Disruptive Innovation from China: Antecedents and Implications

Abstract

A growing recognition of the importance of disruptive innovation has led researchers to examine the question of how disruptive innovation comes about and to what extent it reflects "discovery" versus "creation" of opportunities. Earlier research has focused on the organisational preconditions for disruptive innovation to arise. Much less attention has been paid to the role of innovation processes, including their goals and design, in promoting disruptive innovation. In this paper we aim to begin to fill this gap by better understanding how new innovation processes can act as antecedents for disruptive innovation.

We adopt an inductive theory-building methodology using a set of case studies of Chinese firms to develop propositions about how novel R&D and production processes can foster disruptive innovation. We find that in the case of China the adoption of new innovation processes that re-define the focus of innovation and re-engineer traditional R&D processes in ways that allow the on novel deployment of Chinese cost advantages can create offerings that incorporate the key elements of disruptive innovation. We conclude by discussing the implications for global competition and possible responses as well as directions for future research.

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INTRODUCTION

Disruptive innovation theory has long been studied in the innovation management literature (Adner, 2002, 2006; Calia, Guerrini, & Moura, 2007; Christensen, 2006; Christensen & Bower, 1996; Christensen & Raynor, 2003; Danneels, 2004; Govindarajan & Kopalle, 2006). The concept was originated by Christensen (1997), and focused primarily on technological innovation. Over years, the concept of disruptive innovation widened to include not only technologies but also products and business models (Christensen & Raynor, 2003; Markides, 2006). For example, Christensen and Raynor (2003) suggest that disruptive innovations include discount department stores; low-price, point-to-point airlines; cheap, mass-market products such as power tools, copiers, and motorcycles; and online businesses such as bookselling, education, brokerage, and travel agents.

The growing recognition of disruptive innovation as an important phenomenon in competitive strategy has led researchers to examine the question of how disruptive innovation comes about. A substantial body of literature has explored the conditions under which disruptive innovation is likely to arise from an organization, including the characteristics of its human resource pool (Denning, 2005; Henderson, 2006); its organizational culture (Henderson, 2006; Tushman & O'Reilly, 2002); its resource allocation processes (Chao & Kavadias, 2007; Hogan, 2005; Nelson & Winter, 1982); and its organizational structure (Cohen & Klepper, 1996; Lee & Chen, 2009; Tsai & Wang, 2005). Despite the progress, the nature of the innovation processes that enable disruptive innovation deserves further examination (Yu & Hang, 2010). In particular, our understanding of what kinds of R&D and opportunity discovery and creation processes are likely to give rise to disruptive innovation is limited.

At the same time, a growing body of evidence suggests that China is becoming an important source of disruptive innovation (Li, 2013; Williamson and Yin, 2013). In this paper,

therefore, we seek to fill a gap in the literature by analysing a set of case studies of Chinese firms pursuing potentially disruptive innovation, with the aim of better understanding how new R&D and production process innovations can act as antecedents for disruptive innovation in the context of China and some of the implications of such process innovations for incumbent competitors from the developed markets. This bears on one of the main themes of this Special Issue: the sources of innovation opportunities; in particular, the debate on whether opportunities are discovered or created by entrepreneurs (Shane and Venkataraman, 2000; Alvarez & Barney, 2007), especially in the area of disruptive innovation (Hang & Garney, 2011). In the context of this debate we show that, while the Chinese market is critical in shaping the kinds of innovations that are emerging there, many disruptive innovations in China have their antecedents in the actions of entrepreneurs through the new R&D, design and production processes they have put in place. This is consistent with the "opportunity creation" school as advanced by researchers such as Sarasvathy (2001).

The paper is structured as follows. We begin by examining the existing literature on theories of disruptive innovation. This leads us to identify a gap in our existing understanding about how changing innovation processes might give rise to disruptive innovation and some broad conjectures about what kinds of R&D and innovation processes might promote disruptive innovation. The next section on methods and data explains the case study methodology we deploy to explore these issues and conjectures and how data were collected and analysed to develop a set of propositions about the antecedents of disruptive innovation. We then report findings from the case studies of Chinese firms, and followed by a discussion of the implications for the changing nature of global competition. We conclude by outlining the possible contributions of the present study to existing theory and practice and suggestions for further research.

THEORETICAL BACKGROUND

The theory of disruptive innovation provides the context for interpreting the empirical results and theoretical contributions of this study. In this section we first review the disruptive innovation theory. We then examine new approaches of disruptive innovations that Chinese firms have developed. This leads us to identify a gap in the literature which gives rise to the research question addressed in the remainder of this paper: What are the antecedents of disruptive innovation currently emerging from China?

