LUND UNIVERSITY
School of Economics and Management

Master programme in Innovation and Spatial Dynamics

Innovation in Low-Tech Industries

An Example of the Food Industry in China

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Abstract: The importance of investing in low-tech industries has been underestimated for a long time because of its low R&D input to output ratio. But in reality, so-called high-tech industries only account for 3 per cent of value added in the OECD, while low-tech industries, such as the food industry, indeed do not lack the opportunities of benefiting from innovation. The driving forces of innovation have been constructed and separately examined in a series of former studies. However, there is rare study discussing about cumulative effect of those factors or further reflecting the factors on empirical world. Shedding light on the low-tech industries, the common sectors with largest labor employment, could be a possible way of finding new sources for developing countries to promote economic growth. This thesis focuses on filling in the gap between theory and reality. It first concludes critical factors that influence innovation from micro and macro level and then assesses the driving forces under a systematic review method in order to understand the relation between cumulative effects of innovation drivers and realistic innovation activities. Through decomposing the innovation activities in the Chinese food industry, the result shows that the dynamic interaction between different factors indeed drives the vitality of the innovation activities in the Chinese food industry.

Key words: Low-tech industries, food industry, innovation activities

EKHS31
Master thesis, First Year (15 credits ECTS)
June 2017
Supervisor: Jonas Ljungberg, Emrah Gülsunar
Examiner: Jing Xiao
Word Count:11,686

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1 Introduction

1.1 Background

The current focus of innovation literature is on the large and exceptional cases, such as agglomerations of information and communication technology (ICT) or creative media centers, where the sectors are not only new but also uniquely located in one of the advanced industrial economies. In contrast, the common sectors, which are existing and toiling in every economy, are often neglected by these studies, and those sectors are the study objects that are more convincingly able to generate the rules than the examination of the exceptions (Phillips et al. 2012). One of the reasons that such sectors have been overlooked is that the sectors have already been mature, and when it comes to mature industries, people are generally considering it as the non-high technology sectors that are lack of the chances to absorb new technologies and rejuvenate. That being so, it is not surprising that the research interests towards low-tech industry and corresponding scientific publications have been rather limited (Hoveskog, 2011).

Based on the different R&D intensity of industrial sectors, OECD and Eurostat developed an influential classification system. According to this classification, the food industry is one of the low-tech industries, which are often considered as non R&D intensity industries by policy makers due to its low expenditure to output value ratio. Especially for developing countries, it is a common phenomenon that these countries are seen to obsessively invest in high-tech industries instead of low-tech industries. However, from the data of the OECD, high-tech industries together with medium-high-tech industries only account for 8.5 per cent of value added and their impact on GDP is relatively limited (Von Tunzelmann & Acha, 2005).

It is worth noticing that common sectors, also known as low-tech industries, usually account for a great and stable share of manufacturing value added in less developed

countries and also persist as the major sources of employment (Sandven & Smith, 2005). Even for the advanced economies, some studies found that low technology industries still play a major role in their economies; along with constant technological upgrading, low-tech industries in high wage countries have been successfully innovating and maintaining their comparative advantages (Hoveskog, 2011). A great possibility of improving economic performance was concealing under the common sectors in the developing world, and thus accelerating the transformation of low-tech industries could be the powerful driving force for the growth of their economies.

Incremental innovations usually predominate the growth and performance of low-tech industries, and according to Asheim and Gertler (2005)'s concept of the industrial knowledge base, a key feature of incremental innovations is that their creation process is more associated with the synthetic knowledge base, which is characterized by the novel combination of existing knowledge. It is different from the industries fitting in the analytical knowledge base, which production is based on scientific knowledge, frontline technologies and intensive R&D activities. The innovations in the low-tech industries usually belong to the first category, relying more on tacit knowledge that resulted from the interactive process at the workplace to constantly improve products and production processes, and develop customized solutions (Hansen & Winther, 2015). Thus, non R&D intensity does not necessarily indicate the lack of knowledge intensity and innovations in the low-tech industries are still worth further study.

