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Institutions as a Cause of Upgrading:
The Case of the Chinese Rubber Industry

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Abstract

It has become clear that sizable variation exists in the ability of countries and industries to successfully facilitate upgrading. One causal mechanism that may explain this variation is the presence of state, quasi-state, hybrid, and private institutions. This paper argues that high levels of upgrading in the Chinese rubber industry are unlikely to exist in the absence of institutions. Furthermore, it contends that not all institutions are equal in terms of their ability to induce upgrading. Instead, the effect of institutions is conditioned on the presence of particular features that are only sometimes present. Moreover, the paper argues that the creation and evolution of institutions can help explain their level of effectiveness. It contends segments of the Chinese rubber industry that have greater national security importance, give China a technological advantage, and are integral to economic growth should possess institutions.

A qualitative research methodology is adopted to evaluate this theory. Three institutions, representing different segments of the rubber value chain, are compared and contrasted to assess their creation, evolution, and ability to facilitate upgrading. Thus, sub-sectorial variation between cases is used for comparative purposes. The paper draws on original data collected through interviews at a China rubber industry trade conference as well as existing historical accounts of the development of the industry. The evidence collectively suggests that institutions are often important determinates of upgrading. It also supports the contention that institutions are frequently created as a result of political concerns relating to security, technology, and growth.

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The other three members of my panel are individuals who have had a large impact on the way that I think about learning, my perspective on career decisions, and my long-term aspirations. They are without question some of the greatest mentors and teachers I have ever met.

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Background

Understanding the conditions that lead to innovation and upgrading within developing countries is a critical component of inducing development in transitioning economies. Various schools of thought have emerged during the past fifty years, which have reached drastically different conclusions. On one hand, some argue that the role of the state should be minimized so that the efficiency benefits of free markets can fuel growth and development. On the other hand, some contend that states should only play a role when market imperfections prevent innovation. At the heart of this debate lies a fundamental disagreement over the efficacy of state institutions. This paper contributes to this discussion by examining and measuring the degree to which state, quasi-state, hybrid, and private institutions facilitate upgrading in the Chinese rubber industry.

An examination of the relationship between institutions and upgrading in the Chinese rubber industry is both substantively and theoretically important. On a substantive level, rubber is widely recognized as critical for economic growth in large producing regions. In the case of China, the government has identified rubber as a strategically important commodity, which means that it has been deemed critical for growth and development. Additionally, the cultivation, processing, and use of rubber affects the livelihood of a large and vulnerable population in southwest China. On a theoretical level, understanding the conditions that facilitate upgrading can help address the question of why developing countries have not converged more quickly upon the developed world. Specifically, the origins and efficacy of state institutions have long been a source of considerable debate. China is situated at the heart of this controversy given the country's unique institutional configuration that departs from the model of the East Asian development state. Moreover, the case of Chinese rubber illustrates the tendency of governments to liberalize some sectors of their economies but maintain heavy state control over others. In

short, this paper's contribution is important. Development practitioners have struggled to understand the relationship between institutional creation, institutional change, institutional strength, and economic development for decades. Testing existing theories of the relationship between institutions and development by evaluating the case of Chinese rubber is thus useful.

This paper contends that high levels of upgrading in the Chinese rubber industry should not be present in the absence of institutions. It argues that not all institutions are equal in terms of their ability to induce upgrading. Instead, the effect of institutions is conditioned on the presence of particular features that are only sometimes present. Similarly, the paper contends that portions of the industry that have greater importance for national security, have a higher technological capacity, and are more integral to economic growth will have greater institutional presence. Therefore, it argues that the creation and evolution of the institutions play an important part in understanding the effectiveness or lack thereof of private, hybrid, and public institutions. While it does not establish a causal relationship between institutions and upgrading, it provides evidence that institutions may explain some upgrading present in the Chinese rubber industry.

The paper is divided into a number of sections. The first section reviews existing literature on upgrading, value chains, institutions, and Chinese development. Such a review is important because it helps identify existing agreement and controversy related to these topics. The second section develops a series of hypotheses based upon existing literature. This is valuable because it helps identify a series of testable predictions that have been proposed but not sufficiently analyzed by existing literature. The third section outlines this paper's research design aimed at testing the previously stated hypotheses. This section is important because it explicitly lays out the justifications for the research approach that is adopted. The fourth section contains case studies of a number of institutions that are present within the upstream, midstream, and

downstream segments of the Chinese rubber industry. This section is the essence of the paper because it examines the ways that the case of Chinese rubber conforms to and departs from the expectations of existing literature. The final section concludes the paper by briefly synthesizing core findings and proposing potential directions for additional research.

Literature on Upgrading

Economists have long argued that not all types of growth are equal. During the 1950s, Jagdish Bhagwati developed the theory of immiserizing growth (Bhagwati, 1958). He hypothesized that some growth trajectories lead producers to face intense competition, which can cause a race to the bottom (Johnson, 1955). Sustained growth can avoid this trap by creating a virtuous cycle involving continuous innovation and income growth. This important distinction has led to literature that attempts to explain the difference between types of growth. One established explanation relates to the capacity to innovate, which can be defined as the continual improvement in the development of products and processes (Kaplinsky, 2001). Such a definition is inadequate though since it does not speak to the rate of innovation in comparison to other products and processes. Without a rate of innovation that is faster than competitors, the value added and subsequently the market share of a product will decline over time (Kessler, 1996). Therefore, innovations have to be considered in a relative context, in which comparisons are made between the status quo and alternatives (Kaplinsky, 2001). This recognition of relative endowments allows for a richer analysis of various types of innovation.

A substantial body of literature focuses on two principal methods used to identify upgrading. The first approach revolves around an analysis of core competencies (Hamel & Pralahad, 1994). This framework postulates that upgrading occurs when firms can access capabilities that provide value to the customer, are possessed by few competitors, and involve

high entry barriers. Firms that possess such advantages also run the risk of suffering from structural inertia and a general resistance to change. This phenomenon of firm strengths becoming long-term weaknesses has been referred to as core rigidities (Leonard-Barton, 1995). The second approach focuses not on core competencies, but instead on dynamic capabilities (Teece & Pisano, 1994). These capabilities arise when internal firm processes facilitate learning and evolution, it has access to innovative competencies, and it can avoid path dependence.

The theories of core competencies and dynamic capabilities are very useful in explaining innovation that occurs within firms. Unfortunately, neither provides analysis at a level beyond the firm and therefore cannot capture upgrading involving groups of firms linked together in value chains. Despite this, elements of both explanations, such as the importance of learning and resistance to change, have informed subsequent scholarship on upgrading within sectors. This recent scholarship has led to the creation of an alternative framework of upgrading processes. It theorizes that there are four basic types of upgrading: process, product, functional, and chain (Gereffi, 1999). Process upgrading involves improving the efficiency of processes so that they are better than rival firms. Product upgrading entails the introduction of new products or the improvement of old products faster than rivals. Functional upgrading involves changes in the mix of activities conducted. Chain upgrading entails moving from one value chain to another.

Figure 1 – General Upgrading Typology

	Process	**Product**	**Functional**	**Chain**
Key Feature	Efficiency	Better Product	Mix of Activities	Moving Chains
Examples of Methods Used	--Localizing production --Better sourcing of inputs --Reducing waste	--Introducing a new product --Improving an old product	--Outsourcing functions --Moving within a value chain	--Moving to a new value chain --Drawing on synergies

Some scholars note that there is a hierarchy of upgrading. This perspective postulates that empirical support exists for the claim that most firms engage in a set path of innovation (Gereffi, 1999). The experience of East Asian companies is cited to support the claim that firms follow a trajectory starting with process upgrading, then product, then functional, and finally chain. Subsequent literature has fine-tuned this explanation by arguing that upgrading occurs differently depending upon the product that is being produced. For example, upgrading within firms producing primary commodities is notably different from firms that are providing professional services. This paper focuses on examining upgrading in the context of a primary commodity value chain. Thus, it is natural to use Peter Gibbon's framework for understanding upgrading in this context. Specifically, he notes the challenges inherent in distinguishing between process and product upgrading in agricultural contexts. For example, introducing organic processes also leads to the generation of new products. As an alternative, he advocates looking at the localization of commodity processing, the creation of new forms of product that are distinct from existing commodities, and situations where higher margins are achieved from unprocessed commodities (Gibbon, 2001). This alternative schema is not meant to replace but instead to complement the previous framework. It therefore can be seen as building upon the foundation is created.

Figure 2 – Inputs for Agricultural Upgrading

Type of Upgrading	Higher Margins for Unprocessed Commodities	Producing New Forms of Existing Commodities	Localizing Commodity Processing
Helpful Inputs	-Access to seeds, fertilizer -Large production area -High quality seeds -High quality fertilizer -Knowledge of techniques -Standard grades of output -Quality improvement tech -Investment in equipment -Stable market and demand -Remunerative incomes	-Raw commodity supply -Processing techniques -Processing technology -Processing facility -Quality recognition -Product branding	-Investment in equipment -Supply of equipment -Assembly knowledge -Transportation costs -Technical knowhow -Quality recognition -Product branding

Most subsequent literature has adopted Gibbon's approach to commodity upgrading because it is better able to identify when innovation occurs in agricultural contexts. Although the literature is still evolving, it is in the direction of accepting that upgrading is indeed contextual.

There are many different indicators of the presence of upgrading depending upon the product and segment of the value chain that is being evaluated. The presence of higher yields, more total land cultivated, and a higher price per unit may each indicate upgrading in the cultivation of primary commodities. A higher price per unit sold, a reduction in the cost per unit sold, and the introduction of improved products all may signal the presence of upgrading in the processing of primary commodities. The creation of a better product, reductions in cost per unit sold, and increases in the price per unit sold all may indicate upgrading is present in the use of rubber as an input for the production of downstream products.

Literature on Value Chains

Understanding what upgrading entails is only useful if it can be placed within the development of products or processes. Value chains are useful in this regard because they provide a framework to analyze product and process changes. Raphael Kaplinsky defines value chains as "the full range of activities, which are required to bring a product or service from conception, through the different phases of production." Moreover, he argues that the historical evolution of the value chain has changed substantially over time (Kaplinsky, 2001). In the 1980's Michael Porter, who remains a dominant voice in business strategy, identified two elements of what he labeled value systems. He argued that intra-link functions connect activities performed within particular links of a chain of development and that it is possible to analyze the relationship between multiple links in a value system (Porter, 1985). Womack and Jones complicate the discussion further by using the phrase value stream instead of value system (Womack & Jones,

1996). Subsequently literature has gravitated towards the term value chain if for no other reason than to create a uniform vocabulary and therefore to avoid unnecessary complication.

Around the same time French academics developed the concept of *filere*, meaning thread. Like Porter and Womack, this approach concerned itself with the flow of physical inputs and services as products get produced. Such an approach was first applied to French agriculture in the 1960's and subsequently to French industry in the 1980's (Raikes, 2000). Although largely similar to previous conceptions of value chains, it is static in the sense that it assumes the flow of products within a chain does not grow or shrink over time. More recent scholars studying value chains have subsequently challenged this assumption. Despite this, the *filere* approach is important because it formed the foundation for subsequent work on the topic.

It was not until the 1990's that Gary Gereffi dramatically altered the value chain literature by introducing the global commodity chain concept. This model of product development acknowledged, for the first time, the presence of power relations between dominant lead firms and weaker parties (Gereffi, 1994). Following from this distinction, value chains can be subdivided into buyer-driven commodity chains, in which coordination is undertaken by buyers, and producer driven commodity chains, in which producers play a key role. This acknowledgement of relative strength among critical actors has turned out to be important in the literature that examines the conditions in which upgrading occurs. Moreover, it may impact the degree to which firms within a sector can collect rents. As a result, the commodity chain concept has gained increasing salience over time. Most writing on value chains to this day has therefore focused on the differences between producer-driven and buyer-driven commodity chains. Although this distinction is not central to this work, it provides the rationale for those who argue that industries should be evaluated by looking at the relationship between different segments.

Figure 3 – Global Commodity Chains

	Producer-Driven Commodity Chains	**Buyer-Driven Commodity Chains**
Drivers of Chain Creation	Industrial Capital	Commercial Capital
Core Competencies	R&D, Production	Design, Marketing
Barriers to Entry	Economies of Scale	Economies of Scope
Economic Sectors	Consumer Durables, Intermediate & Capital Goods	Consumer Non-durables
Typical Industries	Automobiles, Computers, Aircraft	Apparel, Footwear, Toys
Ownership of Manufacturing Firms	Transnational Firms	Local Firms, in developing countries
Main Network Links	Investment based	Trade based
Predominant Network Structure	Vertical	Horizontal

Gereffi 1999

It is worth noting that much of the literature on value chains relates to the globalization of chain linkages.[1] Naturally, the global nature of value chains is not central to this thesis, which simply uses value chains as a heuristic for the evaluation of industries within China. Therefore, this paper draws on a related, but distinct, tradition of value chain scholarship that simply uses the value chain framework to study industries within an individual country.[2] The use of this framework is valuable because it allows the researcher to identify individual linkages within a

[1] See: Abonyi 2007, Bair 2005, Bair 2008, Baldwin 2006, Barrientos 2010, Birch 2008, Brach 2009, Cammett 2006, Cattaneo 2010, Cattaneo 2013, Challies 2011, Ciccantell 2009, Coe 2010, Daviron 2002, Dedrick 2010, Dicken 2001, Dolan 2001, Escaith 2009, Fernandez-Sark 2012, Gereffi 1999, Gereffi 2001a, Gereffi 2001b, Gereffi 2003, Gereffi 2005, Gereffi 2011a, Gereffi 2011b, Gereffi 2012a, Gibbon 2000, Gibbon 2001, Gibbon 2008a, Gibbon 2008b, Gibbon 2008c, Giuliani 2005, Goto 2011, Nadvi 2004, Hatani 2009, Henderson 2002, Holweg 2009, Ma 2009, Humphrey 2002a, Humphrey 2002b, Humphrey 2003, Humphrey 2004, Ivarsson 2011, Keane 2009, Keane 2012, Korzeniewicz 1992, Lee 2011, Lee 2012, Lee 2013, Low 2013, Mahutga 2012, Memedovic 2008, Milberg 2011, Natsuda 2011, Oro 2011, Palit 2006, Palpacuer 2008, Peters 2008, Pieter van Dijk 2011, Pietrobelli 2006, Pietrobelli 2011, Quan 2008, Raikes 2000, Rivoli 2009, Ruffier 2008, Schmitz 2004, Schmitz 2005b, Selwyn 2012, Staritz 2011, Staritz 2013, Sturgeon 2008a, Sturgeon 2008c, Sturgeon 2009, Sturgeon 2010, Sturgeon 2011, Thomsen 2007, Thomsen 2011, Van Assche 2009

[2] See: Avdasheva 2005, Avdasheva 2007, Bair 2013, Banjara 2007, Bolwig 2010, Brandt 2010, Collins 2000, Dannenberg 2012, Dubay 2010, Dunn 2006, Fernandez-Stark 2010, Fortwengel 2011, Fromm 2006, Fromm 2007, Gereffi 2012b, Gwynne 2006, Herrigel 2013, Humphrey 2000,Ivarsson 2010, Kaplinsky 2000a, Kaplinsky 2000b, Kaplinsky 2001, Katwal 2011, Lund-Thomsen 2010, Navas-Aleman 2011, Navas-Aleman 2012, Pavcnik 2003, Pelupessy 2008, Ponte 2009, Rich 2011, Rissgard 2010, Saxenian 2001, Schmitz 2005a, Sturgeon 2001, Sturgeon 2008b, Yue, 2010

lager value chain. That creates the opportunity to isolate the points at which upgrading is occurring and therefore more easily identify potential causes. Therefore, this paper draws upon the framework of value chain analysis to identify instances of upgrading within Chinese rubber.

