Unfortunately, a majority of previous studies that examine support systems for innovation tend to focus only on aspects such as policy, governmental support, and regional environments that foster innovation activities (Cooke, 2001) and have limited or no investigation of the enabling role of IT. Furthermore, there is evidence that firms in emerging economies are rapidly developing and deploying sophisticated IT systems, avoiding long-term evolutionary costs and investments, in order to accelerate their innovation capabilities (Williamson and Yin, 2014). Therefore, in order to understand this emergent “frugal innovation” paradigm and the role of IT systems that support it, we turn to the literature on innovation and specifically to IT-enabled innovation (Pavlou and El Sawy, 2010; Tanriverdi, Rai, and Venkatraman, 2010; Tallon, 2011) to identify related findings. Furthermore, within the extant IT-enabled innovation literature, there are references to constructs such as IT flexibility (Rivard, 2004), IT adaptability (Tallon, 2008), and IT leveraging capability (Pavlou and El Sawy, 2010). Studies using these constructs suggest maintaining flexible and highly adaptable IT systems, networks, and communication enable the firm to remain light on IT assets, which can lead to increased innovation and firm performance (Pavlou and El Sawy, 2010; Tanriverdi, Rai, and Venkatraman, 2010; Tallon, 2012).

Thus, relying on the literature on IT-enabled innovation and using ACAP theory as a foundation (Cohen and Levinthal, 1990; Zahra and George, 2002, 2002a), we examine below the role of IT in frugal innovation.

Theoretical Background

The Role of IT

In order to examine the role of IT in frugal innovation, we begin by distinguishing between technology innovation and “IT-enabled” innovation. Technology innovation is a broader term that encompasses technology changes such as manufacturing technology, medical technology, pharmaceutical technology, automobile technology, etc. over time and may include information technology. In the context of this paper, technology innovation is an underlying component of frugal innovation. On the other hand, IT-enabled innovation represents innovation that is driven or enabled by IT or IS. The reason this difference is important to note is because IT-enabled innovation can foster technology innovation and technology innovation, specifically transistor and chip processor technology, can foster IT innovation. Although the two terms may be used interchangeably, in the context of this paper, they are distinguished. As IT has become pervasive throughout the product/service value chain, IT and IS can act as drivers of innovation and have a broader footprint on the organization. As a result, the influence of IT and IS may be seen at various points in the innovation process. For the purposes of this paper, we focus only on IT/IS components that may enable the process of frugal innovation.

Previous studies suggest that using flexible and highly adaptable IT systems, networks, and communication enables the firm to be light on IT assets, thereby increasing innovation and firm performance (Overby, Bharadwaj and Sambamurthy, 2006; Pavlou and El Sawy, 2010; Tanriverdi, Rai, and Venkatraman, 2010; Tallon, 2012; Wheeler, 2002; Zahra and George, 2002). Some studies are even investigating specific IT capabilities that may enable frugal innovation (Ahuja and Chan, 2014). Within the frugal innovation paradigm, IT plays a dual role. IT systems must be able to provide the support required to enable the firm to remain competitive, while at the same time ensuring that investments in IT do not negatively affect the cost efficiency and process capabilities of the firm. As a result, instead of investing heavily in IT infrastructure, firms (particularly start-ups) must increasingly focus on leveraging cloud computing, social media, mobile computing, advanced analytics, project and resource management...
systems (PRMS), organizational memory systems (OMS), cooperative work systems (CWS), and business intelligence (BI) technologies to develop their IT capabilities (Anders, 2014; Park and El Sawy, 2010; Pavlou and El Sawy, 2013), thereby allowing the firm to be flexible (Rivard, 2004) and adaptable (Tallon, 2008) with respect to the cost and usage of IT. An IT leveraging capability also intersects with the “technology innovation” component of frugal innovation which emphasizes agility, adaptability, flexibility, improvisation, and cost-effectiveness of the firm’s technology. According to Gold et al. (2001), IT is a crucial element for the firm’s ability to create, internalize and re-use new knowledge. The IT dimensions that are part of effective knowledge management include business intelligence, collaboration, distributed learning, knowledge discovery, knowledge mapping, opportunity generation, and security (Gold et al., 2001). This seems to align well with some of the IT systems such as OMS, BI, PRMS, etc. that were discussed earlier.

Furthermore, firms (particularly startups) are focusing on leveraging these technologies to develop newer IT capabilities, which allow them to be flexible and minimally invested in cost-intensive IT infrastructure. This is also evident in a Forbes (Anders, 2014) article on Silicon Valley firms which says “Silicon Valley is abuzz with excitement about low-cost startups. Building a company on open-source software and cloud computing is being hailed as a brilliant fusion of the Valley’s three great virtues—cheaper, faster and better. Take extra whacks at costs via social media marketing, crowd-sourced design and offshore engineering, and the perceived gains get even bigger. Estimates are that today’s most ambitious startups can take shape for $100,000 or less, a mere one-tenth of the cost a decade ago”. Thus, within the context of this paper, we adapt the IT leveraging capability construct as the core enabling mechanism for frugal IT innovation. Pavlou and El Sawy (2010) used IT leveraging capability in a New Product Development (NPD) context and defined it as the ability to effectively use IT functionalities to support IT-enabled NPD activities.