In the past, linear model was a common way to analyze innovation process. According to Nooteboom (1994), this early model of innovation sees innovative activities as sequential activities in a predetermined order, which means every step of the sequence is considered as frozen with the requirement of passing through the "permission" before moving to the next step. This concept misled the governments of developing countries to only concentrate on putting a great amount of capital into

technological research to achieve innovative outcome. That is also the reason why the policy makers shift their attention to R&D intensity industries on the early stage, but not surprisingly, the output results they received more often turned out to be poor. On the contrary, the thesis understands innovation in the food industry as a nonlinear process, which involves mutual interactions. Due to the characteristics of analytical knowledge base, the attention of promoting innovations in the low-tech sectors, especially for the developing countries, should be paid on a dynamic perspective, such as boosting linkages in the system. The interaction and collaboration would help companies to overcome the asymmetric nature of knowledge, while the companies themselves as the sources and recipients of knowledge and resources also need to build their own absorptive capabilities. To be more specific, a few examples could be used to explain the interactive process within the food industry. For instance, the technological changes in the machinery or the requirements of new characteristics in food could motivate the innovative food products while policy-driven interactive learning through vertical and horizontal networks could also encourage knowledge spillover to take place and benefits the development of the food industry.

As an opportunity for the sustainable development, especially for the sustainability of food industry, innovation becomes an important instrument to assure a densely populated country surviving and satisfying. To reach a better understanding of innovation and thus to promote innovation, making the questions such as how innovation activities took place and how difficult elements engaging in the activities is worthy of further study.

1.2 Aim and Objectives

Even though recently some scholars have realized the exaggeration of scientific knowledge based production and started to pay attention to innovation in low-tech industries, until now the research has been mainly focusing on those high-wages

countries. As mentioned before, those countries' low-tech industries are remaining stable roles in the domestic economies and comparative advantages in the global market; they are way more innovative and dynamic than have been realized (Hoveskog, 2011). Recent qualitative studies on Danish low-tech industries had found out that so far low-tech industries have the largest increase in machinery investments and the growth of using highly skilled labor in low-tech industries is also remarkably higher than that in other industries (Hansen & Winther, 2015). The confirmed successful story of the developed world has raised the question about how far the low-tech industries have been developed in the developing world and what they could learn from the developed countries.

Lots of low-tech industries were once classified as "high-tech" at the beginning stage of their life cycles, while with the increase of maturity present-day's traditional industries drop out of the category of being cutting-edge (Hoveskog, 2011). Of all the "traditional" low-tech industries, the paper chooses the food industry as the study object in order to conduct the research in a more specific and detailed way. The first reason of making the food industry become the chosen one is that in the research field this industry is categorized as a typical low-tech industry and its innovative outputs are mainly incremental innovations, which are fully in conformity with the aforementioned low-tech industry's characteristics. Second, the food industry is a rather important part in every economy. Especially, this paper intends to give inspiration for developing countries and the improvement in the understanding of the food industry might provide them with a full depth of substantive help. Last but not least, the food industry has a promising future. It has already attracted certain attention in the field and offered several bright stories from the developed countries to the rest of the world. The food industry is defined as a complex collective of a huge variety of organizations that supply food to the world population. It includes agriculture, manufacturing, food processing, wholesale, foodservice and far more than

those; as a result, according to the term adopted by the Economic Research Service of the U.S. Department of Agriculture, “food system” is much more apt as what the industry actually is. Being a mega system, it is far than easy to elaborate its industrial innovation activities in a few lines.

For the former research concerning the food industry in developing economies, they often focus on specific elements affecting innovation activities and offers customized advice afterwards, instead of viewing the food industry as a complex dynamic system or taking cumulative impacts of driving forces of innovation activities into consideration. This thesis intends to apply the deductive research results from the developed countries to a specific developing country’s framework in order to fill the research gap in the lack of study in the low-tech industries of developing country. China is the most populated country in the whole world and its food industry has always served as the core factor of maintaining further economic and social development. With putting a greater focus on innovation, China has set several good innovative examples in the food industry for other developing countries, such as green food. In addition, China is at the forefront of developing countries category and it could play the role as encouraging poorly performers to catch up in terms of innovations without scaring them away with the wide gap between them and developed world. Therefore the food industry in China is chosen as the study example of this paper, and the ultimate purpose is trying to clarify the innovation system in Chinese food industry by analyzing the interplay of innovation drivers within the diverse types of innovation activities and providing the chance to enlighten policy makers about the economic potential of low-tech industries in developing world.

