

Presenter Symposium:  
**Innovation in China From an Individual, Firm, and National Perspective**

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**Institutionalized Choice and Entrepreneurship**

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**The Dark Side of Embeddedness: When Family Relationships Give Rise to Malfeasance**

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**Up, Down, and Sideways: Innovation in China and the Case of Plug-in Vehicles**

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**Analyzing Chinese Approaches to Defense Science, Technology, and Innovation Development**

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**Potential Sponsor Divisions**

TIM: Technology & Innovation Management  
BPS: Business Policy & Strategy  
IM: International Management

The symposium organizer, John Helveston, has received the statements from all participants in the symposium stating that they are not in violation of the Rule of Three + Three.

## **ABSTRACT**

China is rapidly rising as more than just an economic and manufacturing powerhouse but also as a center for emerging forms of industrial innovation, often further downstream and focused on product commercialization and redefinition. Understanding the underlying relationships between individual, firm, and national level factors and this changing innovation environment could become increasingly important for entrepreneurs, managers, and national leaders to successfully navigate China's emerging role in the global economy. In this symposium, we include four papers that explore these relationships, including those between 1) institutions and entrepreneurs, 2) familial ties and malfeasance, 3) institutions and firm innovation directions, and 4) innovation and China's national security strategy. Following the presentations, Barry Naughton, an expert on the Chinese economy, and Minyuan Zhao, an expert on firm strategy in a global context, will provide suggestions and co-lead a group discussion.

**Keywords:** China, Innovation, Institutions, Entrepreneurship, National Security, Embeddedness

## **SYMPOSIUM OVERVIEW**

By John Paul Helveston

In addition to its rapid rise as an economic and manufacturing powerhouse, China has also become a focal nation for the study of innovation. While some scholars have suggested that innovation in China is predominantly limited to process innovations in mass manufacturing (Brandt & Thun, 2010; Branstetter, Li, & Veloso, 2014; Ge & Fujimoto, 2004; Steinfeld, 2004, 2010), others point to more complex and involved forms of industrial innovation, involving product-process co-development focused on product commercialization and redefinition (Breznitz & Murphree, 2011; Ernst & Naughton, 2008, 2012; Herrigel, 2010; Nahm & Steinfeld, 2014; Nahm, 2012). Given this evolving context, how are China's institutions, markets, and policies contributing to the diversity and evolution of innovation in China? This symposium unpacks these relationships from individual, firm, and national level perspectives.

A large body of research suggests that China is playing the typical role of a developing nation in Vernon's classic product cycle (Vernon, 1966), where the observed forms of innovation center around imitation, product modularization, and cost reduction (Brandt & Thun, 2010; Branstetter et al., 2014; Ge & Fujimoto, 2004; Steinfeld, 2004, 2010). These observations remain consistent with the theory that the most sophisticated and technologically advanced products tend to originate in the most industrially advanced nations and later become standardized and commoditized in developing countries. On the other hand, an emerging body of literature is challenging this traditional view, illustrating a complex variety of innovative behavior in China. Some show how Chinese firms are creatively taking advantage of increasingly globalized production environments to catch up and compete with global leaders (Ernst & Naughton, 2008, 2012). Others highlight how Chinese firms are adding value along the production chain through

incremental process innovations (Puga & Trefler, 2005) as well as by becoming an integral part of the commercialization process of new products (Breznitz & Murphree, 2011; Herrigel, 2010; Nahm & Steinfeld, 2014; Nahm, 2012).

As China continues to play an evolving and more complex role in the fractured global production of goods, understanding what factors are shaping China's innovation environment could become increasingly important for entrepreneurs, managers, and national leaders. The four papers in this symposium address a variety of these factors from multiple perspectives.

The first paper takes the individual level perspective. By examining the relationship between institutions and entrepreneurship, the authors find that institutionalizing choice can support and enable rather than constrain entrepreneurial behavior. They also find that this effect can vary depending on the types of individuals affected, influencing decisions to invest in generalized human capital rather than specialization. The authors exploit a natural experiment at a major Chinese university and apply a differences-in-differences approach. These findings suggest that institutions can be structured to increase entrepreneurial behavior, which can lead to an increase in the magnitude and diversity of innovations.