Literature on Institutions

The discipline of political science is rooted in the study of institutions. Broadly defined, institutions can be thought of as "a set of devised behavioral rules that govern and shape the interactions of human beings, in part by helping them to form expectations of what other people will do" (Lin, 1995). For the purpose of this paper, a number of specific institutions are selected because they address market failures and imperfections that otherwise prevent optimal economic performance.[3] Discussions of upgrading are related to literature examining market failures and imperfections because without functioning markets it is difficult for firms to innovate and thus add value to their products. Therefore, this paper contends, as does existing literature, that institutions are central to the creation of an environment that is conducive to upgrading.

Previous research has noted the strong relationship between institutions, development, and growth. Although there is some disagreement regarding the magnitude of this relationship, it is commonly accepted that institutions matter. Acemoglu and Johnson argue institutions positively impact growth when they allocate power to groups with optimal broad-based interests, when they constrain power holders, and when power holders capture low rents (Acemoglu, 2005). Countries that have strong institutions are on average more likely to experience higher levels of growth (Acemoglu, 2012). Moreover, it is not growth that causes institutions, but rather

[3] Market failures and imperfections are often the result of transaction costs, imperfect information, and limited competition. Transaction costs are cost incurred in making an economic exchange, including search and information costs, bargaining costs, and enforcement costs. In other words, they are the costs associated with identifying a partner, bargaining with that partner, and enforcing or monitoring a transaction that is made. Imperfect information refers to situations where parties have varying degrees of information about a transaction. Limited competition refers to a situation in which sellers are selling goods that are different in the absence of competition. This could include monopoly, monopsony, and oligopoly. Later sections will describe them in the context of different segments of the Chinese rubber industry.

institutions that precede growth (Acemoglu, 2000). This argument is supported by many prominent scholars and has thus served as the basis for a great deal of the existing literature.[4]

There are some scholars who question the degree to which institutions matter. These individuals tend to instead propose one of two alternative explanations for growth. First, some argue that growth is a function of geography and not preexisting institutional presence.[5] Second, some argue that growth is the result of integration between countries that takes place irrespective of institutional structures.[6] Both of these explanations have some merit if for no other reason than it is obvious that no one variable can account for all growth. Nonetheless, institutional quality has been found to consistently trump these other factors (Rodrick, 2004a). Moreover, it is increasingly accepted that institutions and markets complement one another under the right conditions. As Dani Rodrik, a professor at Princeton's school of social science, explains:

> A market economy relies on a wide array of non-market institutions that perform regulatory, stabilizing, and legitimizing functions. Once these institutions are accepted as part and parcel of a market-based economy, traditional dichotomies between market and state or laissez-faire and intervention begin to make less sense. These are not competing ways of organizing a society's economic affairs; they are complementary elements that render the system sustainable. Every well-functioning market economy is a mix of state and market, laissez-faire and intervention. (2004a)

Thus, institutions are often seen as a mechanism by which market performance can be enhanced.

It is important to evaluate institutions in the context in which they operate. Therefore, it is necessary to avoid speaking about economic and political institutions as if they are all the same. Indeed, there is wide variation in the structure and function of various institutions relevant to economic development. Moreover, these institutions often have very different relationships with

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[4] See: Acemoglu 2000, Acemoglu 2001, Acemoglu 2005, Acemoglu 2012, Hall 1999, North 1990, Rodrick 2000, Rodrick 2004

[5] See: Bloom 1998, Démurger, 2003, Diamond 1997, Easterly 2003, Gallup 1999, McArthur 2001, Redding 2004, Sachs 1997, Sachs 2001a, Sachs 2001b, Sachs 2001c, Sachs 2003, Sachs 2012

[6] See: Bekaert 2005, Dollar 2002, Dollar 2004, Frankel 1999, Sachs 1995

the state. It is also worth noting that institutions that are effective in one geographic area may be ineffective in another. This reality lends credence to a more sophisticated and nuanced analysis that takes contextual factors into account. The remainder of this section will therefore briefly define the three main institutions that are analyzed in this paper so that some context is present.

The three case studies present in this paper examine, among other things, the role of state farms, business associations, and university-industry partnerships. State farms are farms that are owned, operated, and managed by the state (Zhang, 2010). Business associations are membership organizations that are created to promote the business interests of members (Bräutigam, 2002). University-industry partnerships are arrangements between firms and universities that generally involve the joint sharing of information and material (Branscomb, 1999). The structure, function, and history of these institutions will be discussed in detail throughout subsequent sections.

Literature on China

The role of institutions is very much front and center in discussions related to Chinese development. This may be because China's development trajectory does not fit neatly into any preexisting development framework. Since China has neither liberalized its economy fully nor maintained across the board state control, the country does not fit into the mold of the traditional East Asian development state. Similarly, China does not typify the traditional path espoused by proponents of neoliberal development. Despite this, the country has seen its economy grow at an unprecedented rate. Therefore, understanding what China is doing well has the potential to inform other states that will soon undergo similar economic transitions as they develop.

To understand what China is doing well it is first necessary to understand what China is doing differently. After the end of World War II and throughout the Cold War, a series of political alliances gave countries in East Asia, which were industrializing at the time, access to

foreign markets.[7] China entered into the world economy at a time when emphasis was being placed on the exportation of liberal reforms in the form of structural adjustment policies. Prior to this turning point in 1978, the Chinese economy was best characterized as state owned and collectivized. This makes the sudden shift towards free markets all the more surprising. Most studies characterize the willingness of China to accept foreign direct investment as a function of outside pressure to do so.[8] Some even argue that the power of the World Bank and IMF directly resulted in such reforms (Stieglitz, 2001). Despite this, the role of these agencies varied across countries and does explain much of the story of Chinese economic liberalization.

China departs from some of the central assumptions of the development state model, which postulates that "development states" possess five elements. First, such countries often create an autonomous bureaucracy, which is insulated from interest groups and has the ability to actually implement policies.[9] China may not meet this description given the country's level of decentralization in the area of policy creation and regulatory enforcement. Second, such countries often possess a commitment to private property rights (Johnson, 1982). China may recognize property rights in name, but rules and regulations often violate those rights when they conflict with political and developmental goals (Oi, 1992). Third, such countries may intervene in credit markets to give industries a competitive advantage (Wade, 1990). Chinese credit markets have at times been plagued by inefficiencies and distortions that have prevented the government from adopting such an approach (Huang, 1999). This has resulted in informal finance and locally courted foreign direct investment (Tsai, 2004). Fourth, such countries may

[7] See Stubbs 1999, Stubbs 2005

[8] For newer studies see: Fewsmith 2001, Jacobson 1990, Pearson 1999, Pearson 2001, and Peerenboom 2001. The pioneering older studies were: Ho 1984, Pearson 1991, and Pearson 1992

[9] See Evans 1995, Johnson 1982, and Stubbs 2005

move from import-substitution to export-oriented strategies (Haggard, 1990). China has in a way adopted the opposite approach because it has switched from export-oriented strategies to import substitution in strategic sectors (Hsueh, 2011). Finally, such countries adopt policies that attempt to conform to the market, but intervene for the sake of ensuring markets function optimally.[10] China has departed from this approach in sectors that it deems strategic. In short, China seems to have in many ways moved away from the canonical development state model.

If China's approach to development does not constitute a development state, then it is necessary to examine what category China actually falls into. There are a number of individuals who have attempted to answer this question by treating China's path to development as distinct from previous development trajectories. They argue that an entirely novel path to development, the "Beijing consensus" has emerged. Joshua Ramo coined the term when he argued the Chinese development model involves a commitment to innovation and experimentation, a turn away from GDP per capita as the best measure of development, and an emphasis on self-determination (Ramo, 2004). Eight years later, Josh Williamson described the Beijing consensus quite differently when he spoke of its five dimensions: incremental reform, innovation and experimentation, export led growth, state capitalism, and authoritarianism (Williamson, 2012). Although there is a great deal of variation in how scholars define the dimensions of the Beijing consensus, there seems to be an increasing recognition that China's path to development is structurally different from that of other countries. For that reason, the Beijing consensus has become a salient model to describe the Chinese development trajectory.

Rosyalyn Hsueh, a prominent scholar who studies Chinese development, introduced her own explanation for the presence of the state in some economic sectors despite the genuine liberalization of other portions of the economy. She argues the answer to this paradox lies in a

[10] See Balassa 1981, Balassa 1988, Stubbs 2005, Stubbs 2009, and Wade 1990

"liberalization two-step". China has simultaneously "shifted from universal controls on foreign direct investment and private investment on the aggregate level, across all industries, to selective control at the sectoral level" (Hsueh, 2011). Therefore, at the macro level, China only appears to be more liberal, while at the sectoral level, it has selectively regulated particular industries depending upon exogenous or endogenous forces. Thus, it is possible to conceptualize China's development trajectory as both drawing upon and departing from previous models.

Hsueh hypothesizes that three factors influence the level of state control. First, sectors that have greater strategic value for a country's technology base are more likely to stay regulated. She notes that this decision is subjective in the sense that it is based on the leader's perceptions and is fundamentally a function of politics and economics. Second, state institutions that are more powerful are more likely to stay regulated. Finally, a sector's exposure to the economy, or how it affects competitiveness, dictates the degree of regulation. States are likely to loosen control over sectors during economic booms and tighten control during economic stress.

Hsueh's argument has important implications for the literature on China as a development state. If China really has taken a liberalization two-step, then it has departed from the traditional development state model. Instead, the country may have adopted components of the development state model and then applied them to particular sectors. Hsueh's argument also intersects with the literature on a Beijing consensus. Williamson's understanding of the Beijing consensus as incremental reform, innovation and experimentation, export led growth, state capitalism, and authoritarianism seems to describe elements of Chinese development that Hsueh emphasizes. Finally, her account of Chinese development may support an understanding of China's development in which the country has combined aspects of neoliberal and statist development ideologies and used them selectively to meet particular development goals.

Hypotheses

There are two primary goals to this paper. First, it attempts to answer the question of how one can account for rapid economic growth, especially in terms of upgrading, in the Chinese rubber industry. In doing so, it seeks to assess the degree to which institutions effectively facilitate upgrading. Second, it attempts to evaluate the degree to which the Chinese rubber industry is a case that fits within Roselyn Hsueh's theory of institutional development. Proceeding from these two overarching questions, it tests a number of hypotheses. The first set of hypotheses tests the extent to which Hsueh's theory explains the existence of institutions. The second set of hypotheses tests the degree to which institutions correlate with upgrading.

Roselyn Hsueh's understanding of institutional creation is a function of concerns over technological capacity and/or national security importance, exposure to economic trends, and prior institutional strength. Therefore, this paper will address these three elements by proposing multiple testable hypotheses. Each of them will paint a picture of the conditions under which institutional creation and growth may occur. They therefore provide a plausible explanation for institutional creation, change, and effectiveness.

H1: Segments that have greater military *and/or* technological impact are more likely to possess institutions, while segments that have less military *and/or* technological impact are less likely.

H2: Segments that have a higher level of growth are more likely to possess institutions, while segments that experience uncertainty or low levels of growth are less likely.

H3: Segments that already have strong institutions are likely to maintain that strength, while segments that have weak institutions are less likely to develop institutions.

In addition to understanding why institutions emerge, it is important to understand if they are effective in terms of their ability to facilitate innovation and upgrading. Although this paper will not establish a causal relationship, it will be able to identify any correlation that exists.

H4: If evidence of upgrading is present then institutions are more likely to be present.

The following sections will take these broad hypotheses and describe how they will be tested in the context of the Chinese rubber industry. Additionally, they will outline different segments of the industry and describe the extent to which the hypotheses are accurate.

Research Design

This paper purposively selects a series of three case studies to compare cross-subsectoral and temporal variation within the value chain of the Chinese rubber industry. It examines the upstream, midstream, and downstream portions of the value chain to get a sense of how similar institutions operate in a variety of different segments. This approach is selected for a number of reasons. First, it serves as an excellent model for the study of institutional variation within a specific sector. Previous research on institutional development in China is generally cross-sector. This paper's approach examines different segments of one sector in greater depth. Second, it creates the opportunity to more deeply evaluate the substantive significance of institutions in primary commodity sectors such as rubber. This endeavor is a valuable supplement to previous theoretical research that focuses on broad concepts without testing them in great depth. Finally, purposive case selection is preferable to randomized selection between or within industries because it allows for a richer analysis of the particular dimensions that this paper focuses on.

Each case study examines three distinct aspects of institutions in different segments of the value chain. First, each looks at the conditions that led to the creation of the institution in the first place and its evolution over time. Second, each describes the main features of the

institutions that were created. This description helps to explain why these institutions were selected for analysis. Finally, each section examines the correlation between the presence of the institution and the existence of upgrading. Therefore, each section identifies what institutions emerged, what they try to accomplish, whether they are associated with upgrading outcomes, and why they were created in the first place.

Case Study Components

Given the areas that each case study focuses on, one independent variable is the presence of *military*, *technological capacity*, and *growth* considerations on the part of the government, while one dependent variable is the *presence of institutions*. Another independent variable is the *presence of institutions*, while another dependent variable is *upgrading*. There are other explanations for upgrading that must be considered as well. Both the location of actors and the environment in which actors operate may facilitate or prevent upgrading.

It is important to operationalize the dependent variables that this paper examines. The first dependent variable is the presence of institutions. State, hybrid, and private institutions are easy to identify but vary based on context. They therefore will be identified separately in each section of this paper. Institutions either exist or they do not in a given segment of the value chain. Drawing upon Roselyn Hsueh's framework of institutions, this paper considers state intervention that pertains to the creation and evolution of institutions over time. Specifically, it evaluates the ways in which the Chinese government intervenes in segments of the rubber industry. It examines both the extent of intervention between segments and within a given segment over time. The second dependent variable is upgrading. Institutions are effective when they resolve

the tensions that social actors, in this case the Chinese government, intended for them to address. The specific tension or problem may vary based on a particular context. That being said, many of these problems may arise due to market failures and imperfections that prevent upgrading.

There are different types of data that are relevant to examining this relationship. First, the paper indentifies and describes both the origins and evolution of institutions present in different segments of the rubber value chain. This required an extensive search to identify relevant English language literature on the topic. It also required detailed interviews with stakeholders involved in the industry. Second, data on upgrading was identified. This data varied for different sectors of the value chain. In all cases, it referred to outcomes one would expect to see in the event that innovation and upgrading are present. Using this information, it is then be possible to test the relationship between institutions and upgrading. Although this does not prove a causal relationship, it can show institutions correlate with indicators that are associated with upgrading.

Primer on Chinese Rubber

The cultivation of rubber is driven by downstream demand for rubber products. Based on an even cursory look at the data, it is clear that demand for rubber is increasing worldwide. There are two different types of rubber: synthetic and natural. Synthetic rubber currently accounts for 57% of the total rubber produced globally; natural rubber, the other 43%. (Fox, 2010). This distinction is important because data on rubber demand generally aggregates demand for both natural and synthetic rubber. As a result, when looking at aggregated data, it is difficult to discern demand for only natural rubber. Nevertheless, the statistics on demand for both natural and synthetic rubber are indeed staggering when considered in comparison to historical trends.

