Abstract

Co-evolution is already a key concept in social science research. In the field of management it is only starting to gain awareness, but has proven to be a powerful tool in explaining the developments of industries, firms and economies as a whole. Previous research has conceptualized and measured the co-evolution process in Western capitalist economies. In contrast our goal is to conceptualize and measure the co-evolution process in a planned economy. By applying the co-evolution theory to a planned economy we try to identify where traditional co-evolution theory does and does not explain developments in planned economies. These exceptions will allow us to develop additional pre-conditions for co-evolution in planned economies. We ground our analysis on the developments in the formal market governing institutions, industry and technology. We use these dimensions to empirically analyze the developments in the Chinese automotive industry to illustrate the additional pre-conditions we deem necessary when applying co-evolution theory to planned economies.
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Kristian Willem Vleugels
Chapter 1: Research Introduction

1.1 A description of the research topic

China overtook the US in sales terms to become the world’s largest vehicle market in the world according to the Japan Times. The Chinese Association of Automobile Manufacturers reported record results since China’s sales outperformed those of the US with more than 20%. Additionally, an increase in sales for June 2009 to 1.14mln units secured the industry’s fourth consecutive month of over 1.1mln units sold. Since becoming a net exporter of vehicles in 2005, China's exports have risen; increasing 79% in 2007 to 612,700 units and the Government’s target to top 1mln units in 2010 has been achieved.

These numbers become even more astonishing if we consider that the first automobile produced for private use in China was in the late 1970's (Gallanger, 2006). This interesting case study provides the back bone of this research as it will be used to find exceptions to the existing co-evolutionary theory when applied to planned economies. This theory will allow us to create a better understanding of the Chinese automobile industry and to add to the need for an increase in empirical research within co-evolutionary inquiry systems (Lewin, Volberda, 1999).

First we need to understand how we use the term co-evolution in the context of this research. We define co-evolution in accordance to Murmann’s (2003, pp210) research as “Two evolving populations co-evolve if and only if they both have a significant causal impact on each other’s ability to persist”. To understand why China’s automobile industry was able to capture a dominant market position, it is necessary to examine the causal link between the automobile industry in China, technology, and the formal market governing institutions, three populations crucial for each industry development.

Co-evolutionary analysis is based on the changes over time that are self reinforcing and will lead to a change of the industry dynamics (Murmann, 2003). In order to find the relations that caused the changes in industrial dynamics in China we need to investigate the causal processes that link the industry with formal market governing institutions and the developments in technology.
To find the exceptions of the co-evolution theory in planned economies and to judge the ability of co-evolutionary theory to explain the industry dynamics in the Chinese automotive industry we will establish a proposition. But before we can do this we establish a literature review after asking ourselves the following questions in figure, 2 which address the process from evolution to co-evolution.

This thesis is organized as followed; we will start by looking what the existing theories in use are, about the topic. Then we will construct a literature review according to the 4 questions that we just stated. This literature review will help us to establish a clear overview of the existing academic literature surrounding this topic. Before we can tackle the puzzle of the Chinese automotive industry I will equip the reader with sufficient knowledge about the Chinese automobile industry. Subsequently we will map the causalities that are present in the Chinese automotive industry. Hereafter we will analyze these causalities and determine if they do or do not indicate that co-evolutionary theory can be applied to planned economies. Then we will discuss the conditions that we need to establish in order to apply co-evolutionary theory to planned economies. We will end up with a conclusion considering the theoretical and practical implications and suggest topics for further research.
1.2 Theories in use: the practitioners’ viewpoint

The common consensus in economic theory is that the competitive advantage of a firm is established outside its boundaries (Murmann, 2003). This means that the competitive advantage of firms is either located at the industry or country level. In theoretical economics a firm has a competitive advantage when it is located in an industry or country that has certain specific advantages or a better structure. When looking at firm competitive advantage through this perspective you usually end up attributing it to national variables as climate, natural resources, capital labor-ratios, relative prices of the factors of production or at industry structure variables like concentration ratios, entry barriers, and so on (Murmann, 2003).

The consensus in economic theoretical literature is that the availability of skilled labor is the reason why one country has a competitive advantage over another. But what it lacks is the insight that strong national industries are supported by institutions and highly specialized supporting industries (Porter 1990; Nelson, 1996). The common theories also do not account for changes over time including recent developments in strategic trade theory and their effect on the competitive advantage according to Krugman (1991). They tend to focus more on the differences in industrial leadership at one particular point in time. The big difference in co-evolution theory is that it specifically highlights the changes over time and sees them as a key driver for the creation of competitive advantage of an industry in a particular country.

Besides co-evolution theory there are several sociologist theories like organizational ecology that also determines the environment as the route of competitive advantage. In contrast to early research done for example by Hannan and Freeman (1977) firms are actively involved in creating their own selection environment, over time, allowing them to adapt their features in order to become better equipped for global competition.
Chapter 2: Literature Review

In this chapter a literature review will be provided. The literature review discusses previously published literature that can assist in creating a better understanding of how co-evolution theory can help to understand changing industry dynamics. The topic of co-evolution has not been researched to a great extent but provides us with a good amount of relevant, and very interesting, literature to review.

2.1 Evolution

There are three specific challenges according to Murmann (2003) when looking at the evolutionary models. Those challenges are to identify how variants are introduced, which variants to leave out because they do not fulfill the selection criteria and how certain variants are kept over a long period of time and are adjusted to fit changing criteria. Necessities when studying industrial change as well as when studying technical change is to clearly specify the level of analysis. When correctly identified the researcher specifies the level of analysis that is directly below and above the focus of their investigation (Murmann and Tushman, 2001).

There are two important reasons why evolutionary theories have been developed. Firstly in order to explain the influence of agent’s actions on organizational structures and not necessarily the agent’s intentions. Secondly in order to reiterate the basic reasoning of how human beings behave and make decisions. Therefore the literature assumes that evolutionary research does not focus on the intentions but on the consequences.

Scholars have reached consensus that technological change plays an important role in industrial dynamics and economic growth (Usher, 1954; Landes 1969; Rosenberg 1982). The main body of this research has accepted that that technological innovations are not only able to create new products and industries but also can completely destroy the fortunes of existing firms or even eradicate entire industries altogether (Schumpeter, 1934; Gort and Klepper, 1982; Nelson and Winter, 1982; Tushman and Anderson, 1986; Anderson and Tushman, 1990). Most historical researchers have reasoned that the development of technology should be seen as an evolutionary process (Basalla, 1998; Vincenti, 1990; Petroski, 1992; Ziman, 2000).

When we look at institutions we can see that literature defines them either in terms of consequent patterns of actions or in terms of continuing patterns of ideas and values. In the context of this research institutions focuses on the formal actions, rules, and practices that are combined in the
market governing institutions of China’s one party political system. We specifically not focus on the informal institutions that consist of social aggregates. Institutions are important in social science research since they differ in how efficiently they coordinate human efforts to a particular purpose. Therefore institutions have a profound influence on the performance of a particular institution or economy (North, 1990 Nelson and Sampat, 2001). If the evolution of the government regulated economy is causally linked to the evolution of the Chinese automobile industry, it is proper to speak about a co-evolutionary process in line with Murmann’s (2003) research.

2.2 Industry Dynamics

Levinthal and Myatt (1994) look at industry dynamics by studying the activities and capabilities of firms at a macroevolution level in the mutual fund industry, in order to determine the effects of co-evolution. Their study includes an analysis at both the industry level and firm level. They look whether they can find evidence of relations in the replication of routines, capabilities and competences but also whether there is evidence of relations between the competition and selection.

At a firm level analysis co-evolutionary views can also indicate capabilities of firms and levels of competition according to Huygens, (1999). Support for dynamic interactions between firms has been proved in a research on evolution among Illinois banks by Barnett and Hansen (1996). They found that there is a relation between firm learning and adaptation on the one hand and higher levels of competition and selection on the other. In earlier research similar effects had been called the “arms race” or “the Red Queen Effect” (Beinhocker 1997, Kauffman 1995, Van Valen 1973) after the comment to Alice, “It takes all the running you can do to keep in the same place” (Carroll 1946).

In more recent research on industry dynamics the concept of hyper competition is introduced by D’Aveni and Gunther (1994). Their reasoning is in line with the “Red Queen Effect” as they argue that increasing competition results in short periods of advantages and is subsequently followed by disruptions, a reasoning that is supported in later research by Illinitch et al. (1998).

These co-evolutionary models are all based on the reasoning that adaptation and selection will eventually cancel each other out. This means that the searching behavior of firms for new capabilities will result in their competitive position but due to a simultaneous increase in competitive dynamics, these advantages are quickly outpaced. The main consensus on industry dynamics is that all species keep changing in a never-ending race only to sustain their existing level of fitness (Murmann, 2003).
2.3 Co-evolution

In organization science co-evolutionary theory is not a new concept. Co-evolution has actually been part of the early work on the development of bureaucracy.

According to Weber (1978) the establishment of the bureaucratic form of the firm is actually a response on the changing industry dynamics during the industrial revolution.

Chandler (1962) has a similar observation of a co-evolution event. He noticed that the M-Form\(^1\) of organizations co-evolved in response to the changes in the transportation and communication industries. This development allowed them to become more flexible and to expand their business interests.

Weick (1979) observed a change in the organizing within organizations. Members within the organization where starting to create their own rules and socially established their own environment. Weick therefore sees the environment simultaneously as endogenous and exogenous.

Kieser (1989) noticed that the medieval guilds where replaced by mercantilist due to the co-evolution of institutions and markets. As a result of the co-evolution process the functionality of institutions increased, the social monopolies disappeared and there was even a decoupling of personal motives and organizational goals.


Besides these observations there are much broader co-evolutionary systems. Levinthal (1997) for example compares the impact of firm adaption and population selection in a changing environment. He does this by simulating the firm’s adaption to smooth and rugged fitness landscapes.

A further broadening of the co-evolutionary systems is based on the research of Heylighen and Campbell’s (1995) competitive configurations, by Baum (1999, p. 120) where he shows several alternatives to zero-sum, purely competitive co-evolutionary systems that are very competitive “increase in a firm’s fitness results in a decrease in rival firms’ fitness”; partly competitive “some

\(^1\) The M-form (multi-divisional form) organization is defined as one that consists of “self-contained units” where complementary tasks are grouped together.
resources are shared and others not”; synergistic “an increase in one firm’s fitness results in an increase in rival firms’ fitness”; and independent “an increase in one firm’s fitness does not affect rival firms’ fitness”. Also the research done by Burgelman (1994, 1996) adds to broadening of the co-evolutionary systems. His intra organizational-process model shifts the focus of selection from the firm level to groups of strategic actions inside the firm. His model also indicates that managing intra organizational ecological processes can help firms to improve both the internal learning and external learning.

In research done by Murmann (2003) co-evolution is the combined outcome of, environmental/industrial, institutional and technological effects. In his reasoning co-evolution can happen in all interacting populations of organizations. His theorizing explains that change can both form internal direct actions but also external from feedback of the rest of the system. We can interpret from this that; change can be self-enforcing and does not need to be an outcome of either managerial adaptation or environmental selection but is rather the joint outcome of institutional and environmental effects.

### 2.4 Properties & Requirements

Co-evolution theory is gaining awareness, but it still has a long way to go before becoming a mainstream theory. In this section we consider some of the essential properties of co-evolution and their implications

The first property of co-evolutionary theory is defined by McKelvey (1997, p. 360) he proposes that co-evolution takes place at multiple levels, meaning that interactions happen within firms but also between firms. McKelvey classifies the interactions within firms as micro co-evolution and the interaction between firms and their environment as macro co-evolution. His reasoning is based on the perception that the evolutionary process of variation, selection and retention operates both within the firms and at the population level. Macro co-evolution focuses on firms that operate in a co-evolutionary competitive environment, whereas micro co-evolution focuses on the intra firm competitive context including the development of intra-firm resources, dynamic capabilities and competencies. A clear example of this type of analyses is provided by Pettigrew (1995), where he distincts between the internal context which involves capabilities, resources, culture and internal politics and the external context which involves political, economic and social forces. Another co-evolutionary research that includes multiple levels of research is performed by Baum and Singh (1994) who focus on co-evolution at community, organization, population, and intra-organization level.
When considering a multiple level co-evolutionary analysis you should also take into account the interactions that happen at multiple levels within the co-evolution process. These relations have been observed by both McKelvey (1997) as well as Baum and Singh (1994) and they found that it is mainly a vertical relation where lower levels of co-evolution are influenced by higher levels of co-evolution. McKelvey 1997 explains it as follows “micro co-evolutionary order within firms originates in the context of macro co-evolutionary selections competitive pressure” which is completely in line with research done by Cohen and Stewart (1994). According to leading co-evolutionary theory researchers there are not many studies that follow this essential principle of co-evolution (Tushman and Rosenkopf 1996; Garud and Van de Ven 1992). One of the interesting researches that also includes the multiple levels principle is from March (1991) his study of interaction during environmental turbulence focuses on the microstate level in which he looks at changes in individual believes and at the firm level where he focuses at changes in organizational code.

