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Innovating with Limited Resources: The Antecedents and Consequences of Frugal Innovation

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Abstract: Frugal innovation is a resource scarce solution for emerging market firms. Based upon the resource-constrained innovation perspective, this research theoretically explores and empirically examines the drivers and consequences of frugal innovation. The results of a firm-level survey show that two types of frugal innovation (cost innovation and affordable value innovation) positively affect the performance of emerging-market firms. We also address the issues of how emerging-market firms deal with institutional, technological, and market constraints in emerging markets, and we show how these constraints drive frugal innovation. We find that emerging-market firms with higher levels of capability for institutional leverage and bricolage, and firms that face perceived dysfunctional competition, tend to generate more affordable, value-added new products. Overall, these findings have important implications for emerging-market firms seeking to conduct frugal innovation in resource-constrained emerging markets.

Keywords: frugal innovation; cost innovation; cleaner production; competition; institutions

1. Introduction

One of the key challenges for cleaner production is providing new products whilst being sparing with resources [1,2]. Frugal innovation, defined as "a resource scarce solution" [3], thus has received a large amount of attention from cleaner production as well as innovation scholars [2,4–6].

In fact, innovation for meeting the special needs of emerging markets has become an important source of growth for both emerging-market firms (EMFs) and multinational corporations from advanced countries (AMNCs) [7]. The extant literature on innovation for emerging markets focuses mainly on the innovations that AMNCs make within emerging markets. Less attention has been paid to innovation by EMFs [1–3,7–10]. For example, drawing on institutional theory, Ernst et al. (2015) examines how bricolage, local embeddedness, and standardization affect the ways that AMNCs (i.e., Forbes 500 companies) develop low-cost but valuable innovations for emerging markets [8].

Generally, EMFs and AMNCs share similar institutional and market environments in emerging markets. First, emerging markets typically feature underdeveloped institutions, such as weak systems for market support and underdeveloped factor markets [11–13]. Second, given the inadequate institutions mentioned above, firms in these markets commonly engage in opportunistic or even unlawful behavior as they engage in competition with peers or informal sector operators [14,15]. Thus, fierce dysfunctional competition is a common feature of emerging markets.

Actually, however, the conditions for innovation by EMFs are quite different from those affecting innovation by AMNCs in emerging markets. First, the high-income segments within emerging markets are mainly dominated by AMNCs, but EMFs mainly focus on the low-income segments [9,16]. Customers in these low-income segments are typically very concerned with affordability and are highly sensitive to prices. Second, AMNCs have more strategic assets, such as core technologies, than EMFs [11,12,17]. Therefore, to survive and grow, most EMFs focus on frugal innovation, which we define as the development of lower-priced but appropriately functional products that meet the needs of consumers with limited purchasing power in resource-constrained emerging markets [7,10,18].

The extant literature on the innovation activities of EMFs in resource-constrained emerging markets is somewhat fragmented, and the findings are often difficult to compare [1,3,19]. For example, several similar concepts are used interchangeably by researchers and practitioners. These concepts include Gandhian innovation [20], frugal innovation [18], innovation at the base of the pyramid [21], cost innovation [22], reverse innovation [4,23], or disruptive innovation [24]. Moreover, little research has been done to identify which factors enable EMFs to successfully develop and launch frugal innovations in resource-constrained emerging markets [2,3,10].

To address these gaps in the literature, we first propose a sound conceptualization of frugal innovation. We argue that "cost innovation" and "affordable value innovation" are the two main types of frugal innovation. Then, we examine the implications of these types of innovation for EMF performance. Second, based upon a resource-constrained innovation perspective [25], we propose a theoretical framework for examining the antecedents of frugal innovation. This framework features three perspectives that capture the characteristics of EMFs and their environments. Specifically, we argue that institutional leverage capability helps EMFs to fill institutional gaps, and that bricolage capability helps EMFs to address scarcities of key technological resources. Thus, both types of capability facilitate frugal innovation. Also, perceived dysfunctional competition pushes EMFs to engage in frugal innovation, our study aims to provide an enriched understanding of how EMFs can overcome institutional, technological, and market inertia, and thereby successfully undertake frugal innovation in emerging markets.



Figure 1. Conceptual framework.

2. Theory and Hypotheses

The study of innovation activities by EMFs has generated a debate regarding the necessity of developing new concepts concerning their behavior. Some researchers posit that observing the innovation activities of EMFs can help extend existing theories that have been developed from studying advanced economies (e.g., [26,27]). Recently, however, other scholars have argued that the innovation activities of EMFs are quite distinctive, and these activities cannot be fully explained by the

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existing concepts. For example, innovation is always persistent, irreversible, and path-dependent [28], which may affect the relative competitive power of AMNCs vs. EMFs. For AMNCs, structural rigidity may impede themselves from innovating for customers with quite different needs while EMFs are lacking sufficient Research and Development (R&D) capabilities for developing high-tech innovative products. Therefore, new concepts may be required (e.g., [4,9,29]). This line of literature has proposed several new concepts and terms, which have led to a terminology jungle [1–3,10].

Moreover, little research has been done on the drivers of innovation activities by EMFs. Emerging markets are often characterized as lacking strong legal frameworks (e.g., property rights) as well as critical resources (e.g., world-leading technologies) [11], and even tolerance and social trust as suggested by economic literature (e.g., [30]). These markets also have large numbers of bottom-of-pyramid customers, along with high levels of dysfunctional competition [8,13]. Such markets are therefore radically different from those of advanced countries.

The resource-constrained innovation perspective provides rich insights for understanding the innovation activities of EMFs and the antecedents of those activities. Based mainly on research into entrepreneurship [31] and creativity [32,33], the recent literature on resource-constrained innovation suggests that innovations can be developed efficiently under conditions of resource constraint [25,34–37]. The authors of this literature argue that resource constraints may stimulate managers to find a variety of novel paths to their goals. The challenge of overcoming constraints can induce managers to discover new possibilities through recombining existing knowledge in novel ways. For example, Keupp and Gassmann (2013) find that resource constraints can be triggers of radical innovation [25]. Garrigavon, Krogh, and Spaeth (2013) argue that resource constraints may enable open innovation [34]. In recent years, the relationships between financial resource constraints and innovation have been extensively examined [35–37].