Based on the existing literature discussion of the determinants of the innovation-related activities in the sector, the thesis will examine how those factors mainly generated from the former research of low-tech industries have contributed to

the innovative activities in the food industry in China. The analysis will conduct in both micro-level and macro-level, respectively firm level and industry level. Qualitative data will mainly extract from literature review, while quantitative data will retrieve from the National Bureau of Statistics of China and corresponding articles and reports.

2 Theoretical Framework

2.1 Literature Review

2.11 Innovation in the Food Industry

Innovation has been a hot topic of scientific study in recent years and it is generally considered as the ultimate source of survival and growth for all walks of life. As the theme throughout the whole paper, it is critical to clarify the concept of innovation at the beginning; however, the definitions of innovation, according to a survey in 2013, are more than 40 versions. When it comes to innovation, a common way to interpret it is to connect the concept with doing new things. "New things" could be either concrete as a new product or abstract as a brand new managerial scheme, but they both require the element of being implemented in the reality to be "physical". As stated in The Oxford Handbook of Innovation (2006), innovation is the first attempt to carry out invention into practice, therefore this paper takes above-mentioned idea of understanding innovation as the creation of a novel idea combining with the commercial introduction.

Based on "type", innovation could be further classified to "process innovation" and "product innovation" (Smith, 2006); drill down to the "type" of innovation in the food industry, due to its complex system of horizontal and vertical relationships innovation encompasses throughout the entire food system, such as product formulation and process engineering (Earle, 1997). As Hirsch-Kreinsen et al (2006)'s research on low-tech industries had already pointed out that the main source of innovation

activities in such industries is located at the stock of existing knowledge, food industry being one of the low-tech sectors not surprisingly is also predominated by the synthetic knowledge base. It depends greatly on the interaction between different agents to solve specific problems and employ tacit knowledge that is distributed through exchange and informal way of learning; hence when a company plans to innovate, the interrelationship within the food system is crucial and inseparable for managers to take into consideration. According to the newest study on food and beverage industry conducted by Bayona-Saez et al (2017), they expound the industry is further characterized by the integration along the value chain that actors in different parts of the industry have built all sorts of links and networks.

The agents of innovation activities engaged in the food industry are not merely the companies but also the surrounding environment, no matter from macro level, the industry level, or from micro level, the firm level. For a food system, its innovation development is often closely associated with the relationships between products and consumers, suppliers and buyers, firm's competencies and incentive policies. In Earle (1997)'s article, he attempted to make a panorama of dynamic environment in the industry-level innovation of the food system and it shows in Figure 1. What's more, he also gave his thoughts of the innovation process in the firm level, shown as Figure 2. Now, innovation in the food system is no longer only confined to a company coming up with an excellent new product to attract buyers; in contrast, with intricate horizontal and vertical interrelationship, a meat processor could even innovate by controlling what type of food that being used to feed the animals.

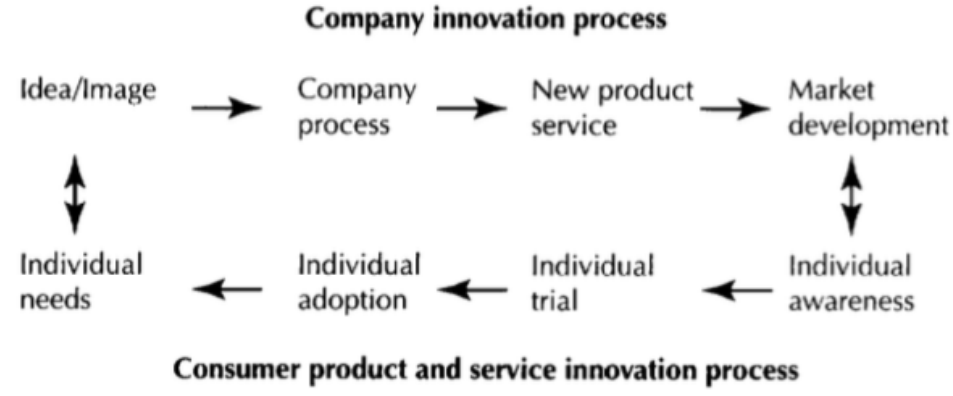
Figure 1

The dynamic environment of innovation in the food system

Source: Earle (1997), page 167.

Figure 2

The innovation process at the firm level



Source: Earle (1997), page 168.