A wider background in multilevel co-evolution can be found in the Variations in Organization Science by Baum and McKelvey from 1999 (Ingram and Roberts 1999; Rosenkopf and Nerkar 1999; Van de Ven and Grazman 1999).

The second property indentified in the literature is the path- or history dependence of co-evolutionary research. This property is based on research by Calori et al. (1997), Kieser (1989) and McKelvey (1997) who all reason that adaptation in a co-evolutionary process is path or history dependent. Path- or history dependence is introduced in early research by Stinchcombe in 1965 and later by Levinthal in 1997, they both argue that the fact that firms may have adapted differently over time is a result of a lack of uniformity between firms in an earlier point in time. This reasoning breaks with traditional population ecology theories that attribute the changes to a set of particular external conditions.

The third property of co-evolution reasons that there is no path dependence in co-evolutionary theory. Firms do not only evolve they also co-evolve in line with their peers and with changes in their organizational environment according to Baum (1999), Kauffman (1993) and McKelvey (1997). Change is driven by feedback from the rest of the system and due to interaction amongst peers; therefore changes occur in all populations within an organization as long as they interact. Baum and Sigh also take this principle into account in their 1994 research where they look at both diffuse co-evolution where one or a couple of variables are influenced by multiple of other variables, and direct co-evolution where one variable influences one other. When looking as such complex interactions between variables the,
dependent-independent variable distinctions is less meaningful. Because the interactions are not one
sided changes in one variable might also be explained by changes in another variable therefore we can
say that there is no path dependence in co-evolution.

The fourth property discusses that besides no path dependence the literature also identifies
there is **nonlinear feedback** in co-evolution. Due to indeterminate feedback paths the changes in one
variable can result in unexpected changes in other variables. The changes in one variable often even
contradict the simple cause-effect logic between dependent and independent variable due to the higher
order feedback process in co-evolutionary interactions according to Baum and Singh (1994) and Casti
(1994). Because of these contradictions the literature assumes that there is a nonlinear feedback
between interactions in co-evolutionary research. The fact is that relations in co-evolutionary theory can
make it very difficult to understand. Anderson (1999) even identified situations where scholars in
strategy an organization research took out the non linear interaction for the sake of simplicity.

The fifth and last property relates to **recursive bidirectionality** based on research by Volberda
(1999). He reasons that that indirect responses that exist outside the direct interactions between groups
and organizations, play an important role. Based on this research, co-evolutionary theory should focus
specifically on the interaction between organizations and their environments. This can also be
interpreted as firms influencing their organizational environment development, and the organizational
environment that actually exists of other firms, also influences firm development. Volberda explains it in
his 1999 research as “Multi directional causalities results in interdependencies and circular causality;
each firm influencing the other and in turn being influenced by the behavior of the other”. Due to the
two directions in which we can view cause and effect relationships the literature argues that the mutual
causalities are recursive bidirectional.

Besides five important properties there are also several requirements for co-evolution research
stated in the literature. These requirements indicate what there needs to be done in order to improve
the existing base of literature. As the literature covers all topics in co-evolution research we must take
into account that not all of these requirements apply to every co-evolutionary research.

According to Volerda (1999) co-evolution research can be the bridge between research in
strategy and organization studies. It is also especially fit for reinterpreting, reframing ad redirecting the
selection adaption discourse. A key requirement for research to realize this potential will be new
research applying and justifying the co-evolution model and increasing the amount of empirical research.
within the field of co-evolutionary research. More and more fields of research are seeing the potential for co-evolution to create a better understanding of their subject like, emergence (Holland 1999), complexity science (Anderson et al. 1999), population ecology and computational organization theory (Carley 1995). Especially due to the fast development of new analytical models empirical research lacks behind. There is a consensus among researchers that empirical co-evolution needs longitudinal methods of analysis and time series data. (Miller and Friesen 1982, Huber and Van de Ven 1995, Henderson and Mitchell 1997, Barnett and Burgelman 1996), however according to the same scholars there is still room for improvement and new research in this field.

The new empirical data should especially focus on new type series data consisting of micro state adaption according to McKelvey (1997). Good micro state research adapts the research questions used to the particular co-evolutionary system it is studying. There are various examples in the literature that focus on co-evolutionary research that include product changes and new product introductions (Sanderson and Uzumeri 1997), strategic adaptations such as mergers, acquisitions, divestitures, greenfield investments, (Webb and Pettigrew, 1999; Lewin and Weigelt 1999), strategic partnerships and alliances (Lawless et al. 1999), changes in organization design (Hunter 1999, Utikal et al. 1999, Obel et al. 1999) and IT implementation events (Hunter 1998, Hanaoka and Sakano 1999). All these examples boil down to the requirements needed for solid co-evolution research. It should be a combination of micro adaptions with other events in history, like regulatory changes, technological changes and changes demographics combined with performance time series and with founding conditions.

A large amount of scholars in co-evolution research have agreed that new insights can be created about adaptive behavior of over- and underperforming populations and individual behavior in organizations by using organization and determining the primary structure of strategic data. Amongst these scholars where Hunter (1999), Lewin and Weigelt (1999) Van den Bosch et al. (1999), Baden-Fuller et al. (1999) and Webb and Pettigrew (1999). This data sequencing according to Mckelvey (1997) boils down to mapping the rates of change in variables under research and apply a certain level of importance to these changes. When doing this the researcher can distinct between the adaption that is dependent and independent of firm environment. When doing so McKelvey (1997) is convinced that there will be new relevant literature created that help to increase the empirical research base.
Chapter 3: Theory & Methods

3.1 The proposition and its relevance

According to the established literature review we can learn that co-evolutionary models help to better understand the dynamics of industrial change (Kauffman, 1995; Lewin et al, 1999; Nelson 1995 Ziman, 1999). This study analyzes the co-evolution of national firm population, technology and national institutions. After having created a better understanding through the interpretation of the literature in the literature review we developed a proposition that expresses a probabilistic relation between Co-Evolution and Industry dynamics of the Chinese Automobile industry.

<table>
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<th>Proposition</th>
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<td>Co evolution as stated by Murmann (2003) between formal institutions and innovation of technology can explain the change in dynamics of the Chinese automobile industry</td>
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Figure 3: The proposition: a probabilistic statement according to the methodology of Hak & Dul (2007)

<table>
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<tr>
<th>Object of analysis</th>
<th>• Co Evolution theory -&gt; Change in industry dynamics</th>
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<tbody>
<tr>
<td>Domain: Unit of Analysis</td>
<td>• The Chinese automobile industry</td>
</tr>
<tr>
<td>Domain: Time Horizon</td>
<td>• Pre reform 1931 - 2010</td>
</tr>
<tr>
<td>Domain: Spatial Dimensions</td>
<td>• Domestic -Mainland China</td>
</tr>
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</table>

Figure 4: The object and the domain based on the methodology of Hak & Dul (2007)

The relevance of this proposition for academic use is twofold. It will add to the academic literature and to the understanding of the industry. According to Murmann (2003) to explain a change in a particular phenomenon as a co-evolutionary process, it is necessary to indentify in detail how two or
more populations are causally linked to produce the observed outcome. The Chief aim of this research is to indentify robust causal processes that explain how social outcomes are produced from a given set of social conditions as explained by Tilly (1998). The methodology of co-evolutionary theory has often been discussed in academic papers. However, studies of simultaneous evolution or co-evolution of organizations and their environments are still rare (Lewin, Volberda; 1999). This proposal will therefore also help to confirm and widen the generalizability of those few academic findings that already have been published. Furthermore it will lead to a better understanding of one of the signature industries of the Chinese economy; the automobile industry. By better understanding the evolution of this pillar industry we create a better insight and understanding of industrial development in China in general.

3.2 Co-evolution conceptually

In applying co-evolution theory to the Chinese automotive industry we analyze the industry according to the following preconditions based on the traditional view of co-evolution theory (Lewin et al, 1999):

- We study the industry adaptations over a long period of time (McKelvey 1997, Levinthal 1997) by using longitudinal time series of microstate adaptation events and measure a rate of change or pace of change;
- We examine the industry adaptation within a historical context of the industry and its environment (Calori et al. 1997, Kieser 1989, Stinchcombe 1965);
- We consider multidirectional causalities between micro- and macro co-evolution (McKelvey 1997), as well as between and across other system elements (Baum 1999). In such systems of relationships among variables, the dependent-independent variable distinction becomes less meaningful. Changes in any one variable are caused endogenously by changes in the other;
- We look for mutual, simultaneous, lagged, and nested effects. Such effects are not very likely to be linear, and as a consequence of feedback flows, changes in one variable can produce counterintuitive changes in another variable;
- We consider that co-evolution is not path dependent, which enables and restricts adaptation at the firm level and at the population level, thereby driving both retention and variation at different rates;
- We also take into account economic, social, and political macro variables that may change over time and influence the deep structure within which micro- and macroevolution operate.
We incorporate changes occurring at the level of different institutional systems within which firms and industries are embedded. Changes in the regulatory environment affect the firm and the industry, but the firm and/or the industry may have also influenced these changes;

3.3 The model

The theoretical framework that is used in this research is defined by Murmann (2003) as “Two populations co-evolve if and only if they both have a significant causal impact on each other ability to persist”. “Such causal influence can proceed through two avenues: (1) by altering the selection criteria or (2) by changing the explicative capacity of individuals in the population without necessarily altering the selection criteria”.

To clarify this theory further we look at Kaufmann’s (1993) idea of coupled fitness landscapes that expresses the same concept of co-evolution. In Kaufmann’s research he specifies that co-evolution occurs due to the changing of the fitness landscape of one firm by the other. This interaction can have various outcomes, it can improve the average fitness of both populations or it can deteriorate it, but it can also improve or deteriorate the fitness landscape of one of the populations but not the others.

Whether the co-evolutionary process is going to improve the firms involved depends specifically on the relationship that connects the two parties so this should clearly be specified in the analysis.

What is central about a co-evolutionary process is the bidirectional causality linking the two parties in the relationship. To understand why the Chinese Automobile industry was able to capture a dominant market position, we must look at the causal links between the national population of industrial firms and the national population of market governing institutions.

Co-evolutionary dynamics are the result of small differences over time that reinforce themselves and cause the dynamics to occur. The difficulty of indentifying co-evolutionary dynamics is to find and display all the causal processes that connect two partners in a co-evolutionary relationship. To claim for example that technology co-evolves with national firm populations, we establish a precise map in order to see when and why this relation occurs.

To add to the theory as stated by Murmann (2003) and Kaufmann(1993) Arthur Stinchcombe (2000) proposes that we need to examine the physiology of the evolving social system to form a proper evolutionary analysis. By the extension a co-evolutionary analysis should examine the physiology that links two or more evolving systems in the case of the automobile industry we need to investigate the flows that link the firms with market governing institutions. I will argue for example that the forced joint
ventures in the automotive industry will be one such important flow that allowed the social and environmental influence to take place.

To explain co-evolution of the automotive industry and the market governing institutions I indentify the formal market governing institutions, and the innovation of technology as the more specific causal mechanism that connected the evolution of each population. Informal institutions are not included because they add to a lesser extend to industry co-evolution according to (Murmann, 2003), furthermore they are very hard to quantify and assess to which extend they do influence development².

Figure 5: Causalities in the Chinese automotive industry

Whether a co-evolutionary process is beneficial or harmful for the parties involved depends on the particular causal relationship that links them and, therefore, that relationship will be specified in the analysis part.

² In this research we will use formal institutions and institutions interchangeably both indicating the formal market governing institutions in China.
3.4 Research strategy

We considered the various possibilities that we have to answer the research question. We also judged the feasibility for the different research strategies before we selected the most appropriate one: an in depth case study, in which the proposition can be reviewed and theory will be developed. We will approach this by looking at historical evidence for co-evolution in China’s automotive industry. By analyzing these events we try to find counterintuitive observations from which we will build new theory. The goal is to find out in what way co-evolution theory is applicable to China in order to justify the model and to clarify the developments of the Chinese automotive industry.

We used China’s automotive industry due to its relevance in China’s economy. The industry is seen as a pillar of China’s economy and therefore provides a good base for generalization among other manufacturing industries. Furthermore we chose the automotive industry in China because of the recent developments in the market which makes this industry a really hot topic, like becoming the world leader in manufacturing in 2010 but also the developments surrounding the new energy vehicles.

We are focusing in depth on a specific market in China, on a unquantifiable topic, e.g. co-evolution, which cannot clearly be indicated by findings in tables, charts numbers and calculations, and as previously mentioned this topic has not been covered in research and is therefore inappropriate to perform solely through a desk research. Therefore we opted for a historical framework and case based on literature research supported by interviews with industry experts in order to get an in-depth view on the developments of the industry. Interviews have therefore been conducted with professionals from Ford, Daimler, Geely, the Erasmus and Wuppertal University.