Within the context of this paper, IT leveraging capability is defined as “the ability to effectively use IT systems and functionalities to support frugal innovation based activities”. Furthermore, IT leveraging capability is shown to be a key enabler of other organizational capabilities (Pavlou and El Sawy, 2006, 2010). As we investigate the “enabling” role of IT in this paper, IT leveraging capability provides a good starting point, which when used in conjunction with other capabilities, may support frugal innovation. In the context of NPD, Pavlou and El Sawy (2010) conceptualized the specific dimensions of IT leveraging capability as PRMS, OMS, and CWS. PRMS are defined as IT tools for resource allocation, task assignment, and scheduling. OMS are systems that provide knowledge coding, directories, and retrieval IT functionalities, supporting the acquisition, assimilation, transformation, and exploitation of knowledge practices. CWS are systems that support real-time communication and group collaboration such as conveyance, presentation, and convergence systems. Among these systems, we only choose to re-conceptualise OMS as KMS (Knowledge Management Systems), in order to more explicitly state and clarify the purpose of “knowledge management” within the firm. Alavi and Leidner (2001) define KMS as “IT systems applied to managing organizational knowledge and to support and enhance the organizational processes of knowledge creation, storage/retrieval, transfer, and application.” Clearly, there is a noteworthy overlap in the definitions and purposes of KMS and OMS; therefore we choose to replace OMS with KMS as a dimension of the IT leveraging capability.

Furthermore, as the business environment in developing economies is turbulent, firms are required to develop capabilities for sensing and responding to dynamic market changes. Firms in emerging economies choose to use IT systems in order to build such capabilities. For example, they use cloud-based business intelligence and analytics-based CRM systems to offer competitive products and services, while maintaining excellent customer relationships (Weill and Woerner, 2012). However, within the Pavlou and El Sawy (2010) dimensions for IT leveraging capability, this aspect is missing. Therefore, we add business intelligence systems as part of IT leveraging capability. BI systems are defined as a type of IT system that provides a set of functions for supporting organizational sense-making of, and acting in response to, environmental change; for example, monitoring and alerting functions for business events related to environmental change, accessing enterprise-wide databases, what-if analyses and data exploration and visualization (Park and El Sawy; 2012).

In summary, IT leveraging capability is a combination of KMS, PRMS, BI, and CWS. On one hand, the role of IT leveraging capability in frugal innovation is crucial in terms of providing the appropriate systems and information at a relatively lower cost to the firm. On the other hand, firms may develop an IT
leveraging capability but may not necessarily be able to absorb, assimilate, and re-use knowledge effectively from their internal and external environments. In order to successfully achieve frugal innovation, firms may be required to develop organizational processes and capabilities to learn from internal and external sources and apply this knowledge to developing products and services for their markets (Zeschky et al., 2011). As a result, relying on IT as an enabler, firms may also develop specific absorptive capacity-related capabilities that provide appropriate organizational and process support. We now examine the absorptive capacity of the firm.

The Absorptive Capacity of the Firm

Previous studies (Joshi, Chi, Datta, and Han, 2010) have shown the application of ACAP to be context-specific. Furthermore, previous studies also have re-conceptualized ACAP and its components to accommodate unique contexts. This is the case in our paper as well. To this end, in this section we move a step forward from the IT leveraging capabilities to address organizational-level knowledge-process capabilities. We then relate these process capabilities to the absorptive capacity of the firm. We then build on ACAP theory to theorize the effects of the specific components of absorptive capacity on the specific components of frugal innovation. This is essentially a “process-based” view of frugal innovation, similar to the conceptualization of an “Innovation Pathway” by Joshi et al. (2010), which has served as a model for IT-enabled continuous innovation.

Evidence from the knowledge management literature suggests that firms that deploy IT systems and digital knowledge repositories tend to retain and re-use collective organizational knowledge, thereby developing better innovative capabilities (Alavi and Leidner, 2001; Borghoff and Pareschi, 1998; Gallupe, 2001; Holsapple, 2004; Nevo and Chan, 2007; Sabherwal and Sabherwal, 2005; Tanriverdi, 2005). In competitive environments, survival requires the effective use of information and decision technologies to gather, manage, and exploit knowledge (Oh, 2009). Absorptive capacity refers to an organization's ability to identify and acquire valuable new information, and to assimilate or internalize the information such that the new knowledge thus generated may be commercially exploited or applied in innovations (Cohen and Levinthal, 1990). Tippins and Sohi (2003) show the crucial role of organizational learning in developing knowledge capabilities. Knowledge capabilities can provide a foundation for change through generative learning processes and have a significant impact on performance outcomes by influencing the type of information that is sought and the manner in which the information is analyzed. In frugal environments, firms compensate for the lack of resources by relying heavily on their internal and external knowledge and learning capabilities, as they constantly seek to drive value for customers and profitability for shareholders. Thus knowledge plays a key role in driving performance in a dynamic and highly competitive environment. Next, we discuss the role of dynamic knowledge capabilities.