As we suggested earlier, there are four types of resource constraints that affect innovation by EMFs: (1) A shortage of affluent customers [8,10,21,38]; (2) constraints imposed by underdeveloped institutions [11,12,15]; (3) constraints arising from lack of access to world-leading technology [11,17]; and (4) market constraints from dysfunction competition [11,14]. We argue that frugal innovation is an effective way to address the lack of affluent customers. Moreover, capabilities for institutional leverage and bricolage, along with capabilities for dealing with perceived dysfunctional competition, all tend to facilitate managers in finding novel paths to alternative solutions. These capabilities help EMF managers to recombine existing knowledge in novel ways. These managers are therefore able to address the institutional, technological, and market constraints of emerging markets by developing and launching frugal innovations. In the next section, we propose a reconceptualization of frugal innovation, and then examine its implications for EMF performance. Then, based on a resource-constrained perspective, we propose a theoretical framework to show how the factors of institutional leverage capability, bricolage capability, and perceived dysfunctional competition can serve as drivers of frugal innovation.

2.1. Frugal Innovation: Reconceptualization and Its Implications for EMF Performance

The billions of rapidly changing, highly price-sensitive customers in emerging markets provide a massive opportunity for EMFs to survive and grow [39,40]. The recent literature on innovation by EMFs suggests that two perspectives on such innovation are emerging. In the more conventional perspective, EMFs are basically what Luo et al. (2011) call "copycats" [41]. In this view, EMFs begin by imitating market leaders or by pioneering technologies that have already proven successful in advanced economies [18,41,42]. Such duplicative or pure imitation strategies are indeed adopted by some EMFs, especially by new firms in the very early stages of developing their businesses [41,43]. However, simply offering cheap, no-frills versions of Western products cannot meet the needs of most consumers in emerging markets [44–46]. Thus, the most successful EMFs quickly evolve from duplicative imitation to innovative adaption as they seek to meet local needs [41].

Recently, a number of scholars have proposed that EMFs invest considerable effort for innovation, as they seek to meet the needs of their customers by providing products with lower cost and sufficient value [2,8,21,44,46]. Several similar concepts have been proposed to describe these innovation efforts [4,10] (Table 1). In reviewing the literature, we find that these innovative solutions by EMFs typically share two features: (1) They meet the low-price expectations of emerging-market customers; and (2) they meet the specific needs of these customers. We thus redefine "frugal innovation" as new solutions that respond to emerging-market consumers' essential needs by offering good value at an affordable price.

Naturally, the goals of reduced price and improved value tend to conflict [8,47,48]. As EMFs may place greater emphasis on cost or value, we identify two types of frugal innovation, namely cost innovation and affordable value innovation.

Cost innovation is mainly focused on achieving dramatically lower costs to meet the expectations of resource-constrained consumers, with a secondary focus on providing functionalities and features that are adequate to meet specific needs. The main purpose for this kind of innovation is to provide a very low price with adequate quality to serve resource-constrained customers. EMFs achieve lower prices by using low-cost local materials or services, by developing innovative manufacturing processes, and by focusing on the basic minimum functionalities or features required by their target customers and their particular circumstances [18,42]. For example, Zeschky et al. (2011) investigated the interesting case of Tata's Nano, a car that was developed for resource-constrained customers in India, who need their own means of transportation in areas with inadequate transport infrastructure [18]. To meet this need, the Tata Nano offers only the most essential functions. The dramatically lower price of around \$2200 is affordable for a great number of emerging-market consumers [18].

Affordable value innovation is mainly focused on developing new functionalities and features that are designed to meet the specific needs of consumers. A secondary focus is placed on providing these products at prices below those of competing products [8]. Although the concept of affordable value innovation was initially developed (by [8]) to describe the innovation activities of AMNCs in emerging markets, we can still use this concept for describing the innovation activities of EMFs. These firms conduct affordable value innovation due to their familiarity with specific demands in their local markets. They commonly seek innovative ways to integrate existing technologies into new product architectures for meeting the particular needs of their target consumers. For example, there are more than 200 million aged people (i.e., over 60 years old) in China. Most of them have minimal education, and have no sons or daughters living with them. Therefore, Xiaomi, a very famous Chinese mobile phone company, has developed a new smartphone model with very basic but innovative functionalities suited to the needs of aged people. Specifically, by integrating existing technology into a new product architecture, this new model includes an easy-to-use interface (for example, bigger font and more audible volume), emergency calling, remote assistance (from their sons or daughters), and health-monitoring functions.

Related constructs	Key References	Definitions	Common Ch	aracteristics	Reconcept	Examples			
Cost innovation	[22]	Leveraging developing economies' cost advantage to develop innovation at dramatically lower costs	Tailored Functionality at the Lowest Cost: (1) Mainly focus	(1) New solutions should meet the low-price expectations of	Cost innovation: Solutions that offer tailored functionalities to	Frugal innovation: Solutions aimed to respond to these consumers'	Tata's Nano, a car, was designed for the millions of people needing transportation. To meet this need Tata correct with only		
Resource-Constrained Innovation	[10,40]	Innovation developed in emerging economies in a context characterized by lower power of purchase, lower understanding of technology, and lower investment resources	lower costs to meet the expectations of resource-constrained consumers (2) Good enough, or tailored	(2) New solutions should meet the specific needs of customers.	dramatically lower costs for resource-constrained customers.	essential needs by offering value with affordable price	essential functions but without such convenience and safety features as power steering, air conditioning, antilock braking, airbags, or a passenger-side mirror.		
Innovation at the base of the pyramid	[21]	Innovation developed in and targeting the large unserved segments of poor people inhabiting emerging economies	functionalities and features designed to meet specific needs.				The dramatically lower price of \$2200 is affordable for those consumers. [18]		
Frugal innovation	[18]	Good-enough, affordable products that meet the needs of resource-constrained consumers.							
Affordable value innovation	[8]	The development of new products that meet the low-price expectations of customers while offering value to customers	New Functionality at a Lower Cost: (1) Mainly focus on new		Affordable value innovation: Solutions that involve new		Haier re-combined existing (or even discarded) washing machine technologies from Asia, Europe, and North		
Reverse innovation	[4,23]	Innovations adopted first in developing countries before being adopted in advanced economies	functionalities and features designed to meet the specific needs of consumers. (2) New products based on new product		functionalities and features designed to offer value to resource-constrained		American, and launched a new line of high-performance washing machines that used only		
Gandhian innovation	[20]	Fast, creative, and improvised way of solving problems in a resource-constrained environment at a lower cost		consumers. (2) New products based on new product		customers at lower costs.		half the water of conventional machines but achieved close to 50% improvement in cleaning	
Disruptive innovation	[24,49–51]	Simple, cheap, small, and easy-to-use products or services that cater to the need of the unserved or underserved market and has the potential to increase revenue by developing an altogether new market.	architectures are still at very lower price points than existing solutions				power at twice the speed and had the added benefit of reducing the wear and tear on garments by 60 percent. [22]		