The second paper takes a perspective of both individuals and firms by examining the impact of embeddedness and social networks on the likelihood of malfeasance in firms. Utilizing detailed data on relationships between firm owners and top-level managers, Li finds that malfeasance is more likely in extended family relationships and less likely in nuclear family relationships, relative to non-familial relationships. Li argues that these differences could be explained by differences in the level of emotional intimacy between owner and manager. These findings have important consequences for both foreign and domestic firm owners and managers in China.

The third paper takes the perspective of the firm and describes how the combination of institutional and market forces are shaping the direction of innovation amongst firms in China's emerging plug-in vehicle sector. By examining national vehicle sales data and conducting 34 qualitative interviews with automotive managers and engineers, government officials, researchers, journalists, and industry consultants, the authors identify three distinct directions of innovation with respect to the technological and business strategy frontiers in the automotive industry. The case study-based findings suggest that both national institutions, such as the joint venture system, and local institutions, such as local protectionist policies, may be insulating independent Chinese firms from foreign and domestic competition. In addition, the findings suggest that the size and heterogeneity of China's domestic market may be providing a sustained demand for the large variety of innovations within this one sector. These findings have important implications for the development of emerging technologies both in China and potentially other developing nations.

Finally, the fourth paper takes a national perspective and assesses China's approach to defense science, technology, and innovation development. Cheung takes an innovation systems approach to examine the Chinese defense economy and identifies important processes that are shaping how China will meet its goal of becoming a world-class defense science and technology power by the next decade. By focusing on defense innovation, Cheung sheds light on an often overlooked dimension of innovation studies and develops a framework for understanding defense / military innovation in China, which often involves dual-use civil-military institutions in China's science, technology, and industrial base.

By combining these four papers, this symposium creates a timely discussion about innovation in China and China's larger role in the global economy. While the papers individually

highlight different relationships, together they shed light on important mechanisms by which individuals, firms, and government interact to shape China's innovation environment. In addition, the papers also provide different views on how China can shape its institutions to reach its goal of becoming a global leader in science and technology. As the global distribution of manufacturing activities continues to shift to China, the innovations that emerge from China could have global impacts for some industries. In discussing the four papers, Barry Naughton will leverage his extensive background in issues related to industry, trade, finance, and China's transition to a market economy, and Minyuan Zhao will leverage her expertise on firm strategy in a global context.

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## PROPOSED SYMPOSIUM FORMAT

Length: 90 Minutes

Action	Minute	Speaker	Event
Introduction	0 – 5	John Helveston	Symposium welcome and introduction
Paper Presentations	5 – 20	Charles Eesley	Institutionalized Choice and Entrepreneurship
	20 – 35	Jian Bai Li	The Dark Side of Embeddedness: When Family Relationships Give Rise to Malfeasance
	35 – 50	John Helveston	Up, Down, and Sideways: Innovation in China and the Case of Plug-in Vehicles
	50 – 65	Tai Ming Cheung	Analyzing Chinese Approaches to Defense Science, Technology, and Innovation Development
Discussion	65 – 90	Barry Naughton Minyuan Zhao	Discussants co-lead the group discussion

## **RELEVANCE TO DIVISIONS**

### **Technology & Innovation Management**

Today, China's Manufacturing Value Added approximately matches that of the U.S., both in absolute and in percentage terms (The World Bank, 2013). In addition, as the largest and most open economy of any large developing country, the incentives for innovation in China could influence global innovation incentives and trajectories. In this environment, both state and non-state actors exert significant influence in individual, firm, and national technology adoption decisions. This symposium explores these dimensions of technology and innovation decisions in China by unpacking the relationships between institutions and entrepreneurs, social relationships and malfeasance, institutions and firm innovation directions, and the role of innovation in China's national security strategy.

### **Business Policy & Strategy**

Over the past few decades, China's economic strategy has transformed from primarily state-owned and managed industry to private ownership and financial liberalization (Huang, 2008). As a result, China has emerged as a major global producer, consumer, and center for unique, downstream industrial innovation. Today, given China's position in the world as the largest and most open economy of any large developing country, the factors shaping the incentives for innovation could have significant implications for entrepreneurs, managers, and national leaders. This symposium unpacks these factors from the perspective of individual entrepreneurs, owners and managers with familial ties, firm innovation directions in emerging technologies, and national security.