Dynamic Knowledge Capabilities

Zahra and George (2002) adapt the Net Enabled Business Innovation Cycle (Wheeler, 2002) to show how IT gains prominence in net-enabled environments and drives business strategy. The NEBIC consists of 4 stages – acquisition, assimilation, transformation and exploitation – and firms try to achieve a competitive advantage at each stage. Absorptive capabilities at each of the four stages lead to innovation and thus firms in net-enabled environments tend to develop knowledge management as a critical IT capability. Furthermore, knowledge management capability when combined with other capabilities of the firm such as entrepreneurship can result in important dynamic capabilities, for example at the process level. Joshi et al. (2010) adopted an approach based on absorptive capacity theory, combined with knowledge management, to study continuous innovation. They concluded that to extract business value from IT, firms need to cultivate IT-enabled knowledge capabilities to innovate continuously so as to enhance firm performance. They highlighted the use of IT-enabled capabilities (supported by KM competencies) in order to investigate the evolution of potential innovations (exploration) to commercialized ones (exploitation).

Based on previous studies (Joshi et al., 2010; Pavlou and El Sawy, 2010), we develop the concept of IT-enabled dynamic knowledge capabilities (for organizational knowledge processes) and provide a theoretical underpinning for our research model by invoking the theory of ACAP. We are opting to label these dynamic knowledge capabilities as IT-enabled because they are enabled by the IT leveraging capabilities (which were discussed earlier) of the firm. Joshi et al. (2010) use a similar argument for IT-
enabled Potential (P) ACAP, Realized (R) ACAP, and Social ACAP capabilities. In our conceptualization, these dynamic capabilities are higher order knowledge capabilities and are built on IT leveraging capabilities. Figure 2 diagrammatically depicts this conceptualization.

Furthermore, these dynamic capabilities provide a structure for the systems and operations of the firm to align with its processes at the tactical level. For example, adopting a new, more rapid methodology for product testing might require tactical changes to already existing processes and methodologies by various departments within the organization. Thus, we rely on theory of ACAP to frame how these dynamic capabilities relate to the absorptive capacity of the firm and IT leveraging capabilities. Consequently, we label these capabilities as “IT-enabled” because they are related to and supported by IT, but are essential for the organizational and operational knowledge processes of the firm. For simplicity’s sake, from here on, we will refer to these capabilities simply as “dynamic knowledge capabilities, thereby keeping the “IT-enabled” aspect implicit. Another example of these types of capabilities can be found in the case of Flipkart, India’s largest online retailer. Flipkart is a much newer firm than Amazon, but within five years of its launch, it has been able to offer same-day deliveries to its customers. Amazon has taken much longer to provide such a service. This can be attributed to Flipkart’s ability to use its IT capabilities and dynamic knowledge capabilities. Flipkart uses a state-of-the-art CRM system and has developed a training program for its senior executives, making them responsible for answering customer calls coming into its call center for the duration of each training session. As a result, a number of executives were able to collectively sense the customer demand for “same day delivery” and then dynamically reconfigure their external supply chains and internal operations with further innovations such as cash-on-delivery and credit-card-at-the-door payment options for customers (Chidambaram, 2014; Nair, 2014).

We conceptualize three dynamic capabilities: 1) Potential Knowledge Capability (P-KCAP) consists of knowledge acquisition and assimilation tasks, making the firm amenable to acquiring and assimilating knowledge (Joshi et al., 2010). 2) Realized Knowledge Capability (R-KCAP) consists of knowledge transformation and exploitation tasks, which reflect firms’ capacity to leverage the knowledge that has been absorbed (Joshi et al., 2010). 3) Social Knowledge Capability (Social KCAP) promotes connectedness, interaction, coordination, and communication among members of firms by creating seamless networks of people, devices, and knowledge (Joshi et al., 2010).

Firms gain new knowledge and develop new insights by information acquisition, information dissemination, and shared interpretation (Tippins and Sohi, 2003). Information acquisition is the process by which firms actively seek out and gather useable information from direct experience, experience of
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others, or the organization’s own memory mechanisms. Information dissemination is the extent to which the information that is obtained by an organization is shared among its functional units, through formal and informal channels. Shared interpretation is the presence of consensus among organizational members with regard to the meaning of information (Tippins and Sohi, 2003). Therefore, organizational learning is seen as an important aspect of absorptive capacity and several previous studies operationalize the absorptive capacity construct using an organizational learning lens (Cohen and Levinthal, 1990; Lane et al., 2006; Oh, 2009; Zahra and George, 2002). In this paper, we also operationalize the absorptive capacity construct using the same dimensions of exploratory learning, transformative learning, and exploitative learning as do several previous studies. This will be discussed in more detail in the next section.