Theoretical insights into disruptive innovation

Christensen (1997) first comprehensively examined the concept of disruptive innovation in his seminal book titled *The Innovator's Dilemma*. According to Christensen, disruptive technologies are technologies that provide different values from mainstream technologies and are initially inferior to mainstream technologies along the dimensions of performance that are most important to mainstream customers. In its early development stage, each product based on a certain disruptive technology could only serve niche segments that value its non-standard performance attributes. Subsequently, further development could improve the performance of the disruptive technology to a level sufficient to satisfy mainstream customers by focusing solely on key attributes. This was often possible because the performance of the mainstream technology may have already exceeded the demand of mainstream customers, resulting in 'performance overshoot' with over-served customers. Market disruption then occurs when, despite its inferior performance on focal attributes valued by existing customers, the new product displaces the mainstream product in the mainstream market. There are two preconditions for such a market disruption to occur: there is performance overshoot on the mainstream attributes of the existing product, and there are asymmetric incentives between an existing healthy business model and the potentially

disruptive business model. Christensen documented these processes in numerous contexts including hard disk drives, earthmoving equipment and motor controls.

In *The Innovator's Solution* (Christensen and Raynor, 2003) the authors proposed a that the innovator's dilemma could be resolved by well-managed incumbent firms by developing disruptive technologies from their sustaining competitive paradigms, hence avoiding their own dethronement. Interestingly for our current purpose, however, in this second book they replaced the term "disruptive technology" with a new term "disruptive innovation", suggesting the application of the theory could be broadened to include not only technological products, but also services and business models innovation, such as discount department stores, low-price, point-to-point airlines and online businesses education. Markides (2006) took this idea further, classifying disruptive innovations into different types: technological, business model, and radical product innovations. All of these different types of disruptive innovations may follow a similar process to invade existing markets and may have equally disruptive effects on incumbent firms. But Markides argued that a disruptive technological innovation is a fundamentally different phenomenon from a disruptive business-model innovation as well as a disruptive product innovation: These innovations arise in different ways, have different competitive effects, and require different responses from incumbents.

Yin and Williamson (2009) studied these different types of disruptive innovations in Chinese firms. They found that three types of innovation were common within their sample. First was "cost innovation": reengineering the cost structure in novel ways to offer customers adequate quality and similar or higher value for less cost (Zeng & Williamson, 2007). Second was "application innovation": finding innovative applications for existing technologies or products (Yu & Hang, 2011). Third was "business model innovation": the well-worn idea of changing one of the four core components of the business model (customer value proposition,

profit formula, key resources or new processes) but with a twist - adjusting those aspects that can be changed quickly and at minimal cost. All of these types of innovation can be considered disruptive in the sense that they attack performance overshoots on the mainstream attributes of an existing product while also creating asymmetric incentives between incumbents' existing business models and the new business model.

Enabling potential disruptive innovation

Building on the research that established the concept of disruptive innovation and developed a more complete typology of disruptive innovations, a substantial body of literature has elaborated on how organizations enable disruptive innovation. The explanations can be divided into four sets of pre-conditions: human resources; organizational culture; resource allocation; and organizational structure.

Two sub-aspects within the scope of human resources have been identified: managers and employees. Christensen and Raynor (2003) suggest that an additional team at the corporate level is required to be particularly responsible for collecting disruptive innovation ideas and putting them into implementation. Moreover, long-term-oriented, subjective-based incentive plans should be adopted instead of short-term-oriented, formula-based incentive plans for key executives (Govindarajan & Kopalle, 2006), so that the senior managers will not be confined by rigid incentives and avoid the risks of disruptive innovation. In terms of employees, meanwhile, disruptors are usually founded by frustrated engineering teams from established firms (Christensen & Bower, 1996).

A firm's culture has also been identified as a critical precondition for the emergence of disruptive innovation. Culture is an effective way of controlling and co-ordinating people without elaborate and rigid formal control systems (Tushman & O'Reilly, 2002). To promote disruptive innovation existing research suggests that it is important for incumbents to prepare

for and institute organizational change and unlearn deeply entrenched values at the advent of potential disruptive innovation. Some integral elements of culture, such as entrepreneurship, risk-taking, flexibility and creativity, need to be preserved and valued in order to develop disruptive innovations (Govindarajan & Kopalle, 2006). At the same time organizations need to develop change mechanisms that can help them through the process of "unlearning" obsolete mental models, approaches to R&D and production that screen out potentially disruptive innovations, or other sources of rigidity (Assink, 2006). This unlearning is especially critical for successful incumbents (compared with latecomers or newcomers), because they often find it difficult to abandon business models, R&D and design strategies and other processes that have worked well in building their current market positions.