Table 1. Reconceptualization of frugal innovation.

As frugal innovation emphasizes both cost and value, the categories of "cost innovation" and "affordable value innovation" represent a general, relevant, and comprehensive framework of classification [10]. We expect that both cost innovation and affordable value innovation are beneficial to the performance of EMFs in emerging economies, in which billions of people are active but resource-constrained customers. As Brown and Eisenhardt (1995) indicate, "product characteristics such as low-cost and unique benefits and fit-with-firm competencies create financially successful products" [47]. Frugal innovators emphasize both cost and value for resource-constrained customers, and they use the competencies of firms that lack access to world-leading technology but are familiar with their target customers' needs [8,22,42,52].

Cost innovation focuses mainly on achieving dramatic cost reductions through tailoring functionalities and features, taking advantage of low-cost local factor markets, standardizing components, and improving the scale and efficiency of production [22,42]. Innovations in all of these cost-related areas can help EMFs achieve higher profit levels. Affordable value innovation focuses on developing new functionalities and features with lower cost, thus providing resource-constrained customers with beyond-expectation innovative products or services [8]. To state our hypothesis formally, we posit that:

H1. Frugal innovation (i.e., cost innovation and affordable value innovation) is positively related to the performance of emerging-market firms.

2.2. Antecedents of Frugal Innovation: Addressing the Institutional, Technological, and Market Constraints in *Emerging Markets*

2.2.1. Institutional Leverage Capability

Public institutions can either constrain the innovation activities of EMFs, or facilitate these activities. On one hand, the innovation activities of EMFs are often constrained by local institutions, especially during periods of institutional transition, defined as "fundamental and comprehensive changes introduced to the formal and informal rules of the game that affect organizations as players" [15]. For example, Zhu et al. (2012) found several institution-based barriers to innovation by small-and medium-sized firms in China [53]. On the other hand, recent research also suggests that local institutions can support innovation, and thus provide EMFs with certain competitive advantages [54,55]. For example, state-owned firms in China have access to policy information, government support, and valuable resources, all of which can foster innovation [56,57]. However, the extant literature has left one important question unanswered: How do some EMFs turn local institutional benefits into firm-specific innovation activities while other EMFs are unable to do so [58–61]?

To answer this question, we draw on the firm-level concept of institutional leverage capability, defined as a firm's "capacity to continuously identify local institutional benefits, establish and maintain the legitimacy to engage with the institutions, purposefully interact with them, and configure its existing resources in such a way as to integrate institutional benefits for achieving its desired end" [62]. Following Landau et al., we argue that an EMF's capacity to identify the institutional benefits provided by local institutions (to access them, adopt them, and utilize them to improve its performance) provides a stimulus for frugal innovation activities.

First, EMFs with a higher capacity for institutional leverage are better able to interact with local institutions [62], and such interaction enables firms to recognize opportunities for initiating new search paths. These firms are better able to access the resources controlled by local institutions for investing in frugal innovation activities. In emerging economies, numerous gaps commonly exist among institutional services [11,63]. Examples include the lack of a well-established intellectual property rights protection system, the various shortages of skilled labor, and the patterns of weak legal enforcement. These institutional deficiencies can strongly constrain an EMF's incentives for innovation.

However, in some cases, governments allocate the key resources they control (such as funding, land, or certifications) to facilitate certain EMFs in achieving "world-class technology". The term

"world-class technology" generally refers to products that offer functionalities similar to those of the mainstream products offered in advanced markets. When an EMF achieves such technology, it may receive recognition from local institutions, and it may even get a certificate of government approval to market that technology. For example, in China's Guangdong province, around 700 new products have received a government-issued certificate that gives them official recognition as a "Guangdong Famous Brand Product". This kind of recognition by the local government helps EMFs to gain support from local institutions and to achieve product recognition by their customers. Therefore, interaction with local institutions can enable EMFs to gain more resources that facilitate frugal innovation.

A second advantage of achieving greater institutional leverage is that it motivates EMFs to seek institutional support more actively, and to integrate the benefits of such support into their own resource bases [62]. This kind of engagement helps EMFs to take advantage of ongoing institutional support for frugal innovation. Attaining high levels of institutional dynamism in emerging markets during periods of institutional transition requires a fast-paced process of launching new policies and abolishing outdated or conflicting policies among different institutions [11]. To better leverage the benefits of institutional transition for enabling frugal innovation, EMFs need to embed the resources they have garnered from other institutions into their own organizational systems on a more permanent basis [62]. For example, the "China's National Recognized Enterprise Technical Center" certification is issued by the Chinese government to firms with high levels of R&D capability. A firm with this certificate can obtain direct and indirect support from the government, and gain priority for receiving certain benefits when new policies are launched. To get this certificate, firms often create new structures and processes, or modify existing structures according to the standards set by the government. When they succeed in getting this certificate, they gain a platform to integrate the resources from public institutions with their own resources for developing frugal innovations.