2.12 The Drivers of Innovation in the Food Industry

The thesis is embedded in evolutionary theory, seeing innovation in the food industry as a complex and nonlinear process. Unlike neoclassical economists explaining the economic growth coming from the implementation of R&D and the diffusion of General Purpose Technology, evolutionary economists also focus on dynamics and contingent nature of innovation. It means the occurrence of innovation is the creative response to multiple agents combined, including its internal impact, external factors and historical situations.

From a sectoral system view, Lee and Malerba (2014) state that there are three types of changes differing the performance of the sectoral innovation, namely technological level, demand level and institutional level. Now if we focus on the food industry, according to Pavitt's taxonomy, the food industry should be classified as "supplier-dominated" (Von Tunzelmann & Acha, 2005). It emphasizes the changes on the supply side. When there are the advancements in machinery or the availability of new biotechnology, the productivity and the product quality within the food sector will both be improved. This "supplier-dominated" is compatible with Lee and Malerba (2014)'s technological level change and its impact on the firms can be easily identified with quality and quantity improvement. Exploiting external knowledge through the horizontal and vertical network of food system, cooperation makes fast-paced technological change available for food companies to carry out innovation.

But when we reflex on the reality, we will notice that apart from the supply side, the demand side is an important driving forces of the innovation in the food industry as Lee and Malerba (2014) mentioned. The changes in income, the newest nutrient research report or demographic changes all may distort the trajectory of innovation in the food industry. As Fryer and Versteeg (2008) concluded, the demand pressure from the market is various, including safety, health and well-being, high quality, convenience, price, environment and sustainability.

Smith et al. (2008) adopted the systematic literature review approach to present a comprehensive view of the factors that influence organizational level innovation management. They included 9 important factors, respectively management style and leadership, resources, organizational structure, technology, knowledge management, corporate strategy, employees and the innovation process (Smith et al. 2008). After Suwannaporn and Speece (2010) conducted quantitative research to examine the critical factors mentioned in the previous literature, they concluded that market

research, technology and strategy matter the most for innovation. Apart from the supply and demand driven sides, the third aspect in organizational level research doesn't seem to match with that in Lee and Malerba (2014)'s article. The strategy mentioned by Smith et al. (2008) and Suwannaporn and Speece (2010) refers to the underlying culture in the corporation, which impacts on the strategic behavior of the organization adopted. For food firms, it is necessary to have strategic vision and goals for carrying out innovation activities. In contrast, from Lee and Malerba (2014)'s point of view, the third driver of innovation results from institutional changes instead of originating from company itself. But if we see industry as a whole, the strategic vision of the industry is actually embedded in institutional consideration. Thereupon the two driving forces at different levels, institutional changes and strategy respectively, are rather complementary than contradictory.

The argument above proves that the food industry does not lack new opportunities to innovate. It is possible that if developing countries identify the driving forces of their low-tech industries and actively join innovation-related activities, in the future low-tech industries such as the food industry would play important roles in developing economies and become new sources for their economic growth.

2.2 Research Questions

This section will mainly specify the research question in order to continue the following empirical analysis. From the aforementioned literature review, innovation in the food industry has already been well defined and the main determinants of corresponding innovation activities have also been clearly specified. In a nutshell, the theoretical section was subdividing the topic into macro level and micro level. From the perspective of enterprises, Smith et al. (2008) and Suwannaporn and Speece (2010) consider the driving forces for innovation are technology, market research and strategy, while standing at the angle of the whole sector, Lee and Malerba (2014) see

the determinants for innovation as technological changes, demand changes and institutional changes.

Even though the factors that affect the innovation activities have been largely discussed in previous studies, the cumulative effect of factors and its impact on innovation seldom being analyzed in empirical way (Smith, 2008). As Markusen (1999) mentioned, the innovation literature is full of "fuzzy concepts" and "scanty evidence", which points out the urgency for the field to fill in the gap between theoretical conjecture and empirical evidence. Therefore, the research question of this paper will be based on the purpose of connecting the relationship between the driving forces of innovation and related innovation activities in the reality.