## **International Management**

This symposium explores China's changing innovation environment from individual, firm, and national perspectives. As China continues to liberalize its economy while seeking economic growth and indigenous innovation, understanding this innovation environment will become increasingly important for both local and multinational firms in China. In addition, as the leading receiver of foreign direct investment (FDI) among developing nations, the relationships examined in this symposium will likely have consequences for firms worldwide.

## PRESENTATION SUMMARIES

### **Institutionalized Choice and Entrepreneurship**

*Charles Eesley, Delin Yang, Xiacong Tian*

#### **Abstract**

This paper addresses a theoretical puzzle regarding how individuals exert agency in the face of institutional constraints. We leverage a unique research setting to extend institutional theory by introducing and testing the concept of institutionalized choice. Institutions enabling individual choice foster entrepreneurship in allowing, rather than restricting individual choices. This paper explores the elimination of an institutional constraint on individual choice – the academic year system – by examining Tsinghua University’s (Beijing) adoption of the credit system in 1984 resulting in institutionalized choice. Using a differences-in-differences approach, we find that a shift towards more individual choice increases entrepreneurial behavior. Furthermore, we find that institutional change is likely to affect different types of individuals in distinct ways, which encourages investment in more generalized human capital rather than specialization. The results contribute to the literature on institutional constraints on variation in individual behavior while addressing the embedded agency puzzle of how durable, stable institutions might foster processes of emergence by theorizing how choice can be institutionalized.

#### **Introduction**

The nexus of institutions and entrepreneurship is becoming increasingly important (Hoskisson et al. 2000, Sine et al. 2005, Haveman and Tolbert 2005, Lounsbury and Glynn 2001, Hiatt et al. 2009). Institutional theory offers important insights into this phenomenon and entrepreneurship is seen as having real world implications for economic growth (Baumol and

Strom 2007). There are two streams of research at this nexus. The first looks at how individuals within an institutional form engage in promoting change (i.e., institutional entrepreneurs) (Lounsbury 2002, Greenwood and Suddaby 2006). The second examines how institutional changes, such as regulatory change, can change rates of entrepreneurship and who becomes an entrepreneur (Sine and Lee 2009, Hiatt et al. 2009). In this paper we examine another aspect of this nexus - institutionalized choice. We define this by the degree to which an institution gives individuals choice.

Traditional discussions of institutions have emphasized constraints, stability, rigidity, and effects of becoming standardized, taken-for-granted, or institutionalized. However, in focusing on the importance of constraints and the impact of institutions, prior literature has had less to say about how institutions might facilitate rather than limit individual choice. The research question we ask is: how can institutions, which often constrain behavior, support individual agency? In this paper, we are interested in individual agency as expressed in entrepreneurial behavior.

A newer stream of institutional theory has focused on institutional entrepreneurs and the embedded agency of individuals who strive to alter existing institutions (Holm 1995, Lounsbury and Crumley 2007). Following this line of theorizing, scholars have pointed to the dilemma of embedded agency – how and when do individuals exert agency while under institutional constraints? Recent literature has pointed to ways individuals can avoid these constraints and exercise their agency by being located in particular social positions (Battilana 2006) or using different discursive strategies (Suddaby and Greenwood 2005). Yet, some scholars question whether this view endows actors with too much “strategic intentions, foresight, and well-rehearsed social skills” (Aldrich 2010, p. 330). However, instead of relying on individuals to act in contradiction to institutional embeddedness, it may be that some institutions allow more room

for choice or even institutionalize choice. Institutionalized choice may open up possibilities for entrepreneurial action and ideas.

We define institutionalized choice as the characteristic of formal or informal institutions that permits individual choice.<sup>1</sup> When choice itself, rather than a specific behavior or action becomes the target of institutionalization then flexibility and variation are built in and explicitly preserved, rather than standardization. The preservation and protection of choice may lead to more creative, innovative and entrepreneurial behaviors. It presents individuals with opportunities to choose new ways of experimenting and recombines ideas or resources into novel actions in the economy.