The Research Model

In order to build the research model, we connect IT leveraging capability, dynamic knowledge capabilities, absorptive capacity, and frugal innovation. The overall research model is shown in Figure 3. Using absorptive capacity (ACAP) theory in a dynamic capability context (Zahra and George, 2002), we argue that a firm trying to innovate frugally must acquire knowledge to learn about internal and external dynamics and then apply this knowledge to transform its systems and processes to fit the frugal framework. IT can be used as a tool to aid in the assimilation and learning process (Chen and Ching, 2004; Heeks, 2012; Oh, 2009), thereby also positively influencing the absorptive capacity of the firm. Collectively, technologies and systems providing effective leveraging capability can enhance information-intensive knowledge processes significantly (Oh, 2009).

Thus, using the above arguments regarding IT leveraging capability and dynamic knowledge capabilities leads to the following propositions:

Proposition 1: The IT leveraging capability level of a firm is positively related to its dynamic knowledge capabilities.

Proposition 1a: The IT leveraging capability level of a firm is positively related to its potential knowledge capability (P-KCAP).

Proposition 1b: The IT leveraging capability level of a firm is positively related to its realized knowledge capability (R-KCAP).

Proposition 1c: The IT leveraging capability level of a firm is positively related to its social knowledge capability (Social KCAP).

Cohen and Levinthal (1990), Zahra and George (2002), Lane et al. (2006), and Oh (2009), describe the absorptive capacity construct via its dimensions of exploratory learning, transformative learning, and exploitative learning. Exploratory learning is used to recognize and understand new external knowledge. Exploitative learning is used to apply the assimilated external knowledge to the internal processes of the firm. Transformative learning involves several processes that affect how the newly acquired knowledge is combined with the existing knowledge of the firm. For the purposes of this paper, we describe these dimensions as: exploratory frugal learning, transformative frugal learning, and exploitative frugal learning. We now relate this absorptive capacity construct to the dynamic knowledge capabilities. Taking a gestalt view, if a firm exhibits higher levels of P-KCAP, R-KCAP, and Social KCAP, it will likely experience higher levels of overall absorptive capacity. As P-KCAP consists of knowledge acquisition and assimilation tasks, it will likely be positively related with exploratory frugal learning. Social KCAP is likely to help augment firms’ social capital and support direct interactions among human members of the firms to cultivate shared frames of reference (Joshi et al., 2010). This relates closely to transformative frugal learning. R-KCAP consists of both knowledge transformation and exploitative tasks and is therefore likely to be related to both transformative and exploitative frugal learning.

This leads us to the following propositions:

Proposition 2: The dynamic knowledge capability levels of a firm are positively related to the firm’s absorptive capacity.

Proposition 2a: The degree of P-KCAP is positively related to the degree of exploratory frugal learning of a firm.
Proposition 2b: The degree of R-KCAP is positively related to the degree of exploitative frugal learning of a firm.

Proposition 2c: The degree of R-KCAP is positively related to the degree of transformative frugal learning of a firm.

Proposition 2d: The degree of Social KCAP is positively related to the degree of transformative frugal learning of a firm.

Joshi et al. (2010) demonstrated that P-ACAP leads to ideation (which is a dimension of innovation) and R-ACAP mediates this relationship. Furthermore, R-ACAP leads to commercialization (which is another dimension of innovation) and this relationship is moderated by Social ACAP (Joshi et al., 2010). This provides us with the basis for interrelating absorptive capacity and frugal innovation. If a firm can re-use its knowledge and learn quickly based on past results, it will tend to make fewer mistakes with respect to its innovation processes. This means that the firm may be able to reduce its expenditure on incremental innovation projects, in accordance with the cost constraint component of frugality. Consequently, firms that have superior exploratory, exploitative, and transformative learning capacity will be more likely to engage in frugal innovation. This argument leads to the following proposition:

Proposition 3: The degree of organizational absorptive capacity is positively related to the degree of frugal innovation.

In order to enhance our understanding of frugal innovation, we need to address the effects of each type of learning (exploratory, exploitative, and transformative) on each component of frugal innovation. Exploratory learning enables firms to develop new products and processes to attract new customers (Benner and Tushman 2003). In the new product development literature, new technology often enables new products (Ettlie and Pavlou, 2006). Thus, firms engaging in exploratory learning will tend to have superior technology innovation capabilities. In contrast, the literature on continuous innovation and firm ambidexterity highlights the fact that firms need to maintain a balance between exploitative and exploratory learning in order to achieve continuous innovation, leading to sustained competitive advantage (Atuahene-Gima and Murray, 2007; Gibson and Birkinshaw, 2004; He and Wong, 2004; Martini, Laugen, Gastaldi, and Corso, 2013). Similarly, organizational survival requires a balance of engaging in sufficient exploitation for current viability, with enough focus on exploration to ensure future viability (Levinthal and March, 1993). Thus, exploitative learning will likely enable the establishment of process efficiencies in order to exploit newly created revenue streams. This directly relates to business model innovation and more generally business innovation. Social innovation practices tend to be broader and are difficult to develop, implement and measure (Brown and Duguid, 1991; Sørensen, 2007). In terms of learning, firms must adopt both exploitative and exploratory learning techniques in order to find social innovation success. The above arguments lead to the following propositions:

Proposition 3a: The degree of exploratory frugal learning is positively related to the degree of technology innovation.