In summary, these arguments suggest that EMFs with higher capabilities for institutional leverage tend to consistently obtain more resources and incentives for conducting frugal innovation. Thus, we propose our second hypothesis:

H2. *Institutional leverage capability is positively related to frugal innovation (i.e., cost innovation and affordable value innovation) by emerging-market firms.*

2.2.2. Bricolage Capability

Innovation often requires a great deal of prior investment in R&D, and it commonly requires access to various types of complementary assets [64]. In general, EMFs simply lack the long-term investment required for developing the assets that AMNCs rely on for innovation. For example, EMFs often suffer from extremely limited access to world-leading technology, and they must innovate using the ordinary resources available in their local market [17]. Yet, despite such resource deficits, some EMFs benefit from having greater familiarity with the local market than the AMNCs seeking to gain customers in resource-constrained emerging markets. EMFs commonly display adaptive agility and freedom of action. They can creatively and speedily combine new ideas with ordinary resources to generate new products that add value yet are affordable for resource-constrained customers. In this study, we propose that capacity for bricolage, defined as "making do by applying combinations of the resources at hand to new problems and opportunities" [31], can drive frugal innovation by EMFs that are facing the challenges of core resource constraints.

A recent stream of exploratory work has examined how bricolage affects the innovativeness and growth of resource-constrained new firms [31,60,65–67]. The findings of such research indicate that new ventures typically lack resources, and the capacity for bricolage may allow them to exploit new possibilities by making creative use of the limited resources at hand [31,66]. We extend the setting for such research from new ventures to EMFs, and we argue that bricolage can allow real innovation by resource-constrained EMFs [8]. Like other new ventures, EMFs typically lack resources for innovation. However, as far as we know, few studies have examined the effects of bricolage in the context of

EMFs [8,60]. In addressing this research gap, we argue that EMFs with a higher capability for bricolage have a greater tendency to seek resources in the market. Such firms also have a greater ability to combine existing technologies with locally available resources to generate affordable, value-added new products.

First, we propose that EMFs that engage in bricolage have "a bias for action" [31,66]. The mainstream literature on innovation management argues that innovations require substantial investments in resources. When facing new opportunities in the local market, some EMFs that lack core technologies do not even attempt to innovate but instead choose to copy. In contrast, EMFs with a higher level of bricolage capability are willing to use the resources at hand to find new ways to make better products [31,66]. The willingness to make do with limited resources is especially crucial for EMFs that engage in frugal innovation because these firms know their local resource-constrained customers much better than AMNCs. They know that most of their customers' needs can be easily met by products with less than world-leading technology.

Second, EMFs that engage in bricolage tend to creatively combine the ordinary resources at hand, and this effort promotes frugal innovation. EMFs that lack core technologies need to identify the sets of resources available in the market, and creatively combine them with the resources at hand to compete with the more resource-rich AMNCs [17]. Moreover, through improvisation and trial-and-error learning, EMFs with a higher capacity for bricolage are more likely to devise low-cost, value-added solutions for their customers. They are also more likely to generate experience-based, tacit innovations that are based on a knowledge of readily available resources [68]. Such experience-based knowledge may be especially critical for EMFs, because it can give them unique insights concerning the local markets that they are familiar with, along with novel ways of recombining knowledge elements to meet their customers' specific needs. Accordingly, we propose a third hypothesis:

H3. Bricolage capability is positively related to frugal innovation (i.e., cost innovation and affordable value innovation) by emerging-market firms.

2.2.3. Perceived Dysfunctional Competition

Perceived dysfunctional competition refers to the degree to which business managers perceive their competitors as opportunistic, unfair, or even unlawful, according to their experience over the most recent three years [69]. Highly dysfunctional competition is associated with fierce competition from other firms or even from informal sector actors [70]. Such competition can involve practices, such as patent and copyright violations, or other unfair tactics [14]. In markets with high levels of dysfunctional competition, companies must pay particular attention to their costs and the value of their products, due to significant pressure from imitators (Li and Atuahene-Gima, 2001). Therefore, managers who perceive high dysfunctional competition tend to search for novel means of prevailing over their competitors. Their interest in developing new value-added products with lower costs tends to increase.

In addition, perceived dysfunctional competition tends to affect the level of managerial discretion [69,71]. Managers who perceive high dysfunctional competition tend to recombine already existing knowledge in novel ways as they seek to develop value-added and lower-cost products. For example, most new products of Tata and Haier are offered at the lowest prices in the market. These firms achieve this advantage by targeting the particular needs of resource-constrained customers, and by producing their products at a high volume [22,42]. In summary, we propose our fourth hypothesis:

H4. *Perceived dysfunctional competition is positively related to frugal innovation (i.e., cost innovation and affordable value innovation) by emerging-market firms.*

3. Method

3.1. Sample and Data Collection

Our empirical setting involves manufacturing firms in China. As China is a large country, we strategically selected five provinces out of 34 provincial administrative regions, representing regions whose economies are growing rapidly due to numerous innovative efforts. These provinces are geographically diverse, namely Beijing, Shanghai, Guangdong, Zhejiang, and Jiangsu. Beijing is the capital city of China, which is located in the Bohai Sea economic development area. Shanghai, Zhejiang, and Jiangsu are located in the Yangtze River Delta (in eastern China), and Guangdong is located in the prosperous Pearl River Delta (in southern China).

Following Gerbing and Anderson's (1988) suggestion [72], we developed a survey instrument. First, we extensively reviewed the related literature, and whenever possible adopted valid measurement items used in previous studies. Second, we conducted 15 in-depth interviews with managers in Chinese manufacturing firms to better understand their innovation activities and the antecedents of those activities. Through our exploratory interviews and comprehensive review of the literature, we developed the measurement items for constructs that had no measures available in the literature. Third, we prepared an English version of the questionnaire. To ensure conceptual equivalence, we used a back-translation process involving two independent researchers. Fourth, we conducted a pre-test involving 18 managers and researchers to ensure the measures' validity.

The formal questionnaire was finalized in May 2016, and we collected our data in the following nine months. Our main respondents were top managers in each surveyed company. We used a list of the "top management team members" in each province (drawn up by a Chinese consultant company) to randomly generate a list of senior managers in 1000 firms. Then, the consultant company helped us to contact these managers to complete the questionnaire. In total, 528 usable responses were received, for a response rate of 52.8%. All of the respondent managers were highly knowledgeable about their firm's innovation activities (with average scores of 4.97 on a scale of 5).