We take advantage of a natural experiment in China where a major university increased the choice provided to individuals in its rules governing the curriculum. We highlight two key findings and contributions. First, we find that institutionalized choice during an individual's university years has a lasting influence on the subsequent likelihood of entrepreneurship. We find an increase in both entrepreneurial behavior and intentions for individuals who graduated just after the reform relative to individuals graduating just before the reform. Second, this effect was particularly strong for students who were not at the higher or lower end of the academic performance distribution. We interpret these results as demonstrating that institutionalized choice influences individual career decisions towards entrepreneurship. Our primary contribution to institutional theory is to introduce the concept of institutionalized choice as a mechanism that leads to individual agency and in particular, to entrepreneurial behavior. In doing so, we add to an important, growing stream within this literature that contributes to the micro-foundations of

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<sup>1</sup> We thank an anonymous reviewer for suggesting important edits to the definition of institutionalized choice, including that it may be permitted but not necessarily taken-for-granted to have initial effects.

institutional theory by showing mechanisms by which institutions influence individual choices (Powell and Colyvas 2008, Colyvas 2007, Colyvas and Powell 2006).

## **Background Literature**

Institutions have been described by neoinstitutional theory as taken-for-granted understandings (Berger and Luckman 1967) or as rules of the game (Powell and DiMaggio 1991). Prior work has shown that cognitive, normative and regulatory pillars of institutions all play important roles in condoning, habitualizing and legitimating certain choices and organizations over others (DiMaggio 1991, Scott 2014). A central finding of institutional theory is that new organizations prosper when they are congruent with their institutional environment as defined by belief systems, regulatory and normative structures (Meyer and Rowan 1977). Institutions constrain action by delineating the set of interpretations and actions available to an individual (DiMaggio 1997, Meyer and Rowan 1977, Powell 1991), prompting many scholars to subsequently write about the “iron cage” resulting from institutionalization and bureaucratization (Weber, 1968). Institutional research has brought to light the importance and ubiquitous nature of standards, norms and rules in society (Brunsson and Jacobsson 2000). Examples of institutions constraining individual and organizational choices have been shown in activist organizations (Loundsbury and Glynn 2001), educational publishing, grievance procedures and in science (Thornton 2002, Edelman et al. 1999, Colyvas and Powell 2006).

Nonetheless, certain phenomena, often associated with organizational emergence or individual agency have been difficult to reconcile with this view of institutions. For example, entrepreneurship is often associated with a belief in individual autonomy, locating agency in individuals as creating and breaking free from habits and traditional ways of doing things (Aldrich 2010, Meyer and Jepperson 2000). Yet we have relatively less theoretical insight into

questions of individual agency in the presence of institutional constraints (Hwang and Powell 2008). The paradox of embedded agency refers to how individuals are able to exert independent choices and action in the face of institutionalized constraints. Agency is defined as an individual's ability to intentionally pursue interest, alter the rules or distribution of resources, and affect the social world (Scott 2014).

Recent work in institutional theory has examined various mechanisms where institutional environments may lead to more variation and adaptive behavior. This has taken the form of fluid or proto-institutions, institutional complexity, and institutional polycentrism (Ostrom 2005). Emergence-based institutionalization, for example, has been studied in the context of proprietary disclosure in academic life sciences (Colyvas and Maroulis 2015). In many of these the institutions themselves or which institution one must follow is somewhat malleable or flexible. In this paper, we propose a mechanism, that does not rely on the institution itself being malleable, but rather where the institutionalized behavior is choice. Rather than the institutions being flexible themselves, they allow for choice in individual behaviors. Individuals who receive education and training under this type of institutionalized choice by extension, carry this training forward in their careers.

Instead of relying on individual agents themselves to act in contradiction to institutional embeddedness, it may be that some institutions inherently allow more room for choice than others. Thus, in contrast to this work on institutional entrepreneurs, we focus on how environments with institutionalized choice may foster the pursuit of new opportunities and entrepreneurship (new firm creation) in particular. If institutions provide for individual choice, then an individual does not have to break free from institutional constraints. When institutions allow choice to be the focal action (under institutionalized choice), then agency becomes more

embedded into the institutional context. In contrast to prior work, we propose a novel mechanism that emphasizes the role of the type of institutional environment in an individual's past, specifically whether they were educated in a system that provided institutionalized choice. Our contribution is a novel mechanism in which educational training under institutionalized choice in the individual's past develops his entrepreneurial intentions and behavior. This idea of institutionalized choice offers a contribution to literature on institutions and entrepreneurship as a different mechanism to explain why certain institutional environments foster individual agency and specifically, entrepreneurship.