Proposition 3b: The degree of exploitative frugal learning is positively related to the degree of technology innovation.

Proposition 3c: The degree of exploratory frugal learning is positively related to the degree of business innovation.

Proposition 3d: The degree of exploitative frugal learning is positively related to the degree of business innovation.

Proposition 3e: The degree of exploratory frugal learning is positively related to the degree of social innovation.

Proposition 3f: The degree of exploitative frugal learning is positively related to the degree of social innovation.

Transformative learning subsumes the knowledge assimilation and transformation processes. Transformative learning (Mezirow, 1997) is the process of effecting change in a frame of reference. To that end, shared meaning and shared focus are developed among individuals, teams, and organizations belonging to diverse settings. In order for a firm to be effective at frugal innovation, it is important for its
staff to interpret codified knowledge and decision-making processes in a reasonably consistent manner. Transformative learning dictates how efficiently and effectively a firm can create meaning from its knowledge base. This activity tends to affect all aspects of frugal innovation, which leads to the following proposition:

Proposition 3g: The degree of transformative frugal learning is positively related to the degree of business, technology, and social innovation.

In summary, the propositions that are presented above can potentially inform several streams of IS literature. First, the relationship between IT capabilities and IT-enabled innovation will be better understood. This can potentially enrich the IT capabilities literature. Second, the role of dynamic knowledge capabilities in facilitating a particular type of innovation (frugal innovation) can be clarified. This can potentially contribute to the KBV literature. Third, these propositions explore the relationship between organizational learning and its antecedents at the overall construct level as well as the underlying relationships between various dimensions of the constructs. This can potentially inform the literature on organizational learning and learning capabilities.

Control Variables

Since frugal innovation usually takes place in resource-constrained environments, firms often engage in strategic alliances and partnerships (Oh, 2009; Chi, Ravichandran and Andrevski, 2012). A firm’s strategic alliances and partnerships may play moderating roles in the relationships between degree of learning and firm innovation levels. Furthermore, some industries are known to be more knowledge intensive (Cohen & Levinthal, 1989) than others and therefore the learning and innovation capabilities vary by industry. In addition, organizational maturity levels may have an impact on how well embedded the learning processes are within organizations (Dougherty & Hardy, 1996). Thus, mature organizations may possess superior learning capabilities and therefore may be more innovative.

Both entrepreneurial theory and Austrian economics highlight the fact that entrepreneurial ability of the firm (or the individual entrepreneur) drives the innovation process (Kirzner, 1997; Barney, Wright & Ketchen, 2001). Furthermore, Pinchot (1985) also describes how intrapreneurship, which is

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1 See Appendix A for a summary of the propositions and their underlying logic.
entrepreneurship adopted internally by a firm, can lead to better innovation capabilities. Clearly, the entrepreneurship culture of the firm may have an effect on its learning and innovation outcomes. Finally, firm size contributes towards the learning capabilities that a firm possesses. Smaller firms with smaller teams collaborate more closely and their learning is usually quicker, while large firms are more likely to engage employees in formal training programs, thereby slowing the process of learning. These differences may affect the ability of the firm to innovate. Consequently, in the research model, we introduce control variables such as industry, industry alliances, maturity, entrepreneurial ability, and firm size.

In addition to the above controls, we also control for firm-specific capabilities related to Potential KCAP, Realized KCAP, and Social KCAP. According to Kogut and Zander (1992), learning (in the form of innovation) occurs when firms recombine capabilities to generate new applications from existing knowledge. This recombination of existing capabilities is termed “combinative capabilities” and refers to the intersection of the capability of the firm to exploit its existing knowledge as well as its capability to exploit its unexplored potential. Furthering this concept, Jansen, Van Den Bosch and Volberda (2005) clarify the definition and organizational purpose of such combinative capabilities and also specify three separate capabilities that enable exploitation and exploration of knowledge. According to Jansen et al. (2005), organizational mechanisms associated with coordination capabilities (i.e., cross-functional interfaces, participation in decision-making, and job rotation) primarily enhance the potential absorptive capacity (P-KCAP in our context) of the firm. Similarly, organizational mechanisms associated with socialization capabilities (i.e., connectedness and socialization tactics) primarily increase the realized absorptive capacity (R-KCAP in our context) of the firm. Finally, organizational mechanisms associated with system capabilities (i.e., routinization and formalization) tend to have mixed (to a certain extent both negative and positive) influences on P-KCAP, R-KCAP and Social KCAP. As a result of these findings, we include firm-wide coordination capabilities, socialization capabilities, and systems capabilities as moderators for the relationship between dynamic knowledge capabilities and organizational absorptive capacity (more specifically, Proposition 2).