To assess non-response bias in our study, we first tested for differences between the early (first three months of data collection) and late (last three months of data collection) respondents [73,74]. Then, we tested for differences between participants who completed the survey and participants who did not fully complete the survey [74]. No significant differences were found regarding their key firm characteristics (i.e., age and number of employees), which indicated that non-response bias was not a significant concern in our study.

Table 2 presents the descriptive statistics of the sample. Of 526 firms, 12.12% had been in operation for less than 5 years; 19.70% had operated for 5 to 10 years; 19.89% had operated for 10 to 15 years; 23.11% had operated for 15 to 20 years; and 25.19% had been in business for more than 20 years. Of the 526 firms, 57.20% had fewer than 500 employees, and 42.80% had more than 500 employees. In terms of their locations, 13.83% were in Beijing, 20.27% were in Shanghai, 33.71% were in Guangdong, 15.53% were in Zhejiang, and 16.67% were in Jiangsu.

Variables		Frequency	Percent	Cumulative Percent
Firm age	≤5 years	64	12.12%	12.12%
0	5 to 10 years	104	19.70%	31.82%
	10 to 15 years	105	19.89%	51.70%
	15 to 20 years	122	23.11%	74.81%
	20 to 25 years	41	7.77%	82.58%
	≥25 years	92	17.42%	100.00%
Region	Beijing	73	13.83%	13.83%
Ũ	Shanghai	107	20.27%	34.09%
	Guangdong	178	33.71%	67.80%
	Zhejiang	82	15.53%	83.33%
	Jiangsu	88	16.67%	100.00%
Listed firm	Yes	114	21.59%	21.59%
	No	414	78.41%	100.00%
High-tech firms	Yes	339	64.20%	64.20%
Ũ	No	189	35.80%	100.00%
Employees	<500	302	57.20%	57.20%
1 9	500-2000	138	26.14%	83.33%
	>2000	88	16.67%	100.00%

Table 2. Characteristics of sample firms.

3.2. Measurement

Table 3 presents all of the measurement items and their validity assessments. Table 4 shows the descriptive statistics and correlations among all of the variables. We used a 5-point Likert-type scale to measure cost innovation, affordable value innovation, perceived dysfunctional competition, institutional leverage capability, bricolage capability, and performance (1 = strongly disagree; 5 = strongly agree).

Variables	Items	Outer Loadings	T Values	Cronbach's Alpha	rho_A	Composite Reliability (CR)	Average Variance Extracted (AVE)
Affordable value	The innovation product provides new value to low-income customers	0.926	102.252	0.814	0.819	0.915	0.843
Innovation [6]	The innovation product is affordable for the low-income population	0.910	75.935				
	Returns on investment	0.794	36.72	0.844	0.845	0.889	0.617
	Market share growth	0.747	41.69				
Performance [75]	Sales growth rate	0.777	31.591				
	The growth rate of its profit	0.789	33.294				
	The competitive position relative to its major competitors in the same industry	0.818	49.149				
	We are confident of our ability to find workable solutions to new challenges by using our existing resources	0.797	28.687	0.878	0.883	0.904	0.542
Pricelago	We gladly take on a broader range of challenges than others with our resources would be able to.	0.734	28.384				
[66,76,77]	We use any existing resource that seems useful to respond to a new problem or opportunity	0.715	20.61				
	We deal with new challenges by applying a combination of our existing resources and other resources inexpensively available to us	0.725	22.991				
	When dealing with new problems or opportunities we take action by assuming that we will find a workable solution	0.671	16.725				
	By combining our existing resources, we take on a surprising variety of new challenges	0.743	28.655				
	When we face new challenges, we put together workable solutions from our existing resources	0.751	29.427				
	We combine resources to accomplish new challenges that the resources were not originally intended to accomplish	0.739	27.159				
Cost Innovation	The innovation product offers similar or tailored functionalities comparing to the mainstream products in the market	0.787	30.597	0.629	0.646	0.794	0.562
[42]	The innovation product has a drastically lower price comparing to the mainstream products in the market	0.727	20.587				
	The innovation product is good enough and at lower costs for resource-constrained customers	0.735	20.173				
Dereferretionel	Unlawful competitive practices such as illegal copying of new products	0.843	34.115	0.861	0.881	0.905	0.703
competition [14]	Counterfeiting of your firm's own products and trademarks by other firms	0.864	45.363				
	Ineffective market competitive laws to protect your firm's intellectual property	0.806	23.8				
	Increased unfair competitive practices by other firms in the industry	0.840	38.707				

Table 3. Construct measurement and confirmatory factor analysis results.

Variables	Items	Outer Loadings	T Values	Cronbach's Alpha	rho_A	Composite Reliability (CR)	Average Variance Extracted (AVE)
	We are able to identify new institutional benefits in the local environment in a quicker manner.	0.754	30.502	0.932	0.934	0.941	0.573
	We are able to predict new institutional changes in a more efficient manner.	0.689	20.167				
	We have intensive connections with local institutions	0.780	34.185				
Institutional	We have the ability to access institutional support.	0.774	34.863				
leverage capability [62]	We take advantage of external resources available through institutions	0.805	40.221				
	We are highly recognized by the local institutions	0.707	24.114				
	We are able to adopt the institutional benefits in a quicker manner	0.675	16.509				
	We are able to adopt the institutional benefits by various ways	0.770	30.143				
	We tend to adjust the organizational structure appropriately to take advantage of institutional opportunities	0.743	31.105				
	We tend to adjust the intra- and inter- organizational communication network appropriately to take advantage of institutional opportunities	0.781	32.21				
	We integrate various sources of existing resources in order to take advantage of institutional opportunities	0.810	47.371				
	We invest heavily in order to augment the value conferred by the institutions concerned	0.779	33.304				
	1. The technology in this industry is changing rapidly	0.795	28.049	0.796	0.806	0.868	0.624
Technological turbulence [78]	2. Technological changes provide substantial opportunities in this industry	0.840	41.629				
	3. A large number of new product ideas have been made possible through technological breakthroughs in this industry	0.837	42.171				
	4. It is very difficult to forecast where the technology in this area will be in the next few years	0.676	18.291				