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# **The Dark Side of Embeddedness: When Family Relationships Give Rise to Malfeasance**

Jian Bai Li

## **Abstract**

Research on embeddedness and social networks has shown that social relationships generate trust and dedication, but scholars have also surmised that social relationships may give rise to malfeasance. So which kinds of relationships tend towards malfeasance rather than dedication and trust? To answer this question, I study malfeasance in owner-top manager relationships in family firms located in China's Yangtze River Delta region. Drawing on detailed data on 932 owner-top manager relationships from 249 informants at 82 firms, I find that, relative to owner-nonfamily relationships, owner-nuclear family relationships are less likely to engender malfeasance while owner-extended family relationships are more likely to do so. I argue that this is because relationships generate trust only when the parties involved actually share high levels of emotional intimacy. When a relationship is nominally "intimate", opportunistic actors may take advantage of the relationship to embezzle, steal, and commit other kinds of malfeasance. My study makes contributions to the literature on embeddedness as well as to the research on family businesses.

## **Paper Summary**

One of the core insights of economic sociology is that social relationships are effective at deterring cheating, fraud, and other forms of malfeasance. Central to this insight is Granovetter's (1985) concept of "embeddedness": that is, economic transactions are often conducted not via arms-length exchanges, but via relationships laden with affectual, social, and cultural content. Such content generates intimacy and trust, which in turn facilitates the exchange of up-to-date, detailed, and nuanced information (Powell, 1990). At the same time, the content present in

relationships also promotes reciprocity, such that the parties involved are more likely to subjectively abnegate malfeasance in favor of behavior that result in mutual gain (Uzzi, 1996). Thus conceptualized, social relationships are effective at deterring malfeasance because 1) relationships provide more accurate, relevant, and trustworthy information and 2) relationships motivate actors to refrain from engaging in malfeasance.

However, scholars have also noted that social relationships often give rise to malfeasance. Precisely because these relationships are often characterized by trust and dedication, the actors involved may “drop their guard” against deviant behavior (Nee and Ingram, 1998). For this reason, relationships may actually serve as fertile grounds for malfeasance—particularly if the payoffs are high (Grief, Milgrom, and Weingast, 1994). Similarly, deviant schemers may have more success carrying out malfeasance within the context of a social relationship than outside of it (Nee and Ingram, 1998; Desmond, 2012). In the words of Granovetter (1985) himself, “both enormous trust and enormous malfeasance may follow from relations.” Yet, while prior research on embeddedness and social networks have thoroughly studied how relationships generate trust and dedication, scholars have paid less attention to when and what kinds of relationships may actually engender malfeasance.

I address this gap by examining malfeasance in relationships between firm owners and top managers—some of whom are owners’ family members—in family enterprises in China’s Yangtze River Delta region. Drawing on detailed interview data I gathered from 249 informants at 82 firms in this region, I examine which kinds of owner-family top manager relationships are *even more* likely to engender malfeasance than owner-nonfamily manager relationships. Given the prevalence of family businesses around the world, the importance of family firms to China’s economy, and owners’ reliance on relationships to curb malfeasance in emerging economies, my

study not only addresses an interesting theoretical question but also bears practical implications for executives in family businesses.

My findings are consistent with my theorizing regarding relationships and malfeasance. I find that, relative to owner-nonfamily manager relationships, relationships between firm owners and nuclear family in the top management are less likely to engender malfeasance. Yet, I also find that relationships between firm owners and extended family in top management are *more* likely to engender malfeasance. I argue that this is because embedding employer-employee relations in family has two opposing effects: the trust and dedication generated by family relationships may indeed de-motivate malfeasance, but the family norms specific to these relationships may also inhibit the implementation of formal governance arrangements and drive malfeasance. The level of emotional intimacy in the relationship determines which effect manifests. In owner-nuclear family relationships, high emotional intimacy so strongly de-motivates malfeasance that the parties involved refrain from cheating even if conflicts between family norms and formal governance create opportunities for doing so. But in owner-extended family relationships, low emotional intimacy does not sufficiently de-motivate malfeasance, while family norms also inhibit the implementation of formal governance arrangements. This “nominal” embeddedness thus creates a perverse incentive structure that significantly increases the likelihood of malfeasance.