In this section we have examined frugal innovation using the lens of ACAP theory. First, we explored the role of IT in enabling frugal innovation. We used “IT leveraging capability” consisting of four different types of IT systems (i.e., KMS, CWS, BI, and PRMS) as an enabling capability. We then conceptualised IT-enabled dynamic knowledge capabilities that operate at the process-level of the firm and create flow and dissemination of knowledge across the firm. These capabilities include Potential KCAP, Realized KCAP, and Social KCAP. These capabilities were then shown to drive the overall absorptive capacity of the firm. Specific components of the absorptive capacity, such as exploratory learning, exploitative learning, and transformative learning were linked to specific dynamic knowledge capabilities. The overall absorptive capacity was related to frugal innovation and we went a step further to relate the specific components of each of these constructs.

In summary, we have developed a comprehensive research model and presented it with supporting propositions. We have investigated the conceptual underpinnings of frugal innovation along with its antecedents, explored the role of IT in enabling frugal innovation, relied on the theoretical lens of absorptive capacity theory to examine frugal innovation and provided a research model with propositions for future empirical research.

**Limitations**

As with any study, there are several limitations. First, this paper is conceptual in nature and the propositions have not been tested empirically. Second, we are investigating frugal innovation, which is a phenomenon seen in emerging markets, although some instances may be observed in developed economies as well, albeit using different terminology. It is noteworthy that our model was not created to be specific to any particular setting. Therefore, its applicability is not limited to emerging economies. Furthermore, the propositions may be of more interest to firms in developed economies, especially to those firms that seek to innovate and expand their products and services to serve emerging markets. The applicability of the research model is not limited to multi-national corporations (MNCs). The model can also be of relevance to small businesses and startups in developed economies as these firms learn frugal innovation approaches. This is discussed further in the contributions section.
Third, the paper examines an emergent phenomenon and is limited by the availability of a foundational theory to form the basis for the arguments and ideas. We have therefore focused on well-established theories in the extant literature on IT-enabled innovation, knowledge management, dynamic capabilities, and organizational learning. Using this literature base, we have carefully attempted to identify different antecedents of frugal innovation in order to highlight the process-based view of innovation and to remain linked with established theoretical explanations such as the “innovation pathways” described by Joshi et al. (2010). Additionally, we have also tried to provide illustrative examples from practice in order to clarify the context, relevance and understanding of the theoretical underpinnings.

Another potential limitation is that the outcome measure for our model is innovation-based and not firm performance-based. Nevertheless, it is important to note that previous studies have included innovation as a dimension of firm performance (Aral and Weill, 2007; Kim et al., 2011; McAfee and Brynjolfsson, 2008). Thus, this paper implies that frugal innovation drives firm performance to some extent. Furthermore, very few econometric measures for firm performance that appropriately and comprehensively capture frugal innovation are available. The literature on frugal innovation must be broader and deeper before relevant linkages to economic measures, financial performance, and productivity can be drawn more easily. Finally, a potential limitation regarding how “frugal innovation” is different from innovation in general may also exist. The concept of frugal innovation itself may be called into question as it could be confounded by other innovation mechanisms such as open innovation, lean innovation, inclusive innovation, etc. Although this may be a valid criticism, it must be noted that most of the other innovation paradigms are single dimensional, while frugal innovation is multi-dimensional. A firm can simultaneously engage in social, technology, and business innovations and this is what makes frugal innovation very interesting as a phenomenon and very challenging as a research topic. It is only via thorough scientific and empirical investigation that we will be able to carve out a space for frugal innovation research and establish its boundaries.

Contributions

Firstly, this paper contributes to the frugal innovation literature and extends it by highlighting the role of IT in enabling frugal innovation. Secondly, it provides a theoretical base for studying frugal IT innovation, by integrating the extant literature on innovation, RBV, KBV, absorptive capacity theory, IT capabilities, and dynamic capabilities with frugal innovation concepts. It also contributes to absorptive capacity literature, by highlighting the use of absorptive capacity theory in an emerging innovation paradigm. Thirdly, this paper provides a look inside the “black box” of the relationship between the three different types of learning (as specified by ACAP) and their effects on the different components of frugal innovation. Such detailed examination of the relationships between components of frugal innovation and types of learning further consolidates and explicates previously known relationships between learning and innovation in general. Additionally, it opens an avenue for further research in this area and establishes a base for examining the specific types of learning that might support other innovations. This is a noteworthy contribution. Similarly, the paper provides a detailed view of the relationships between three different types of dynamic knowledge capabilities and three different types of learning within the absorptive capacity construct. As a result, we have uncovered new linkages between the knowledge-based view of the firm and dynamic capabilities. This is also a contribution to absorptive capacity theory, as we have potentially extended it by highlighting IT capabilities (specifically, IT leveraging capabilities) and IT-enabled dynamic knowledge capabilities as antecedents. Furthermore, the paper identifies ways in which the research on frugal innovation can move towards well-established, mainstream research, and provides various IS perspectives for studying frugal innovation.