Two comprehensive entities study rubber demand: the International Rubber Study Group (IRSG) and the Rubber Economist. The IRSG, an organization that provides information on

industry trends to its corporate members, collects detailed information on rubber supply and demand. The Rubber Economist, a rubber consultancy that is headed by the former chief of the ISRG's office of statistics, publishes information about the topic in a subscription-required newsletter. Both of these sources require extensive corporate membership fees to gain access. Fortunately, Prachaya Jumpasut, the head of the Rubber Economist and former head of the IRSG office of statistics and economics, gives biennial talks in which he provides some broad information. In a recent talk, Jumpasut noted that consumption of rubber will likely increase from 22.1 million tons in 2008 to 23.2 million tons in 2018. More importantly, the relative share of natural rubber will likely increase from 43% to 48% due to high oil prices (Prachaya, 2009). This prediction implies that consumption of natural rubber will increase from 9.6 million tons in 2008 to 13.8 million tons in 2018, at a growth rate of roughly 3.7% per year.

Jumpasut discusses factors that are driving increased demand for rubber generally and natural rubber specifically. He argues that China will surpass the US as the world's largest consumer of rubber in 2012 with a predicted consumption of 3.45 million tons or 18.2% of total global consumption. He predicts that China will eventually consume about 30% of the world's total, but Chinese demand will then flatten out (Prachaya, 2009). A decade old ISRG report, now publically available, reaches a similar conclusion when it predicts that China will need 11.5 million tons of rubber in 2020, but will only be able to produce about 4 million tons from domestic sources (IRSG, 2004). Therefore, when it comes to countries that are driving demand for increased cultivation of rubber, China is a clear frontrunner at the moment.

The opposite side of the supply-demand equation involves the ability of China and other countries to cultivate the necessary amount of natural rubber required to meet expanding global demand. Under the assumption that the previously discussed predictions are accurate, China will

need to import roughly half of its supply of natural rubber by 2020. That being said, the Chinese government has made a substantial push over the last half century to expand the country's domestic rubber cultivation and thus ensure a limited degree of self-sufficiency. This expansion of rubber cultivation has taken place in two areas: Yunnan and Hainan. Although both areas are important to the story of Chinese rubber cultivation, this paper focuses on rubber cultivation in Yunnan for two reasons. First, there is a larger and more complete English language body of literature that discusses the region. Second, the individuals that I interviewed had more knowledge and personal connections to rubber cultivation in Yunnan.

Map 1 – Yunnan Province

Sturgeon 2008

Yunnan province is located in southwest China and borders Burma, Laos, and Vietnam. Both Yunnan Province and Hainan Island are suitable for rubber cultivation because they are relatively close to 10 degrees from the equator, which is arguably the ideal latitude for the

cultivation of rubber. At about 20 degrees from the equator, both Yunnan and Hainan fall outside the ideal geographic area. However, their location in the south of China makes them more optimally situated than other regions. This is not to imply that rubber cultivation occurred in Yunnan and Hainan solely because of their climate. Instead, a web of social, political, and economic factors led to the growth of rubber cultivation in both areas. Subsequent sections examine these motivating factors in the context of Yunnan.

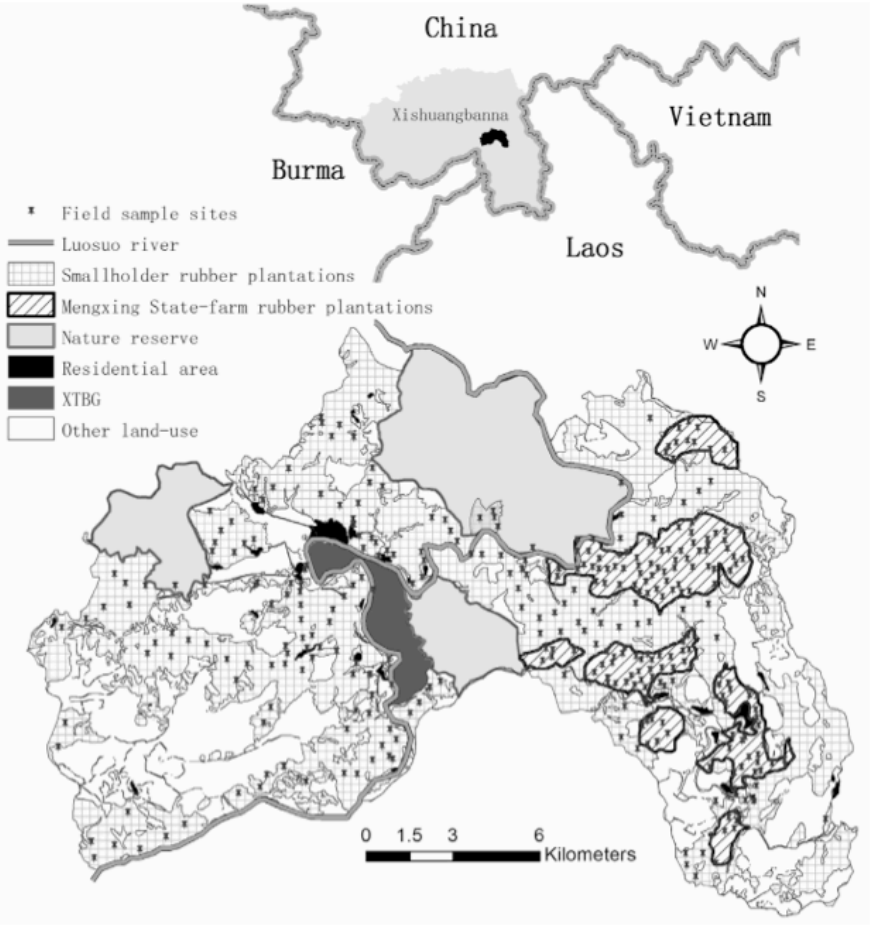
Upstream Upgrading

There are three outcomes that one would likely observe in the context of upstream agro-industries in which upgrading exists. First, yield per hectare may be higher due to processes that are adopted to improve the efficiency of production on an otherwise finite amount of land. Second, the total cultivated land per farm may increase as rubber production becomes more profitable and the incentive to grow rubber instead of alternatives increases. Finally, profit per unit of product may increase as cultivation techniques are improved. Although not every type of upgrading necessarily involves these three outcomes, they serve as imperfect proxy indicators for the presence of upgrading. Therefore, it makes logical sense to start an analysis of the upstream Chinese rubber industry by looking at yield, profitability, and total land cultivated.

The yield of Chinese rubber farms has increased since the first rubber trees were planted in the country. This is not surprising because improved yields are commonly seen in many agricultural contexts as technology advances and new cultivation techniques allow farmers to optimize their available land. Unfortunately, there is not good country-level data on the history of rubber yields. However, there has been a large-scale effort to track rubber yields in Xishuangbanna Prefecture, the largest rubber-producing region of Yunnan, over the past half century. This area, depicted in the map below, is ideal for studying rubber cultivation because

rubber has come to dominate the prefecture's economy and ecology. Indeed, there are few areas that are more heavily dominated by the growth of rubber than Xishuangbanna.

Map 2 – Xishuangbanna Prefecture



Fang Yi 2013

The only study that cites recorded data on Chinese rubber yields through the present-day utilizes state records that track rubber production in Xishuangbanna. These records are ideal for the purpose of this paper because they show the region's rubber yield in relation to the total number of hectares of land that are cultivated. This relationship is important because alternative approaches, that simply track yield without relating it to hectares utilized, cannot eliminated the possibility that production is not actually any more efficient. This is because such data does not

provide a method to determine whether increases in land or improved farming cause higher yields. Therefore, the data that happens to be available is well suited to correctly measure yield.

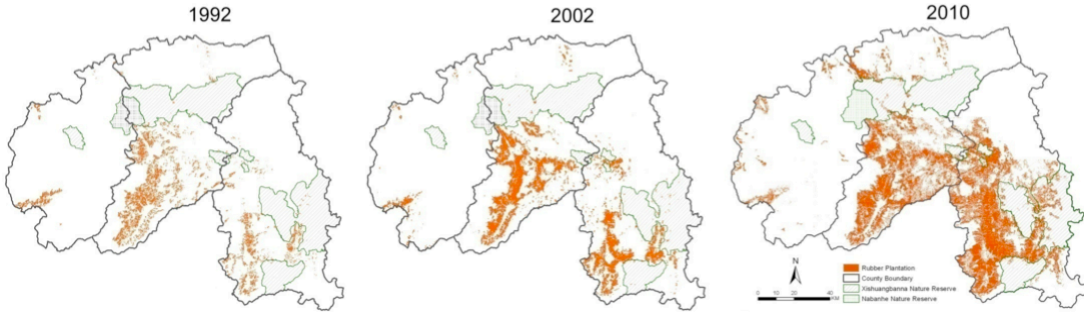
Figure 4 – Total Yield & Plantation Area in Xishuangbanna

Year	Area (ha)	Yield (tons)
1963	6,130	27
1970	18,282	732
1975	27,227	1,767
1983	49,678	17,426
1990	88,711	53,400
1993	88,911	~85,000*
1997	108,065	123,557

Data taken from Jiang 2003
*Estimated based surrounding data.

The total amount of land used for the cultivation of rubber has progressively increased over time. The ability to gauge, at a national level, the amount of land devoted to a particular crop really only resulted from the expansion of satellite imaging and the realization that it is valuable for agricultural purposes. As a result, a number of researchers have used satellite images, field teams, and government archives to track the expansion of land devoted to rubber over time. The results are staggering. One study, by Yi Zhaungfang and Chuck Cannon, has found that rubber cultivation in Xishuangbanna expanded very rapidly since the beginning of the 1990s. More shockingly, they argue prior to 1992 the increase was more pronounced.

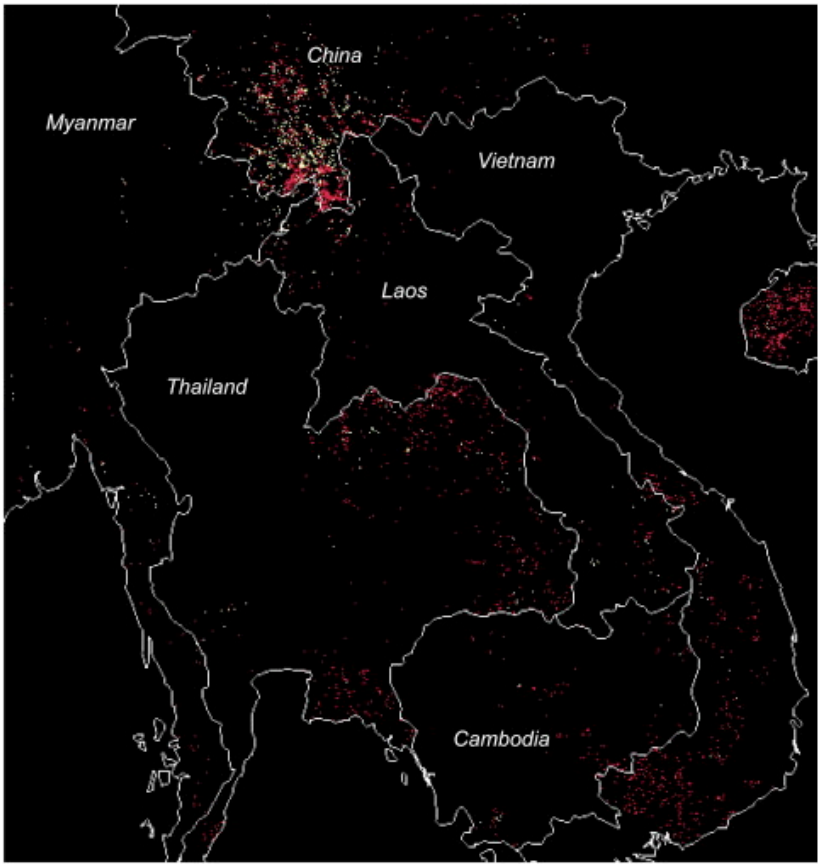
Map 3 – Rubber Expansion in Xishuangbanna



Zhaungfang 2012

Other studies have looked at the expansion of rubber throughout all of Southeast Asia. Many of them have concluded that although expansion has occurred in many Southeast Asian countries, likely driven by increased demand, the expansion of cultivation in Yunnan is particularly pronounced. The image below is a recent satellite image taken of rubber production throughout Asia. The intense concentration of red and yellow in Southwest China signifies the increasing expansion of rubber in the region. The yellow dots signify very recent rubber cultivation, while the red dots signify older cultivation. The density of rubber cultivation in Yunnan quickly becomes clear in comparison to the rest of Southeast Asia.

Map 4 – Rubber Expansion in Southeast Asia



Li & Fox 2012

The profitability of rubber cultivation is exceedingly difficult to gauge. This becomes especially pronounced when one thinks about the ways that profitability varies between different

farms and the difficulties involved in collecting and aggregating this information. Profitability is a function of the revenues of farms in relation to their costs. Profitability is therefore dependent on both the costs of inputs and the price at which rubber is sold. In terms of the revenue side of the equation, rubber prices have fluctuated over the past quarter century. As a result, the profit margin of farms constantly varies even if costs are held constant. To further complicate matters, intermediaries often pay less than the market price of rubber and thus there is even greater variation in the revenue that farmers can acquire from year to year.

Rubber Prices Snapshot

Trading Economics 2014

The cost side of the equation is even more challenging to measure. Aggregate costs involve the costs of material, labor, management, land, and associated fees. These fixed and variable costs vary extensively between farms that are geographically and environmentally similar and depend mostly on the structure of the farm in question. Thus, subsequent sections will discuss the limited existing profit data, which compares state farms and household farms. This is fortunate because such data allows for comparisons to be made between the institutions that are hypothesized to play the largest role.

Mechanics of Cultivation

The cultivation of rubber involves difficult work. In order to plant rubber trees, one has to clear a site, terrace fields if necessary, prepare the soil, space trees appropriately, and then plant them. This process is both time and labor intensive depending upon the geography of the particular region. Once the trees are planted they must be maintained. Maintenance involves the applying fertilizer, preserving terraces, weeding, controlling pests and disease, loosening soil, and planting trailing legume or green manure (Guo, 2005). After the trees have grown to an appropriate age, typically five to seven years, tapping begins. There are two components of tapping that are challenging: the technique by which trees are tapped and the frequency of tapping. Poor technique can permanently damage the tree and decrease the amount of latex that can be produced. Similarly, tapping too frequently can also result in damage and decreased latex production, while tapping infrequently can lead to suboptimal latex output.

The challenges of rubber cultivation are often compounded by three additional difficulties that manifest themselves in Yunnan. First, the weather in the region, although more suitable than other areas of China, involves long dry seasons, cold air temperatures, and poor cold air drainage, which all make rubber production unpredictable. These conditions have historically plagued farmers. For example, during 1973, 1974, and 1976 many rubber trees in Yunnan froze, which resulted in the death of the trees and huge economic losses for farms that cultivated rubber trees (Chapman, 1991). Second, soil erosion can lead to both the loss of water and nutrient absorption capacity as well as the contamination of nearby crops. This has been a continuing problem due to the hilly terrain that characterizes much of Yunnan (Cheo, 2000). Finally, poor infrastructure in the region has resulted in high transportation costs for farmers and more importantly can prevent the diffusion of information and technology. As a result, mountain

roads often lead to the isolation and segmentation of farms from relevant support structures (Cheo, 2000). Keeping these challenges in mind is important when thinking about the history of the industry because many of these obstacles have informed various developments.

History of Cultivation

It is important to understand the history of rubber cultivation in Yunnan for a few reasons. First, it provides context that enables one to better evaluate both the creation and evolution of institutions. Second, it reflects the conditions that led to efforts to upgrade and innovate in both state and household farms. Finally, it provides the context that helps one understand changes that are happening. Without such a discussion, it would be very difficult to have any type of discussion about the intricacies of rubber cultivation in China.