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12
1. Affordable value innovation	3.625	0.911	0.918											
2. Cost Innovation	3.662	0.709	0.602	0.736										
3. Bricolage capability	4.017	0.566	0.442	0.470	0.749									
4. Dysfunctional competition	2.906	0.995	0.167	0.190	0.088	0.839								
5. Export	0.580	0.495	0.114	0.036	0.105	0.061	1							
6. Firm age	16.151	45.256	0.073	0.089	0.071	0.095	0.172	1						
7. Firm size	2.569	0.990	0.090	0.154	0.266	0.059	0.340	0.343	1					
8. High-tech	0.640	0.480	0.048	0.124	0.155	0.019	0.102	0.004	0.003	1				
9. Institutional leverage capability	3.876	0.640	0.435	0.457	0.615	0.194	0.116	0.142	0.315	0.167	0.757			
10. Performance	3.800	0.600	0.320	0.361	0.548	0.118	0.139	0.069	0.335	0.099	0.562	0.785		
11. Private firms	0.620	0.486	-0.065	-0.119	-0.075	-0.086	-0.266	-0.335	-0.287	-0.092	-0.152	-0.151	1	
12. Technological turbulence	3.617	0.759	0.244	0.281	0.413	0.474	0.059	0.058	0.161	0.068	0.475	0.381	-0.144	0.790

Table 4. Descriptive statistics and correlations among the latent variables.

Notes: Correlations that are 0.086 or larger are significant at the level of p < 0.05 (two-tailed). The square roots of the AVE are on the diagonal and highlighted in bold.

Performance. We adopted the measures of firm performance from [73] and [79]. We asked managers to evaluate their firm's returns on investment, sales growth rate, market share growth, growth rate in profits, and position relative to major competitors in the same industry.

Frugal innovation. As discussed earlier, we identified two dimensions of frugal innovation in emerging markets, namely cost innovation and affordable value innovation. We developed three items to measure the extent to which the firms' innovative products offered (1) similar or tailored functionalities compared to the mainstream products in the market; (2) drastically lower prices compared to the mainstream products in the market; and (3) improved quality with reduced cost for resource-constrained customers. The measurement of affordable value innovation was adapted from [8].

Perceived dysfunctional competition. We adopted four items from [14] to examine the managers' perceptions of unlawful competitive practices, ineffective laws regulating market competition, and unfair competitive practices.

Bricolage capability. Based on Senyard et al. (2009, 2014) [66,76] and An et al. (2018) [77], we measured bricolage with eight items, capturing the elements of Baker and Nelson's (2005) [31] definition of bricolage: (1) Making do with available means, (2) using the existing resources at hand, and (3) applying combinations of resources to create new solutions and opportunities

Institutional leverage capability. Based on Landau et al. (2016) [62], we developed 12 items to measure each focal firm's capability for identifying, accessing, adopting, and applying institutional benefits.

Control variables. We controlled for several potential effects of extraneous variables. We first controlled for firm age, measured by the number of years the firm had been in operation. Firm size, measured by the logarithm of the employees, was also included. For firm ownership, we included a dummy variable, i.e., private firm (yes = 1, no = 0). For measuring exports, we asked the managers to indicate whether the firm had exported its products beyond China [27]. This variable was also dummy coded (1 = yes, 0 = no). We included a dummy variable, i.e., high-tech firm (yes = 1, no = 0). Finally, we controlled for technological turbulence, which was measured by four items adapted from [78].

3.3. Adequacy of Measurement: Reliability, Validity, and Common Methods Variances

We took several steps to ensure data validity and reliability. To examine the reliability of the measures, we calculated the Cronbach's alpha and the composite reliability. The Cronbach's alpha reliabilities ranged between 0.629 and 0.932, and the composite reliability values ranged between 0.794 and 0.941. These results indicated that the reliability of our measures was acceptable [80].

The results of the confirmatory factor analysis showed that all of the item loadings were above 0.67 (t > 16.50), and that each of the latent variables had an average variance extracted (AVE) above 0.50 (with the lowest AVE value being 0.54). These results provided evidence of convergent validity [70,81,82].

To assess discriminant validity, we first estimated the cross-loadings [80,81], and the results indicated an acceptable level of discriminant validity. The standardized root means square residual was 0.054, which was less than 0.08 [83], which suggested that our model had a good fit. Next, we conducted a chi-square difference test [84]. The results indicated that a two-factor model had a better fit than a single-factor model in every pair, thus providing more evidence of discriminant validity.

We took several measures suggested by Podsakoff et al. (2003) [85] to design the study in a way that minimized concerns over common method variance. First, we used Harman's one-factor test to check for the presence of common method variance. Second, following Podsakoff et al. (2003) [85], we subjected all of the key variables (the seven multi-item constructs shown in Table 3) to a factor analysis. The results indicated that more than one factor (i.e., out of the seven factors) was extracted, and less than 50% of the variance could be attributed to the first factor, which suggested that common method bias was unlikely to be a significant issue in our study. Third, we followed Podsakoff et al.'s (2003) [85] latent variable approach to control for the effects of an unmeasured latent methods factor. We found that all of the significant relationships held after controlling for the latent common methods

variance factor, which provided evidence that common method variance was not an issue in this study [8,27].

4. Results

We selected the variance-based structural equation modeling approach of partial least squares (PLS) for our analysis. Specifically, we analyzed our model using SmartPLS 2 software. We chose this software because of its ability to focus on both prediction and theory development. We also calculated the variance inflation factor (VIF) coefficient (the maximum was 1.888), which indicated that problematic multicollinearity was not an issue in our model. As recommended by Hair et al. (2013) [80], we applied the nonparametric bootstrapping technique to assess the size of the path coefficients and their significance. Table 5 provides all of the path estimations, and Figure 2 summarizes our results. We also provide all of the nonparametric evaluation criteria, i.e., the effect size (f2), in Table 6, and all of the coefficients of determination (R2) and the cross-validated redundancies (Q2) in Table 5 (Hair et al., 2013). The results shown in Tables 5 and 6 indicate that our model had sufficient predictive power (Stone–Geisser criterion) [80]. Table 7 presents the path estimation and significances.