By first mapping the case study we get a good view of how the industry, technology and institutions evolved over the last 60 years in China. The evidence will be abstracted by analyzing the case study. The theory building will go through the following steps.

Map the automotive industrial development in China including the causalities that are apparent in the industrial landscape

Determine which parts of co-evolutionary theory are applicable to China’s planned economy

Compare and extent on the literature findings by creating pre conditions for the new theory

Figure 6: The case study in steps

In order to map the case of the Chinese automotive industry we scanned the Proquest database for all published articles related to the automotive industry development in China chronologically from now until the beginning of the industry. Subsequently we distilled all the information from these
publications that were relevant to the industry, technology and the institutional development. Afterward we analyzed whether there were causalities between these populations on a yearly basis. Then we included this causality in the map and elaborated on it in the analysis part. This gave us a large amount of causalities from which we could conclude if they were in line with traditional co-evolution theory. For the theory building part we analyzed whether there were exceptions in the case study that could not be explained by co-evolutionary theory. These exceptions were then transformed into statements and we discussed with industry experts. The industry experts gave their view on these statements increasing the validity of the observations. After this we used these observations to add preconditions to the traditional co-evolution theory to get a better understanding of industry development in planned economies.
Chapter 4: The Case

Before attempting to solve the puzzle of the Chinese automobile industry, I will equip the reader with sufficient knowledge about the Chinese automobile industry starting with a short introduction into the Chinese automotive industry, followed by an extensive map of the industry that is divided in industrial developments, technological developments, and institutional developments. After this chapter we will be able to clearly indentify and analyze the interactions through time.

4.1 Introduction to the Chinese automobile industry

The Chinese automotive industry started as a small part of China’s First Five-Year Plan (1953–57). The first Chinese-produced automobile was a medium sized truck that rolled off the line in 1956 from the First Auto Works (FAW) in Changching. For the following thirty years nothing drastically changed in the industry and it was just another part of the struggling communistic industrial landscape. The developments in the industry where limited during this time and vehicle outputs, in the biggest country on earth, remained below half a million units until the 1980’s (Murray 1994). Furthermore, the industry produced only medium-sized truck and there was no guidance in the industry that could have changed the focus of production to other types of trucks, passenger cars were even completely off the agenda.

The little development that did happen in China was proving to be of no use when China opened its doors to the world in the 1970s. In the motor vehicle sector expertise was lacking, there had been little or no development of new technologies, cultivation of skilled and creative workers, or acquisition of technological capacity compared to foreign countries. The central government knew that for a boost of the economy the country needed new vehicles but they did not want to depend on imports. Therefore the central government decided that they wanted to attract foreign technology and production capacity by setting up joint ventures. The development of the industry finally started.

The next major changes to the passenger car industry were only unveiled in July 1994 with the publication of the Ninth Five-Year Plan for the sector (East Asian Executive Reports, 1994). Once of a sudden the central government announced some extremely ambitious plans to accelerate and develop the industry over the period 1994–2009. They included a series of initiatives that were designed, over that fifteen-year period, to triple the production levels of 1994. They also focused on transforming the domestically oriented inward looking industry into a strong global player. The plan focused around consolidating the industry, which had become fragmented over many players, into three to four very
large and internationally competitive automotive enterprise groups. These companies were meant to have a long-term objective, to design and manufacture passenger cars that did not make use of any imported parts or components. A plan that has not been executed to its fullest until this date.

In the last decade industry development in China took off seeing an increase in facilitation by institutions and a turnaround in the development of the industry’s approach to technology. China started to develop its own technology and is gradually catching up with the rest of the global automotive industry during this period. In the more recent years the local manufacturing industry has become very focused on technology development especially in New Energy Vehicles (NEVs), which is widely supported by the institutional environment.

Recently China overtook the US in sales terms to become the world’s largest vehicle market in the world. The Chinese Association of Automobile Manufacturers reported record results as China’s sales outperformed those of the US with more than 20%.

4.2 Mapping the Case Study

In this subsequent part we will map the industry according to three phases: the pre reform phase, the post reform phase and the last era. These three phases all have had a distinct influence on the evolution and co-evolution of the Chinese automotive industry, as will be discussed. For each of this phase we look at the developments in institutional, technological and industrial environment. Furthermore we map the directional causality between these developments. A quick overview can be obtained from the tables, after which the content will be discussed into more detail in chronological order divided over the three populations; institutions, technology, and industry.
### 4.2.1 Pre Reform

<table>
<thead>
<tr>
<th>Date</th>
<th>Institutional</th>
<th>Technology</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>1953-1954</td>
<td>Collectivization of industry takes place from 1951 to 1954, by which time industry was entirely in state hands</td>
<td>China relied heavily the Soviet Union, for technical assistance, mainly for transport of rural products and military supplies</td>
<td>Industry began life as a minor component of China’s First Five-Year Plan (1953–57) with great emphasis on the development and growth of heavy industry</td>
</tr>
<tr>
<td>1955-1957</td>
<td>The R&amp;D system, which separated product development from manufacturing and market needs was directly controlled by the central government</td>
<td>Product development was carried out solely by the Changchun Automobile laboratory, which was then responsible for developing products for the major car companies in</td>
<td>The industry only produced trucks and was a support pillar of the military. Industry stayed under 500,000 a year as it did not possess the capability for product</td>
</tr>
<tr>
<td>1958-1958</td>
<td>Great Leap forward meant producing cars in small scale industrialization</td>
<td>First Auto Works produced its first passenger car in 1958, the Hongqi (Red Flag) based on a Daimler design</td>
<td>Small-scale industrialization throughout rural areas</td>
</tr>
<tr>
<td>1960-1963</td>
<td>The Sino-Soviet split occurred</td>
<td>Mao halted all foreign technology transfer and assistance into China</td>
<td>The Chinese automobile sector was cut off from technology and foreign investment for a crucial two decades</td>
</tr>
<tr>
<td>1964-1965</td>
<td>“Third Front” campaign</td>
<td>Technology for economies of scale dissapeared</td>
<td>Heavy industry was decentralized and dispersed</td>
</tr>
<tr>
<td>1966-1976</td>
<td>Cultural Revolution</td>
<td>No investment in the automobile industry and no development of technology</td>
<td>There were hardly any cars produced, 33 automobile factories produced 150 cars</td>
</tr>
<tr>
<td>1977-1978</td>
<td>China moved toward a multi layered division of labor structure under the formal regulation</td>
<td>Simple technology involved in truck manufacturing helped to maintain this structure</td>
<td>Two large national manufacturers under central government control, medium sized manufacturers, and many small local manufacturers under local control</td>
</tr>
</tbody>
</table>
**Formal Institutional**

The first keen formal institutional influences were felt during the collectivization of the automobile industry which took place from 1951 to 1954. By this time all industries in China were in state hands and controlled by Mao’s one party government. One of the most important changes that the central government made to the industry in the upcoming years was the separation of the product development and the manufacturing.

After the first term of the Chinese Communist Party (CCP) a social and economic campaign was developed which reflected the planning decisions from 1958 till 1961, it was called the great leap forward. In this campaign the CCP aimed to use the vast population of China to rapidly transform the country from an agrarian economy into a modern communist society through the process of agriculturalization, industrialization and collectivization. The Great Leap Forward however turned out to be a disaster. Although tremendous investments were made to transform the economy, the increases in output as a result of these investments were low. As eloquently put by Liu Shaoqi\(^3\) China had to rely more on education, acquiring technical expertise and applying bourgeois methods in developing the economy. As a result there were no noteworthy developments in the Chinese Automobile industry at this time, neither in output or technical development. The focus of Mao on the local development of the industry led to the Soviet Sino split to occur making the Chinese automotive independent of the Soviet industry.

The Great Leap forward created enormous tension within China and resulted in an international volatile situation. In order to secure its industry for a potential war the CCP decided to build a range of industrial bases in its remote yet strategically secured hinterland. This campaign was called the Third Front Campaign and caused the automobile industry to be dispersed throughout China.

After the Great Leap forward Mao and the CCP were still not convinced that capitalism was purged from China. In a new attempt called the Cultural Revolution they tried to further advance socialism into the nation. During the Cultural Revolution, much economic activity was halted, with "revolution", regardless of interpretation, being the primary objective of the country. Elsewhere, the ten years of the Cultural Revolution also brought the education system to a virtual halt. The university

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\(^3\) Liu Shaoqi was a Chinese revolutionary, statesman, and theorist. He was Chairman of the People's Republic of China, China's head of state, from 27 April 1959 to 31 October 1968
entrance exams were cancelled during this period, not to be restored until 1979 under Deng Xiaoping. Many intellectuals were sent to rural labor camps, and many of those who survived left China shortly after the revolution ended. According to most Western observers as well as followers of Deng Xiaoping, this led to almost an entire generation of inadequately educated individuals. During these ten years of revolution the Chinese economy including its automotive industry came to a standstill. The brain drain this campaign caused was felt for years among others in the automotive industry.

**Technology**

The technology involved in the Chinese automotive industry was in the beginning years mainly based on China’s partnership with the Soviet Union. Soviets helped start China’s First Auto Works (FAW) in 1953 in the northeast city of Changchun. For FAW they provided the design and the technology for the production of trucks that were mainly used for transport of military supplies and rural products. The product development was centralized by the CCP and was solely carried out by the Changchun automobile laboratory.

The technology transfer from the Soviets proved limited in the upcoming years as both local vehicle manufacturers and suppliers were notoriously short of technology. The car manufacturing engineering departments only had the technological capability required for maintaining routine production; it did not possess the capability for product development, this was one of the main reasons for the technological stagnation.

Then in 1958 the actual first passenger car was produced up till now China had only produced trucks. The passenger cars only served purpose as limousines for the government elite. Just as first production of automobiles started in China, Mao halted all foreign technology transfer and assistance into China, bringing an end to the Sino soviet cooperation. Thus the Chinese automobile sector was cut off from technology and foreign investment for a crucial two decades.

In the years to come technology development in China stagnated as Mao’s campaigns brought the economy to a standstill. Later on during the Cultural Revolution the technological developments even went in reverse. Due to its simple nature technology involved in truck manufacturing, sustained in this period.
Industry

The Chinese automotive industry began life as a small component of China's First Five-Year Plan (1953–57). The main concern in the immediate post-liberation (1949) phase was that of land reform and economic recovery, to set the conditions for subsequent economic growth. The ensuing First Five-Year Plan saw great emphasis placed on the development and growth of heavy industry.

In the years to come the Chinese industry only produced trucks. It was a support pillar of the industry. The production stayed under half a million trucks a year. The industry was heavily supported by the Soviet Union but was cut off from foreign investment during the Soviet Sino split in the 1960’s.

During the third front campaign under central planning the industry was decentralized and dispersed around the country to make factories more immune from attack. These dispersed factories proved to be very inefficient as the 33 automobile factories produced 150 cars in 1965, all for governmental use.

During the cultural revolution the industry was restructured again, based on the American structure of the big three small three, with two large national manufacturers directly under central government control, a few medium sized manufacturers, and many small local manufacturers in each province under the control of local governments.
### 4.1.2 Post Reform

**Industry Co evolution, Post Reform**

<table>
<thead>
<tr>
<th>Date</th>
<th>Institutional</th>
<th>Technology</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>1979</td>
<td>China opens the doors, they need new vehicles but don't want to rely on imports, China’s government decided to reach out to foreign companies.</td>
<td>Much expertise had been forgotten or lost and since the early 1960s there had been little or no development of new technologies or cultivation of skilled and creative workers.</td>
<td>The automobile industry experienced a second infancy.</td>
</tr>
<tr>
<td>1983-1988</td>
<td>Joint venture structure promoted by the government to obtain foreign knowledge.</td>
<td>The basic production technology is being transferred to the car manufacturers.</td>
<td>American motor company starts first joint venture, VW soon follows.</td>
</tr>
<tr>
<td>1989</td>
<td>Joint-venture car manufacturers have been hit hard by governmental austerity measures.</td>
<td>The technology input still comes from foreign multinationals as local development of R&amp;D is slow.</td>
<td>High inflation and economic hardship constrain the automotive industry.</td>
</tr>
<tr>
<td>1993</td>
<td>China begins allowing overseas investors freedom in such matters as setting prices.</td>
<td>There is a marked tendency for smaller Chinese vehicle and components manufacturers to seek FDI deals without reference to central government.</td>
<td>Demand in the Chinese market starts growing.</td>
</tr>
<tr>
<td>1994-1995</td>
<td>First Industrial Policy in China based on protectionism and technology transfer.</td>
<td>Eventough the car manufacturers obtained technological development, parts makers have not, so there is still little involvement by the part makers in the product development process.</td>
<td>Rationalisation of the vehicle manufacturing sector.</td>
</tr>
<tr>
<td>1996</td>
<td>Taxes and fees levied on auto purchases boost the total price of the vehicle by at least one-third, making them unaffordable to most private individuals.</td>
<td>The foreign companies do not feel the need to introduce new products due to their solid posidon creating a market of older foreign models.</td>
<td>Joint ventures take a monopoly position.</td>
</tr>
<tr>
<td>1999</td>
<td>The Chinese government is calling for increased private automobile ownership in its next 5-year plan.</td>
<td>China's own auto industry, considered one of the state’s least efficient but most profitable, can only get stronger, most likely with continued foreign technology partnerships.</td>
<td>While business conditions are not exactly ideal in China, its never-ending potential makes China a risk worth taking.</td>
</tr>
</tbody>
</table>
Formal Institutional

Under the leadership of Deng Xiaoping also known as the great reformer, China opens its doors. Since the Sino Soviet split in the sixties China had hardly developed its automotive industry. Realizing they needed new vehicles, but hesitant of becoming totally reliant on imports, China’s government decided to reach out to foreign companies through technology licensing and the formation of joint ventures.