The resource allocation process has also been shown to influence a firm's capability for disruptive innovation. Empirical research suggests that resource allocation processes using strategic buckets to manage sustaining vs. disruptive projects independently are more effective in allowing disruptive innovation to flourish (Chao & Kavadias, 2007; Hogan, 2005).

Organizational structure has been found to influence the probability of disruptive innovation through the impact of firm and business unit size and the presence of collaboration between incumbent firms and start-ups. Both case studies and surveys in high-tech industries have shown that the size of the firm is negatively correlated to the success of disruptive innovation (Christensen & Raynor, 2003; Tushman & O'Reilly, 2002). The implication is that a large corporation wishing to promote disruptive innovation should attempt to foster flexibility by having smaller business units. New start-ups, meanwhile, are frequently found to be relatively fertile ground for disruptive innovation, but lack complementary assets that are often critical to develop potentially disruptive ideas, while the necessary complementary assets are captive within incumbent leaders (Rothaermel, 2001). Collaboration between

incumbent firms and start-ups, therefore, can facilitate potential disruptive innovation.

All of these findings can help guide the management of firms to create the right pre-conditions for disruptive innovation to emerge. However, this extant literature on how R&D and production process innovations impact the extent of disruptive innovation even when preconditions are favourable is scarce. A notable exception is the work by Yu and Hang (2011), who explained how to create technology candidates that could facilitate disruptive innovation in due course. Drawing on the evidence from Chinese firms, we hope to further contribute to filling this gap by exploring new process innovations that can enable firms to promote, and then deliver on, opportunities for disruptive innovation in the context of China.

METHODS AND DATA

As we have already noted, evidence suggests that China is becoming an important source of disruptive innovation (Williamson and Yin, op. cit.). Existing research also suggests a number of factors that encourage Chinese firms to focus on disruptive innovation including a lower number of legacy customers, a relatively small installed base compared with the potential future size of their domestic market, intense pressure to make a step-change improvement in value for money to unlock the Chinese mass market, low income levels of the majority of Chinese consumers encouraging focus on "good enough" or "sufficient" product performance on key attributes, shortage of capital invest and lack of experience in traditional R&D focused on higher performance and extended functionality (Zeng and Williamson, op. cit.). Chinese firms, therefore, are a potentially fertile ground for examining what R&D and innovation processes they deploy to convert these incentives into disruptive innovations.

In seeking to answer this question we rely on inductive theory building using multiple cases (Eisenhardt, 1989). We chose this multiple case study methodology because it has

proven particularly effective in developing new theory from consistent patterns within case data using replication logic in which each case serving to confirm (or disconfirm) the emergent theory (Eisenhardt, 1989; Martin, 2011). Moreover, multiple case studies are more likely to yield more generalized, robust, and parsimonious theory than single-case studies (Langley, 1999; Yin, 2003).

Data Collection

We relied on several data sources: observations, interviews, and archival data such as internal documents, annual reports, websites, and news articles. Triangulation of all data collected can overcome the limits of relying on one method and provides more accurate information (Jick, 1979). We conducted two round of interviews (a total of 35 semi-structured interviews) with the first round between March 2010 and January 2011 and a second round between June 2011 and September 2011. The second round of interviews complemented the first by asking follow-up and clarification questions. Interviews were conducted with employees drawn from multiple levels in the hierarchy and multiple business units within the sample of 14 firms. We started the interviews by asking background questions such as the name of the informant, their role in their firm, and how many years have he/she worked with their firm. We encouraged informants to provide more details when their descriptions were brief or when novel strands of narrative emerged (Martin & Eisenhardt, 2010; Strauss & Corbin, 1990). Data collection stopped when theoretical saturation was reached (Strauss, 1987). Interviews commonly lasted 30 minutes to two hours. Interview notes were written down immediately after each interview, normally within 24 hours.