Previous studies on the food industries in high-tech countries have promised us with a bright future in this low-tech industry and also have raised certain curiosity towards the development situation of this industry in the developing world. In addition, China is still a novice in the field of innovation, and even though the important drivers of innovation activities in the low-tech industry have been discussed a lot in previous research, there are few articles analyzing the performance of those factors in the context of China. In order to fill in the theoretical and empirical gap and achieve a better understanding of how the innovation activities occurred in the Chinese food industry, now it is the time to relate the multiple elements and events, respectively the determinants of innovation in the food industry indicated by the former theories and the historical evidences of the food innovation activities in China. We should also consider that a mega system like the food industry is composed of numerous firms, so when it comes to seeing the general evolutionary pattern behind an industry there is no point to ignore the innovation path at a micro level, a specific firm. Even though the paper has endeavored to include as much detailed discussion as possible, it is vital to emphasize that due to the limitation of space, it forbids the possibility of

encompassing comprehensive activities related to the innovation in the Chinese food industry. The paper will mainly focus on the Chinese firm level and industry level innovation related activities and analyze its interrelation with the three main determinants in the respective levels that were mentioned above in the literature review section. At the macro level, “green” innovation and food traceability systems are chosen as the innovation activities to access due to its representativeness of food production innovation and its importance to food safety issues respectively. At the micro level, considering its achievement of being innovative, Mengniu Dairy Company is selected as the research object.

In view of the above points, the research questions of this paper are formulated as the following two parts:

1. At the Industry Level:

How do technological changes, demand changes, and institutional changes influence the innovation activities of food traceability systems and “green” innovation in the Chinese food industry over the last two decades?

2.At the Firm Level:

How do technology, market research, and strategy influence the innovation activities emerged in Mengniu Dairy Company over the last two decades?

3 Methodology

In this section, the methodological approaches adopted by this research will be explained. It is divided into three parts. The first part will discuss about the general research design strategy and methods. The second and third part will present the research design of this study and the method for collecting data.

3.1 Research Approach

The paper is based on systematic literature review. Detailed approaches that are used in this whole study will be described separately.

Deductive approach

Considering that the purpose of this research is to bridge theory and reality, the paper is mainly constructed in a deductive structure. Former scholars have already concluded the factors that mainly contribute to innovation activities in the food industry, while the deduction of those agents also taking major effect on the China context will be assessed through empirical examples. The paper assumes that demand side, supply side, and macro-planned strategy are the three most effective factors and thus the performance of their roles is going to be analyzed.

Systematic review

A systematic review of validation studies is helpful to validate the predictive performance of a model (Debray et al. 2017). In this paper, the ultimate goal is to analyze the cumulative effect of the factors that influences innovation, but the problem is that it is hard to capture the direct correlation between the activities and combined elements. Systematic literature review provides a transparent tool to select sources of information and then summarize the results of publications to validate the accuracy of the prediction model. It brings together as many studies as possible to ensure the robustness of the drawn conclusion, and thus the qualitative and quantitative data used in this paper will mainly be secondary data retrieved from selected studies.

The paper will adopt the five procedures Cooper (1988) and Avella et al. (2016) suggested about literature review, namely defining the review question / forming hypotheses, collect data, evaluate the appropriateness of the data, analyze and

interpret relevant data, and organize and present the results. The review questions have already been proposed in the section 2.2; data collection, evaluation and analysis will be discussed in the third part of this section, while the results will be presented in the empirical part.

Case Study

Case study is a research approach to conduct in depth study of a complex issue in the real life context. It is widely used in a variety of disciplines, and thus for a paper embedded in systematic review, case study will be a useful way to specify validation. Due to the flexibility of choosing methods to interact with data, it makes case study become a good method to do research. It is a good way to go detailed analysis of small number of units, especially when the cases are bounded by time and activity (Creswell 2013). For the firm level research, considering that the thesis is going to combine theory with certain company's historical innovation activities to test and identify the roles of factors, taking the measure of case study design will be an appropriate approach; on the other hand, for the industry level, considering that a wide range of innovation activities exists in the sector, choosing typical cases to screen will make the literature searching more specific.

3.2 Research Design

For the purpose of building an empirical relation between the drivers of innovation and corresponding innovation activities at the firm level, Mengniu Dairy Company is chosen as the object of case study. Choosing this dairy company is mainly due to two reasons; first, Mengniu is one of the most successful domestic company in China and second, innovation has been always playing an important role in its development. By using the case study method, the thesis will follow the evolutionary path of Mengniu and select a few representative innovative events in its historical timing, such as releasing new products and innovation cooperation, documented in the literature to

correlate the activities with the theoretical assuming driving forces of technology, market research, and strategy. In addition, in order to know how strategy got involved in the firm level innovation activities, the company vision and purpose of making those choices will also be analyzed.