In terms of extending previous literature on IT capabilities, IT-enabled dynamic capabilities, and absorptive capacity theory, this paper has taken a process-based approach. This is similar to the “innovation pathways” approach suggested by Joshi et al. (2010). For example, we have shown the innovation pathway in terms of the social innovation dimension of frugal innovation. We started with the use of CWS, which is used for communication and collaboration as part of IT leveraging capability. In the next step of the pathway these IT capabilities were used to drive the social dynamic knowledge capabilities (Social KCAP), which promotes connectedness, interaction, coordination, and communication among members of firms by creating seamless networks of people, devices, and knowledge (Joshi et al., 2010). We then related this dynamic capability to the transformative frugal learning of the firm. Transformative
frugal learning consists of several processes that affect how the newly acquired knowledge is combined with the existing knowledge of the firm. In order for this to take place, communication, collaboration, and shared interpretation among the workforce are important considerations. These can be useful for social, business, and technology innovations and were therefore represented in our research model. We have thus created a nomological network of constructs starting with IT capabilities and leading to frugal innovation, thereby extending the notion of an “innovation pathway” or “innovation pipeline”. By so doing, this paper aims to make a significant academic contribution by establishing a basis for future related empirical investigation.

In terms of practitioner implications, this paper provides insights to firms, particularly startups, regarding their choice, deployment, and usage of IT systems for innovating in resource-constrained environments and for maintaining high operational efficiency. Similarly, SMEs can learn how to be frugally innovative and incorporate social and technological innovation practices into their existing innovation programs, thereby enhancing their innovation profiles with greater corporate social responsibility and sustainability initiatives. Within the current economic environment, firms in developed economies (especially startups) can learn from firms in developing economies about how to provide affordable, scalable, and socially viable products and services, while being innovative and responsible at the same time. The paper also provides a good reference source to firms with dual missions (for example, hybrid organizations), where profitability and social responsibility are considered equally important performance metrics. Using IT capabilities to drive frugal innovation can be very useful for such firms as they try to balance cost reduction with growth in revenues and market share. Furthermore, MNCs can also benefit from the ideas described in this paper as they innovate to compete on a global scale. Apple’s struggles in trying to establish a foothold in emerging markets are well known and Apple is now trying to re-focus on emerging markets by offering a number of affordable products and services (Mukherjee and Malviya, 2014; Worstall, 2013). Other such MNCs can take note of the use of appropriate IT capabilities to drive growth in emerging economies by serving customers who are highly conscious of price and the value of goods and services. Thus, MNCs’ use of IT capabilities, products and services may be tailored for emerging markets. Additionally, this paper also offers insights to MNCs about ways in which to enhance their innovation profiles by implementing cost-effective innovation programs for meeting market-specific, technology, business, and social demands.

Future Work

As this paper is conceptual, we suggest that conducting follow-up empirical studies forms part of the future work to be completed. We recommend that the entire research model be tested. In order to do so, several studies will be needed to investigate the complex relationships among IT leveraging capabilities, dynamic knowledge capabilities, organizational absorptive capacity and frugal innovation. We recommend that researchers use a range of research methods, e.g., case studies, action research and surveys. Kanter (1999) and Yin (2003) state that case studies are appropriate when researchers seek to describe phenomena, explore processes, and investigate why and how phenomena interrelate. Therefore, case research would be appropriate, for example, if researchers wish to compare and contrast frugal innovation in firms in emerging economies with frugal innovation in developed economies. Structured, semi-structured and open-ended interviews could be conducted with upper level managers and executives within the firms as they tend to have a more strategic understanding of the firm and its functions. A case research approach would allow the gathering of rich, qualitative data (Booth, Colomb and Williams, 2003, p. 82), supporting complex and comprehensive analyses of IT-enabled frugal innovation. In terms of studying the business value of IT-enabled frugal innovation, future studies may also investigate how frugal innovation contributes to the overall performance of the practicing firms by deriving specific financial and market-oriented performance measures. As certain contributions of frugal innovation seem relevant to corporate social responsibility research, there may also be opportunities to integrate these topics in future empirical investigations.

Action research (Lewin, 1946), enabling real innovation-related problems to be addressed as researchers observe and alter business practices, could complement case research. In particular, it could take place in firms seeking to embrace frugal innovation. It could also provide opportunities for the dissemination of research findings arising in emerging economies to firms in developed economies. Action research could also help to identify the extent to which frugal innovation practices are particularly context specific.
Several other methodologies could be utilized in future research (e.g., ethnographies, field experiments and surveys). For instance, online and paper-based surveys could facilitate the gathering of quantitative and qualitative data from large numbers of firms in both emerging and developed economies. The survey questions could be designed to operationalize the constructs in the research model. Reliable and valid scales would support rigorous testing of the model.