Data Analysis

We used within-case and cross-case analyses following recommendations for multiple

case studies (Eisenhardt, 1989; Miles & Huberman, 1994). We started by writing up individual cases that triangulated all of our data including observations, interviews, documents (Jick 1979), where the accessing processes were the unit of analysis. We then conducted a cross-case analysis using replication logic across firms, treating each firm as a case. During the cross-case analysis we probed for alternative theoretical relationships and constructs that might fit the data better than our initial emergent theory (Eisenhardt, 1989; Gilbert, 2005). Some of novel conceptual constructs and new theoretical relationships were revised or deleted if they did not replicate across the cases. Using replication logic, we stopped data analysis until we reached a strong match between emergent theory and empirical data.

CASE STUDY FINDINGS

Because traditional R&D processes in most organisations are generally not designed to create and deliver disruptive innovation (Christensen, 1997) we conjectured that new innovation processes with a different modus operandi as well as different goals and performance criteria might need to be implemented in order to promote disruptive innovation. The first finding of our research is that leading Chinese companies have developed organisational routines to enable them to create and deliver on opportunities for disruptive innovation -- especially of the types of innovation, cost, application, and business model innovation found to be common in earlier research (Yin and Williamson, op. cit.). The innovation routines that we found underpinning this disruptive innovation in our case studies included: industrialisation, parallel engineering, modularisation, and pragmatic decision-making. During our investigations in China we came across many firms that did not adopt these models, but rather relied on low factor costs to offer the lowest possible prices in a "race to the bottom". This suggests the firms that embraced an developed specific R&D and innovation routines to leverage abundant resources and low factor costs in novel ways did so

as a conscious strategic choice to try to gain advantage against competitors who enjoyed access similar abundant and low-cost resource pools. The ways in which these innovation routines enabled Chinese companies to deliver different types of disruptive innovations to the market are summarized in Table 1. This evidence led us to define the high-level model of the antecedents of disruptive innovation depicted in Figure 1. In what follows we detail these relationships.

Industrialising the R&D process

Some Chinese firms we studied have enabled disruptive innovation by industrialising the R&D process by adopting an "assembly-line" approach analogous to that used in manufacturing. Huawei, for example, is a Chinese multinational networking and telecommunications equipment and services company headquartered in Shenzhen, Guangdong province. It was founded in 1987 as a distributor of imported telecoms products with an initial registered capital of merely USD 3,000. The company then disrupted the telecoms industry by offering telecommunications equipment to operators with adequate functionality and reliability that could be installed rapidly, customized easily to local requirements, and serviced remotely all at a lower price than its major competitors. This enabled it to become the largest telecommunications equipment maker in the world, having overtaken Ericsson in 2012[1]. Its products and services have been deployed in more than 140 countries and it currently serves 45 of the world's 50 largest telecoms operators.

In order to complete a complex R&D task, Huawei often finely divides the process down into a multitude of specific activities. It then assigns an engineer, or even a group of engineers, solely to that specific, mini-task. So that while a company like Apple might dedicate a total of 10 engineers to a particular R&D project, Huawei would assign a 100-person team to the same opportunity. With each individual or small team working on a

[1] The Economist, 3 August 2012, "Who's afraid of Huawei".

narrowly-defined task its R&D assembly line", Huawei can complete the overall task much faster than a competitors where the smaller sized team means that each individual must tackle a more complex, multifaceted challenge (Zhang, 2011). This is possible because of the large supply of qualified engineers available in China, allowing companies like Huawei to gain the economies of scale and specialisation in R&D, not just in manufacturing. This industrialised R&D process is generally poorly suited to "traditional innovation" that typically focuses on developing completely new technologies or substantially pushing forward the boundaries of functionality. But it does appear to work well when the aim is to disrupt incumbents who have created performance overshoot by providing sufficient functionality with improved value for money, greater reliability, flexibility or shorter cycle times – goals that are often core to Christensen's original concept of disruptive innovation.

By industrialising R&D in these ways to leverage the huge pool of engineers and other staff available in China, therefore, Chinese companies are able to develop the products and processes necessary to exploit opportunities for cost, application and business model innovation at much lower levels of investment and more rapidly than using traditional R&D processes designed to develop technologies designed to innovate on the basis of improved functionality or more sophisticated products. Industrialized R&D processes therefore enable Chinese companies to bring products adequate to meet the basic functionality and reliability demanded by mainstream, mass-market consumers with a wider choice of incremental features, more customization, faster and at lower prices than competitors using traditional innovation processes are in a position to deliver. It this enables innovations are disruptive in the sense that the up-end conventional wisdom about the relevant bases of competition in an industry and the existing business models of incumbent firms.