My study contributes to the literature on embeddedness. My core contribution is a theoretical framework that may begin to explain how embedding economic transactions in certain types of relationships may increase the likelihood of malfeasance. The key concept I present is the idea of *connotative meaning*: that is, when an economic transaction becomes embedded in a social relationship, the social context surrounding the relationship infuses

behaviors within that transaction with an additional layer of social meaning (Weber, 1978). So, for instance, monitoring a nonfamily manager may be accepted as standard practice, but monitoring a family manager may bear the additional meaning of mistrust. When the connotative meaning of certain business practices conflicts with the norms relevant to the relationships these practices are embedded in, these practices may become normatively inhibited. If these practices are crucial to curbing malfeasance (i.e. formal governance), then embeddedness may actually create perverse incentive structures and drive malfeasance.

My study also contributes to the research on family businesses. The family business literature, ironically, has focused predominantly on the *business*, while dynamics within the *family* remain under-examined (Handler, 1994; Stewart and Hitt, 2012). So while prior studies have shown that family top managers are both more dedicated and more likely to cheat (Morck et al., 2005; Gomez-Mejia et al., 2007), research on family businesses have not been able to discern *which* kinds of family are likely to be dedicated and *which* are likely to cheat. This paper contributes by opening the black box of family relationships and highlighting how different types of family relationships actually exhibit differing behaviors when it comes to malfeasance. In doing so, I contribute to settling an old debate within the family business literature: it's not about *whether* family managers are more or less likely to cheat—it's about *which* family members.

Finally, my study bears practical implications for firm owners and entrepreneurs in emerging economies. As many emerging economies do not possess well-developed regulatory institutions (Redding, 1990; Khanna and Rivkin, 2001; Acquaah, 2007), firm owners and entrepreneurs in these economies often appoint individuals with whom they have social relationships to top management positions and rely on these relationships to curb malfeasance. This paper serves as a reminder that owners still need to implement formal governance

arrangements even if the top managers are people they have close relationships with. This is because discerning whether or not a relationship that appears to be intimate *actually* is intimate is often difficult. As I show in this study, even the owners' relationships with their family members—which in many emerging economies are supposed to be the most intimate of social relationships (Fei, 1992)—may engender malfeasance when formal governance arrangements are not in place. Relationships, while often beneficial, may not be substitutes for formal governance.

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## Up, Down, and Sideways: Innovation in China and the Case of Plug-in Vehicles

*John Helveston, Erica Fuchs, Yanmin Wang*

In recent years, the Chinese government, motivated by rapidly increasing energy demand and limited oil and natural gas reserves, has promoted policies for energy efficiency and research investments in new energy-saving technologies. At the same time, China has also become home to distinct forms of industrial innovation, which often occur downstream in technology commercialization and redefinition (Breznitz & Murphree, 2011; Ernst & Naughton, 2008, 2012; Herrigel, 2010; Nahm & Steinfeld, 2014; Nahm, 2012). Some evidence suggests that these two themes could be synergistic; that is, despite having less stringent requirements in WTO negotiations (WTO, 1979), developing nations like China that receive large amounts of foreign investment may be able to successfully reduce pollution while contributing to advances in industrial innovation (Wheeler, 2001).

Given this context, this paper describes how the evolution of institutional and market forces within an industry (automotive) is associated with the directions of innovation that firms are taking with respect to an emerging technology sector (plug-in vehicles). In this study, we are not interested in *invention*, or the creation of new ideas, but rather *innovation*, or “a continuous learning process in which firms master and implement the design, production and marketing of good and services that are new to them, although not necessarily new to their competitors—domestic or foreign” (Metcalf & Ramlogan, 2008). This definition of innovation follows closely to the findings by Nahm & Steinfeld (2014) who suggest that innovations are not about the “newness” of an idea, technology, process, or organizational strategy, but rather about their ability to command commercial value in the marketplace. Indeed the context in which firms are innovating will be of central focus throughout this paper.

With this broader definition of innovation, we aim to bring attention to the richness of China's innovation environment for plug-in vehicles which, in combination with potential greater consumer willingness to accept plug-in vehicles (Helveston et al., 2015), could yield some distinct advantages in terms of realizing the potential energy and environmental benefits of plug-in vehicle adoption (Lang et al., 2013; Zhou et al., 2013) while also developing industrial leadership in emerging technologies and business models. Our goal is not to make causal claims but rather to derive new theoretical insights on what factors are associated with differences in the directions of innovation observed in China's plug-in vehicle sector using inductive grounded theory-building techniques (Eisenhardt, 1989; Glaser & Strauss, 1967).