Table 5. Inner model evaluation.

Figure 2. Results of the hypotheses testing.

Table 6. The effect size (f2).

	Affordable Value Innovation	Cost Innovation	Performance
Affordable value innovation			0.009
Cost Innovation			0.034
Bricolage	0.06	0.105	
Dysfunctional competition	0.015	0.016	
Institutional leverage capability	0.054	0.052	
Controls			
Export	0.004	0.003	0.008
Firm age	0	0	0
Firm size	0.004	0.01	0.011
High-tech	0.002	0.001	0.002
Private firms	0	0.004	0.002
Technological turbulence	0.002	0	0.103

	Original Sample (O)	T Statistics	<i>p</i> -Values	2.50%	97.50%
Affordable value innovation -> Performance	0.125	2.545	0.011	0.028	0.219
Bricolage -> Affordable value innovation	0.280	4.291	0.000	0.162	0.415
Bricolage -> Cost Innovation	0.346	4.996	0.000	0.221	0.484
Cost Innovation -> Performance	0.292	5.717	0.000	0.194	0.393
Dysfunctional competition -> Affordable value innovation	0.117	2.838	0.005	0.036	0.198
Dysfunctional competition -> Cost Innovation	0.113	2.892	0.004	0.036	0.188
Export -> Affordable value innovation	0.054	1.367	0.172	-0.022	0.135
Export -> Performance	0.084	1.965	0.050	0.000	0.167
Firm age -> Affordable value innovation	0.015	0.435	0.664	-0.079	0.048
Firm age -> Performance	-0.024	0.528	0.598	-0.073	0.102
Firm size -> Affordable value innovation	0.058	0.683	0.494	-0.191	0.122
Firm size -> Cost Innovation	0.083	1.832	0.067	-0.012	0.157
Firm size -> Performance	0.051	1.558	0.119	-0.032	0.099
High-tech -> Affordable value innovation	-0.043	1.099	0.272	-0.121	0.03
High-tech -> Performance	0.046	1.078	0.281	-0.039	0.128
Institutional leverage capability -> Affordable value innovation	0.274	4.002	0.000	0.134	0.393
Institutional leverage capability -> Cost Innovation	0.258	3.784	0.000	0.118	0.385
Private firms -> Affordable value innovation	0.011	0.270	0.787	-0.07	0.092
Private firms -> Performance	-0.075	1.842	0.066	-0.158	0.001
Technological turbulence -> Affordable value innovation	-0.048	0.915	0.360	-0.143	0.059
Technological turbulence -> Cost Innovation	0.018	0.338	0.736	-0.083	0.127

Table 7. Path estimation and significances.

H1 proposes that frugal innovation (i.e., cost innovation and affordable value innovation) is positively related to the performance of EMFs. Our results indicate that the path of cost innovation -> performance is positive and significant ($\beta = 0.292$, p < 0.001), and the path of affordable value innovation -> performance is also positive and significant, thereby supporting H1. H2 proposes that institutional leverage capability is positively related to frugal innovation (i.e., cost innovation and affordable value innovation) by EMFs. Our results indicate that both paths are positive and significant ($\beta = 0.274$, p < 0.001; $\beta = 0.258$, p < 0.001), thereby supporting H2. H3 proposes that bricolage capability is positively related to both cost innovation and affordable value innovation by EMFs. Our results indicate that both paths are positive and significant ($\beta = 0.280$, p < 0.001; $\beta = 0.346$, p < 0.001), thereby supporting H3. H4 proposes that perceived dysfunctional competition is positively related to both cost innovation and affordable value innovation and affordable value innovation and affordable value innovation and affordable value innovation H3. H4 proposes that perceived dysfunctional competition is positively related to both cost innovation and affordable value innovation. Our results indicate that both paths are positive and significant ($\beta = 0.113$, p < 0.05; $\beta = 0.117$, p < 0.05), thereby supporting H4.

5. Discussion

In this study, we assessed how EMFs undertake frugal innovation in a resource-constrained emerging market, namely China. Based on a review of the literature regarding the innovation activities of EMFs, we proposed a new conceptualization of frugal innovation, and we examined how its two dimensions (namely cost innovation and affordable value innovation) affect firm performance. Moreover, from the perspective of resource-constrained innovation, we also examined how EMFs address these institutional, technological, and market constraints in emerging markets, and we showed how they pursue frugal innovation. As such, our study echoes the call by Subramaniam et al. (2015) [7] to examine the innovation-related issues of firms in emerging economies. In addition, our study contributes to the literature in two major ways.

5.1. Contributions

First, although a recent upsurge of research on the innovation activities of EMFs has established the importance of emerging markets [7,8,10,42], this body of research has also led to a terminology jungle [10]. Our study contributes to this research field by proposing a reconceptualization of frugal innovation that involves examining the performance of innovation in terms of two dimensions (i.e., cost innovation and affordable value innovation). We argue that frugal innovation should respond to the essential needs of resource-constrained consumers by offering improved value (value) with affordable price (cost). Based on whether firms place their main emphasis on cost reduction or value enhancement, we identify two types of frugal innovation, namely cost innovation and affordable value innovation.

We find that cost innovation contributes to the performance of EMFs by dramatically reducing costs through tailoring functionalities and features, and by achieving low costs through the use of local factor markets, standardizing components, and achieving scale and efficiency. Affordable value innovation contributes to the performance of EMFs by emphasizing new functionalities and features with lower cost, thus providing resource-constrained customers with beyond-expectation innovative offerings. This positive relationship between frugal innovation and performance is consistent with the extant literature [8,10,18,42]. However, our conceptualization contributes to a clearer understanding of existing concepts regarding innovation as they relate to emerging markets. Therefore, our study provides grounds for a more systematic approach in future research [10,18].