This analysis leads us to the following proposition:

Proposition 1: Industrialising the R&D processes can facilitate disruptive innovation in

China by reducing the total investment cost required to rapidly develop a product that offers greater value for money to consumers by incorporating uniquely market-relevant features and/or performance and offering these to consumer sooner than incumbents and at lower prices.

Parallel Processing in R&D

We found that some leading Chinese firms such as Lenovo adopted a different approach to accelerating disruptive innovation, borrowing not from the concepts of assembly lines used in manufacturing, but from the idea of "parallel processing" commonly used in supercomputers. Lenovo is a Chinese multinational technology firm with headquarters in Beijing, China and Morrisville, North Carolina, United States. The company was founded in Beijing in 1984 as a reseller, distributor for foreign brands such as IBM. In 1990, Lenovo started to manufacture its own PCs and by 1997 became the market leader in China over international leading firms such as Dell, HP and IBM. In 2004, Lenovo made a strategic choice to expand abroad and bought IBM's PC business for USD 1.25 billion. The company then disrupted the global PC sector and became the world's second-largest personal computer vendor by unit sales[2].

Following their acquisition of IBM's personal computer business back in late 2004, Lenovo adopted many of the R&D disciplines and procedures IBM had developed over decades of successful innovation. But Lenovo also modified the IBM R&D blueprint by introducing a parallel-processing approach. Instead of treating R&D as a linear process, Lenovo began to create a new R&D process that allows various functions that are normally

[2] Gartner, 14 January 2013, "Gartner says Declining Worldwide PC Shipments in Fourth Quarter of 2012 Signal Structural Shift of PC Market".

sequential steps to be conducted simultaneously.

The concept of simultaneous engineering is certainly not new (Clark and Fujimoto, 1991), but in the Chinese disruptive innovators we studied it had been adopted more extensively than appears to be the case in most incumbent firms, involving more development stages and greater timing overlaps. Pushing this parallel processing in the innovation process beyond accepted limits clearly carries risks, not least because the information necessary to shape the next step maybe incomplete or unavailable when the tasks are undertaken in parallel. But for disruptions such as cost, application and business model innovation where the underlying technology remains unchanged this risk is relatively small. Because the overall architecture of the tasks to be performed and the interfaces are already pre-defined by a standardised approach, it is not always necessary to work sequentially. Instead, much of the work can proceed in parallel relying on standardised interfaces to make sure the results of each task come together in a coherent whole. Within the context of many forms of disruptive innovation that do not involve revolutionising the underlying product architecture nor redesigning the interfaces between stages of the innovation process, parallel processing can be efficacious. Based on this observation from our case research, therefore, we advance the following proposition:

Proposition 2: Parallel processing in R&D can facilitate disruptive innovation in China by reducing the total time and cost required to develop a product that offers greater value for money to consumers by incorporating uniquely market-relevant features and/or performance compared with incumbents and at lower prices.

Modularising product development

We observed that modularisation of the product development process (not only the more common technique of designing a modular product) was another important process tool

used by Chinese firms to enable disruptive innovation – especially in helping them to test the market potential of cost, application and business model innovation ideas by launching them onto the market in rapid waves. This advantage is potentially significant because in Christensen's model of disruptive innovation rapid improvement of the performance of disruptive technology allowing it to attract new customers and gain economies of scale is key.

In mobile handsets, starting as an OEM (Original Equipment Manufacturer) or a distribution channel for leading brands, Chinese companies such as Tianyu Longtong and Jinli Group, among others, have captured a high share of the mid- and lower-tier markets by breaking down the design process into separable modules, so that redesign focuses only one attribute at a time. By limiting the re-design to small increments in one aspect of the functionality, rather than waiting until to have a model that more completely new, successive upgrades and new models of cheaper me-too phones with added features can be released into the market every few weeks[3]. These me-too alternatives are labelled as shanzhai phones (after "shanzhai": the mountain fortress where outlaws hide, hinting at their illegal nature). In 2012 shanzhai products ranked second in the Chinese mobile phone sector with 16.1% market share[4]. In some instances new shanzhai phones reach the market even ahead of market launch of the models of leading brands that inspired them!

Modularisation of the product development process is key to the shanzhai manufacturers incredible speed to market. Many buy the core modules that form the heart of the phone from MTK, based in Taiwan. MTK, through its past experience in the DVD market has integrated the parts required for a mobile phone into a set of basic hardware modules. It can also supply its customers with the software to knit these modules together, forming a platform capability of underpinning a wide range of alternative functions. Shanzhai phone

[3] 21st Century Business Review, 2011.