In 1980 FAW merged with the Changchun Automobile laboratory, the largest R&D institution in China, under government’s direction. At the same time national markets where formed in the governments pursued of business group policy under the influence of Japanese management practices introducing the first signs of market economy since 1949.

In the subsequent year the government policy still pushes hard for the development of the automobile industry by promoting joint venture structures. For the foreseeable future the entire industry is still being controlled by the central government as they believe that the automotive industry is one of the pillars of establishing a solid manufacturing economy.

Due to corruption in the higher echelons of the CCP a large inflation hits the Chinese economy in the late eighties. In response to the general economic malaise, Li Peng adopted several austerity measures in the middle of 1988. The primary goal of these measures was to reduce economic growth and included such measures as limiting joint ventures, curtailing capital investment, tightening fiscal and monetary controls, re-imposing centralized control on local construction projects and cuts in capital investment.

By 1993 the formal institutional restrictions became looser in an effort to modernize the automobile industry as the Chinese government allows overseas investors freedom in matters as setting prices. At this time the Chinese government has only allowed foreign investors in eight joint ventures. These policy changes take a more concrete form in china’s industrial policy in 1994, the first real industrial policy of the communist regime. Foremost amongst this policy is the proposed rationalization of the vehicle manufacturing sector, which at 1994 consists of around 120 producers, many of which are economically unviable in the longer term. The country’s existing vehicle producers would be merged into no more than three or four ‘internationally competitive’ corporations by 2010 at the latest. This should be achieved by offering tax and other advantages to large volume producers. Alongside, this new policy aims to encourage greater private car ownership on the back of rising living standards.
Foreign ownership in joint ventures was limited to fifty percent to give the Chinese partners more control and bargaining power. Li Qing, head of the car division of the Ministry of Machinery Industry, indicated at this time that foreign investors could take up to a 50% holding in Chinese car firms as long as they brought opportunities to develop the local industry, a vague prescription which allows ample scope for the government to increase their demands on competing foreign companies. According to Li, foreign firms would have to obtain approval from the Ministry of Machinery Industry's car division, the State Planning Commission and the Ministry of Foreign Trade and Economic Cooperation.

By 1996 the auto industry had still not reached its potential. Output is mainly constrained by the heavy taxes enforced upon by the central government. Although the auto industry has been designated a pillar industry under the Ninth Five Year Plan (1996-2000), the government has levied additional taxes on car purchases to help finance road development. Over the past several years, annual auto output has grown much faster than the country's road network, leading to worsening traffic congestion in the cities and coastal provinces.

In 1997 the large state owned enterprises have not yet engaged in any significant R&D activities, although government had encouraged them to establish R&D centers. Most companies complied or were in the process of doing so. The Chinese government is calling for increased private automobile ownership in its 5-year plan presented in 1998. China's auto industry, at this time considered one of the state's least efficient but most profitable, can only get stronger, with continued foreign partnerships.

Technology

In the motor vehicle sector much expertise had been forgotten or lost and since the early 1960s there had been little or no development of new technologies, cultivation of skilled and creative workers, or acquisition of technological capacity. Due to direct competition caused by the opening up of the market to foreign but also domestic producers the R&D model of Chinese car production changed. The most important change was a move towards in house R&D systems. The product development capability attained by establishing a strong in house R&D system helped to implement a series of technological innovations that began from the model change. The industry changed its technology strategy from the so called ‘technology push’ (compete adoption and imitation of the Soviet technology in the early period) to ‘demand pull’ (emphasis on the independent product development to meet market needs). It only introduced important technology and equipment that could not be produced domestically.
Domestic technology development does however appear to be very slow as the main source of technology input still comes from foreign manufacturers in the 90’s. By now the car manufacturers obtained some degree of technological development, parts makers have not, so at this time there is still little involvement by the part makers in the product development process. Because Chinese car manufacturer’s almost have no technological capabilities to engage in large scale production of passenger cars by itself, its strategy for passenger cars is to build a mass production system by participating in the multinational corporations global network.

There is a marked tendency for smaller Chinese vehicle and components manufacturers to seek FDI deals without reference to central government. They are aware that access to foreign capital and production technologies will largely determine which producers survive into the next century. At this time, most are too small, under-capitalized and relatively technologically backward to survive in the longer term, especially if the government allows more foreign competition.

By the mid nineties the general lack of R&D manifests itself in a persistent reliance on foreign manufacturers, usually their joint venture partners or license providers, who deliver products, designs, and often also tooling, manufacturing equipment and production extorts. For suppliers, a lack of R&D expertise means that local suppliers are often excluded from the bidding process for new vehicles, as they cannot provide the necessary development capabilities to develop a component from the concept stage to the final, manufactured item. For Chinese groups that operate with foreign joint venture partners this means those Chinese suppliers, who in many cases belong to the same group as the joint venture company are de facto excluded from the bidding process. Chinese suppliers are thus therefore demoted to contract manufacturer status, as opposed to being full service suppliers like European, American or Japanese competitors that are operating in China.

By the end of the nineties several local firms gave up R&D and production of their own cars, and merged their own plants into joint ventures. This means that the industry can only get stronger with continued foreign technology partnerships.
Industry

As can be seen in Appendix I, the post reform period started the initial growth of the industry. The reforms of Deng introduced a gradual industry development. Part of the first reforms of Deng Xiaoping was the restructuring of the automotive car industry. Under the supervision of the China national Automotive Industry Corporation, seven large business groups were established including the nationwide local car parts manufacturers.

The industry landscape saw its first joint venture in 1983 when American Motors Corporation signed a 20 year contract to produce their Jeep model vehicles in Beijing. Not long thereafter Germany’s Volkswagen signed a 25 year contract to make passenger cars in Shanghai, and France’s Peugeot agreed to another passenger car project to make vehicles in Guangzhou.

By 1985 the country produced a total of only 5,200 cars. As domestic production could not meet demand, import totals rose dramatically, despite a 260 per cent import duty on foreign vehicles. The country spent some $3 billion to import more than 350,000 vehicles (including 106,000 cars and 111,000 trucks) in 1985 alone. By the end of the eighties the economic hardship in China constrained the automobile industry. This resulted in the Chinese government pledging to bail out its auto industry, which was struggling with plunging sales and rising stockpiles at this time.

During the nineties globally, China remained a relatively insignificant producer, importer and exporter of cars and car components, except in the production and export of certain types of specialized lorries, military transports and agricultural machinery. As a results the Government boosted the industry by pooling more than 100 billion renminbi (12 billion dollars) to support eight major sedan and mini car manufacturers in the coming years to build up the automobile industry's annual output to 1,000 billion renminbi (120 billion dollars). At this time an absolute flood of investments flowed into the automobile sector during the 1990s from the Chinese government and foreign sources

By the end of the nineties the automobile industry increasingly relies on the private sector firms and individual consumers for future growth. The private sector accounts for 50% of automotive sales, up from 26% in 1991. Given the increasing importance of private demand, the outlook for the car sector will depend in large part on the overall performance of the economy. Growth in demand is also hampered by the lack of financing facilities and poor distribution networks.
### 4.1.3 The Last Era

Figure 9: The last era overview

<table>
<thead>
<tr>
<th>Date</th>
<th>Institutional</th>
<th>Technology</th>
<th>Industry</th>
<th># Cars Prod</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>WTO membership means that China has to start playing by Western rules. Local parts requirements will be removed, and import tariffs will be brought down to a level that mandates a truly competitive marketplace</td>
<td>Accession to the WTO means that foreign multinationals feel better protected, improving the efficiency of technology transfer</td>
<td>Only a rather small number of models dominate the market</td>
<td>703,521</td>
</tr>
<tr>
<td>2002</td>
<td>China smooths over the import regulations for foreign companies who do not have to use a Chinese partner anymore for imports</td>
<td>China is still struggling to create an independent domestic automotive industry as it still relies on foreign seeing</td>
<td>China’s emerging middle class is buying cars on a large scale</td>
<td>1,101,696</td>
</tr>
<tr>
<td>2003</td>
<td>IPR dispute between foreign automotive companies and local competitors seem troublesome</td>
<td>Education in China can allow for a comprehensive package of localized skills and engineering</td>
<td>Sales and profits in the country are rising exponentially</td>
<td>2,018,875</td>
</tr>
<tr>
<td>2004</td>
<td>Several state owned enterprises have started to establish their own R&amp;D centers although so far the large groups have not yet independently developed any significant products</td>
<td>R&amp;D is seen as a second step after establishing a local manufacturing presence, which by now has largely happened</td>
<td>Despite a slowdown in sales, there has been no let-up in the pace of investment in the market, with all the leading automakers jostling for position in the market</td>
<td>2,480,231</td>
</tr>
<tr>
<td>2005</td>
<td>China’s policy of joint venture partnership with established world carmakers has clearly succeeded in that most of the cars sold in China are made in the country and the proportion is still improving</td>
<td>The links with foreign companies should lift design, production and sales capabilities, and the volume of foreign and Chinese brand cars made in China before export will really take off</td>
<td>China has reached the car export phase, but its development will differ from the Japanese model set 30 years ago because most Chinese makers have influential joint venture manufacturing partners from the developed economies</td>
<td>3,078,153</td>
</tr>
<tr>
<td>Date</td>
<td>Institutional</td>
<td>Technology</td>
<td>Industry</td>
<td># Cars Prod</td>
</tr>
<tr>
<td>--------</td>
<td>---------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>2006</td>
<td>The domestic industry is rife with allegations that engineering designs are copied from rivals and even from partners</td>
<td>Local Chinese manufacturers do not pay enough attention to R&amp;D, concentrating only on getting bigger, instead of developing their own technology they are buying it</td>
<td>China has been the worlds second largest consumer of automobiles in 2006</td>
<td>5.233.132</td>
</tr>
<tr>
<td>2007</td>
<td>With political support from the Government, Cost-efficient local enterprises will invest more into the self-innovation and expand the exportation</td>
<td>Local parts enterprises with professional strength seek for more advanced technologies and more market shares by acquisitions and being involved in the global division of labor</td>
<td>Chinas exportation of cost-efficient auto parts maintains a fast growth and China auto parts industry is gradually absorbed in the matching system of foreign-funded car makers</td>
<td>6.381.116</td>
</tr>
<tr>
<td>2008</td>
<td>WTO membership has resulted that trade disputes will be dealt with as laws become better enforcable solving the trade dispute between China and the West</td>
<td>BYD plans to unveil the country's first homegrown electric vehicle for the mass market, at least a year ahead of similar efforts around the world</td>
<td>A combination of increasing entry and falling prices makes China an intensely competitive market. The core challenges for multinational firms are reducing the price of their products, and for domestic brands increasing the quality of their products</td>
<td>6.737.745</td>
</tr>
<tr>
<td>2009</td>
<td>The government has encouraged mergers to strengthen the domestic industry for some time, particularly as international firms have become prominent</td>
<td>China's Ministry of Science and Technology is veering away from its previous preference for clean diesel as an alternative fuel of choice and is moving towards hybrids</td>
<td>The industry is starting to develop its own unique segment focussing on renewable energy</td>
<td>10.383.831</td>
</tr>
</tbody>
</table>
| 2010   | China is proving that a definitive incentive policy on alternative fuel vehicles will bring investment in the local production of new products | Germany's VW is the latest carmaker to form a high-profile partnership aimed at developing electric vehicle (EV) technology based on Chinese design | China has overtaken the US as the world's largest car market. Ford Motor's executive chairman, Bill Ford Jnr, has been quoted as saying it would be 'the height of arrogance' to dismiss Chinese brands as serious rivals. | 15.000.000  

*Figure 10: The last era overview 2/2*
Formal Institutional

In 2001 the government establishes policy to consolidate the automotive industry. After various efforts experts seem weary that this attempt is going to work. Reducing the 100-plus carmakers to four or five large conglomerates, Ashvin Chotai⁴ sees this as a long-term goal. "In the past, the government has failed miserably to consolidate the industry," he says. "We see more fragmentation in the near term than consolidation." With growing fragmentation comes a capacity glut, which industry observers say already is looming as a major problem.