For connecting innovation drivers and innovation activities in the whole industry level, the thesis will choose two innovations that emerged in the Chinese food industry, respectively food traceability systems and "green" innovation. The first innovation represents process innovation in the industry, while the second one is closely concerned with product innovation. Recently, frequent food safety incidents have caught the eyes of all the agents working in the Chinese food industry. Food traceability systems as innovative measures to ensure the security in the food chain are obligatory in some parts of the world, such as European Union. However, the implementation of these systems is still facing many challenges in China and the innovation-related activities in this aspect urgently need to be enhanced. Thus, in the paper, certain attention will be paid to the critical factors that impact the success of innovative traceability development and adoption in context of China. Apart from the analysis of food traceability system, the perspective of blooming "green" innovation will also be taken into consideration to narrow down the concept of innovation activities in the industry. In the past ten years, the food industry in China has been heading towards a more sustainable direction, in which CO_2 emissions in the whole industry are reducing while the organic and green food market is winning more hearts of consumers. The changes in technology, customer attitude towards sustainable development together with institutional guidance during the last ten years that cultivate the innovative way of development in the food industry will be discussed. When it comes to identifying the government influence in the food industry, the data will include not only national institutional reforms within the innovation system but also institutional changes within regional innovation system, especially the policies

that contribute to the enhancement of innovation network.

3.3 Data

3.31 Collecting Data

The purpose of conducting data collection is to provide empirical studies with quantitative and qualitative data. The paper mainly conducts the analysis through the secondary data collected from official documents, company reporting, company news archive, consulting company reports, synthesis of official statistics and scientific literature.

The databases used for collecting secondary data include Google Scholar, LUBsearch and EBSCO HOST. What's more, because of the insufficient information about company level innovation in the library database, the news archive stored on the websites was also taken into consideration and the websites includes Google search and Arla.com. The keywords and search terms that used for literature search is also divided into industry level and firm level. For the industry level, the following keywords and terms are being chosen: “food traceability” and “innovation” and “China” (26 papers), “food traceability” and “Chinese innovation” (14 papers); “green innovation” and “food” and “China” (440 papers), “green innovation” and “Chinese food”(132 papers). For the firm level, the selected keywords are: “Mengniu” and “innovation” (10 papers).

3.32 Source Materials

Based on combined keywords and terms, there are more than 600 articles found in the databases that includes the topics we are interested in. However, due to the similarity of search terms concerning the same topic, to some extent the search results are overlapping. Beyond that, according to the inclusion criteria together with the aim and objective of this paper, most of the found articles are either irrelevant with the

research target of this paper or lack of valid information to contribute to the research questions. Some of the articles touch upon engineering or computer science fields instead of economic field, and some others only briefly mentioned keywords without providing detailed discussion. In total, only 21 articles were taking into consideration and the rest of found articles were excluded from the discussion. The selection results covering the whole empirical analysis are seen in the Table 1.

Table 1. Found Sources Based on Keywords and Terms

Innovation activities	Sources
Food Traceability System	Duan, Mao, Wang, Fu and Xu (2017) Tang, Li, Sun, Lv, Gai, Mei and Xu (2015) Zhang, Zhang, Liu, Fu and Mu (2010) Wu, Liu, Zhu, Wang, Wang and Xu (2015) Zhou and Jin (2013) Wu, Wang, Zhu, Hu and Wang (2016) Mao, He, Cao, Bigger and Vasiljevic (2015)
Green Food	Lin and Xie (2016) Ling, Zhou and Ma (2010) Wang, Wang and Jia (2011) China Green Food Development Center (2017) Paull (2008) Lin, Zeng, Ma, Qi and Tam (2014) Thøgersen and Zhou (2012) McCarthy, Liu and Chen (2016)
Mengniu Company	Fair Disclosure Wire (2017) Interim Report (2016) Li and Liu (2011) Arla Press Office (2012) & (2014) Bei (2012)

Bridging the connection between the factors that influences innovation and realistic innovative activities in Chinese food industry will be conducted according to the secondary data and literature review. Among the literature, qualitative data for the

development of a dairy company will be mainly collected from listed articles. Besides, in order to avoid rushing to the conclusion reached by particular example of the firms, the whole food industry level is another perspective to identify the overall industrial development path. The collected data about rising sustainable innovation and value chain surveillance innovation in the food industry is going to be further analyzed. The additional quantitative data has been retrieved from the National Bureau of Statistics of the People' Republic of China together with related reports that conducted empirical analysis on the Chinese food industry. The collected quantitative data will be applied to summarize general information about Chinese food industry.