A Brief Timeline of Chinese Cultivation

1906: The first rubber trees were planted in Hainan. They all died.
1950s: The Korean War led to US imposed sanctions on Chinese rubber imports.
1955: The Mengxing State farm was created. It was the first state farm in Yunnan.
1952-1956: The development of large numbers of state farms occurred.
1958-1978: State farms owned agricultural and forestland and a land quota system existed.
1978-1983: Land was contracted to individual farmers but forests remained state controlled.
1983: Forestry reform (liangshandidi) moved control of forests to households.
1985-1987: The state implemented a campaign to encourage rubber cultivation.
1994-1955: The state implemented a poverty alleviation campaign that led to more cultivation.
2002: The state implemented the grain for green project. It led to greater cultivation.

The first rubber trees in China were planted in 1906 at Hainan Island. Only one year Malaysian Chinese introduced later rubber trees in Yunnan. In both regions, almost all of the trees quickly died due to environmental conditions that were absent in other areas where rubber was traditionally grown (Jainchu et al, 2005). Despite this initial failure, Yunnan and Hainan are the only two locations in China that currently produce a substantial volume of natural rubber. Interestingly, there is considerable debate relating to which location is more productive for rubber cultivation. Some argue that Hainan is a more suitable condition for rubber cultivation

due to a more favorable climate and a longer history of producing large rubber yields (Alton, 2005). Others argue that Yunnan is a more suitable location for rubber because the region has consistently increased productivity on state farms and has only recently received the support structure that Hainan has benefited from for the past half century (Huang, 2004). Regardless, rubber cultivation in China takes place within these two areas and does not take place elsewhere.

Between the early 1900's and the end of World War Two there was little cultivation of rubber in China. It was not until the creation of the first state farms, established in the mid-1950s that rubber production markedly expanded. The next major shift occurred when land reform occurred in China during the agricultural reforms of 1978. This new system led to the rise of an alternative model of cultivating rubber that departed from the state farm system. The new system, part of the Household Responsibility System (HRS), allowed individuals to cultivate their own land through a quota and contract system. Subsequent reforms that took place in 1983 had the same effect on forestland because they moved control of forests to households. The result was a mixed system in which state farms still existed nearby reformed legacy state farms.

History of State Farms

State farms (*guoying nongchang*) and state livestock farms (*guoying muchang*) have been largely ignored in literature discussing Chinese economic development. This neglect may stem from their utilization of a small amount of total cultivated land in China. In 1957, state farms comprised roughly 1 percent of agricultural land (Kuo, 1972). That number would increase to almost 4 percent in 1964 (Chao, 1970). By 1978, the trend flattened out since state farms still occupied 4 percent of such land (Brugger, 1980). Today, after decades of reforms, they occupy roughly the same percentage of total cultivated land as they did in 1978. Despite encompassing a relatively small portion of total agricultural land, state farms are central to the evolution of rural

development in rural China. This is because they have transformed the regions in which they exist. Recent estimates suggest they operate in 30 provinces, occupy 29 million hectares of land, employ 3.5 million people, support another 12.4 million, and contribute to 3.4 percent of rural output (Jia, 2004). To this day, they are a defining characteristic of many frontier regions.

State farms perform a number of functions that are central to state objectives in frontier regions. First, state farms encourage large construction and infrastructure projects in remote underdeveloped regions (Jih-Pao, 1977). This outcome has been viewed by the state as important not only for development, but also in the context of ethnic unrest and frontier defense (Zhang, 2010). Second, state farms serve as supply centers for everything from grain strains to rubber clones, which would be difficult to acquire otherwise (Kuo, 1972). Moreover, they have served as demonstration centers for modern farming techniques related to mechanized agriculture (Stravis, 1978). Third, state farms provide employment for demobilized soldiers, urban unemployed, and individuals who are returning from overseas (Zhang, 2010). This is strategically important because they employ vulnerable demographic groups. Finally, state farms are a source of grain, vegetables, livestock, and industrial raw materials for export (Woodward, 1982). During wartime, unrest, and economic vulnerability these supplies have helped hedge against food and commodity insecurity (Zhang, 2010). In short, state farms have developed over time to perform a specific set of functions that vary based upon context.

The precursor to the modern state farm was first developed in the decade prior to founding of the People's Republic of China. During the Yan-an era of the late 1930's, the Chinese Community Party (CCP) suffered a series of defeats at the hands of the nationalist army and was forced to retreat to the Loess Plateau. This geographic area was a nearly inhospitable region at the time. To make matters worse, the CCP lacked a strong tax base and immediately

started to suffer as a result of an effective economic blockade. These duel challenges left the CCP with little choice but to acquire grain through organized agricultural projects. To accomplish this task, military forces were organized into production units under the umbrella of what was called the "Big Production Movement" (Zhang, 2010). It was this model of state-led organized agriculture that would subsequently be transplanted to other regions of China. This initial development therefore set the stage for the evolution of state farms over time.

The state farm concept was not adopted by every region but was instead utilized by the national government in particular contexts. At the request of the newly formed centralized government, local governments in Xinjiang, Heilongjiang, Inner Mongolia, Guangdong, and Hainan Island developed large state farm systems (Zhang, 2010). Although state farms comprised a small portion of the total amount of cultivated land over the next few decades, they were hugely important in the areas where they were located. To illustrate this point, in the case of Heilongjiang alone, 40 percent of all land was devoted to 103 state farms comprising 23.2 percent of cultivated land in the province (Woodward, 1982). The central government selected these regions as ideal locations for state farms due to their inhospitable landscape and their location in frontier areas where ethnic instability was a concern.

The initial structure of state farms allowed them to meet the demands placed by the state. Unfortunately, this same structure was unsustainable over the long term. By the 1970's, it was clear that state farms were in quite a bit of trouble. Indeed, for the three decades leading up to the 1970's they had lost huge amounts of money (Sun, 1999). Despite nearly five billion dollars in investment, they were operating at a loss for almost the entirety of a decade (Liu, 1999). In 1978 alone, they lost 2.19 billion dollars (Guo, 1999). Aside from simple profitability concerns, state farms, almost across the board, suffered from exceptionally low productivity as measured by

yield. Moreover, they were slower to adopt technology than non-state farms. Figure 5 puts some of these trends into perspective using data from 1957 to 1998.

Figure 5 – State Farm Descriptive Data

Year	Number of Farms	Workers (millions)	Land Area (million mu)	Grain Output (billion jin)	Revenue (bllion yuan)	Profit / Loss (million yuan)
1957	804	0.44	15.8	1.45	0.67	57.4
1962	2123	2.16	43.7	3.8	1.58	-142
1965	2062	2.60	50.0	--	3.65	460
1978	2067	1.53	64.2	12.9	8.5	-2,190
1998	2101	12.0	71.6	32.9	--	--

Zhang 2010

The problems that state farms faced were largely a function of their structure. When Deng Xiaoping initiated a series of economic reforms, state farms were targeted as an area that needed structural change. Prior to reforms, state farms essentially performed social functions traditionally associated with governments. They provided "cradle to grave" services to employees and ensured that populations were employed, housed, and fed. In short, they took on the role of de facto local governments in the geographic areas in which they operated (Zhang, 2010). These functions were a burden from the perspective of maximizing profit. This was because the provision of social services, as a result of concerns related to higher levels of employment, increased costs. That in turn reduced the profit margin of state farms. The challenge for Deng Xiaoping era reformers was therefore to design a system that would perform the same basic sets of economic and social functions while remaining profitable.

Those who wanted to reform state farms examined each of the features that defined these institutions. At their core, state farms were distinct from other institutional configurations in the sense that all assets, including land and capital, were owned by the state (Sun, 1999). Even managers and workers were agents of the state who received standardized wages and were entitled to particular levels of social benefits. This near complete ownership was advantageous because it allowed the state to completely control all decisions. At the same time, this original

model of ownership involved exceptionally high upfront and long run costs and demanded the state internalize all risk. Those interested in reforming state farms would therefore focus on altering this dynamic by fundamentally changing the role of state farms in many rural areas.

There were two waves of reforms to state farms. The first wave involved experimentation at a local level. As early as the mid 1970's, some state farms allowed individuals to keep surpluses, which was previously unheard of (Liu, 1999). This became the first step towards the localization of production on state farms; however, the central government did not support such changes until the 1984 adoption of the Household Responsibility System (HRS). The second wave of change occurred shortly afterwards and involved a division of land on state farms through allocation based on contract. Those who were awarded contracts then had to meet a quota, but were allowed to keep all surpluses. The state farm still played a role in farming by providing technology and services on a fee-for-service basis as well as allocating land and controlling how it was used (Zhang, 2010). Despite this, farmers had measurably more control in this system and internalized comparatively greater risk.

These two waves of change occurred at the same time as another vitally important alteration to the previous state farm model. A number of government agencies, including the State Bureau of Agricultural Reclamation, the Ministry for Agriculture and Forestry, the Ministry of Commerce, the Ministry of Water Conservancy and Power, and the Ministry of Machine Building, decided that state farms should become more integrated with the rest of the Chinese economy (Woodward, 1982). The result was the creation of integrated agricultural industrial commercial enterprises (IAICE). This IAICE model became common practice on most state farms over the next decade (Zhang, 2010). Because state farms have direct access to raw materials, integrating agriculture with commercial industry would facilitate vertical integration.

This outcome would add value to products because farms could sell processed products midstream and thus retain greater profit. The result of these reforms was very positive. By 1979, just one year after suffering massive losses, a twelve-year losing streak was reversed. That year the profitability of state farms was about 90 million dollars for the first time.

The state farms that were set up in Yunnan to cultivate rubber followed the same developmental path as other state farms throughout China. Take labor issues for example. The first farm, set up in the mid-1950s, employed socialist production units, which were comprised of mostly Han Chinese who were relocated to the region (Ahlheim, 2012). Local minorities were not recruited to work on these farms and were instead left to continue under the substance agriculture model that previously dominated the region. Han Chinese were selected instead of local minorities because the Han were considered to be the only ethnicity fit for farming according to the official state ideology (Sturgeon, 2006). Initially, many of the workers were demobilized soldiers, but they were replaced during the Cultural Revolution by educated youth from Chinese cities (Fox, 2009a). It was not until the 1980's and the remigration of state farm workers back to cities that local ethnic minorities started to work on state farms (Sturgeon, 2010). Thus, the labor force on state rubber farms was very similar to that of other state farms.

Another area of similarity pertains to the structure of the farms themselves. State rubber farms performed the same basic functions, outlined in the following section, as state farms that produced grain for example. This was in large part due to the management structure of state farms across the country. The Chinese Ministry of State Farms and Land Reclamation centrally controlled all state farms. As a result, decisions about the management structure and operation of state farms were made centrally and then handed down to local specific branches of the agency for implementation. This method, while allowing for experimentation, meant that most farms

followed the same basic evolutionary model. For example, the reforms of state farms that took place during the late 1970's varied to some extent based on geography, but generally followed the same trajectory. This may have been due to a decision made by the central government that cost overruns were becoming an issue for all state farms. Therefore, state farms, including those producing rubber, were ordered by the central government to change their structure.

Functions of State Farms

The Bureau of State Farm Management in Kunming has overseen state farms in Yunnan during the past half century. It is a subset of the Chinese Ministry of State Farms and Land Reclamation and a sister organization to the Bureau of State Farm Management in Hainan. The evolution of these agencies and interviews with individuals who are involved in rubber cultivation indicate that the Bureau of State Farm Management in Kunming deliberately structured state farms in response to a particular set of challenges that have changed over time. This section will outline the functions that state farms performed and discuss some of the historical circumstances that may have led to the decision to manage state farms in this way. It will focus on the four most important dimensions of what state farms do: making employment decisions, providing high-quality inputs, disseminating information cultivation, and providing services to farmers and their families.

One of the functions of state farms has been to provide to farmers materials that are either necessary for or improve the cultivation of rubber. There are two examples that are common across various state farms. First, the provision of clones is generally common practice among state farms. The Chinese government, based on the advice of Russian technical advisors, decided to modify and provide clones that are more suited for the climate of the region. They therefore tasked state farm offices with the charge of providing rubber clones as well as working with

outside researchers to modify them when necessary. This is illustrated by the use of RRIM 600, PD 86, GT 1, and PR 107 clones that were modified based on studies of Malaysian and Indonesian rubber clones (Chapman, 1991). Second, the provision of fertilizer is generally common practice across state farms. Chemical inputs, especially the yield stimulant Ehtephon, when used on trees that are ten years or older, are shown to double production of rubber (Ao, 2004). This is in part because rubber can be tapped once every four days to obtain the same yield as a tree without such treatment could produce if tapped every other day (Wang and Chen, 2004). The provision of clones and fertilizer to farmers is important as it improves the productivity of the farm as measured by yield and is a good hedge against risk associated with inclement weather. Thus, state farms perform an important role as repositories for materials that they then subsequently distribute to farmers.

Another function of state farms has been to disseminate information related to weather and its relationship to cultivation. This often involves setting rules that mandate the adoption of certain practices. State farms help farmers deal with temperature by restricting the planning of rubber to elevations below 1000 meters to mitigate the risk of cold air drainage. They also regulate the ability of individuals to plant trees on northern facing slopes. Finally, they encourage the use of seedlings rather than budded stumps or grafted plants, which increase the risk of long run freezing (Chapman, 1991). State farms also help farmers deal with rain, which can prevent the tapping of trees. In fact, they developed a plastic shield that allows for farmers to collect latex even when it is raining (Fang Yi, 2013). This has dramatically increased the yield on farms given that rain is a common occurrence in Yunnan's tropical environment.

An additional function of state farms is to provide information about farming techniques and best practices. State farms help dictate tapping frequency and consistency by providing

farmers with information about the dangers of over tapping, which causes bark damage that can reduce a tree's lifespan from 35 to 25 years. Interestingly, there is data to show that farmers listen to this advice because tapping frequency on individual farms is 5 to 10 times per day, while tapping frequency on state farms is 2.5 times per day (Fang Yi, 2013). State farms also provide information about the ideal proximity of one rubber tree to another. Since studies have shown that in Yunnan's environment 495 rubber trees per hectare is the optimal density, state farms tell farmers that such spacing is most advantageous (Huang, 2004). Finally, state farms help farmers identify land that is most productive either because it is southern facing or because of its gradient (Fang Yi, 2013). By providing these functions state farms improve productivity by ensuring farmers have access to accurate information about best practices.

Another function of state farms relates to their ability to impact local and regional labor markets. State farms are large employers in the regions in which they operate and can therefore set wages for rubber tappers. For example, state rubber farms in Yunnan during 1988 provided monthly wages of 160 yuan or 42 dollars because they wanted to encourage increased wages for workers (Chapman, 1991). At the time, these wages compared favorably with urban workers and were designed to entice a larger workforce to rural areas. Moreover, state farms have often provided substantial resources for workforce training (Fang Yi, 2013). Without this structure, comparable training would not have been available in the more isolated parts of Yunnan. Finally, state farms dictate the type of worker present. They enticed and at times even forced large numbers of Han Chinese to work on farms. This is illustrated by a cursory look at the demographic shifts in Yunnan during the past century. In 1935 the population was 73 percent Dai, while in 1988 the population was roughly one-third Dai and one-third Han (Chapman,

1991). Therefore, state farms have had a role in setting wages, providing training, and dictating the ethnicity of the workers and stakeholders involved in rubber cultivation.

A final function of state farms involves providing social services to the surrounding community. State farms have provided schooling, electricity, healthcare, and pension plans at times during their history (Jianchu, 2005). Moreover, they have served as an intermediary that purchases rubber grown on local farms in an attempt to protect rubber farmers against price volatility that resulted in part from the 1983 shift to household farming. These functions became a huge burden on state farms when the government decided such farms should become profitable enterprises. Some estimates go so far as to approximate that half of all expenses related to state farms were the result of the provision of social services (Gu & Li, 2011). As a result, modern day state farms have shied away from the cradle to grave approach to the provision of social services that characterized early state farms. They have instead focused on balancing budgets.