[4] The Register, 25 May 2012, "Nokia and Symbian still number one in China".

manufacturers, therefore, simply need to purchase the relevant modules from MTK, commission a design firm to redesign particular features or attributes such as the exterior case and then undertake the final assembly of the handset. This means they can focus the efforts almost exclusively on managing the product development process to maximise the speed with which they can test new models in the market. The rapid "launch-test-improve" cycle of innovation is particularly well suited to cost, application and business model innovation.

The use of modularization for Disruptive Innovation development has also been confirmed in other research (Brown & Hagel, 2005; Hang, Chen, & Subramian, 2010). Brown and Hagel (2005) explained that Chinese motorcycle manufacturers in Chongqing adopt "localized modularization" for disruptive innovation - a loosely controlled, supplier-driven approach that speeds up a company's time to market, cuts its costs, and enhances the quality of its products. Hang, Chen and Subramian (2010) indicated that Yadea, a Chinese electric bike maker, shifted to modular architecture, coupled with high volume, quickly brought down the price for mass-market consumption. These findings lead us to posit:

Proposition 3: Modularising the product development process can facilitate disruptive innovation in China by reducing the total time and cost required to develop a product that offers greater value for money to consumers by incorporating uniquely market-relevant features and/or performance compared with incumbents and facilitating innovations that drive down prices rapidly by speeding up the rate at which multiple aspects of the product can be improved..

Pragmatic decision making in the R&D process

The traditional decision making processes that have become embedded in many global corporations understandably reflect the demands mature markets where legacy customers can be cautious about change and where regulatory constraints and risk aversion

all militate against the launch of new products or business models until these have thoroughly researched and tested. Rules, regulations and "standard operating procedures" originally designed for routine activities have permeated many large companies including the supposed crucible of creativity: R&D. Meanwhile the move away from traditional corporate hierarchies towards so-called "flat organisations" has necessitated extensive consensus building, involving key members of every department or team that might be impacted, before radical changes are decided upon and implemented. Such consensus building is generally time consuming because each different department has their own agenda in mind and is prone to the pursuit of local optimisation rather than taking the perspective of what is best for the entire organization.

An increasing number of large companies are coming to recognise these problems associated with highly structured and corporate consensus-driven R&D and innovation processes leading them to engineer a shift towards more decentralised models that enable more localised and rapid decision making. General Electric's disruption of its own internal structure and processes is a good example (Immelt, Govindarajan &Trimble, 2009). Hamel (2007) have gone even further suggesting that innovation will lead to competitive advantage primarily when is based on a novel management principle that challenges some long-standing orthodoxy and is part of an on-going program of rapid-fire invention where progress compounds over time.

Interestingly in our sample of Chinese firms we observed that the structures tended to be even more hierarchical and our experience of their typical Western companies. We found that in Chinese firms a single, senior individual often overlooked the entire R&D process and his or her word was proverbial "law". Such dependence on the judgement of a single executive increases the risk that R&D efforts end up moving in a completely unproductive direction. But this hierarchical structure and decision making does speed up the process of

initiating, developing and launching innovations. At the same time, we observed that the innovation processes adopted by Chinese companies provided extreme horizontal flexibility to marshal and re-combine resources from different departments and functions horizontally across the organisation behind a favoured idea. Whenever a problem arose in the R&D process the most common approach for Chinese companies is to call for an immediate meeting attended by the heads of relevant departments. A quick diagnosis was performed and solutions often swiftly decided upon, after which immediate action was taken by the participating party (in large part because of intense pressure from the vertical hierarchy on the entire group to deliver). This process might be dubbed "huddle-and-act".

Chinese companies can also often afford to take decisions to back a potential innovation more quickly than firms in high-cost locations because even moderate market success will take them beyond their lower break-even levels. The economics of creating a new mobile phone again provides an instructive example from our case studies. For a company located in Europe or the USA, such as Nokia, such a project needs to cover an investment of millions of dollars before it becomes profitable. Each new innovation project therefore represents a significant decision for which the probability of success must be thoroughly assessed before proceeding.

By focusing on a different set of disruptive cost, application and business model innovation opportunities, by contrast, we observed that Chinese firms are able to launch as many as 20 new models for the same total investment as their Western competitors. Each innovation therefore represented a small, rapid-fire bet. Only a small proportion needed to succeed in order to make the whole programme profitable so that each launch decision could be taken quickly even if the available information is incomplete, allowing Chinese phone makers to respond to rapidly changing consumer preferences and fashion trends.