To explore China's plug-in vehicle innovation environment, we conduct four case studies on firms developing plug-in vehicles and plug-in vehicle components in China. We examine 2014 national sales data and conduct 34 qualitative interviews with automotive managers and engineers, government officials, researchers, journalists, and industry consultants. In addition to identifying three distinct directions of innovation ("up", "down", and "sideways") with respect to the frontiers of automotive technology and the frontiers of organizational and business strategies, this study investigates the roles of institutional and market forces as well as the historical path dependencies of firms in shaping the innovation environment. Our findings suggest that the coevolution of institutional and market forces as well as the historical path dependencies of firms may be shaping the rich and diverse innovation environment in China's plug-in vehicle sector. Specifically, both national institutions such as the joint venture system and local institutions such as local protectionism may be insulating independent Chinese firms from foreign and domestic competition; at the same time, the size and heterogeneity of China's domestic market may be large enough to sustain demand for the large variety of innovations within one sector.

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## **Analyzing Chinese Approaches to Defense Science, Technology, and Innovation Development**

*Tai Ming Cheung*

China's leaders see science, technology, and innovation as essential ingredients in the pursuit of power, prosperity and prestige. This is especially the case in the military realm where the possession of homegrown innovation capabilities is deemed vital to national security. A concerted effort is now underway to lay the foundations and conditions to meet the goal of becoming a world-class defense science and technology (S&T) power by the next decade. How successful China will be in this ambitious endeavor has profound implications for the rest of the world, and especially competitors such as the U.S. If China is able to catch up and begin to match the technological standards of other world leaders, this could lead to a destabilizing and costly long-term arms race with the U.S. and other major powers. On the other hand, if China is unable to narrow the technological gap and remain dependent on external sources for critical needs, this will undermine its ability to compete for strategic influence and safeguard its expanding security interests in the Asia-Pacific region and beyond. This paper assesses Chinese approaches to defense science, technology, and innovation development

### **Defining Defense Innovation**

Defense innovation, broadly defined, is the transformation of ideas and knowledge into new or improved products, processes, and services for military and dual-use applications. To distinguish from its military variant, defense innovation refers primarily to organizations and activities associated with the defense and dual-use civil-military science, technology, and industrial base.

The key components of defense innovation can be distinguished from different perspectives. One approach is to classify by type: product, process, and organizational

innovation. Product innovation refers to new or improved goods and services; process innovation is concerned with improvements and new and improved ways in how to produce these goods and services; and organizational innovation is about improved ways of organizing activities and institutions.

Another dimension in which to view defense innovation is the nature and degree of the innovative change that is being carried out. Is the outcome imitational or genuinely innovative in nature, and if it is the latter then is this incremental or radical in scope? Seven categories of imitation or innovation can be defined:

- **Duplicative Imitation:** Products, usually obtained from foreign sources, are closely copied with little or no technological improvements. This is the starting point of industrial and technological development for latecomers such as China.
- **Creative Imitation:** This represents a more sophisticated form of imitation that generates imitative products with new performance features.
- **Creative Adaptation:** Products are inspired by existing foreign-derived technologies but differ from them significantly.
- **Incremental Innovation:** This is the limited updating of existing indigenously developed systems and processes. This innovation is often the result of organizational and management inputs aimed at producing different versions of products tailored to different markets and users, rather than significant technological improvements through original research and development (R&D).
- **Architectural Innovation:** This refers to “innovations that change the way in which the components of a product are linked together, while leaving the core design concepts (and thus the basic knowledge underlying the components) untouched” (Henderson and Clark,

1990).

- **Component or Modular Innovation:** This involves the development of new component technology that can be installed into existing system architecture. Modular innovation emphasizes hard innovation capabilities such as advanced R&D facilities, a cadre of experienced scientists and engineers, and large-scale investment outlays.
- **Radical Innovation:** This requires major breakthroughs in both new component technology and architecture and only countries with broad-based, world-class R&D capabilities and personnel along with deep financial resources and a willingness to take risk can engage in this activity.

These imitation and innovation types will be analyzed in more detail later in this paper.