Evaluating State Farms

This history of rubber cultivation and state farms raises two important questions. First, what are the ways, if any, that state farms fit into Hsueh's typology of institutional creation and evolution? Second, do state farms actually facilitate upgrading and if so how would we know it? Given the history of state farms, described in previous sections, it is possible to evaluate each of these questions in turn. The first portion of this section will start by evaluating the possibility that state farms may explain the presence of outcomes typical of situations in which upgrading is present. The second portion of this section will then assess the degree to which the motivation behind the creation and evolution of state farms fits within the framework outlined by Hsueh.

To assess the presence of upgrading induced by state farms it is useful to compare state farms to their logical equivalent: small family farms operating under the Household

Responsibility System (HRS). These farms are discussed in existing literature, which sometimes refers to them as household farms, family farms, or smallholders. They are generally farms that operate on smaller plots of land and do not have connections with one another. This model of farming existed prior to the creation of state farms and remains throughout China to this day. Figure 6 uses existing government data, taken from a survey conducted throughout Yunnan province, to assess and compare the effectiveness of these two models of farming.

Figure 6 – Comparative Data

System	*Farm Area (10,000ha)*	*Production Area (10,000ha)*	*Yield (kg/ha)*	*Total Value (Million USD)*
State Farms	10.09	6.88	1725.00	119.39
Smallholders	11.03	4.41	1345.50	59.76
Total	21.12	11.2	2535.25	179.15

Data taken from Jiang 2003

As previously discussed, it is useful to identify the presence of upgrading based on higher yields, greater cultivated land, and higher profit per unit sold. Based on these criteria, data do show that state farms are more effective than smallholders. In terms of yield, state farms are slightly more than 20% more productive than smallholders. In terms of production area, state farms have steadily risen to surpass smallholders in Yunnan. They now occupy roughly 25,000 more hectares of land than smallholders. In terms of profit per unit sold, the total value of the products from state farms is roughly double that of smallholders despite producing relatively similar volumes of product. Although comparative data does not exist regarding profit per unit sold, it is likely that state farms are more profitable given the discrepancy in total value. Since other factors, including geography and the environment, are being held constant, it is safe to assume that at least a correlation exists between state farms and outcomes typical of upgrading.

The history of both the creation and evolution of state farms provides a clear picture of the ways that state farms fit within Hsueh's framework of institution creation and change.

Indeed, it is evident that state farms have been shaped, at least in part, by military considerations, concerns related to technology improvement, the economics of the sector more broadly, and path dependence. These considerations will be discussed in turn but a significant caveat is in order. This paper in no way argues that these concerns encompass all of the motivations for the creation and evolution of state farms and it does not attempt to describe the importance of each. Doing either of these things would ignore the significant historical variation in motivations for particular actions. Instead, it only seeks to illustrate how each of these considerations has played a role in the politics behind the formation and evolution of state farms.

Military considerations were a driving force in the story of both the creation and evolution of state farms. The trade sanctions that resulted from the Korean War served as one of the motivations behind the original creation of state farms. Moreover, the use of demobilized soldiers on state farms indicates that the farms served a dual purpose for the state because in addition to producing rubber they provided a check against unrest within the ranks of the army. Similarly, state rubber farms were created in regions that were previously occupied by large ethnic minority populations. State farms were seen as a mechanism to both encourage Han migration to these areas and establish a state presence in these regions. Thus, they were a way that the government could stabilize these areas and increase the presence of the state. It is important to note that this function, primarily revolving around boarder security issues, is different from Huseh's conception of security as a function of military considerations. In short, both the desire to create a supply of rubber for military purposes and the aim of stabilizing at-risk regions informed many of the important government decisions made about state farms.

Technological considerations were also important for both the creation and evolution of state farms. The dominant narrative of the government during the 1950's painted the local ethic

minority populations in Yunnan as technologically backwards and incapable of learning the techniques of modern agriculture. This broad narrative was one of the explicit ideological justifications for the creation of state farms that employed Han Chinese instead of local minority groups. More concretely, the government used state farms as a mechanism to spread new technological innovations to regions that would otherwise not have the capital or knowhow necessary to utilize them. This mechanism was especially important in the context of natural rubber production because of the challenges of growing rubber in Yunnan. Although it is impossible to answer the counterfactual of what would have happened absent state farms, it may be the case that the technology would not have existed to produce rubber in Southwest China for decades after the 1950's or even at all.

Economic trends were somewhat important for the creation and evolution of state farms. Nonetheless, economic ebbs and flows might not have been as significant as concerns related to national security and technology. An important function of early state farms was to insulate against price shocks by ensuring that overcapacity or scarcity did not create massive fluctuations in prices that could make forward planning challenging. More importantly, the decision to reduce state management of state farms in the direction of liberalization occurred based on concerns related to state farm profitability. That said, neither of these elements is entirely consistent with the argument that segments that have higher growth will maintain stronger institutions because aggregate growth of rubber in China has widely fluctuated during the past half century.

Path dependence may explain aspects of the way that state farms have evolved. The decision to reform state farms from enterprises that were entirely controlled and managed by the state to farms that leased land to individuals was driven by a deep-seated concern about the profitability of state farms. Around the time period when state farms were being reformed some

officials believed that state farms should be abandoned in their entirety. Despite this sentiment the government decided to simply alter the way they functioned. This willingness to stick with state farms may, at least in part, have been a result of the resources that were invested in the institutions as well as the deep-seated bureaucracy that surrounded them. Thus, the simple creation of state farms, which were very complex institutions, may have sustained them over time. Despite this, it would be inaccurate to overstate the role of path dependence in the evolution of state farms. There is not much evidence that decision makers consciously articulated these justifications for the reform process. Thus, they may not have been very important.

In conclusion, the creation and evolution of state farms can be explained by some of the political motivations that Hsueh highlights as drivers of institutional change. Specifically, the concerns related to national security and technological capacity played a major role in both the creation and evolution of state farms. Moreover, path dependence may explain part of the story behind the reform of state farms during the late 1970's. Despite this, there does not appear to be much support for the economic growth explanation of institutional creation and change. Aside from the question of motivations, there is indeed a strong correlation between the presence of state farms and the existence of indicators of upgrading. Thus, it is likely that state farms have played a meaningful role in innovations that have occurred.

Other Institutions

Other institutions have made meaningful contributions to the development of rubber cultivation in China. This section briefly highlights some of these institutions, focusing on their contribution to innovation in the industry and their connections to the development of state farms in China. Since these institutions are not the focus on this case study, this section's discussion of both the institutions themselves as well as the outcomes that are produced will be limited.

Therefore, this section does not provide analytical value other than to provide context for understanding the role of state farms by describing the environment in which they operate.

The Xishuangbanna Tropical Botanical Garden (XTBG), a subset of the Chinese Academy of Sciences, is a government sponsored research institution that explores sustainable uses of plant resources with an emphasis on forest ecology. It is home to 13,000 species of tropical plants living in 35 collections and more importantly, conducts research relating to rubber (Fang Yi, 2013). Both the headquarters in Xishuangbanna, as well as the divisional office in Kunming, have sponsored teams that have conducted research on the environmental impacts of rubber cultivation as well as potential strategies to conserve the region's biodiversity despite increased demand for rubber. One important innovation that came from research at XTBG has been the development of new rubber varieties including 77-2 and 7-4 (Sturgeon, 2008). Moving forward, the local government has requested that XTBG cooperate with the Yunnan Society of Tropical Crops and the Yunnan Institute for Agricultural Engineering Research and Design to conduct a five-year study on the development of bio-industries in the region (Fang Yi, 2013). This project will encourage rubber research because of its growing importance to the region.

Chinese government ministries have also played an important role in the cultivation of rubber. As described earlier, the Bureau of Land Reclamation was the agency tasked with the creation and management of state farms. In close cooperation, the Chinese Department of Commerce frequently gives subsidies, loans, and tariff exemptions to rubber producers to incentivize particular actions. Unsurprisingly, both the Ministry of Agriculture and the Ministry of Forestry have played key roles in the regulation of land use. They have each therefore had important roles in overseeing many of the key changes to the upstream section of the industry. It

is telling that all of these agencies have at times interplayed and coordinated their actions with state farms because it demonstrates the importance that the government places on these farms.

Downstream Upgrading

There are four outcomes that one would likely observe in the context of downstream agro-industries in which upgrading exists. First, greater numbers of new products may be created due to innovations that enable producers to improve existing products and create entirely new ones. Second, a higher price per unit sold indicates the addition of value to products and therefore may point to the presence of upgrading. Third, connections may be made between downstream industries and upstream suppliers due to efforts to coordinate actors. Finally, a larger volume of exports of final products may exist because products are able to more effectively compete in international markets. Although these three outcomes may indicate the presence of upgrading, they do not paint a complete picture of the extremely complicated and highly variable upgrading processes that occur in both the downstream and midstream segments of the industry. Thus, their existence is useful in painting a partial but often incomplete picture of the performance of the industry as a whole. In short, these indicators do have limitations.

The creation of <u>new or improved products</u> is difficult to measure. Although it is certainly possible to list various product innovations that have occurred, such information would not be particularly useful in describing the aggregate innovation in product creation and design that occurs across the entire industry. Therefore, I draw on conversations and data collected at the most recent Chinese rubber industry trade conference held in Qingdao on March 23-25, 2014. The speakers at the conference all used a common phrase to describe the status of the industry. They noted that although China's rubber industry is currently *big*, it is only now becoming *strong*. Rende Fan, the current honorary chair of the Chinese Rubber Industry Association

(CRIA), provided a particularly succinct assessment of his views on the current state of the midstream and downstream industry. He argued that it is useful to think of the progression of the industry in terms of three stages. Figure seven briefly outlines each stage.

Figure 7 – Stages of Development

Primary (2002-2004)	Intermediate (2005-2008)	Advanced (2009-Present)
-Chinese rubber consumption was 3.06 million tons in 2002, which was 3.01 million more than the US and was ranked 1st in the world -Rubber machinery sales were 540 million in 2003, which was 315 million more than Germany and ranked 1st in the world -Production of waste rubber, rubber chemicals, rubber steel wire, cord canvas, and rubber shoes ranked 1st in the world	-Chinese tire production was 250 million in 2005, which was 228 million more than the US and ranked 1st in the world -Chinese tire export sales were 6.41 billion, which was 6.094 billion more than Japan and ranked 1st in the world -Chinese carbon black production was 1.852 million tons, which was 1.521 million tons more than the US and ranked 1st in the world	-Chinese synthetic rubber capacity reached 2.5 million tons, and production reached 1.97 million tons, which was 1.962 million tons more than the US and ranked 1st in the world -Chinese firms are now beginning to lead in the formation of new varieties and forms of raw materials, modern marketing, intelligent manufacturing, and recycling of waste products

Rende Fan 2014

With the typology of three developmental stages in mind, it is possible to begin to think about some of the significant product advancements that have occurred during the primary, intermediate, and advanced stages of industry development over the past decade. For brevity's sake, this section will select two companies to look at in some detail to illustrate the presence of new product creation and the continued improvement of old products. First, it will look at the China operations of MESNAC, which is a leading rubber and tire machinery supplier. Second, it will look at the China operations of Lanxess, which is a specialty chemicals group involved in rubber production. The activities of these two companies can be thought of as a microcosm of the broader activates that occur throughout different segments of the Chinese rubber industry.

The main branch of MESNAC that operates in China is located in Qingdao in an industrial park that is in close proximity to the Qingdao University of Science and Technology. The university will be discussed in detail in subsequent sections. According to the company's website, this location is responsible for nearly 400 patents and software copyrights, has drafted 24 standards, and has undertaken 50 national scientific and technological projects (MESNAC, 2014). These statistics are direct indicators of innovation relating to the development of new machine equipment as well as the improvement of existing products. It is worth noting that MESNAC equipment is not only sold to Chinese companies, but is also widely used throughout the world due to the unique research that the company conducts in Qingdao.

The Lanxess Rubber Testing and Research Center in China is also located in the same industrial park in Qingdao and is home to MESNAC. The center, established in 2008 through a joint cooperation agreement with the university, is designed to "strengthen the company's innovative ability to *develop new products* and applications as well as *enhance existing products*" (Lanxess, 2014). The center covers 3,000 square feet and houses research facilities, a rubber mixing and testing laboratory, and a pilot plant. Students from the university regularly attend Lanxess functions, and most of the employees of the center are graduates of the university. Although the center is only six years old, it represents the willingness of large foreign companies to invest in Chinese infrastructure to enhance their own research and testing capabilities. Therefore, it may be one of the first of many companies to invest in Chinese rubber.

A higher price per unit sold indicates the presence of upgrading. Unfortunately, it is difficult to identify data that systematically tracks profit both because there are so many different rubber products and because companies that are not publically listed may not disclose this information. Fortunately, data does exist that tracks the production of rubber products. This is

useful because increased production is generally an indicator of the presence of higher profit. After all, companies are unlikely to produce goods that they think aren't sufficiently profitable. Figure eight shows the production predictions of Deng Yali, the President of the CRIA.

Figure 8 – 2014 Production Predictions

Name of Product	Prediction (in HMU*)	Percent Growth
Car Tires	5.62	6.24
Radial Tires	5.11	7.35
All-steel Radial Tires	1.12	4.7
Motorcycle Tires	2.1	13.51
Bicycle Tires	2.8	-6.7
Conveyer Belts	5.5	5.8
V-Belts	22.5	2.3
Rubber Hoses	15.5	19.2
O-Rings	49.6	6
Auto Anti-Vibration	157	5
Rubber Shoes	14.7	-2
Condoms	72.5	1.7
Surgery Gloves	17	3
Other Gloves	16	5.3
Rubber Powder	55	10
Carbon Black	498	5.91
Rubber Chemicals	105	5
Anti-ager	35	6.06
Steel cord	193.7	6
Hoses & Belts	13.8	5.3
Tire Steel Wires	67.5	6.1
Terylene Cord Fabrics	19.7	5.9
Radial Tire Molds	34	6.3

Deng Yali 2014 – *HMU = Hundred million units

Production levels are one potential indicator of higher profit per unit sold, but an even more direct indicator may be the profitability of the industry itself. Although such a measure, like that of production levels, does not directly indicate profit per unit, it does show that there is both growth in the industry and that such growth is profitable for companies involved in the sector. Therefore, although it cannot isolate upgrading in particular companies or products, it provides a rough indicator of the existence of upgrading throughout an industry. Figure nine draws on CRIA data to illustrate the industry's profitability in 2013.

Figure 9 – Industry Profitability

Industry Segment	2013 Profit Growth (%)
Overall Industry	5.57
All Tires	5.31
Cycle Tires	5.73
Car Tires	7.07
Rubber Shoes	4.38
Latex Goods	3.95
Carbon Black	0.16
Waste Rubber	5.94

Deng Yali 2014

The presence of linkages between upstream and downstream segments of industries is an important indicator of the level of coordination between firms. Although it is not possible to measure the aggregate level of connectivity between different segments, it is possible to anecdotally examine the degree to which downstream and upstream firms cooperate. During my participation in the CRIA conference in Qingdao, there was ample opportunity to speak with both upstream and downstream participants. Many of them emphasized the importance they placed on cultivating relationships with each other. For example, the delegation of Thai economists and government officials was among the largest of any group attending the conference. When we met, they spoke about the need to understand current trends in the downstream section of the industry so that they could better assist farms, which were cultivating rubber in Thailand. By the same token, European manufacturers of synthetic rubber with whom I spoke rationalized their participation in the conference by speaking about their desire to both learn more and better connect with an emerging and growing Chinese market. Downstream Chinese producers were also interested in connecting with upstream suppliers because they desired the opportunity both to secure inputs needed for products and to reduce their costs.