In addition to internal liberalization, at this time Deng also established a series of "special economic zones" in which foreigners could invest in China taking advantage of lower labor costs. This investment helped the Chinese economy grow.

China’s accession to the World Trade Organization in 2001 immediately escalated activity, prompting major infrastructure development and pressuring the government to continue its support of the economy. In 2002 China smoothes over import regulations in order to ease tension over its expanding trade surplus with the US. In 2003 the first IPR lawsuit goes to trial in China since it joined the WTO, as the domestic industry is filled with allegations that engineering designs are copied from rivals and even from partners.

By 2004 several state owned enterprises have started to establish their own R&D centers although so far the large groups have not yet independently developed any significant products. On this evidence, China’s policy of joint venture partnership with established world carmakers has clearly succeeded in that most of the cars sold in China are made in the country and the proportion is still improving. However, the country's planners had hoped that by now there would be a healthy export trade, and this is not yet happening. The inertia is causing discomfort in political circles and some change of behavior at major companies. Furthermore, Chinese carmakers face the probability that they will be targeted in patent infringement cases once their cars arrive.

In 2006 the government aims at a significant development of the automobile industry in the 11th five year plan period. With political support from the Government, Cost-efficient local enterprises will invest more into the self-innovation and expand the exportation.

⁴ Ashvin Chotai, managing director at Intelligence Automotive Asia Ltd
In 2008 China lost a trade dispute at the World Trade Organization for the first time since its WTO accession in 2001 as a dispute settlement panel has made an effective ruling in favor of the United States and the European Union against China on a car parts tariff dispute. This contributes to the improved international environment for the automotive industry.

By 2009 the consolidation plans of the government still haven’t worked out. The government again revealed plans to increase consolidation in the sector, which would involve reducing the number of manufacturers from 14 to 10. The government has encouraged mergers to strengthen the domestic industry for some time, particularly as international firms have become prominent. Other elements include providing subsidies of around CNYSbn (US$730mn) to support car purchases in poor, rural areas throughout the year, scrapping older cars to make way for new purchases, developing consumer finance and increasing the government’s use of domestic models.

In 2010 the government shifts its focus more on the intrinsic development of the industry as China plans to impose strict fuel economy standards for vehicles following similar proposals in the US. The New York Times has reported that An Feng, president of the Innovation Centre for Energy and Transportation, said that by 2015, carmakers in China will be required to raise the fuel economy of their vehicles 18% compared with the standards introduced on January 1. China is proving that a definitive incentive policy on alternative fuel vehicles will bring investment in the local production of new products. The central government has implemented a pilot program in five Chinese cities that are mostly home to major carmakers, which is now being matched by local authorities and already securing production projects.

Technology

The 2001 accession to the WTO means that foreign multinationals feel better protected, improving the efficiency of technology transfer. Although the accession improves the position of the foreign manufacturers in China the domestic manufacturers still struggle to operate independently and still need to rely on the foreign overseeing.

In 2003 the president of electrical, electronic, safety and interior systems, Delphi Corporation David Wohleen said "World class quality is not an option, it is a requirement." Wohleen indicates that China does offer a comprehensive package of localized skills and engineering. He says that while foreign companies are certainly interested in global exports from China, its main interest is in serving the "depth" of the domestic market. This depth is what’s driving the foreign car manufacturers for years.
By 2004 R&D is still seen as a second step after establishing a local manufacturing presence, which by now was largely happened – thanks to numerous joint-ventures with Western (and later as Eastern firms) While China no longer relies on vehicle imports it still relies on foreign seeing, and challenge now is to create an independent Chinese automotive industry. Beijing motors and Dongfeng show interest in increasing R&D work in China (Holweg et al, 2005) yet concerns were also raised with regards to the competitiveness of such products, and whether they would meet the standards European, US, Japanese and Korean models provided for the Chinese domestic market. Since the Chinese designed products were manufactured under the same cost structure as the non Chinese products, design inferiority is implied. The links with foreign companies should lift design, production and sales capabilities, and the volume of foreign and Chinese brand cars made in China, before export will really take off. In 2006 Local Chinese manufacturers do not pay enough attention to R&D, concentrating only on getting bigger. Instead of developing their own technology they are buying it.

In 2007 according to Frank Zhao, Director of Zhejiang Geely Holding Group Ltd., Chinese domestic carmakers must craft compelling brands, retain talent and develop their own technology. But the Chinese carmakers' growth strategies are confusing, he said. They do not pay enough attention to R&D, concentrating only on getting bigger. Instead of developing their own technology, Chinese companies are buying it.

In 2008 we suddenly see that China has skipped a step in technology development and has acquired an advanced position in the new energy vehicle field when BYD unveiled the country's first homegrown electric vehicle for the mass market, at least a year ahead of similar efforts around the world.

In support of China’s dominant position China's Ministry of Science and Technology is veering away from its previous preference for clean diesel as an alternative fuel of choice and is moving towards hybrids, according to Automotive News. An advisor to the ministry claims that Minister Wan Gang is 'very much in favor of hybrid technology', as it provides a stepping stone to the use of all-electric cars. This is considered a more long-term alternative to petrol in China. One group not so encouraged by the move towards hybrids are the European carmakers who had been lobbying the Chinese government to use their clean diesel technology.

We see a new trend occurring in 2010 when suddenly foreign manufacturers want joint ventures with Chinese companies to learn from their technology on the NEVs. Germany's VW is the latest carmaker to form a high-profile partnership aimed at developing electric vehicle (EV) technology.
The company has signed a memorandum of understanding with Chinese battery manufacturer BYD, which has already produced its own plug-in electric car, the F3DM, through its BYD Auto unit. Under the terms of the agreement, the two sides will study options for joint development of lithium-ion battery packs for hybrids and EVs.

**Industry**

As can be seen appendix I, the industry skyrocketed in the last era. The WTO accession in 2001 marked the boom of the automobile industry in China. This is another strong indicator that the formal industry governing institutions are fading away as dominant driver of industry development.

According to Andy Turton, President of NFO Automotive in North America in 2003 "China is revving up to potentially become a huge player in the global automotive market, as Western automotive manufacturers struggle for differentiation among their individual brands, China is ahead in the game when it comes to successfully managing the emotional content of their brands." "The 80% sales growth in China during the first six months of this year was not driven by consumers wanting a car to get from point A to point B. "Clearly, there is a growing recognition that cars of particular brands have a considerable impact on one's social standing, and the automotive market in China has taken note. Now, there are an overwhelming number of aspirational cars for consumers to choose from, and this excitement of being able to buy social mobility is fueling the explosive growth in vehicle sales this year." This indicates that the growth of a wealthy middle class in China is propelling industry growth. Although sales and profits in the country are rising exponentially, politics in the region can quickly turn volatile, laws are up for debate, a modern banking system still is in its infancy and international policy has been slow to take hold. Nevertheless, the world's leading carmakers and parts suppliers have reached a consensus that China is the most important place to be.

After an explosive couple of years, China's car market hit the buffers in 2004. Despite the slowdown in sales, there has been no let-up in the pace of investment in the market, with all the leading carmakers jostling for position in the market. Carmakers are talking big numbers - altogether, foreign carmakers are spending US$13bn to triple annual capacity to 6m units by the end of the decade. But this has raised new fears that overcapacity, the bugbear of the auto industry in its developed markets, could hit China as well.

By 2005 the industry takes up speed again and China established itself as the third largest automobile market since 2003 and is increasingly taking up the lead role in world businesses.
The industry witnessed a sales growth by 44.4% year-on-year, the sales turnover of the Chinese automobile industry being 453.132 billion Yuan. China has reached the car export phase, but its development will differ from the Japanese model set 30 years ago because most Chinese makers have influential joint venture manufacturing partners from the developed economies. Their links with foreign companies should lift their design, production and sales capabilities, and the volume of foreign and Chinese brand cars made in China for the international market can be expected to rise.

Even moving up one step in 2006 when car sales reached 7.2797 million units in China with a year-on-year rise of 27.32%, and 7.216 million units were sold, up by 25.13% year-on-year. China has been the worlds second largest consumer of automobiles in 2006, motorcycle producers exported 6.4035 million motorcycles to overseas markets, up by 41.11% year-on-year. And the foreign exchange earnings got to US$2.52 billion, a year-on-year rise of 41.35%.

By 2007 China is both the fastest growing motor vehicle market and the fastest growing vehicle producer. China is also the world's second-largest car market. Despite competition from international brands, domestic carmakers sold the most passenger vehicles in China in 2007. Thanks to a wave of new models from such carmakers as Chery Automobile Co. and BYD Auto Co., domestic brands grabbed 28.7 percent of the market last year. Japanese brands were second with 28.3 percent, according to Automotive Resources Asia, a unit of J.D. Power and Associates. China automotive companies are moving abroad as Salinas chose China FAW Group Corp., a major state-owned automaker in China to produce cars in Mexico.

2008 proved to be difficult as sales of passenger vehicles in China fell 10% in November from a year earlier to 522,800 units, according to the semiofficial China Association of Automobile Manufacturers. It was the third monthly decline in four months. Yale Zhang, a Shanghai-based senior car-industry analyst for U.S.-based CSM Worldwide, said "big ups and downs" in sales of young indigenous independent carmakers such as Chery are a cause for concern. Nigel Harris, CMO at Ford Motor Co, talked about his confidence in a promising Chinese car market. According to Harris, China will overtake the US as the world's No. 1 car market, and it could happen in 2015, but North America has had a big correction. A combination of increasing entry and falling prices makes China an intensely competitive market, and consolidation in the automotive sector is likely. The core challenges for multinational firms are reducing the price of their products, and for domestic brands increasing the quality of their products.
The industry took a turn in 2009 as the World Trade Organization’s (WTO) Appellate Body has upheld a ruling that China's import tariff structure for automotive parts contravenes membership commitments. A complaint was brought against China by the US, EU and Canada in 2006, which claimed that the tariffs discriminated against foreign parts and aimed to pressure foreign parts makers into establishing Chinese facilities in order to avoid the tariffs.

By 2010 it becomes official China is the automotive force to be reckoned with, especially the new energy vehicles of domestic producers. In 2010 China has overtaken the US as the world's largest car market. Besides this the local brands are catching up with the foreign manufacturers. Ford Motor's executive chairman, Bill Ford Jnr, has been quoted as saying it would be 'the height of arrogance' to dismiss Chinese brands as serious rivals. The fact that Geely has acquired Volvo from Ford and plans to make the Swedish unit a viable one is testament to this, while the Warren Buffet-backed BYD Auto has big plans of its own. The company has been clear in its goal of wanting to become the world's largest carmaker by 2025.
Chapter 5: Analyses

In this chapter I expand on the co-evolutionary theory to explain how China moved from a laggard to an uncontested leader in this industry. Although academic disciplines from economies to strategic management have provided a variety of theories to account for industrial success and failure, not one theory can adequately explain why and how China came to dominate the automotive industry, co-evolution theory could provide the answer. First we start with the analyses of the causality between technology, the industry and the formal institutions in the three periods. Hereafter we look at how these causalities relate to the existing theory of the co-evolution and if this theory can explain the industry developments in China.
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**Figure 11: Co-evolution causalities**
5.1 Analyses Pre Reform Causality

In the first phase we can distinguish three clear moments of directional causality. It shows that the institutions influence the industry when the central government decides to centralize the entire industry. Furthermore, the institutions also influence the level of technology as they engage in a relationship with their political ally, the soviets, in order to obtain the needed technology. Additionally, the technology also heavily influences the industry, as the lack of knowledge on building passenger cars resulted in an industry that solely existed out of trucks.

In the time hereafter until the reform it is obvious that institutions remain to have the largest influence on the industry. In the pre-reform period, the formal institutional influences mainly had a negative effect on the industrial development. At the same time technology, or rather the lack of it, influenced the industry, since the lack of technology in product development resulted in a stagnated production number. The industry was only capable of producing one type of truck so it did not take long for the industry to mature. The institutions also influenced the technology as the government centralized the R&D for the automotive sector in one laboratory and disconnected it from the manufacturers. This meant that the development of products, even though it were only trucks at this time, was not based on consumer demand, a trend that would remain for many years.

In the subsequent time we mainly see the influences of campaigns like the Great Leap Forward and the Cultural Revolution, initiated by the formal governmental institutions, which take a grip on nationwide industrial development. During the great leap forward the institutions clearly influence the industry as they promoted small scale industrialization throughout the rural areas causing the industry to be spread out nationwide, creating huge inefficiencies.