4 Empirical Analysis

4.1 Macro Perspective - Industry Level

4.11 The Overview of Food Industry in China

Rapid economic development in China has accelerated the changes in the food industry. From thousand years ago, the food industry was mainly traditional slash and burn agricultural production. Million acres of land was cleared to make room for humans to grow crops and rear animals, and imagining if today we still maintain this way of producing food, not only would population densities make it impossible but also the unsustainable production procedure would bring more serious problems to human beings. Nowadays, with the changes in people's lifestyle, food production has been shifted from a traditional diet to more diverse directions. It is estimated that there are more than 35,000 food processing and food manufacturing plants engaging in the food business in China. Considering that National Bureau of Statistics of China does not set up a separate account for the annual total consumption for the food industry, the statistics of annual food sales are retrieved from 2013-2017 annual China Food & Drink Reports which are published by Business Monitor International Research (BMI Research). The sales in Chinese food industry from 2010 to 2016 shows in the Figure 3, and the growth rate of total food consumption over the past

seven years shows in the Table 2.

Table 2

Food Sales in China from 2010 to 2016

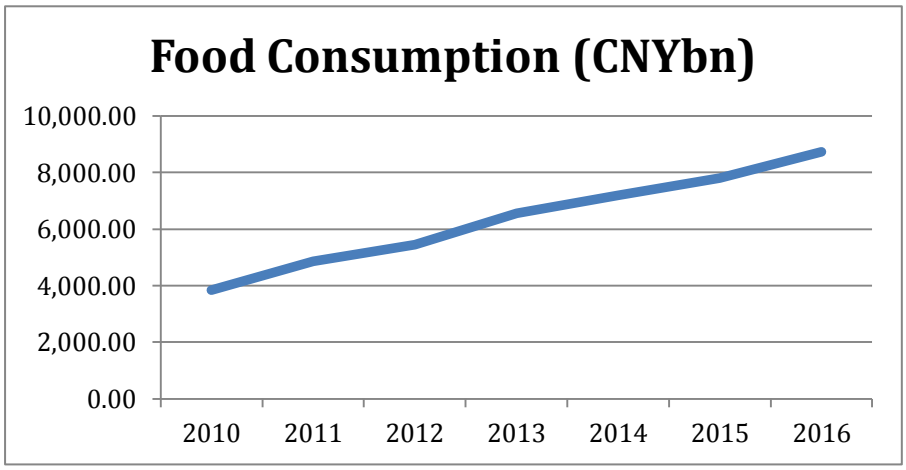
Food Sales: Historical Data							
	2010	2011	2012	2013	2014	2015	2016
Food Consumption (CNYbn)	3,846.4	4,854.2	5,436.7	6,556.7	7,190.8	7,801.7	8,733.0
Total food consumption growth,%,y-oy	11.4	26.2	12.0	20.6	9.7	8.5	8.6

Data source: Business Monitor International (2017), China Food & Drink Report 2013 to 2017.

Note. Food consumption recalculated at the constant prices of 2016.

Figure 3

Food Consumption in China from 2010 to 2016



Data source: Business Monitor International (2017), China Food & Drink Report 2013 to 2017.

Note. Food consumption recalculated at the constant prices of 2016.

Food and beverage industry has always been the pillar industry in China, and until 2010, it had maintained over 10% annual growth rate for 16 years. At the same time, agricultural and food products are also one of the main imported goods in China, accounting for 10% of the total imports. Even though the growth in food sales has been slow down for the past three years, according to the BMI data, the growth rate still has remained above 8.5% and the total sales reached 8,733 billion CNY in 2016 (BMI Research, 2017). Considering that China is the most densely populated country in the whole world, the food demand for feeding nearly 1.4 billion populations gives

positive hopes for the continued growth of the food industry in China. The general trend of the food industry in China has been shifting from traditional low cost food to more sophisticated premium products, and it is one of the fastest growing sectors.