Data does not exist that tracks the volume of exports of rubber products made in China. Fortunately, there is relatively comprehensive and recent data that tracks the exports of Chinese

tires, which comprise a large share of the rubber products that are exported each year. Figure ten uses CRIA data that charts changes in export volume from 2011 to 2013.

Figure 10 – Tire Export Volume

Product Type	Year 2012	Growth Rate (%)	Year 2013	Growth Rate (%)
Tires	441	9.6	499	13.3
Saloon Tires	151	6.1	176	16.5
Truck & Car	233	13.1	267	14.1

Deng Yali 2014

Although the growth rate of tire exports is very high, as evidenced by the previous table, such a trend does not necessarily imply that export revenue is growing. In other words, it is possible that exports are rising because Chinese companies are selling tires more cheaply and can thus outcompete foreign firms on price but not because Chinese tires are of higher value. Figure eleven uses the same CRIA data to track changes in export revenue from 2011 to 2013.

Figure 11 – Tire Export Revenue

Product Type	Year 2012	Growth Rate (%)	Year 2013	Growth Rate (%)
Tires	159	7.6	162	1.7
Saloon Tires	59	5.7	62	5.2
Truck & Car	81	8.9	81	0.9

Deng Yali 2014

This data shows China is exporting tire products that are increasingly more and more valuable, which is a likely indicator of the presence of upgrading. This proves that Chinese industry can compete with foreign alternatives and beat them out for international market share. More impressive though may be the fact that these numbers are not reflective of the entire rubber industry. Since these numbers do not account for companies that produce the inputs for tire products, but only account for finished tires, they do not paint a complete picture of the strength of Chinese tire production. In reality, it is likely that the industries total export revenue is substantially higher than these figures. Thus, if exports are indeed an accurate indicator of upgrading then it seems likely that substantial innovation and upgrading are taking place.

Mechanics of Processing

The processing of rubber is a complicated procedure that varies based upon whether natural rubber or synthetic rubber is being produced. Since this paper focuses on the production of natural rubber, this section discusses the processing of natural rubber. The base ingredient, natural rubber latex fluid, must first be obtained from rubber trees. At that point, the watery substance is filtered to eliminate some of the impurities present, packed intro drums, and shipped to a processing plant. There are a number of different intermediate rubber products that can then be produced. One product is ribbed smoked sheets used for the production of tires and other heavy rubber products. That process involves clumping the latex by adding acid, rolling the clumped fluid-like substance into sheets to remove water, chemically treating the semi-solid substance, and heating it at low temperatures to prevulcanize it. The rubber is later vulcanized through a chemical process for converting rubber into more durable goods after sulfur, curatives, or other accelerators are added. A second product, used in the production of goods like condoms and medical gloves, is not processed by drying rubber, but instead purifies and adds chemicals to the fluid form of latex. Although both processes are different, each contains a complicated procedure that involves sophisticated technology and requires workers with substantial training and experience. Incorrectly processed rubber is one of the major causes of faulty final products. Therefore, getting the processing of rubber right is exceptionally important.

Mechanics of Tire Production

There are many downstream rubber products whose creation and production varies widely. As a result, it is simply not possible to discuss the complications involved in the production of each product. Instead, this section will focus on the production of tires, which are a major segment of the Chinese rubber industry. It is important to note that tires are made of much

more than just rubber. The final products require fiber, textiles, steel cord that reinforces the tire's inner lining, body plies, bead assembly, belts, sidewalls, and tread. The process of making a tire involves a number of steps. First, a specialized mixing process is necessary to produce a more durable rubber compound. Then, the fabric cord, steel cord, and bead wire must be prepared. After that, the inner liner, steel belt and ply cord must be "calendared". Then, extrusion or the process of shaping the tire's sidewall and tread occurs. Finally, the actual building, curing, and inspection of the tire take place (Maxxis, 2014). There is of course variation in this process depending upon the type of tire that is being produced.

History of Production

The midstream and downstream development of the Chinese rubber industry dates back to the founding of the People's Republic of China (PRC) in 1949. Shortly afterwards, the country started to systematically think about the development of many industries. One of the industries that China initially focused on for a variety of reasons was the development of its rubber industry as well as its sister plastics and chemicals industries. Since many products involve rubber as an input, the rubber industry was one of the first to develop in strength. Furthermore, the Chinese government placed emphasis on sectors that involved "heavy industry" during the first three decades of economic planning. Since rubber is an input for many industrial and construction projects that are central to the development of heavy industry it has greatly benefitted.

Although the production of rubber occurs in both Yunnan and Hainan, the bulk of the midstream and downstream Chinese rubber industry has developed in Qingdao. The city has become important for the development of rubber due to the colocation of companies and business associations as well as the existence of government financial support. The concentration of the industry has become so pronounced that some have labeled Qingdao "the rubber city".

Map 5 – Qingdao

Wikimedia Commons 2014

This section will focus on two institutions that have been particularly important to the development of the Chinese rubber industry. While this emphasis will not account for the development of the numerous segments of the industry that produce a variety of inputs and final products, it is beneficial for a number of reasons. First, it provides context for the development of many parts of the rubber industry by describing the history, functions, and effectiveness of two very important institutions. Second, it examines the ways that small portions of the midstream and downstream industry operate in greater detail. This approach is useful because it enables great focus and depth of analysis related to a section representing a microcosm for the rest of the industry. Thus, although this approach paints a limited picture, it is useful for beginning to understand the industry and can serve as the foundation for subsequent research.

History of Qingdao University

The genesis of what is now called the Qingdao University of Science and Technology (QUEST) dates back to the years following the founding of the PRC.[11] The Shenyang Rubber Industrial College was founded in 1950 to encourage the development of a workforce capable of creating a domestic Chinese rubber industry. At the time, Shenyang was one of the centers of Chinese heavy industry. For this reason, the government selected this location for the college. In 1956 the university moved from Shenyang to Qingdao, which is only slightly southeast of Shenyang. Both cities are located in the Liaoning province, relatively close together, and the decision to move the university was made for a couple of reasons. First, Qingdao has the geographic advantage of being close to the water. Second, at the time of the move, Qingdao was home to the largest concentration of rubber factories. Shugao Zhao, the current director of rubber research at the university, recalled during our interview that Qingdao was home to four rubber factories at the time of the university's move. Given there were only a total of thirteen rubber factories throughout all of China at the time, this concentration was both unprecedented and meaningful. Geography and proximity to industry therefore led to the decision to move the university's location from Shenyang to Qingdao after only a few years.

The original mandate of the college was relatively narrow. The school was created for the explicit purpose of training a workforce to provide labor for the rapidly expanding rubber industry. In 1958 the college expanded to a university and started offering students the option of pursuing other courses of study that, although linked to rubber, departed from the original and narrow mandate of the college. Although this diversity in emphasis has expanded to many different types of engineering, the main focus of the university is still related to rubber. Shugao

[11] This section draws entirely on a conversation that I had with Shugao Zhao on March 25th, who is the current Director of the Key Rubber Laboratory and an employee of the Chinese Ministry of Education.

Zhao went so far as to argue that rubber is “at the core” of everything that the university does, even fields that seem only tangentially related to the topic. A cursory examination of the majors offered at the university seems to support this assessment. The school offers undergraduate majors in rubber technology, rubber machine equipment, chemical products, chemical engineering, automotive production, polymer material engineering, and chemical material engineering among others. Thus, most of the university’s emphasis is placed directly on rubber production or on fields of study that support rubber related teaching and research.

Perhaps the most important development in the evolution of the university took place in 2003 when the Key Laboratory of Rubber-Plastics (KLR) was created. Despite this, it was not until 2006 that the Ministry of Education, which oversees and governs the university, accredited the laboratory. Although the university dedicated tremendous resources to teaching and research on rubber prior to the creation of the laboratory, the government’s decision to create the KRL greatly expanded the capacity of the university to train students and conduct research. The lab conducts research on four areas that were identified as strategic focuses: the molecular design of rubber/plastics, the structure and function control as well as optimization of rubber/plastics, functional and social rubber/plastics products, and modeling and processing of rubber/plastics.

The creation of the KRL was significant because of the resources that it provides to its researchers, teachers, and students. The lab is equipped with 46 technical instruments valued at 40 million RMB. These machines enable high-level, cutting-edge rubber research and teaching. In actuality, the value of the lab technology is higher because the 40 million RMB estimate does not take into account the sizable amount of technology that has been donated by companies. The lab is also quite large and occupies a space of 4000 square feet. It became clear after walking around the university that the lab space is one of the largest on the campus. Perhaps most

importantly, the lab employs a staff of 50 of which 40 hold doctorates, 16 are professors, and 20 are associate professors. In addition, well known scientists frequently visit the KRL for communication and instruction as guest lecturers and researchers. The technology, amount of space, and expertise of the KRL therefore differentiates it from many of its domestic and international peer institutions and helps it to stand out at an industry leader.

The Key Rubber Lab, under the auspices of QUST, offers doctoral and masters degrees to students. The PhD program offers three degrees in materials sciences, materials process engineering, and polymer chemistry and physics. The masters program offers four degrees in materials science, material process engineering, polymer chemistry and physics, and material processing. On average, 120 students enroll in both programs each year. These students, especially the PhD candidates, are the day-to-day labor source for the research labs. They also provide additional teaching for lower level undergraduate classes at the university. It may be for these reasons that Shugao Zhao has described the graduate student population as “the heart and soul” of the day-to-day functioning of the lab and therefore universities rubber research.

The KRL has used its resources to focus on research. The lab has accumulated a total research fund of 35,470,000 RMB since 2003. It has undertaken a number of projects including two ‘973’ national research projects, four ‘863’ national research projects, 24 National Natural Science Foundation of China projects, 40 provincial level research projects, five international cooperation projects, and 54 international cooperation projects. These projects have led to 150 SCI collected papers, nine books, and seven authorized patents. Shugao Zhao emphasized that this outcome was impressive given that the lab has only really been active for less than a decade. As a result, he argued that the lab has successful and has bolstered the stature of the university.

Both the university broadly and the laboratory specifically have developed close connections with the industry as well as other universities. The KRL has signed cooperative agreements with SINOPEC, Petro-China Company, Hangzhou Zhongce Rubber Company, Qingdao Haier, and Lanxess Chemical. The KRL has also developed a joint-training masters program for students and demonstration laboratories with the University of Erlangen-Nuernberg and Paderborn University in Germany, KraussMaffei Berstorff Company, ICC Company, Netzsch Company, Zwick Company and the Alpha Company. Finally, the KRL has developed academic exchange programs with Akron University, the Goodyear Company, the German Rubber Research Institute, and the German Engineers Association. These connections have spilled over from the lab to the entire university in the form of greater name recognition.

Functions of Qingdao University

The Chinese Ministry of Education is the governing body of universities in China. As a result, this ministry governs the Qingdao University of Science & Technology and the Key Rubber Lab. It created the university and others like it to perform a number of specific functions. It also managed the evolution of the university to meet a set of specific objectives. This section will outline the functions that the QUST and the KRL perform and discuss some of the historical circumstances that may have led to the decision to structure the university to perform these specific tasks. It will focus on the two most important dimensions of what the university does. Therefore, it examines the university's role in teaching students and conducting research.

One of the functions of the university is to conduct research relevant to the continued development of the Chinese rubber industry. This research has taken many forms. Some research is aspirational in the sense that it is designed to create new innovative research in machine equipment, processing, and product design. Other research focuses on improving existing

products. Research focused on existing products utilizes the university's testing center. Both areas of research though are quite similar in the sense that they rely heavily on the university's technological capacity and the large postgraduate labor force. As a result, the university has something of a comparative advantage when it comes to new product related R&D because it possesses the two critical components that characterize an environment conductive to research.

The research process of the university lies at the heart of the school's mandate. All research conducted at the school is based on the practical application of findings throughout the industry. Research funding is allocated based on a project's potential to add value to the industry. This philosophy is quite different from the American notion of a liberal arts education. Instead of training students to conduct research for the sake of scientific inquiry, the goal has always been to produce research that is useful for the continued growth and development of the industry. This focus on industry capabilities is evidenced by my conversation with Shugao Zhao. During our discussion, he noted that over 60% of research projects conduced by the university entail working with rubber companies, and most of those projects are jointly designed.

Another function of the university is to teach students who can then go on to contribute to the development of the industry. Shugao Zhao made the argument that it is useful to think about the evolution of Chinese universities in relation to the reforms of the 1970's. Prior to the reforms, both industry and universities were entirely controlled by the government. After the reforms, many industries became less micromanaged by the government. As a result, many universities including the QUST decided that they should enter into partnerships with private companies, which turned out to be very positive for the growth of the school. Nonetheless, the explicit goal of the QUST remained meeting the workforce needs of the rubber industry. What changed was the ability of universities to better monetize their work. After the reforms took place, private

companies, in desperate need of a steady stream of employees, were eager to enter into advantageous cooperation agreements with universities. These agreements often resulted in companies making generous contributions to universities in the form of money and technology.

An incredibly unique aspect of the QUST model is the emphasis that it places on the needs of the industry. Everything from the broad major paths that the school offers to the specific syllabi that are used in classes is a reflection of close consultation with industry leaders. Shugao Zhao explained that professors are required to stay up to date with timely trends in the field so that they can better teach their students skills that are useful. This process has occurred through a number of unique mechanisms. First, many professors have a background in the field and are therefore aware of the needs and constraints that are placed on industry. Second, all professors periodically lead their students to relevant factories and companies to learn about their work, conduct individual inspections of these companies, and hold one-on-one conversations with industry leaders. As a result, the QUST has coevolved with the industry itself.

The result of this approach speaks for itself. Shugao Zhao encouraged me to ask others whom I met during my trip where they attended university. Many of the leaders that attended the conference and whose biographies were posted online graduated from the QUST. Some of the university professors with whom I spoke argued that "virtually every great icon" in the field of Chinese rubber has some personal connection to either the QUST or the KRL. Professors at the KRL emphasized that this track record of success is important because it is at the point of being "virtually self-sustaining." By that they meant that the name brand of the QUST has become so embedded within the industry that the credential of a QUST degree has become very valuable.

A substantial portion of my conversation with individuals at the QUST centered on the relative emphasis placed on teaching and research. In all of these conversations, professors made

clear the priorities of the university. They argued that the teaching function of the school is always prioritized over the research function of the school. In other words, the university is primarily a teaching environment that has a secondary function of conducting research. Shugao Zhao summarized the purpose of the school through an analogy that has been roughly translated. He said that one could conceptualize teaching and research as the two legs of a person. Without one of the legs, it is difficult to walk. Therefore, teaching and research cannot occur in the absence of one another. At the same time, the legs must maintain a balance with one another and support the rest of the body. Similarly, when tension exists because both legs want to go in different directions, one direction must be chosen. Therefore, at times teaching or research may win out over the other if a decision has to be made. Following from this analogy, he noted that he has always favored the strong leg of teaching to the weaker leg of research. Although both are important, he said it would be "naïve" to suggest that simply conducting research is enough.

Evaluating Qingdao University

This history of Chinese universities and their relationship with industry raise two important questions. First, what are the ways, if any, that the Qingdao University of Science and Technology fits into Hsueh's typology of institutional creation and evolution? Second, does the university actually facilitate upgrading and if so how would we know it? Given the storied history of the QUST and the KRL, described in previous sections, it is feasible to evaluate each of these questions in turn. The first portion of this section will start by evaluating the possibility that the university explains the presence of outcomes typical of situations in which upgrading is present. The second portion of this section will then assess the degree to which the motivations behind the creation and evolution of the QUST and the KRL fit within the Hsueh's framework.