More importantly, our findings indicate that the frugal innovation activities of EMFs are driven by specific factors, namely institutional leverage capability, bricolage capability, and perceived dysfunctional competition. These findings add to the extant literature by explaining how EMFs address the institutional, technological, and market constraints in emerging markets through practices of frugal innovation. In particular, given similarly underdeveloped institutions in their emerging markets, some EMFs are able to turn local institutional benefits into firm-specific innovation activities, whereas other firms are unable to do so [58–61]. We explain this discrepancy by proposing that EMFs with higher capacity for institutional leverage consistently gain more resources and find greater incentives for conducting frugal innovation. These findings indicate the importance of institutional leverage capability for exploiting location-based institutional benefits and for converting these benefits into firm-specific competitive advantages [62].

In addition, our study adds to the literature on bricolage, which has mainly been focused on entrepreneurial firms. Only recently have some scholars extended studies on bricolage from new firms to incumbent firms [8,79]. For example, Ernst et al. (2015) find that bricolage is important for AMNCs (i.e., Forbes 500 companies) seeking to innovate for customers in low-end markets [8]. Our results indicate that EMFs with higher levels of capacity for bricolage have a strong tendency to practice resource-seeking in the market, as they look for combinations of existing elements or resources that can generate affordable, value-added new products. Thus, we extend the research context of bricolage from firms based in developed countries to EMFs. Moreover, our results provide evidence supporting Luo and Child's (2015) proposal that EMFs without strategic assets can achieve completive advantages by creatively recombining ordinary resources into new products that meet the requirements of particular markets [17].

Finally, our study also provides interesting findings concerning the role of perceived dysfunctional competition in promoting frugal innovation by EMFs. The canonical literature on innovation defends exactly the opposite position [14,69,70]. Contrary to the theoretical arguments made in previous studies [14,66,67], our results suggest that perceived dysfunctional competition impels EMFs to develop new products with lower cost as a means of prevailing in situations of fierce competition. In fact, Liu and Atuahene-Gima (2018) find that instead of differentiation strategy, a cost-leadership strategy will positively relate to innovation performance as dysfunctional competition increases [86]. This finding suggests that in markets where innovation cannot be adequately protected (e.g., dysfunctional competition), innovators could use cost-leadership strategy (e.g., frugal innovation) to be less exposed to imitation [86]. For example, Chinese Xiaomi is famous for providing new products with satisfactory

quality but a very low price, preventing low cost-orientated competitors from entering the market. Therefore, our findings appear to challenge the assertion that dysfunctional competition is innovation destroying, thus opening up a new direction for future research.

5.2. Limitations and Future Research Directions

Our research has several limitations that should be addressed in future research. First, the cross-sectional nature of our study limits any tests of causal linkages in our model (e.g., the endogeneity problems). Future research using longitudinal data and appropriate econometric analysis (e.g., the generalized method of moments) are needed to test the Granger causality of our proposed model. Moreover, as the capabilities and innovation activities of firms may change during periods of economic transition, future researchers should undertake longitudinal studies to examine various intriguing questions regarding the evolving effects of economic transitions.

Second, the argument of innovation-driving effects of dysfunctional competition needs further exploration since we have not ruled out possible influencing factors, such as institutional supports and barriers to innovation. In fact, in emerging markets like China, where market failures exist (e.g., high level of dysfunctional competition), opportunistic behaviors of other companies to take advantage of the spillovers that innovation generates without making the corresponding investments or taking on the corresponding risks are common (e.g., [58]). In our theory, we propose that dysfunctional competition positively relates to frugal innovation, which means that frugal innovation could be one type of innovators' strategy to cope with these opportunistic behaviors. However, this argument needs further exploration by incorporating at least two key variables: The aid that companies receive from public institutions (in monetary terms and access to new knowledge) and the level of barriers to innovation that they must face. If the barriers are very weak and public aid is very large, companies may not be reluctant to innovate, even if there is an important perceived dysfunctional competition. Therefore, we call for future research joining us by exploring these effects.

Third, another way to address resource constraint for EMFs is to initiate R&D collaborations locally and globally [87–90]. For example, inter-firm linkages and spillovers are key drivers for EMFs' innovation [91]. Future research could incorporate open innovation theory to explore other drivers of frugal innovation. More generally, according to the economics of innovation literature, innovation inputs are diverse [92]. For EMFs, embodying technological change may be crucial, future research could thus explore how technological change may affect EMFs' frugal innovation.

Fourth, we explored the impact of frugal innovation on firm performance. Future research is needed to examine their implications for other firm-level, industry-level, as well as social-level variables. For example, the impacts on firm performance may be mediated by the links between innovation inputs, innovation outputs, and productivity (e.g., [93]). Future research could further examine these relationships. Moreover, frugal innovation is a subset of product innovation and such innovations are good not only for firms' performance but also for job generation, which is a crucial social aspect in emerging countries that needs further exploration [94].

Fifth, our theoretical model may be influenced by firm-level characteristics and industry-level variations. For example, sectoral belonging is a key aspect of innovation (e.g., [95]). In our paper, we only partially considered the dummy "high-tech". Future research could build a more fine-grained theoretical model for different firms in different industries.

Finally, our sample only includes EMFs in five provinces in China, which might limit the generalizability of our findings. Hence, replicating and extending this study in other regions of China (such as less economically developed provinces) and in other emerging economies may provide a basis for determining the external validity of our findings. Moreover, in addition to Ernst et al.'s (2015) focus on frugal innovations of AMNCs in emerging markets [8], we explored and empirically tested frugal innovations for EMFs in emerging markets. Future research may explore frugal innovations by both types of firms in developed markets. For example, an emerging stream of literature on reverse

innovation has noticed that frugal innovations developed in emerging markets could be successful in developed countries (e.g., [96]).

In conclusion, as emerging markets continue to grow, it is of critical importance to better understand how EMFs innovate in serving their markets. Our study advances this intriguing area of research by examining the antecedents and implications of frugal innovation for emerging markets. We hope that further research continues to explore and document the innovation activities of EMFs in their fast-changing markets and institutional environments.

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