Future studies can also use the methodology described by Jansen et al. (2005) in order to test the propositions. They conducted empirical research at a large European multi-unit financial services firm. They used a broad-based survey with management teams and senior employees at a financial service provider having branches in various countries that were geographically distinct entities with their own clientele. This is an especially useful scenario in the context of this paper as well. As frugal innovation is primarily being observed as a phenomenon in emerging economies, a western firm with a subsidiary in an emerging economy would be ideal for this study. Such a setting would be ideal in terms of observing IT leveraging capabilities, dynamic knowledge capabilities, and organizational learning capabilities in both the subsidiary and the owner firm, with a possibility of observing frugal innovation in the emerging market subsidiary. The measures and scales developed for the constructs by Joshi et al. (2010), Jansen et al. (2005), and Kogut and Zander (1992) could be helpful in terms of data collection. Furthermore, indicators would have to be developed for measuring “frugal” innovation by adapting existing indicators for business model innovation, technology innovation, and social innovation. However, as a cautionary note, it would be important to remember to take into account cultural and environmental differences when conducting such a multi-unit study, based in different geographies.

Conclusion

In this paper, we have investigated the emerging paradigm of frugal innovation. In particular, we looked at the role of IT systems and capabilities in enabling frugal innovation. As there is a lack of well-established frugal innovation theory to guide our work, we utilized other theories related to IT-enabled innovation. Using the theoretical foundation of absorptive capacity theory and the extant literature on IT capabilities, dynamic capabilities, knowledge management, and firm innovation, we built a research model for frugal innovation. In order to achieve this, we investigated the conceptual underpinnings of frugal innovation along with its antecedents and examined the role of IT in enabling frugal innovation using the IT leveraging capability construct. We also used IT-enabled dynamic knowledge capabilities to make linkages with absorptive capacity theory to examine frugal innovation. Finally, the research model provided empirically testable propositions and helpful guidance for future research.

References


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Enabling Role of IT in Frugal Innovation


Appendix A

<table>
<thead>
<tr>
<th>Proposition</th>
<th>Underlying Logic/Rationale</th>
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<tbody>
<tr>
<td>Proposition 1: The IT leveraging capability level of a firm is positively related to its dynamic knowledge capabilities.</td>
<td>Collectively, technologies and systems providing effective leveraging capability can enhance information-intensive knowledge processes significantly (Oh, 2009). A firm trying to innovate frugally must acquire knowledge to learn about internal and external dynamics and then apply this knowledge to transform its systems and processes to fit the frugal framework. IT can be used as a tool to aid in the assimilation and learning process (Chen and Ching, 2004; Heeks, 2012; Oh, 2009), thereby also positively influencing the absorptive capacity of the firm.</td>
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<tr>
<td>Proposition 1a: The IT leveraging capability level of a firm is positively related to its potential knowledge capability (P-KCAP).</td>
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<tr>
<td>Proposition 1b: The IT leveraging capability level of a firm is positively related to its realized knowledge capability (R-KCAP).</td>
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<tr>
<td>Proposition 1c: The IT leveraging capability level of a firm is positively related to its social knowledge capability (Social KCAP).</td>
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<tr>
<td>Proposition 2: The dynamic knowledge capability levels of a firm are positively related to the firm’s absorptive capacity.</td>
<td>If a firm exhibits higher levels of P-KCAP, R-KCAP, and Social KCAP, it will likely experience higher levels of overall absorptive capacity. As P-KCAP consists of knowledge acquisition and assimilation tasks, it will likely be positively related with exploratory frugal learning. Social KCAP is likely to help augment firms’ social capital and support direct interactions among human members of the firms to cultivate shared frames of reference (Joshi et al., 2010).</td>
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<tr>
<td>Proposition 2a: The degree of P-KCAP is positively related to the degree of exploratory frugal learning of a firm.</td>
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<tr>
<td>Proposition 2b: The degree of R-KCAP is positively related to the degree of exploitative frugal learning of a firm.</td>
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<tr>
<td>Proposition 2c: The degree of R-KCAP is positively related to the degree of transformative frugal learning of a firm.</td>
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<tr>
<td>Proposition 2d: The degree of Social KCAP is positively related to the degree of transformative frugal learning of a firm.</td>
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</tbody>
</table>
**Proposition 3:** The degree of organizational absorptive capacity is positively related to the degree of frugal innovation.

**Proposition 3a:** The degree of exploratory frugal learning is positively related to the degree of technology innovation.

**Proposition 3b:** The degree of exploitative frugal learning is positively related to the degree of technology innovation.

**Proposition 3c:** The degree of exploratory frugal learning is positively related to the degree of business innovation.

**Proposition 3d:** The degree of exploitative frugal learning is positively related to the degree of business innovation.

**Proposition 3e:** The degree of exploratory frugal learning is positively related to the degree of social innovation.

**Proposition 3f:** The degree of exploitative frugal learning is positively related to the degree of social innovation.

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Joshi et al. (2010) demonstrated that P-ACAP leads to ideation (which is a dimension of innovation) and R-ACAP mediates this relationship. Furthermore, R-ACAP leads to commercialization (which is another dimension of innovation) and this relationship is moderated by Social ACAP (Joshi et al., 2010).

Firms engaging in exploratory learning will tend to have superior technology innovation capabilities.

Organizational survival requires a balance of engaging in sufficient exploitation for current viability, with enough focus on exploration to ensure future viability (Levinthal and March, 1993).

Firms must adopt both exploitative and exploratory learning techniques in order to find social innovation success.