A combination of hierarchical vertical, but horizontally flexible organisational

structures, low break-even points and a highly fluid home market with lighter regulation and less loyal customers more willing to experiment, therefore, has encouraged Chinese competitors to develop flexible R&D and decision making processes that can create new opportunities, especially for disruptive cost, application and business model innovation. Based on the above reasoning, we advance the following proposition:

Proposition 4: Pragmatic and rapid decision making in the R&D processes can facilitate potential disruptive innovation in China by reducing the total time and cost required to develop a product that offers greater value for money to consumers by incorporating uniquely market-relevant features and/or performance compared with incumbents by facilitating the development and implementation of cost, application and business model innovation.

DISCUSSION

Our multiple case study research suggests that new or unconventional R&D and innovation processes are important antecedents to the disruptive innovations previous research has identified as being prevalent in Chinese companies. In particular, moves to industrialise R&D processes, extend the use of parallel processing to more development stages with greater timing overlaps, modularise product development processes, and adopt pragmatic and rapid processes for R&D decisions, appear to underpin and facilitate disruptive innovation. These findings beg the question of whether developments in the approach of Chinese to the process of innovation matter for competitors in the wider global market? We believe they necessitate a re-think among incumbent competitors, especially in developed economies, for two key reasons. First and foremost, emerging markets, especially the BRIC (e.g., Brazil, Russia, India and China) and VISTA (i.e., Vietnam, Indonesia, South Africa, Turkey and Argentina) are becoming increasingly important as drivers of global demand. As the *Economist* magazine has pointed out, already by 2005 the combined GDP of emerging

and developing economies had risen to above half of global GDP when measured at purchasing-power parity[5]. On average developing country markets are now also growing an order of magnitude faster than those in the developed world. The capabilities to succeed in emerging markets, therefore, will be decisive in the next round of global competition (Knight & Cavusgil, 2004).Yet these capability requirements are often substantially at variance with those associated with success in a world where global demand had been dominated by consumers in developed markets (Prahalad, 2004). In order to unlock the mass market in these countries requires a step-change in the price/performance ratio and value for money – and, therefore, the identification of broader opportunities for disruptive cost, application, and business model innovation as well as the new types of R&D and innovation processes necessary to underpin these types of innovation.

A second important shift in the global market stems from the fact that China's 1.3 billion people (including a potentially active labour force of 800 million) can't move from economic isolation to become an integrated part of the world economy without a downward pressure on global labour rates. And that process, which began in 1978 when China started to open up to the world, still has a long way to go: there are still at least 500 million Chinese still to move from low-productivity agriculture to be efficiently employed in manufacturing and services. That's before we even take account of another 1 billion that might make this transition in India and other developing countries over the next decades. While these shifts continue, and there is little reason to suppose they will stop, at the macro level downward pressure on wages will continue. These forces have led real income levels of a significant segment of the working population in the developed world to stall or even to decline (especially among less-skilled workers in the North America and Europe). Many also feel their job security is under threat. As a result, a substantial, and growing, market segment of

[5] The Economist, 17 April 2010, "Networked Networks".

consumers in the developed world have become acutely focused on seeking out the lowest prices and best "value for money". At the same time, they want to maintain interest and excitement by being able to chose products they see as keeping up with new trends and are loath to restrict their choice of variety. From our research it seems that Chinese firms are developing R&D and innovation processes that will improve their chances of delivering disruptive innovation that will enable them to prosper from this growing segment that demands "every day low prices" and increased value for money for innovative products as well as commodities (Tan, 2011). In order to compete as their existing profit engines based on ever-increasing functionality and product sophistication are disrupted by this shift in market demand and competition from China, global incumbents will need to rethink both how they identify opportunities for innovation and the capabilities needed to realise them.

A successful response probably involves both a shift in mind-set and an extension and re-engineering of innovation capabilities. First, exposure to disruptive innovation may need to be reassessed and the focus of innovation broadened to give greater weight to opportunities for cost, application and business model innovation relative to pure technological advancement. Second, to improve the likelihood of delivering these kinds of innovation R&D and innovation processes may need to re-engineered to create new processes that can run in parallel with established approaches. This reengineering is likely to involve more industrialisation of some R&D processes, greater use of parallel processing in more development stages with greater timing overlaps, more modularisation of the development processes for products aimed at mainstream and value segments and the adoption of less process-bound and more pragmatic and rapid decision making in respect of R&D projects.