### **Innovation Studies and the Neglected Place of Defense Innovation**

The study of innovation has become a thriving academic enterprise over the past few decades. One English language survey of the annual number of publications with innovation in its title soared from under 10,000 at the beginning of the 1970s to nearly 60,000 by the mid-2000s (Fagerberg and Sappasert, 2010). The topic has received extensive attention across a wide range of disciplinary fields, most notably economics, business and strategic management studies, political economy, geography, and technology and engineering, leading some proponents to argue that this constitutes the rise of a new inter-disciplinary field of ‘innovation studies’.

Conspicuously absent from this field is security studies. While innovation broadly defined has attracted interest by security scholars, this has been sporadic, diffuse, and compartmentalized in nature. The study of military and defense innovation has been largely excluded from the mainstream examination of the topic, as exemplified by the dearth of these

topics in the leading academic journals on innovation issues such as *Research Policy* and *Strategic Management Journal*.

This state of affairs is especially ironic as defense-related issues were among the chief drivers behind the early development of the innovation field. The national innovation systems concept, for example, grew out of the examination by leading innovation scholar Christopher Freeman of the development of the military industrial complex during the Cold War, who initially coined the notion of a ‘military innovation system’ (Godin, 2010).

As academic and policy research on civilian innovation activities took off in the 1970s and 1980s, national security-related issues were largely overlooked. In one of the pioneering comparative studies of national innovation systems edited by Richard Nelson that was published in 1993, he noted that there was surprise among his project collaborators that “national security concerns had been important in shaping innovation systems, in many leading countries” (Nelson, 1993). Nelson added that there was no consensus as to whether military R&D and procurement “has been a help or a hindrance to the commercial competitiveness of national industry.”<sup>2</sup>

There have been occasional efforts to examine the defense and national security aspects of innovation, especially in the post-Cold War era. One early effort in the late 1990s was led by Judith Reppy, who pointed out that the defense industrial complex had many of the attributes that the NIS framework was most concerned with, such as systems, well-defined boundaries, and robust institutions and organizations (Reppy, 2000). The definition of innovation was also sufficiently broad to include technology transfer and diffusion. Countries with large defense economies such as the U.S., Russia, France, China and the UK offered the best examples for examination using the NIS approach because of their national and systemic attributes and their extensive role in innovation. A more recent evaluation of the role of defense R&D in the U.S.

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<sup>2</sup> Ibid, p. 513.

and U.K. innovation systems in the late 2000s pointed to new trends since the beginning of the 21<sup>st</sup> Century (Mowery, 2009). Of particular note has been the accelerating privatization of defense research, especially in the U.K., the impact of the 9/11 terrorist attacks in the U.S. on defense R&D, and the shift in the dynamics of technology transfers between the defense and civilian sectors from military-to-civilian spin-off in the 1990s to increasingly ‘spin-in’ in which the military sector seeks to broaden its industrial and R&D base into the civilian economy. While there was little attention paid to developments elsewhere in the world, some of these key trends such as privatization and civil-military integration are also having a profound impact in shaping defense innovation systems in the Asia-Pacific region and other parts of the world.

Examining the Chinese defense economy from an innovation systems approach helps to shed light into critical processes that would otherwise be overlooked or ignored in more conventional assessments of defense industry and military modernization issues.<sup>3</sup> Key issues of focus include how the R&D process works, competence building through education and training of the work force, the role of incentives and governance regimes in promoting entrepreneurship and risk-taking, the interactions between technology-push and demand-pull factors, and the bringing together of complementary knowledge through linkage activities within the system.<sup>4</sup>

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<sup>3</sup> The key Western works have covered issues such as the structure and reform of the defense industry, defense conversion, development of the strategic weapons sector, arms trade and proliferation, Russian military assistance, weapons developments, commercialization and technology transfer activities. The bulk of work on dual-use-related issues has focused on defense conversion that appeared during the heyday of the Chinese defense conversion drive in the 1980s and first half of the 1990s. For an excellent critique of the state of the field in the study of the Chinese defense economy at the beginning of the 21<sup>st</sup> Century, see Bates Gill, “Chinese Military-Technical Development: The Record for Western Assessments, 1979-1999,” in James C. Mulvenon and Andrew N.D. Yang (Eds), *Seeking Truth From Facts: A Retrospective on Chinese Military Studies in the Post-Mao Era* (Santa Monica: RAND Corp., 2001).

<sup>4</sup> See Tai Ming Cheung, *Fortifying China* (Ithaca: Cornell University Press, 2009).

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