An important influence during the Great Leap Forward campaign is the Soviet-Sino split. Through this event we once again see a very clear influence of the institutions on the development of the technology. Since Mao’s policy halted all Soviet technology transfer and assistance into China it cut off the automobile industry from technology and financing for a crucial two decades. Crucial because other Asian nations, now known for their automobile industry, like Korea and Japan, were at a similar level of development at this period, this could have prevented China to become a laggard in the international automotive industry.

The subsequent “Third Front” campaign is another great example of how the governmental institutions influenced the industry, as the automotive industry was decentralized and dispersed through the hinterland to make it less vulnerable to attack in times of war. Yet again a second order
effect on technology occurred as the industries central product development laboratory was disconnected from the industry.

The Cultural Revolution initiated by the government brought the Chinese economy to a grinding halt, causing it to lag even further behind its “competing” nations.

The low level of technology involved in producing simple trucks kept the industry intact at the same level as 25 years ago, the end of the Cultural Revolution in 1979. In a last effort the government yet again rearranged the industry by assigning two large national manufacturers under central governmental control a couple of medium sized manufacturers and many small manufacturers under local governmental control.

The overall institutional behavior at this period is influenced by the ideology of communism. Communism made the central government believe that there was a lack of independence and therefore they heavily focused on reorganizing the national economy and industries, amongst which the automotive industry. Another major driver of institutional decision-making at this period was caused by a fear of Western countries to undermine their regime and possibly attack China, causing drastic changes in the industrial landscape.

5.2 Analysis

Post Reform Causality

In the initial phase of the reform we see the first influences of the industry on the institutions after having seen the institutions influence the industry for 3 decades. The experience of a second infancy of the industry, after 30 years of political and economic malaise, influences the government to take measures in improving the industry’s position. The government does not want to import cars to stimulate the economic development as this would harm the economy; therefore they decide to reach out for foreign manufacturers in order to establish joint ventures to produce the cars domestically.
In the subsequent phase we see a change in the industry in the form of increased competition caused by the opening up of the market to foreign but also domestic producers, which influences a change in the R&D model of Chinese car production. The most important change was a move towards in house R&D systems. This move was needed for two reasons; to adjust the products to customer demands and to be able to transfer knowledge from foreign manufacturers to domestic manufacturers. Foreign manufacturers where drawn to China because they saw a huge potential in a country with a population in excess of a billion people that were unable to drive a car because the nation had been closed for three decades. At the same time institutions again influence the industry as they restructure the car industry for the fourth consecutive time, placing the entire industry under the supervision of the China National Automotive Industry Corporation.

The increased need for technology is acknowledged by the government who promotes joint ventures with foreign companies further by allowing more joint ventures to take place creating causality between technology and institutions. The establishment of these joint ventures changed the industrial landscape for good. The focus of the institutions on the automotive industry is strengthened further when the industry is dubbed as a pillar industry. The Chinese government declared the automotive industry a “pillar” industry in 1985, targeted for financial and developmental assistance.

In the subsequent period technology is still the main driver for industry change as the need for technology in the Chinese automotive industry allows an increased amount of joint ventures. The government starts to ease regulation in order to improve the industry's development. A new trend that is happening is the tendency for smaller Chinese vehicle and components manufacturers to seek FDI deals without reference to central government. This marks a starting point of a reduced dependence on the government for development in the automotive industry.

Technology also influences the development of the industry in different ways as the lack of technology of the part suppliers only allows them to become contractors instead of full service providers as can be seen in foreign car markets, restraining the domestic industry. Also the lack of technology of the local joint ventures partners allows the foreign partners to introduce older products. Technology joint ventures influenced the development of the industry also by creating a barrier for the indigenous industry that was not operating in a joint venture. Technology also influences the institutional systems as the government changes policy in order to capture the importance of technology.

During the post reform period the industry changed due to an ease of regulation by the government, the opening up of the market and the transfer of technology towards domestic
manufacturers. During the nineties industry became more supported by industrial growth and private firms so there was a decreased dependence on institutional support. This proved to be one of the main starting points for the industrial boom in the last era.

During the post reform period we see new drivers of institutional decision making emerge. After the failed attempts of industrial reform a bigger gap has been created in industrial development than before the change to communism. In order to bridge this gap the government starts to slowly loosen control and starts changing the regulations to better support the development of industries, with in particular the automotive industry. Through time these improvements result into more opportunities in the Chinese automotive supported by more entrepreneurial actions. During the end of this period we see the establishment of various privately held automotive brands like Geely in 1994, Foton Motor in 1996, Chery in 1997, Hebei Zhongxing Automobile in 1999, Rongcheng HawTai Automobile in 2000 and Qinhuangdao Jincheng in 2000 all currently producing between 30,000 to 350,000 cars a year.

The Post Reform Period

- In the post reform period we see that the turnaround in government policy influences the interaction between the three populations to a large extent. Slowly but surely we see that over the period the interaction and the causality between the populations picks up resulting in an increased development of the industry. Especially the importance and the influence of technology on development is recognised in this period. Towards the end of this period the dependence on institutions for industrial growth is almost gone paving the way for causality to increase in the Chinese industry. A process which is supported by a large amount of entrepreneurial actions.

5.3 Analysis causality Last Era

In the first phase of the last era formal institutions in the form of accession to the WTO influence the level of technology as the foreign manufacturers are more willing to share technology as they feel better protected. WTO accession is another step towards a more open market economy resulting in an increase of sales in the automotive industry marking a start of the automotive boom in China.

The domestic automobile industry in China is struggling to develop itself independently and then we see the government changing policy in order to accommodate further foreign support for the industry. So here we observe the industry influencing governmental decision making but subsequently we see the government’s decision making also influence the industrial development. This support for
joint ventures opens up more opportunity for foreign car manufactures in China creating a better institutional environment in which business can thrive.

Even though IPR disputes exist no foreign manufacturer has decided to abandon the Chinese industry. It does however affect the ease of technology transfer between foreign and local manufacturers to some extent.

The state owned enterprises are starting to independently develop products which have not resulted in any new developments. This indicates that the market is being dominated by foreign brands and products that are produced in joint venture structures. At this time the domestic automobile industry has still a long way to go to catch up with these conglomerates.

In the following year the industry took a turn when it started exporting cars, resulting in a change to high standard technology that is needed for exportation which was being leveraged by their influential joint ventures with foreign multinationals.

In the subsequent year we see that technology is still influencing the industry as it actually drives a wedge between the foreign joint ventures and the independent local manufacturers creating large discrepancies in technology and competition.

Institutional support for exportation changes the industry from a domestic focused manufacturing industry into a domestic and export focused automotive industry. At the same time the support industries are catching up as they are supported by the global division of labor.

Suddenly we see that the Chinese domestic companies have made a technological leap they stopped looking at incremental technology and design and leap forward with radical innovations in new energy vehicle production. BYD has taken a leading role in this technological revolution. Emphasizing on the new energy vehicles gives the domestic Chinese automotive industry a new focus. The eased institutional policies have changed the traditional industry and made it much more competitive demanding lower prices of the multinationals and increased quality of the domestic producers.

Technology is changing the industry as the domestic market has become very much focused on the development of new energy vehicles which will prove to be critical for China’s development, as the Chinese know that it would not be possible for all Chinese to drive a fossil fuel car. The technology therefore changes the institutions as the government supports the new energy vehicles through policy changes.
The leap in new energy vehicle technology China made has created an interesting learning relation from the foreign manufacturers from the Chinese manufacturers creating an industry learning turnaround. Improved policy from the government improves this relation.

The drivers of institutional decision making changed again during the last era. Now the institutions are driven by the success of the industry the needs of manufacturers and the development of new technologies. They are therefore becoming more focused on specific parts of the industry and often act as incubators for the development of new technology.

The Last Era

• In the last era we have seen a dramatic increase in the amount of relations and causalities between the industry technology and institutional populations. This increase in populations has gone hand in hand with industry growth showing strong signals of co-evolution. Especially the development of the NEV has been a result of strong interaction between technology and the national institutions. Also the interaction between the industry and its potential and the results on the supporting institutions has been.
5.4 Fine-grained environmental Analysis

In this part we will analyze the environment in which the Chinese automotive industry resides in finer detail. This analysis is performed to statistically underpin the extent to which the context influences automotive development in China, in order to increase the validity of this research. This detailed analysis is based on the approach of Berry et al (2010) that was constructed to develop the institutional theories of national business, governance and innovation systems. We perform this detailed analysis by looking at the correlation between cars produced and four institutional dimensions e.g. economic, political, demographic and knowledge.

Where Berry et al (2010) uses nine dimensions for analysis we only selected four of the most appropriate measures that apply to our research topic. The analysis of these four variables allows us to put our analysis of the Chinese automotive industry developments into a finer grained context of institutional development. Each of the four dimensions exists out of several variables in line with the research of Berry et al (2010). We can only plug in the variables which are not constant so we had to exclude the policy-making uncertainty. Even though we exclude this variable we still have enough variables to represent all the dimensions. With this information we can construct the following correlation matrix.

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*Figure 12: Variable overview*
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<td>-0.84202</td>
<td>0.871676305</td>
<td>0.964817</td>
<td>0.821447</td>
<td>0.98489657</td>
<td>0.993857</td>
</tr>
</tbody>
</table>

**Figure 13:** Correlation between the dimension’s variables and cars produced.

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Based on these outcomes we can only say that there is a positive correlation between the development of cars produced and income, exports, imports, size of state consumption, WTO membership, political rights, life expectancy, population over 65 and the number of patents & articles. Let’s take a closer look at these variables and see whether they are in line with our earlier findings.

**Economic Development**

We start analyzing the variables by considering economic development as suggested by Whitley (1992). The international business literature has focused on three specific indicators of economic development. Development is seen in terms of income level (GDP per capita), prevailing inflation rates, and intensity of trade with the rest of the world. These indicators are important, because they are correlated with consumer purchasing power and preferences, macroeconomic stability, and the openness of the economy to external influences. These factors have been found to influence, for instance, foreign market entry mode, firm survival and performance, amongst other variables.

In China there is a very high correlation between the development of income and the development of the cars produced. This is completely in line with our factual observations of the developments in China, where we saw that the development of a large middle class has caused for a great demand of automobiles in China. Especially when we look at graphical development in Appendix II we see that income and cars produced follow almost the same trajectory. Another important observation we make here is the importance of high market potential for manufacturers as the slope of the production line is steeper than the development of income.

The correlation between cars produced and inflation is negative. In a planned economy like China the inflation rate is strictly controlled by the government who makes adjustments to inflation through their control over the financial system. This means that it follows a rather random path against development as can also be seen graphically in Appendix II.

Surprising is the positive correlation between import and export and the Chinese automotive industry, since the Chinese government imposes high tariffs on car imports to ensure domestic production. However over the last years China has also become an exporter of automobiles and is leveraging its low cost position to become a strong player in the international car market. This could explain why the correlation between exports is slightly higher than the correlation between imports. The high correlation of imports and exports is also an indication of an increased openness of the Chinese economy to foreign influences over the last decades which has clearly been case.


**Political Development**

In addition to different levels of economic development, the institutional literature has also emphasized on the nature of the political systems (Henisz, 2000; Henisz & Williamson, 1999; Whitley, 1992 in Berry et al, 2010). Our approach focuses on formal institutions and follows China along continuous political dimensions that are in line with Berry et al (2010), such as institutional checks and, democratic character, the size of the state related to the economy, and external trade associations. These variables have been found to correlate with the choice of foreign markets to enter, the choice of entry mode, and foreign direct investment flows.

The size of state consumption is slightly negatively correlated with the development of cars produced. Intuitively we would say that the expenditure of the government should have been increased over years to facilitate the development of the industry, but this would be a wrong observation. The state facilitates the industry more through regulatory ways than through consumption. When we look at a graphical trajectory of state consumption in Appendix II we can indeed see that the state consumption has doubled immediately after the reform and stayed at a steady level since.

Political rights are slightly positively correlated with the development of the cars produced in China. This is not as surprising as the political rights in China have improved over time. This included more freedom for companies to do business in China, through joint ventures and other contractual agreements which benefited the development of the automotive industry.

The development of the civil rights however is negatively related to the development of the cars produced in China. Where the automotive industry only improved over time the civil rights only deteriorated according to the experts of Freedom House. Besides this the civil aspects of politics has hardly come to light in any industry in China.

The fact that the WTO agreement is positively related to the development of the cars produced comes as no shock. As earlier noted in the factual analysis the membership of the WTO has boosted China’s economy and is seen by experts as one of the key instigators of the industry boom that started in late 2000. This is mainly a result of the influence the WTO membership has on the overall economical environment due to the standards that are attached to membership of the WTO.

**Demographic Development**

Institutional theory also identifies demography as a key dimension of development as suggested by Whitley, 1992. It is seen in terms of the size, growth, age structure, and qualities of the population. These dimensions have direct implications for market attractiveness and growth potential. We focused
the analysis on differences in life expectancy rates, birth rates, and the age structure of the population, these factors closely follow the attractiveness of an economy for firms according to Berry et al (2010).