In fact, our findings from case study evidence in China suggest that this kind of re-engineering of the R&D processes may be critical to the implementation of what has been termed "reverse" innovation (Govindarajan&Trimble, 2012) or "Jugaad" innovation (Radjou,

Prabhu & Ahuja, 2012) because these kinds of innovation are unlikely to be effectivey and efficiently delivered R&D and innovation processes that were designed to deliver innovation focused on technological improvements, additional functionality or greater sophistication.

Of course, given the relatively small sample size our results are preliminary. The findings do suggest, however, that further research designed to understand the antecedents of disruptive innovation across a broader range companies in China as well as those headquartered in other countries where R&D and innovation processes may be being re-engineered.

CONCLUSION

The antecedents of innovation on the technological frontier or that focused the development of greater functionality have been extensively studied (Scott & Bruce, 1994; De Tienne & Mallete, 2012). Existing research has also explored the pre-conditions under which disruptive innovation is likely to arise within an organization. There has been much less investigation, however, of the nature of the R&D and innovation processes that might facilitate disruptive innovation. The fact that a significant amount of disruptive innovation has been coming from Chinese firms in recent years suggested that an analysis of its antecedents might shed light on this question. Based on multiple case studies of Chinese firms we found that their adoption of new or somewhat unconventional R&D and innovation processes did seem to facilitate various kinds of disruptive innovation. Specifically, the industrialisation of R&D processes, the extended use of parallel processing in more development stages with greater timing overlaps, the design of modular product development processes, and the adoption of pragmatic and rapid processes for R&D decisions, do appear to underpin and facilitate disruptive innovation in our sample of firms.

From a theoretical standpoint our results suggest that in understanding the antecedents of disruptive innovation it is not sufficient to explain the preconditions that create a favourable environment for disruptive innovation to emerge, including: the characteristics of its human resource pool; its organizational culture; its resource allocation processes; and its organizational structure. It is also important to model another important link in the logic chain: the mechanisms by which the R&D and innovation processes firms choose to adopt facilitate (or impede) the successful emergence of disruptive innovations.

This conclusion also has relevance to the long-standing debate on whether opportunities for disruptive innovation are discovered or created by entrepreneurs. Our findings show that while the Chinese market is undoubtedly shapes the kinds of innovations that are emerging there, the fact that many disruptive innovations in China have their antecedents in new R&D, design and production processes that entrepreneurs have put in place shows the importance of creating opportunities for disruptive innovation (rather than solely discovering them).

For a managerial standpoint, as global market growth is increasingly driven by consumers in developing economies and the "value-for-money" segments in developed economies, these findings suggest that, perhaps somewhat surprisingly, incumbents may need to look to emerging economies such as China that we might to find the some of the keys to delivering the kinds of innovation that will allow companies to thrive and prosper in the next round of global competition. Incumbent firms increasingly exposed to disruptive innovation may also need to re-engineer their existing R&D and innovation approaches to create new processes. Even when these can run effectively in parallel with established procedures, the barrier of unlearning existing approaches to innovation may need to be overcome to achieve this kind of change.

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Table 1

R&D and production process innovations (representative cases)

Case firms	R&D and production process innovations	Disruptive Impact	Results
Huawei	Industrialising the R&D process	Providing adequate functionality, rapid installation, higher levels of customization, sooner than incumbents and at lower prices.	(1) Founded in 1987 as a distributor of imported telecoms products (2) Now the largest telecommunications equipment maker in the world
Lenovo	Parallel processing in R&D	Reducing the total time and cost required to develop a product that offers greater value for money to consumers.	(1) Founded in 1984 as a reseller, distributor for foreign brands (2) Now the world's second-largest personal computer vendor by unit sales
Tianyu, Jinli Group	Modularising product development	Reducing the total time and cost required to develop a product that offers greater value for money to consumers by speeding up the rate at which multiple aspects of the product can be improved.	(1) Started as an OEM or a distributor channel for leading brands (2) Shanzhai products ranked second in the Chinese mobile phone sector with 16.1% market share in 2012
Tianyu, Jinli Group	Pragmatic decision making in the R&D process	Reducing the total time and cost required to develop a product that offers greater value for money to consumers by facilitating the development and implementation of cost, application and business model innovation.	(1) Started as an OEM or a distributor channel for leading brands (2) Shanzhai products ranked second in the Chinese mobile phone sector with 16.1% market share in 2012

Figure 1
R&D and production process innovations enabling potential disruptive innovation