Assessing the university's ability to facilitate upgrading is difficult because it is virtually impossible to eliminate alternative explanations for the presence of upgrading. That being said, strong evidence exists that indicates a correlation between the university and upgrading for a number of reasons. First, businesses like MESNAC and Rubber Valley have opened their doors adjacent to the university. The colocation of businesses operating in different segments of the value chain is important because it is an indicator of the vertical and horizontal integration of businesses and thus upgrading. More notable though is that the university has not been a passive observer of these developments but has instead actively worked to facilitate these outcomes. For example, MESNAC is a technological offshoot of the Ministry of Education. Similarly, the QUST was one of three other sponsors, including the local district government and MESNAC, which actually created Rubber Valley. Therefore, it seems that the university has played a direct and very active role in these developments. Second, the reputation of the university as a leader in workforce training and research supports the conclusion that the university really does contribute to new product creation and old product improvement. Although such an effect is difficult to quantify, it is presumably very large given the notoriety of the university within the industry.

The history of both the creation and evolution of the QUST and the KRL provides a clear picture of the ways that these institutions fit within Hsueh's framework of institution creation and change. Indeed, it is clear that the university has been shaped, at least in part, by military considerations, concerns related to technology improvement, the broader economics of the sector, and path dependence. It is worth noting that these explanations do not fully encompass all of the motivations for the creation and evolution of the university. Instead, they provide an incomplete, yet useful picture of the key drivers of decision makers who originally created the university and subsequently shaped its evolution.

Military considerations were an important driver of the creation of the university. As mentioned earlier, the establishment of the university closely followed the founding of the PRC. This was at least in part because rubber was identified as a component for heavy industry necessary to strengthen China's ability to defend itself. Shugao Zhao repeatedly mentioned the importance that the PRC placed on becoming self-sufficient from other countries. Although he did not explicitly state this, his answers implied that self-sufficiency is not only a necessary precondition for growth and innovation but, perhaps more importantly, a source of stability and security. Conversely, the absence of such security was considered a strategic vulnerability due to the risk of supply disruptions. The original founding of the college in Shenyang may serve as evidence for this claim. Not only was the original college created to strengthen industry for "security reasons" but it also had a strong relationship with the military according to current students with whom I spoke. In short, although not discussed explicitly, one of the rationales for the creation of the college was probably a desire to ensure stable inputs for military technology.

Technological considerations were perhaps the largest driving force behind the creation and evolution of the university. When the PRC was founded, the very weak manufacturing infrastructure posed a massive problem. Component parts for basic finished goods necessary for further development, like tires for cars, were needed, but there was no preexisting domestic industry that could fuel the country's growth. This was largely, but not entirely, due to the lack of skilled labor necessary to create, manage, and grow businesses that could produce these products. As a result, Shugao Zhao said that the government made a decision to expand higher-level technical education to train the future leaders of industries that were deemed strategically important. A necessary result of this decision was the creation of institutions that conducted technical research, and the government either intentionally or unintentionally created hubs of

technical innovation. Thus, the decision to create the university was closely connected to the government's decision to guide high-tech industries.

Economic trends were somewhat important for the decision to initially create and subsequently expand the university. Rubber was considered to be an important input for many industries that were necessary to strengthen China's economy. Given that the economy was so weak, especially when it came to industrial capacity, the government decided that it needed to take an active role in trying to pick sectors of the Chinese economy to grow. During our conversation, Shugao Zhao said he believed that rubber was a logical area for the government to support because it was so important for other industries that were cornerstones of China's continued path to development. The decision to liberalize portions of the rubber industry was also driven by motivations related to growth. As the industry started to perform at a higher level, it became clear that it was no longer necessary to maintain total control over the industry because companies could be successful on their own. Nonetheless, the government continues to closely consult with industry through institutions like the QUST.

Path dependence may explain aspects of the development of the QUST. The creation of a university system in China that focused on the development of workforce training created a system of instructors, ministry officials, and industry leaders that benefited from the status quo. These actors had the power to lobby decision makers to keep the emphasis on training designed to meet industry needs. When the reform period happened, the government maintained an active role in university administration because it decided that there was need for involvement. The actors who benefitted from the system were the strongest supporters of this line of thought.

History of Rubber Valley

Rubber Valley is an association of government-backed companies with the stated goal of creating a 500-acre ecosystem conducive to the development of the Chinese rubber industry. Its

stated mission is to "promote the sustainable and sound development of the chemical and rubber industry" while its vision is to "build a sustainable and sound ecosystem for the chemical and rubber industries" (Rubber Valley, 2014). Moreover, its core values are "innovation" and "win-win opportunities" while its stated cultural characteristic is "family like" (Rubber Valley, 2014). What is perhaps most fascinating about Rubber Valley is the way that its development has occurred in such a short period of time and yet how it has already attracted such a substantial degree of national and international attention.

A Brief Timeline of Rubber Valley

2011: The Chinese Rubber Industry Association, the Qingdao Shibei District Government, the Qingdao University of Science & Technology, and MESNAC sign a strategic cooperation agreement to build Rubber Valley in Qingdao, China.

2011: Rubber Valley signed a strategic cooperation agreement with the State Intellectual Protection Press to co-build its *International Intellectual Property Information Center* and with the Qingdao Bonded Port to co-build the Qingdao Bonded Port Rubber Industrial Park.

2012: Rubber Valley's development model was finalized and approved.

2013: Rubber Valley established the *Qingdao International Copyright Exchange Center*, the *BOCE-Rubber Valley National Rubber Exchange*, the *National Chemical Rubber Industry Technology Transfer Center*, and the *Chemical Rubber Industry Mediation and Arbitration Center* at its headquarters in Qingdao, China.

Rubber Valley was created in January of 2011 when the Chinese Rubber Industry Association, the Qingdao Shibei District Government, the Qingdao University of Science and Technology, and MESNAC reached a strategic cooperation agreement that pledged each entity's support in the creation of Rubber Valley. It was only months later that the long-term plans for Rubber Valley were finalized and construction began on the first phase of the project. To provide context, the development of Rubber Valley has been broken into four stages that will take place over a time period of roughly 20 years. It did not take long for Rubber Valley to start to sign additional strategic cooperation agreements with other entities later that year. Rubber Valley

agreed to terms with the State Intellectual Property Press to co-build its property information center and with the Qingdao Bonded Port to co-build the Qingdao bonded port rubber industrial park. Finally, the development model of Rubber Valley was officially finalized and approved by all parties in May of 2012. The following year, Rubber Valley established additional centers to perform functions necessary to create a "one stop shop" for rubber companies.

There are a number of advantages that Rubber Valley brands as "strategic benefits" of opening an office at their campus in Qingdao. First, the campus is easily accessible by land, sea, and air. Therefore, it is easy for people and goods to travel to and from its location in the Shibei district of Qingdao. Second, it is located literally next-door to the Qingdao University of Science & Technology and therefore is in close proximity to some of the best and brightest young minds that have a background in the study of rubber in China. In addition to access to talent, Rubber Valley is also located next-door to the university's research lab, facilitating quick communication about the newest innovations in rubber production. Third, the company enjoys the support of the district, provincial, and central governments and can thus offer preferential state treatment to companies who chose to locate to the area. Finally, perhaps the most important advantage of Rubber Valley is its proximity to the rubber companies that operate in the province. Shandong Province is home to 200 tire, 3000 rubber, 300 machinery, 2000 raw material, and 100 chemical companies (Rubber Valley, 2014b). These companies comprise 15% of all rubber companies in China, 30% of the country's entire gross rubber output value, and 50% of all tires produced in China. Thus, it is no understatement to call it the rubber capital of China.

Rubber Valley has already partnered with many ministries and agencies of the Chinese government, companies, associations, and universities during the three short years of its existence. It is quite impressive that these partners have all bought into the Rubber Valley

concept in such a short amount of time. For the purposes of clarity, these partners can be split up into three different categories. First, Rubber Valley has partnered with agencies of the Chinese government, Chinese government sponsored associations and research institutes, and foreign governments. Second, it has partnered with state-owned, hybrid, and privately owned rubber companies. Finally, it has partnered with companies that can provide services to the rubber companies that are located on its campus. As a result, Rubber Valley has attempted to bring government, rubber companies, and third-party firms together to create a "one-stop shop" for any type of company involved in rubber production regardless of the type of products it sells.

Figure 12 – Rubber Valley Partners

Government Affiliated	Third Parties	Rubber Companies
--Shibei District Government --Qingdao University S&T --Chinese Rubber Industry Association (CRIA) --City of Akron --Thai-Chinese Relationship Council --Thai-Chinese Culture & Economy Association --National Engineering Research Center for Rubber and Tire Production --Eve Rubber Research Institute --China Duzhong Rubber Research Institute	--Bank of China --China Construction Bank --Agricultural Bank of China --Industrial & Commercial Bank of China --Hua Xia Bank --Bank of Qingdao --Shandong Re-Guarantee --Peoples Insurance Company of China --Brennan, Manna & Diamond --China Blue Economic Industry Fund Management --PICC Property & Casualty Company --Qingdao Zhongcheng Industry Investment Center	--Sinochem Group --Lanxess --Hunan Rubber Group --Exxonmobil Chemical --Sri Trag Group --MESNAC --Cabot --Hersbit Chemical --Double Star --Sailun --Jihyu Tires --Seagift

Rubber Valley 2014b

The presence of all of these partnerships raises the even more fascinating question of the extent to which these actors are actually cooperating. For example, it is possible to imagine that the level of cooperation of these very different governmental and nongovernmental actors is more show than substance and basically exists in name only. In order to test the extent to which these various partnerships are defined by ongoing cooperation, I used my tour of Rubber Valley

and my time at the CRIA conference and exposition to ask anyone that would speak with me about Rubber Valley. The general takeaway from these conversations was that although Rubber Valley is still quite young, the rubber industry in the country is excited that the government and industry have created Rubber Valley because it shows the importance of the industry to the country's economy and signals continued government support for the foreseeable future.

Functions of Rubber Valley

The four parties that signed the original strategic cooperation agreement that created Rubber Valley explicitly designed it to perform a specific set of functions. This section will outline the functions that it was designed to perform and discuss some of the historical circumstances that may have led to the original decision to create it this way. It will focus on the seven functions or "platforms", as Rubber Valley calls them, which most closely embody what Rubber Valley is designed to achieve. It is worth noting that the following section draws on two sources. First, it utilizes notes from a series of conversations held with officials during my tour of Rubber Valley. In particular, it draws on a one and a half hour conversation that I had with Meng Yan, who is the Assistant to the Director of Strategy and Development at Rubber Valley. Second, it uses the English language pamphlets and flyers that I collected during my trip to get a sense of how Rubber Valley brands what it does to the outside world.

One of the functions of Rubber Valley is <u>enterprise incubation</u>, which is traditionally defined as the provision of business assistance services to startup and early stage companies. Rubber Valley departs from this model in the sense that it emphasizes that its business assistance services apply to companies at any stage of development. Its promotional material says it provides whole lifecycle services. At the seed stage of a company's development, they can help a company get off the ground. At the growth stage of development, it can help the company accelerate their growth. Finally, at the mature stage of development, it can provide services to

help the company navigate the challenges of new market entrants and changes to the industry more generally. The business incubation function of Rubber Valley is apparent upon visiting the portion of the campus that has already been built. The building that houses the offices of partnership companies also has a series of financial services firms and law firms located nearby to assist companies with needs that they might have. A non-exhaustive list of the intermediary services offered includes commodity inspection, taxation, quality supervision, accounting, law services, management consulting, lending, insurance, leasing, food, housing, and security. My tour guide said the close proximity of these entities was designed to improve the ease of access for firms that are interested in taking advantage of these services.

Another function of Rubber Valley is the sponsorship of scientific research. While the company itself does not conduct research of its own, it supports its members who conduct their own research projects. The results have been impressive. According to promotional material, Rubber Valley has already supported one world-class, six national, and 51 provincial research institutions. This may be due to the active role that the QUST plays in the management of Rubber Valley. Having a university as a founding member of the company may make the organization more likely to support research on rubber production because it fits within the philosophy of one of its founding members. It is certainly a reflection of the desire to link production, universities, research, and capital together. To illustrate this point, Rubber Valley has created a Technology Transfer Center with the goal of bringing innovations occurring in the university to market and linking researchers with sources of funding. Regardless, it is unique for an organization as young as Rubber Valley to provide so much support and advice to researchers.

An additional function of Rubber Valley is the safeguarding of the intellectual property of its members. Rubber Valley has set up two different centers to perform this task. The National

Copyright Exchange Center is tasked with working with companies operating in multiple countries so that their intellectual property is protected in China. The Rubber Mediation and Arbitration Center is tasked with working with companies who allege that their intellectual property rights have been violated. It works to arrive at a mutually agreeable solution in situations when such rights have been infringed upon. Thus, Rubber Valley has three intellectual property objectives relating to copyright issues, patent claims, and arbitration. Additionally, the intellectual property division has also created the Rubber Valley Certification System. This is also important because it is a reliable third-party mechanism to certify rubber product quality.

Yet another function of Rubber Valley is the support of education and workforce training programs. Through the Center for Productivity Promotion, the organization has entered into partnership programs with local and national colleges. Its location next to the QUST, as well as the role that the university played in the organization's founding, has naturally led to an exceptionally close working relationship. More interesting though may be the international partnerships that Rubber Valley cultivated. The University of Akron in the United States, King Mongkut's University of Technology – North Bangkok in Thailand, and Bangkokthonburi University in Thailand have all reached cooperative agreements with Rubber Valley. Moreover, Rubber Valley created the National Polymer Material Innovation & Entrepreneurship Contest for college students to incentivize and reward students who conduct research at university.

An additional function of Rubber Valley is its commodity transaction service. The platform creates a third-party trading service that integrates information related to the current price of rubber into an interface that allows buyers and sellers of natural rubber to trade with one another. It is designed to create a one-stop shop for all parties involved in the process and is an alternative to the two other large rubber trading platforms that exist in Tokyo and Singapore. The

trading system is operated by the Qingdao Rubber Valley Supply Chain Company, which is a limited company that is affiliated with the broader Rubber Valley organization. Although it was recently created, it has already become the second largest natural rubber-trading platform by volume. This may be because the platform allows for buyers and sellers to conduct all of their business in one sitting by working with the commodity exchange to transport and store rubber from the seller to the buyer. This service naturally makes the supply of rubber quite simple.

Yet another function of Rubber Valley is its warehouse and logistics service. The service works with companies that are partners with Rubber Valley to provide efficient and convenient solutions to the supply chain challenges that emerge as a result of the transfer of natural rubber from buyers to sellers. The platform draws on the creation of the International Rubber Bonded Delivery Center, which is operated by the Qingdao government. The delivery center allows for goods to be stored without the payment of duty until they are sold to companies within China. This storage capacity in turn enables Rubber Valley not only to manage the supply of rubber into and out of Qingdao but also to serve as a credible signal to traders at the exchange of a reliable and quality verified repository of natural rubber. Although not its primary function, this system has the added benefit of managing the supply of rubber and thus can serve as a hedge against overcapacity, according to John Ren, the Deputy General Manager of the exchange.