There is a positive correlation between the numbers of cars produced and the development of life expectancy. This increase of life expectancy points to an increase in market attractiveness. This is in line with earlier reasoning and again underscores the importance of market potential for the development of the automotive industry in China.

The fact that there is a negative correlation between the birthrate and the number of cars produced is caused by the one child politics. As can be seen in the graphical analysis in Appendix II the birthrate is decreasing over time while the number of cars produced is increasing over time. Furthermore can a decreasing population result in a decrease of the consumer market over time.

In line with the negative correlation of birth rate is the negative correlation between cars produced and population under 14 and the positive correlation of people over 65. The increase of people over 65 means that there is an improvement of life standards in China hence more people can afford a car. The decrease of population under 14 means that there is also a decrease in growth potential of the car market as less consumers will be entering the market.

The demographical effects of birthrate and age structure will not affect the automotive market in the short run as until now only a small percentage of the 1.3 billion Chinese people own a car. When the market becomes more saturated these numbers will become increasingly important for the development of the industry.

**Knowledge Development**

The institutional literature also proposes that development depends on the capacity to create knowledge and to innovate, which has important implications for a countries role in the global economy (Furman et al., 2002; Nelson & Rosenberg, 1993: in Berry et al, 2010). Proximity to knowledge has been argued to influence the location choice of multinational firms, because of the potential for spillovers. Following the literature on national innovation systems, we measured knowledge distance using the number of patents and of scientific articles per capita (Furman et al., 2002; Nelson & Rosenberg, 1993 in Berry et al 2010).

Both of the variables are highly positive which is not surprising. Especially in the last years the number of patents really took off. This is in line with our previous findings that discuss the domestic development of new technology focusing on the New Energy Vehicles.
The positive correlation of the number of cars produced and the increase in the number of scientific articles also comes as no surprise. The spillover effects of the knowledge development have been explicit in the automobile industry. Specific examples are the automotive university in ChongChing just miles away from Ford’s production facility and headquarter, which has established itself as the main employer of the universities alumni. A similar example is the PhD program at Geely through which they try to optimally benefit from these spillover effects, improving their own technical capabilities.

5.5 Co-evolutionary Analysis

To explain a change in the Chinese automotive industry as a co-evolutionary process, and thereby validate the use of co-evolutionary theory in a planned economy, it is necessary to indentify in more detail how the populations are causally linked to produce the observed outcome. In line with solid social science research (Tilly, 1998) we identified robust causal processes in the analysis part that explains how the Chinese automotive industry has developed. To explain the co-evolution of the automotive industry and technology in the period between 1953 - 2011 we indentified, the change in technology dependence, a change in economic planning, and increase in supporting industries, the emergence of enormous market potential, the transfer of technology between foreign and domestic manufacturers and the shift of technology towards the new energy vehicles as the more specific causal mechanisms that connected the evolution of the populations. In this analytical picture, the agents in one population alter the success chances of the agents in a second population. In co-evolution, the path of one population is significantly influenced by the characteristics of a second population indicating that co-evolution theory has an explanatory value in the development of the Chinese automotive industry.

Unlike a static theory, it is not necessary in such a dynamic account that a country which at the end of longer period possesses a large leadership in market share starts out with a significant lead (Murmann, 2003). Over time relative small differences in market share can amplify and develop into much larger differences, provided that self reinforcing processes dominate self limiting ones. This is precisely what happened in the Chinese automotive industry. Because of the potential of the market share and a surplus of capable laborers due to the reform, combined with the emergence of recent innovations, manufacturing firms are producing more cars in the Chinese market than in the United States or Japan. Based on their technology advantage and large domestic market the U.S and Japanese firms dominated the market for the last centuries. But the institutional developments in China combined with the increased focus on technological development allowed the Chinese automotive industry to become more competent in producing cars than the U.S or Japanese industry.
When China’s economy opened up after 25 years of economic malaise there was huge unemployment in a country with virtually no cars. This institutional turnaround was crucial for the development of the industry as it is today. In the first place the high level of unemployment allowed for cheap labor and an abundance of input for the industry. In the second place after thirty year of development a large middle class has been established in China, all looking to buy a car. In the case of China the gain in market share became self reinforcing, whereas in the U.S the market share only reduced. Over the recent decade this led to a dramatic reversal of fortunes of the two national industries: In the recent years China came to dominate the industry in a way similar to American firm’s domination of the packaged software industry at the turn of the twenty first century (Murmann, 2003).

A second category of self reinforcing processes is related to the institutional environment of the firm populations. After the reform China had virtually no technology that was needed in order to support an automotive industry. The government saw the need for automobiles in order to reform the economy and refused to import them. Acknowledging the lack of technology they allowed foreign manufacturers to come to China to produce their cars there. This vital decision allowed for a rapid development of the automobile industry in China, which became dominated by the foreign-domestic joint ventures. These developments in turn helped Chinese firms cement their dominance of the world automotive industry. The fact that these firms were forced to operate under a joint venture structure is in complete support of Pfeffer and Salancik’s (1978) resource dependence theory of organizations, as Chinese firms did not shape their selection environment so they would find it hard to expand and face serious competition from foreign firms. This is why the automotive industry development is largely founded on foreign firm involvement. Institutional support for the development of NEV’s will likely cause this to shift towards the domestic manufacturers as they start to develop a superior technology which will become the main focus of the global automotive industry in the near future.

In the Chinese automotive industry, government policy and the transfer of technology were the key factors that mattered for the relative success of national populations of firms. At other times industries, tax laws, employer–employee relations and financial institutions may play a decisive role in the long term competitive success of firms. We have good reason to believe that co-evolutionary processes will also shape these latter institutional structures. Of course, it was not the social environment that invented industrial-scale processes and manufactured cars. Firms played a crucial role in translating institutional differences into competitive advantages. Among many other things firms had to take technology from their joint venture and scale them into domestic industrial production.
Besides the traditional theory of co-evolution we can also observe that co-evolution theory also works in reverse. An interesting way of validating co-evolution theory as it has not yet been done before. Due to the decreased amount of causalities between the populations we see a decrease in industry development and even a reverse to some extent in the pre reform period. From this we inherently can derive that co-evolution theory works both ways.

Overall we can say that the co-evolution theory as presented by Murmann (2003) holds for a planned economy and can explain the development of the Chinese automobile industry. In order to extent the existing model of co-evolution we have formulated several conditions in order to make it better applicable to a planned economy which will be discussed in the discussion part.

**Figure 14: Co-evolution analysis visualized**

- **Co-evolution is not a static process**
  - The US and Japan do not have a significant lead anymore in the automobile industry due to the rapid co-evolutionary process in China

- **Co-evolution is self reinforcing**
  - High unemployment resulted in cheap labor which resulted in a competitive position for China
  - Governmental control resulted in local manufacturing and foreign technology transfer improving the Chinese technology base on which they developed groundbreaking NEVs

- **Co-evolution is resource dependent**
  - Firms were not able to create their own selection environment and where dependent on external resources

- **Different factors will drive future co-evolution**
  - As the industry develops other institutional differences will be translated into a competitive advantage

- **Co-evolution is multidirectional**
  - An increase in causalities spurs industrial development but a decrease of causalities also decreases the level of industrial development
Chapter 6: Discussion

In this chapter we will discuss how we can make it easier for co-evolution theory to explain events like the changing dynamics in the Chinese automotive industry. We will discuss seven observations based on expert opinions and historic analyses that help us find pre-conditions to co-evolution theory in planned economies that Murmann (2003) and others did not find. As observed from the interviews in combination with the analysis of the causality in the three periods there are various conditions that are not mentioned by traditional co-evolution theory that need to be included when observing planned economies.

Market potential has a disproportional influence on the co-evolutionary model in planned economies\(^5\) \(1\)

Even though the business environment has never been optimal the industry is still skyrocketing in the last decade ignoring IPR problems, regulations problems, quality problems, just because car manufacturers see an enormous potential in China’s automobile market. This enormous market potential has become the counterbalance of the negative factors in the Chinese automotive industry. Market potential is one of the basic factors for industry development, due to its inherent nature it has never been highlighted as a pre-condition for co-evolution. We choose to emphasize its importance in this research because without extensive market potential in planned economies, foreign manufacturers would not consider working in the difficult institutional environment that is often plagued with property right concerns and issues alike.

Researchers have not yet reached a consensus if market potential is a pre-condition for industry. Therefore the observation is in contrast with theories of certain academic researchers especially in research done by Harris (1954) and Krugman (1998). Harris measured the market access of each county in the United States using several ad hoc but fairly sensible measures of "market potential": a weighted sum of purchasing power across locations, with the weight for each location depending inversely on its distance. He came to an exciting suggestion that the concentration of production was self-reinforcing.

\(^5\) Derived from an interview with Mr Schroeter Director of Daimler China
Firms chose to produce in regions with good access to markets; but access to markets tended to be good in regions in which many firms chose to produce. This theory formed the foundation for Krugman’s (1998) research in which he argues that the dynamics of the economy can, if one likes, be viewed as the co-evolution of two landscapes: a landscape of current distribution of economic activity, which determines a second landscape of market potential, which in turn determines how that first landscape changes over time. In the Chinese automotive industry we observe the exact opposite; the market potential determines the landscape of current economic activity. Since the market potential is so high in China it changes how manufacturers observe the market landscape. Instead of seeing a difficult market with lots of pitfalls and constraints they see an unraveled land of opportunities. Because of this view on the market the foreign manufacturers are more willing to enter in joint ventures and share their technology in order to gain a foothold in the market. It also influences the Industry as the opportunities stimulate entrepreneurial actions in order to capitalize on these opportunities. Even the formal institutions change into a more supportive regulatory environment in order for China itself to benefit as much as possible from the current market conditions. We can conclude from this that market potential is a pre-condition that needs to be highlighted when applying co-evolution theory to a planned economy.

*The realization of supporting industries has been crucial for the co-evolutionary process* \(^6\)  \(\text{(2)}\)

China slowly moves away from being solely a manufacturing economy to becoming a service economy as well. As China no longer depends only on the manufacturing industry the protectionism of the government becomes much less, allowing for more room for co-evolution to occur as more causalities and links are established under less tight regulations. This effect is even greater in the automobile industry as it was dubbed a pillar industry in China and is therefore one of the longest and most extensively regulated industries in China. Besides the relief of pressure, the establishment of a solid high end service industry fuels further development of the automotive industry as more causalities are realized between the (novel) high end service industry and the automotive industry improving the process of evolution and co-evolution. Not all theory acknowledges that strong national industries often

\(^6\) Derived from an interview with Professor Buhui Qiu former strategic analyst of Ford Motor Company
tend to be supported by secondary industries and therefore fuel co-evolution (Porter 1990; Nelson, 1996). Theory established by Lewin and Volberda does underline the importance of supporting industries. Through this observation we want to integrate these two different streams of the literature that have not been connected yet, allowing for this observation to function as a pre condition for co-evolution to be applied in planned economies.

The formal government regulated institutions are a dominant factor in the co-evolutionary model

As observed from the case study co-evolution is nonexistent under a tight centrally planned economy. The institutional causality is dominating in the planned economy. As seen in the pre reform phase all the causality relations were one-sided, as it was only the government that influenced the industry and technology. In a one-sided economy without co-evolution there will be no development. As a result we also see that the development of the automotive industry during this period completely stopped. After the reform China allowed for more interchangeable relations to be established between the formal institutions, technology and the industry and ergo the industry developed. The traditional theory argues that the influence of institutions is limited to how efficiently they coordinate human efforts and institutions and they have an influence on the performance of other institutions and/or the economy (North, 1990 Nelson and Sampat, 2001). When defining the influence of institutions in this way, it grossly underestimates the weight of formal institutions in co-evolutionary research in planned economies. A good example of this is the analysis of the causalities in the pre reform period. It boils down to the fact that the weight of the three populations differ in the western economies and the planned economies. Where in the Western economies the weights are more or less equally distributed in the planned economies the formal institutional influence has a much higher weight and should therefore be accounted for in the preconditions of the co-evolutionary theory when applied to planned economies.
A precondition that is stated in Murmann’s (2003) theory on co-evolution deals with IPR’s, and its importance for the development of a successful industry. A steady IPR environment in the respect of Murmann’s research creates a competitive advantage for firms creating superior capabilities for manufacturing and marketing product and thus is essential to industry development. In China however we see a lack of IPR regulations but industry still developments on a rapid pace. This is mainly caused by the vast potential of the market in China which causes firms to ignore the IPR issue and keep producing and focusing on the Chinese industry fuelling its development. The theory agrees with this unexpected situation to certain extend as the effects of changes in one variable frequently contradict inferences based on simple cause-effect logic of linear relations according to Baum and Singh (1994) and Casti (1994). So we see that a steady IPR environment is not a precondition as stated by Murmann but only if the market potential is large enough to offset the damage due to a lack of IPR’s can be compensated for.