A final function of Rubber Valley is cultural exchange and exhibition. The cultural exchange portion of the platform centers on the magazines, newspapers, websites, and forums that Rubber Valley publishes or sponsors. The Strategy Development Department at Rubber Valley cooperates with the Shandong Rubber Valley Cooperation Company, a subsidiary of Rubber Valley focused on public relations, to facilitate dialogue and cooperation between Chinese, Southeast Asian, European, and American rubber companies. They create programming

that involves everything from tug of war to calligraphy lessons for foreign companies and use magazines to keep all parties up to date on new rubber trends. A related function of Rubber Valley is the sponsorship of exhibitions and expos like the one that I attended. This sponsorship is designed to both spread the Rubber Valley name and to encourage companies to relocate to Qingdao and the Rubber Valley campus. It is worth noting that the largest rubber conferences in China in 2014 were either hosted by or heavily sponsored by Rubber Valley. All of these programs are designed to meet the same basic objective, which is enhanced cooperation.

Evaluating Rubber Valley

There are two important questions that arise given the apparently rapid growth of Rubber Valley over the span of four years. First, what are the ways, if any, that Rubber Valley fits into Hsueh's typology of institutional creation and evolution? Second, does Rubber Valley actually facilitate upgrading and if so how would we know it? Given the exceptionally rapid growth of Rubber Valley, described in previous sections, it is feasible to evaluate each of these questions in turn. The first portion of this section will start by evaluating the possibility that Rubber Valley explains the presence of outcomes typical of situations in which upgrading is present. The second portion of this section will then assess the degree to which the motivations behind the creation of Rubber Valley fit within the Hsueh's framework.

Evaluating the effect of Rubber Valley on upgrading outcomes is challenging given that the organization has only existed for a few years. Therefore, it would be surprising to see substantial shifts in some indicators of upgrading that may lag behind changes to the industry. That being said, the unique nature of Rubber Valley has arguably meant that it has had a short-term effect on at least a couple of the indicators of upgrading. Earlier sections discussed the creation of new products, a higher price per unit sold, more connections between segments, and a

larger volume of exports as some of the most common. Given how recently Rubber Valley was created, it is unlikely that many new products have been created over the past few years that would not have been otherwise. Even if they have been, there is no way to systematically evaluate this claim. That being said, the research, workforce training, and exchange functions of Rubber Valley do seem ideally suited to eventually lead to such an outcome. By the same token, it is unlikely that the price per unit of various rubber products has increased, and even if it has it could not be measured. Despite this, the commodity transaction function may enable a more even distribution of profit between companies that produce rubber because it removes a more costly and less effective intermediary that would otherwise

Rubber Valley has affected connections between upstream suppliers and downstream producers and led to an increase in the volume of exports from Qingdao. The central organizing function of Rubber Valley is to better connect companies that are located in different segments of the value chain. The suppliers, middlemen, and producers who all have physical office space next to each other may indicate that this outcome is already occurring. Rubber Valley has also facilitated the growth of exports to other countries. It is worth noting that evidence for this is entirely hearsay and anecdotal. Despite this, during my interviews and tour, many people said that the Rubber Valley encourages companies to invest in infrastructure necessary to export their products. They do this by connecting Chinese and foreign firms, enhancing communication by providing interpretation services, and educating firms about the benefits of selling their product to the international market instead of just domestically.

The creation of Rubber Valley was substantially more recent than that of the QUST or state farms. Therefore, it is much easier to understand how the institution may fit within Hsueh's framework for institutional creation and change. It seems very clear that the creation of Rubber

Valley was shaped, in large part, by concerns related to technological capacity and economic growth, but it is much less clear that either military considerations or path dependence played a meaningful role in the decision making process that led to its creation. As a final caution, these explanations are only part of a complex story that motivated the creation of Rubber Valley. They therefore provide a meaningful, but incomplete picture of the decision-making process.

Technological considerations were a driving force in the story of the creation of Rubber Valley. Indeed, the founding of Rubber Valley was almost entirely motivated by a desire to attract the companies, universities, and government agencies involved in cutting-edge technological innovation. This is evidenced by the decision of the founders of Rubber Valley to draw on Silicon Valley in the United States and Skolkovo in Russia. Meng Yan said that these other innovation hubs were used as a template and model because they were successful in attracting high-tech companies to a specific geographic region. Moreover, he used language similar to that which I constantly heard at the conference. He said that although Qingdao was a big producer of rubber products it could only become strong with continued technological innovation. He further noted that Rubber Valley is a platform that is designed to facilitate this outcome by attracting companies that produce higher value added products in China.

Economic trends were another factor that motivated the creation of Rubber Valley. When Rubber Valley was first formed a few years ago, the rubber industry in China had already grown very large. Despite this, many of my conversations with others at the conference led me to believe that there were still concerns about the continued development and growth of the industry. Given the rate of technological innovation that was projected to occur in the area of rubber, the government deemed it important for both growth and development. Rende Fan stated this bluntly during his opening speech in which he first used the framing of moving from “big”

to “strong.” Thus, the government may have supported Rubber Valley because it concluded that technological breakthroughs within the rubber industry will contribute to continued growth.

Neither military considerations nor path dependence appear to have played a meaningful role in the decision to support the creation of Rubber Valley. By the time that Rubber Valley was established in 2011, there was no longer the same risk of supply disruptions that threatened inputs for military equipment during earlier decades. As a result, the government viewed the rubber industry as strategically important, but not strategically vulnerable. The distinction is important because investment decisions were no longer justified on the basis of security, but were instead based on a desire to improve growth and technological innovation. Similarly, the short history of Rubber Valley’s existence makes it exceedingly unlikely that path dependence played much of a role in any of these decisions. It is possible that the rapid increase in the strength of Rubber Valley will sustain its capacity and future growth over the long term because actors will increasingly benefit from the current system and decisions will lock-in programmatic functions. Despite this, such a claim is simply conjecture at this point.

Other Institutions

The downstream and midstream segments of the Chinese rubber industry contain many different institutions that are designed to perform a wide variety of functions. It is beyond the purview of this paper to discuss all of them in depth. Instead, this paper focused on the Qingdao University of Science & Technology and Rubber Valley, which are two of the most influential and important organizations involved in the development of the city’s rubber industry. Despite this, even Qingdao is a relatively small piece of the puzzle. Drawing on statistics that were discussed earlier, 85% of rubber companies, 50% of all tires produced, and 70% of China’s gross rubber output value comes from other geographic regions (Rubber Valley 2014b). Therefore,

both the QUST and Rubber Valley represent a partial and incomplete picture of the institutional composition of the industry, which is actually dispersed across many different Chinese regions.

The Chinese Rubber Industry Association (CRIA) is a business association that has a membership of over 1,200 companies and operates throughout China. It was established in 1985 and has the independent legal qualification of the Ministry of Civil Affairs. Its members include companies that produce "tires, middle weight tires, rubber products, latices, rubber tubes, rubber tapes, rubber shoes, carbon black, reclaimed rubber, rubber machinery, rubber materials, trade bodies, and research institutes" (Rubber Valley, 2014c). The main office of CRIA is located in the Chao Yang District of Beijing, but it has smaller offices in cities that are large centers of rubber production. To achieve its goal of "promoting and developing the rubber industry in China," it has created a yearly conference to promote information sharing, connect producers and suppliers, and encourage cooperation between companies (Rubber Valley, 2014c). The CRIA rubber conference and exposition takes place in the spring of each year and is the largest in China. The CRIA is an institution that has successfully achieved some of its goals.

There are other research institutes, business associations, and universities that play important roles in the midstream and downstream segments of the Chinese rubber industry. Some of these institutions are controlled and/or supported by the state while others are private. Indeed, there is wide variation in the degree of state intervention in the creation and development of these institutions. Many of them are most accurately described as hybrid institutions, similar to Rubber Valley, in the sense that both state and private actors have been involved in the decision-making process that has led to their development. It would be fascinating to examine these institutions in greater depth and more systematically map their relative importance to the development of the broader region.

Findings

This paper finds support for a number of the hypothesis that it tests. It finds that the cases of state farms, the QUST, and Rubber Valley support the argument that institutions do in fact correlate with outcomes that have been traditionally associated with upgrading. Upon examining the upstream segment of the Chinese rubber industry, this paper finds support for the contention that state farms correlate with increased yields, increases in the total amount of land that is cultivated, and increased farm profitability. Upon examining the downstream segment of the Chinese rubber industry, this paper finds support for the contention that the QUST and Rubber Valley correlate with higher new product creation, greater levels of exports, and deeper linkages with upstream producers. As a result, the paper contains evidence that some of the institutions that it examines in great detail seem to correlate with possible indicators of upgrading.

This paper also evaluates the hypotheses proposed by Roselyn Hsueh and finds mixed support for her explanations of both institutional creation and change. Both state farms and the QUST were created due to political considerations revolving around a concern about both preventing rubber supply chain disruptions for military products and about the stability and security of producing regions. That said, the concerns related to border security that defined the creation of state farms were quite different from the military considerations that Huseh discusses. This is because the story was not so much about military readiness but was instead about managing and preventing ethnic unrest. The case of Rubber Valley does not contain the same deep concern about either military readiness or border stability. The creation of state farms, the QUST, and Rubber Valley were all motivated by the desire to create institutions in a sector of the economy where technological capacity could be large, but had not yet reached its potential. Put otherwise, the state supported institutional creation observed in this paper because the production

of rubber necessarily contained complex technology that intersected with some of the national security interests of the state. Similarly, the creation of all three institutions was motivated by an underlying concern about the rubber industries contribution to economic growth. The government therefore intervened though institutions to jumpstart the industries that it deemed were important. This decision to intervene in strategic sectors during the early phase of their development fits with Huseh's prediction that the state will support strategically important sectors at the beginning of their development. That said, she also notes that these institutions may endure over time due to path dependence. This paper finds that's path dependence is precisely what has kept the QUST and state farms strong over time, but has not yet had a meaningful impact on the evolution of Rubber Valley given its recent development. In short, Hsueh's explanations provide a useful framework for understanding the motivations that are present among individuals who made important decisions about these institutions.

Figure 13 – Salience of Motivations

Motives / Institution	State Farms	QUST	Rubber Valley
Military & Security	✔✔	✔	None
Technology	✔✔	✔✔	✔✔
Economy	✔	✔✔	✔
Path Dependence	✔	✔	None

"✔✔" = Very important "✔" = Important "None" = Not Important

Limitations

The approach of this paper contains limitations that necessarily constrain the conclusions that one can draw. There are three particular limitations to this paper's research methodology worth emphasizing. First, the paper does not attempt to prove that a *causal relationship* exists between the institutions it examines and outcomes that may indicate the presence of upgrading. Instead, it only attempts to prove that a *correlation* exists between the institutions it examines and outcomes that may indicate the presence of upgrading. Second, the paper *does not prove* that

the motivations of decision makers involved in both institutional creation and institutional changes were entirely consistent with Hsueh's explanations for these events. Instead, it attempts to show how some of the considerations Hsueh found important may have motivated individuals who were involved in these decisions. Shy of reading the minds of such actors, it would never be possible to fully understand the complexity present in their thought process. Finally, the paper analyzes a very small number of cases that are not a representative sample of the industry. Instead, it examines three institutions in details by really focusing on their development.

While the limitations of this paper are considerable, the value of such work is substantial. What the paper ultimately accomplishes, which is to tell a story of some of the motivations behind the decision to create and change these institutions, is a solid platform for subsequent research to analyze these issues in greater depth. More importantly though, the findings of this paper alone start to paint a picture of China's decision to adopt a unique approach to the development of a previously nonexistent industry. Moreover, they show that the Chinese approach, at least so far, seems to be working very well. As a result, some of the policies adopted by the Chinese, in the form of support for universities, associations, farms, and clusters, may be a model for other countries to follow as they think through these complex decisions.

Future Research

The process of writing this paper has been helpful in developing a broader agenda for subsequent research. Additional work should build upon this paper's methodology by developing better measures of the presence of upgrading and using large-N techniques to systematically chronicle the existence of institutions. Moreover, it should build upon the limited fieldwork reflected in this paper and continue to engage government officials, industry leaders, and stakeholders to better understand the motivations for important actions that were taken. Finally,

more work should focus on other components of the development of the industry such as the transition from state ownership to hybrid and private ownership and the role of foreign direct investment, trade liberalization, and increased demand for rubber products. This research will provide a useful supplement to the very limited existing scholarship examining these topics.

As noted above, there are also a few areas that would further develop the argument made in this paper. In the event that more time was available, it would make sense to explore some of these directions in greater detail. They predominately relate to the measurement of upgrading. Due to time constraints and data availability, the decision was made to focus on a high-level measure of upgrading that outlined outcomes indicating the presence of upgrading. An alternative approach, which more fully documents the process of upgrading itself, would be preferable because it would trace the ways that upgrading occurs and therefore what is causing it. Future research that builds upon this paper could document these changes by chronicling specific areas where upgrading is present. It could draw on data that measures indicators like patents and prices for individual goods to track change over time. Such an approach would nicely complement the method adopted by this paper and would provide support for claims that institutions not only correlate with indicators of upgrading, but instead play a role in causing it.

Another promising area of expansion involves developing better methods to demonstrate the presence of a causal relationship. Causal relationships can be demonstrated by showing the temporal ordering of variables, providing evidence of an association, and controlling for other factors. This paper shows the temporal relationship between motivations, institutions, and outcomes. It also provides some evidence that such an association may exist. Despite this, it does not systematically control for other possible causes of the presence of an association. Moreover, it could provide additional evidence to establish a stronger association between institutions and

upgrading. These additional steps would be able to better inform the ongoing discussion within the political science literature about the relative effectiveness of institutions.

There are a number of research strategies that could better support such an endeavor. First, better interview preparation may help to identify both the right people to interview and the best questions to ask. Identifying the people who were actually involved in the decision-making process is helpful because it provides stronger evidence for why they did what they did. Second hand sources, while useful, cannot speak to the motivations for others actions with the same level of authority. Moreover, focusing on developing a better list of questions to ask can focus interviews in a direction that leads to the best information being revealed. For example, in hindsight, it would have been useful to push my interviewees to speak more fully about the role of national security concerns in the decision-making process. Second, better collection of documents, especially attempts to acquire government documents, could illustrate the policy rationales for the creation of state farms, the QUST, and Rubber Valley. Even a comprehensive effort to find non-English language news statements and press releases may yield useful information. Therefore, future research on similar topics could benefit from adopting some of these strategies to better address some of the questions that are asked in this paper.

Appendix – Trip Timeline

This paper draws extensively on a research trip that I took to Qingdao, China from March 21, 2014 to March 30, 2014. During that trip I had a chance to meet with key decision makers involved in both the creation and evolution of the Qingdao University of Science & Technology, the Key Rubber Lab of the Ministry of Education, and Rubber Valley. This is a brief overview of important meetings and tours during my trip:

Saturday (March 22) – Arrived in Qingdao

Monday (March 24) – Rubber Valley
Meeting @ 10:30 with Meng Yan – The Assistant to the Director of Strategy and Development
Tour @ 11:45 with Meng Yan & Flora Lan – The International Department Director

Tuesday (March 25) – Qingdao S&T
Meeting @ 10:00 with Shugao Zhao – The Director of the Key Rubber & Plastics Lab
Tour @ 12:30 with Professors and Students of the Key Rubber & Plastics Lab
Tour @ 1:30 of University with my Interpreter / Guide

Wednesday (March 26) – CRIA Conference

Thursday (March 27) – CRIA Conference

Friday (March 28) – Factory Visits
Tour @ 10:00 of Lanxess Rubber Testing Center
Tour @ 11:30 of Qingdao S&T
Tour @ 12:30 of Rubber Valley
Dinner @ 5:00 with Rubber Valley Management
Met with Zhang Yan and Lu Jianping – General Managers

Sunday (March 30) – Returned to Atlanta

Appendix – Tables & Charts

Figures

Maps

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