*Technology is not a steady evolutionary process*

The Chinese evolution seems to have skipped a step in development, as China is leap frogging from a technology absorber on traditional engine and automotive technology to a technology distributor in the field of NEV’s. This is in line with the standard theory that technological change plays an important role in industrial dynamics and economic growth (Usher, 1954; Landes 1969; Rosenberg 1982). Even the more radical development is supported by scholars whom argue that technological innovations not only are able to create new products and industries but also can radically destroy the fortunes of existing firms or even eliminates entire industries altogether (Schumpeter, 1934; Gort and Klepper, 1982; Nelson and Winter, 1982; Tushman and Anderson, 1986; Anderson and Tushman, 1990). But this observation disagrees with many historians of technology that argue that the development of technology is best understood as an evolutionary process (Basalla, 1998; Vincenti, 1990; Petroski, 1992;
The process we see in China is not a straight evolution process but leap frogs through its development. Besides the leapfrogging another indication that technology is not a standard evolutionary process in the planned economy is observed. It appears that changes in technology seem to be a second order effect when it comes to the causalities of co-evolution in a planned economy. In the context of a planned economy this is not a surprising observation as formal regulations are most often seen as the determining factor in industry change. In the context of the co-evolutionary theory this is much more unusual as technology has usually been observed as a first order effect of co-evolution in for example the dye industry development in Germany (Murmann, 2003). The theory does however deal to an extend with this second order effect. In Baum and Singh (1994), for example, they make the distinction between direct co-evolution, in which one population evolves in response to another population, and diffuse co-evolution, in which one or more populations evolve in response to several other populations in a broader ecological system. Based on this when looking at co-evolution in a planned economy we must pay special attention to the indirect influences of technology, avoiding underestimation of the importance, when compared to industry and institutional influences. Nonetheless in the context of planned economies a clear precondition should be stated for these developments in technology.

Co-evolution benefits foreign companies more than local companies

The local car industry did not benefit as much from the industry as the foreign companies did. This observation disagrees with the studies on evolution with in particular with one of the most prominent, performed by Barnett and Hansen (1996). He reported findings that support dynamic interactions between firm learning and adaptation on the one hand, and higher levels of competition and selection on the other. According to this theory after the economic reform in China the domestic and foreign manufacturers were more likely to compete in a more persistent form of co-evolution dubbed an “arms race” or “the Red Queen effect” (Beinhocker 1997, Kauffman 1995, Van Valen 1973). Due to the enormous lag in technology and development of the domestic manufacturers they do not benefit as much. In order to do so they will need to catch up in technology and development, from there

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8 Derived from an interview with Mr Zhao Director at Geely China
on we will see a more persistent form of co-evolution between the domestic and foreign manufacturers. This observation is more industry specific in China’s automobile industry and is therefore not determined as a precondition for co-evolution theory in planned economies. It is however an important observation which is key to the development of the automotive industry in China. When this situation continues consequences could be an unstable future growth of the industry that depends to heavily on foreign involvement.

In contrast with other industries, technology transfer in the automotive industry was a success$^9$

The co-evolution between technology and industry was not always as difficult as claimed. This observation disagrees with the theory on the ease of joint ventures in China as explained by Shenkar (1990), who says that many IJVs in the PRC seem to run into major difficulties. Furthermore this observation also starts the relevance of research on firm use of their inter-partner network structure to overcome knowledge transfer difficulties between foreign and local IJV partners in the Chinese automotive industry as performed by Zhoa et all (2005). As all interviewed experts and historical research points out that inter-partner network structure are the root of establishing joint ventures. Research as done by Zhao argues from the mindset that government regulated joint ventures will inherently fail and need to be secured by inter partner networks, but in practice this does not seem to be the case. This observation is also more industry specific to China’s automobile industry and is therefore not determined as a precondition for co-evolution theory in planned economies. It is however an important remark which adds to the development of the automotive industry in China, as it implies that the expensive and frequently redundant constructions to safeguard technology are often not needed in China’s automotive industry.

From these observations we can establish several preconditions for planned economies that the Murmann’s (2003) and others did not find, that will help increase the explanatory capabilities of co-evolution theory in planned economies.

$^9$ Derived from an interview with Professor Buhui Qiu
The first precondition for technology is that it does not necessarily follow a straight path in development in planned economies as it leap frogs to catch up with the global industry level. The second precondition is that technology in planned economies is often observed as an indirect effect which could lead to the underestimation of the importance of this population.

The first precondition for the formal governing institutions focuses on the above average effect of the institutional environment in planned economies which must be accounted for. The second precondition accounts for the limited influence of supporting institutions like IPR’s in planned economies which are tightly related to the existent market potential as previously discussed.

The first precondition for the industry is the need for a certain level of market potential to be present in the industry, the larger the market potential the larger the industry development. It must be noted that a certain threshold in market potential has to exist in order to overcome industrial distortion as often observed in planned economies. The second pre-condition is that supporting industries need to have established themselves, as they are key providers for interaction and causality in planned economies and relieve pressures of institutional influences on one industry.

When taking these pre-conditions into account when studying industry dynamics in planned economies we find it easier to observe the causalities that matter for the industry dynamics. The explanation of the changing dynamics in the Chinese automotive business would have been more detailed if besides the effects of technology and the importance of formal institutions, also the important effect of market potential on the industry dynamics in planned economies, would have been emphasized.
Chapter 7: Conclusion

In this thesis we focused on the challenge of developing new insights into the theory of co-evolution and increasing the generalizibility of the theory by expanding it for use in planned economies. More specifically we use the Chinese automotive industry as a case study to find the exceptions of co-evolution theory when applied to a planned economy. We combined expert opinions with solid historical research in order to come up with new additions. Not yet before has an extensive in-depth case study been preformed that focuses on industry co-evolution in a planned economy. Now we will look at the conclusions we can draw from the analysis and observations and asses the theoretical and practical implications as well as providing some suggestions for future research.

7.1 Theoretical Implications

After performing this research we believe that co-evolutionary theory can be applied to industry development in any context, also within a planned economy, in the same way as scholars believe that evolution and co-evolution theory can explain many other developments like economic change or the development of a language (Murray, 2003; Lewontin, 1974). Under the assumption that the right preconditions are set and the theory is applied to the situation correctly. In the analysis part we have argued that the development of the Chinese automotive industry can be explained with co-evolution theory after extensive analysis of the causalities within the industry over the past 60 years.

In this research we found preconditions that others did not find. We visualized this contribution in figure 14, for an elaborate explanation of this figure I refer to appendix III. The already existing conditions for co-evolution are depicted by the grey areas whereas the contributions of this research are visualized by the light blue areas. Whereas all new contributions naturally apply to the planned economy there are exceptions in the traditional literature that do not explain certain developments in which case they are accentuated with a red outline.

Besides the preconditions to the fundamental theory of co-evolution another important observation in this research adds to the generalizability of co-evolutionary theory in planned economies. The established notion that co-evolution theory can be applied in reverse e.g. that a decrease in the amount of causalities observed within an industry will lead to a decrease in industry development, drastically improves the ease of implementing co-evolution theory to planned economies. As from now also the lack of causalities that can be observed in strict planned economies, can be used as a starting point to indicate the industrial development trajectory.
Figure 15: Preconditions related to co-evolution theory in planned economies

- Traditional preconditions for co-evolution
- Additional preconditions for co-evolution
- Populations of research

Traditional co-evolution preconditions:
- Interaction
- Non linear
- Non path dependent
- Multiple levels
- Non path dependent
- Steady IPR environment
- Development leads to increased competitive dynamics
- Creates and destroys industries
- Political macro variables
- Historical context
- Evolutionary process
- Different institutional systems
- Long period of time

Applicable in planned economies:
- Technology
- Formal Institutions
- Industry

Not applicable in planned economies:
- Radical evolution of technology
- Above average influence
- Market potential
- Indirect effect of technology
- Limited effect of supporting institutions
- Horizontal supporting industries
7.2 Practical implications

The practical implications of applying co-evolutionary theory to planned economies in general and the Chinese automotive industry in particular allows us to say something about the key drivers of the industry change and possibly also about the future developments in the industry.

In the post reform period the changes were gradual and in line with the guidelines set by the government for the reform of the entire economic and institutional system. This is translated in a gradual improvement of the automotive industry over these years, mainly driven by policy reforms and an increase of economic openness over time. Allowing for foreign companies to come in and supply the market with much needed technology is giving the industry a solid base for future development.

The subsequent boom in the industry, that started in 2000 – 2001, was kicked off by the gained WTO membership of China. The continuation of this fast growth was ensured due to further easing of the political constraints with regards to operations in China for foreign and domestic companies including improved regulations surrounding exports and imports. Besides this the development of knowledge in China played a big role in the boom during the last era. Improvements of the educational system during the pro reform period allowed for a large amount of highly educated workers to enter the employment market during the last ten years improving the technological capabilities of firms. Last but definitely not least is the importance of economic development in China as a whole. This last era has been a turning point for economic development in China as a whole benefitting the automotive industry tremendously.

When pointing our eyes to the future we can safely say that the Chinese automotive industry will remain to develop at a fast pace. Especially as future economic developments are regarded as positive. At the moment of writing, one of the main drivers of the industrial development is the continuing growth of the Chinese middle class which will fuel the market potential for cars in China leveraging the industrial difficulties. In time the formal institutions will develop further and will make the industrial landscape more facilitating in term regulations and IPR, creating a reduced dependence on market potential in order to keep China attractive as an automotive market. Furthermore the developments surrounding the new energy vehicles will give China the competitive advantage they need in order to become an independent car manufacturing economy.

Considering that every Chinese family would own a fossil fuel powered car, the world supply of fossil fuel would run out within 25 years. So the further development of the Chinese economy as a whole depends on the success of the new energy vehicles.
However there is no sun without shadow and hence a word of caution must be included here. China moved away from being a laggard to being an industrial leader, a growth that took the country less than thirty years where it took the U.S and Japan over 60 years to develop such an extensive automobile industry. This rapid development pared with its increased causalities may cause the Chinese industry to become unstable. Clear signs of this are the leap frogging in technology. Without even having familiarized with the fundamental technology of traditional petrol engine designs the local industry is already focusing on even more advanced technology projects in the NEV sector. The effects of “too much co-evolution” could become an Achilles heel for the Chinese automotive industry. Without familiarizing itself with the traditional technologies the future industrial growth could be founded on a poor foundation of knowledge. In line with this unstable growth is the dependence on foreign companies for these fundamental technologies that causes local companies to benefit less from industrial development than foreign manufacturers. Besides this there is a looming demographics issue in China which could distort the market attractiveness due to the aging of the population. The effects of the aging population will not be felt in the short term but could become a serious problem for China’s development, not only in the automobile industry.

7.3 Limitations and suggestions for further research

There are several limitations to this research one of them is the focus on the automotive industry. In order to create a better understanding on how to apply co-evolutionary theory to planned economies similar research needs to be performed on multiple industries in planned economies. Furthermore the focus on China as benchmark for the planned economy provides an enormously interesting base but more insights into the applicability of co-evolutionary theory can be found when looking at stricter planned economies like North Korea, which would however be much more difficult to research when it comes to gathering data. Besides the geographical issues also a closer look at the firm level co-evolution in China can provide a more detailed insight in the workings of co-evolution. The firm level performance development over time in planned economies would be interesting to analyse to establish a wider theoretical background on co-evolution in planned economies.
Appendix I – Overview cars produced in China

Appendix II - Graphical Development of the Dimensions

Automotive Development
Economic Development

Economic Development - GDP

Economic Development - Inflation
Political Development

Knowledge Development - Patents & Articles

- Scientific and technical journal articles
- Patent applications, residents
Demographic Development

Demographic Development - Life expectancy at birth

Demographic Development - Birth rate
Political Development

Demographic Development - Age Distribution

Political Development - Government Consumption

General government final consumption expenditure (% of GDP)
Political Development

- Polconv: 0 = Constrained, 1 = Not Constrained
- WTO Member: 0 = No, 1 = Yes
- Political Rights: 1 = Highest Freedom, 7 = Lowest Freedom
- Civil Liberties: 1 = Highest Freedom, 7 = Lowest Freedom

Graph showing the development of political factors over the years from 1960 to 2008.
Appendix III – Analysis of pre conditions old and new

Where traditional co-evolution theory explained what happened in the Chinese automotive industry

- Interaction
- Non linear
- Non path dependent
- Multiple levels
- Increased competition
- Historical context
- Long time period

Where traditional co-evolution did not explain what happened in the Chinese automotive industry

- Creates and destroys industry’s
- Evolutionary processes
- Political macro variables
- Different institutional systems

Where additional pre conditions are needed in planned economies that Murmann and other did not find

- Radical evolution of technology
- Indirect effect of technology
- Above average influence
- Effect of supporting industries
- Limited effect of supporting industries
- Market potential
- Horizontal supporting industries
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