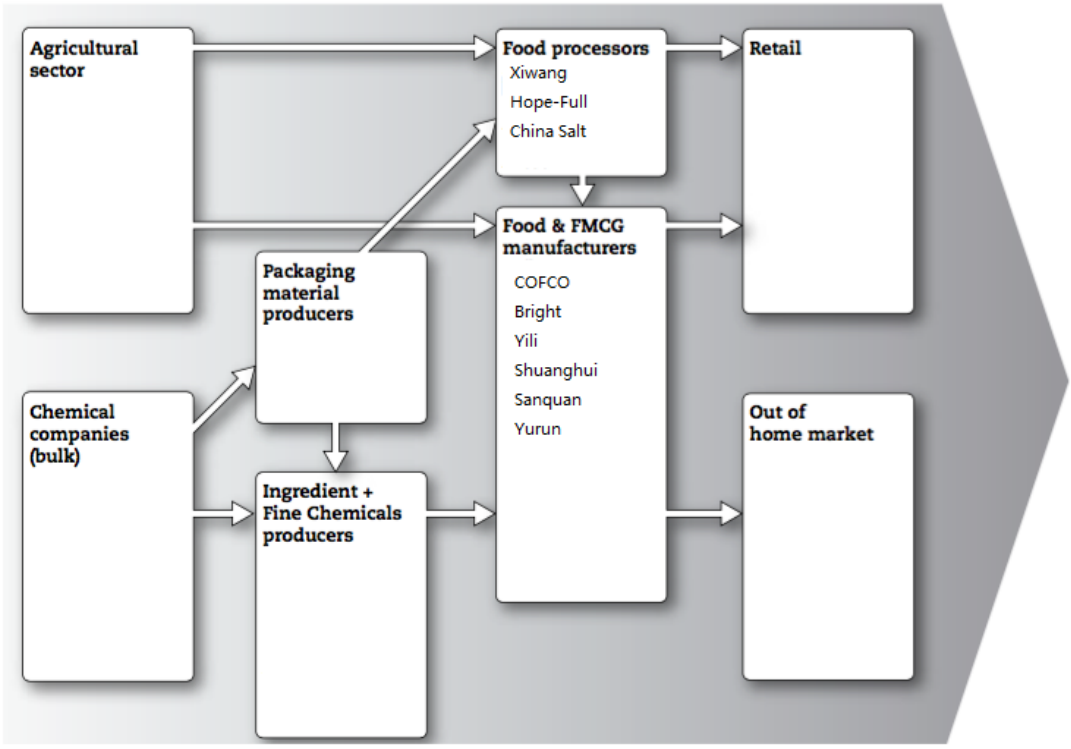
4.12 The Dynamics of Chinese Food Industry

Value chain

The value chain of the food industry is a complex knowledge network, and more specifically it refers to a network of all the stakeholders engaging in different phases of production to the final stage of delivering the food commodities to end customers (Kaplinsky & Morris, 2002). At every stage of the value chain, different value was being added to the products. In a dynamic network like the food system, each step of value added is not only independently controlled by one stakeholder or the linkage of only two stakeholders along the value chain but also embedded in a number of interactive activities, including the interplay between different stakeholders anywhere in the network. The structure of food value chain in China and its main players shows in the Figure 4. From farmers to food processor and then to distributors, the collaboration along the food value chains makes sure that the safe delicious food presents at shop and is ready for consumers to purchase and consume. One of the successful food value chains in China includes the Guhe Swine Cooperative, which involves a whole operation chain from breeding to retailing, and especially the mutual help within the cooperative it's an innovative and effective measure to enable its financial constrained members to get through hard times (Chen et al. 2015).

Figure 4

The value chain and main players of Chinese Food Industry



Note. Own elaboration on main players of food processors and food manufacturers in China,

The value chain frame retrieved from *Forecasting & Planning in the Food Industry*, Eyeon. Available at:

http://www.eyeon.nl/documenten/whitepapers/eyeon_wp_forecasting_planning_in_the_food_industry.pdf

In addition, each parts of the value chain also holds the responsibility of keeping food safe. A little mistake along the chain could put public health in danger and in return bring a deathblow to company's reputation. Especially, in recent decades, the frequent incidents of food production safety in China have drawn attention to the keen desire of food information symmetry and safer food supply. Since 1978 China opened its market to the global world, the rapid industrialization and growth makes the economic environment more competitive and thus it becomes more difficult for Chinese suppliers to suppress price to a lower level. In order to maintain price advantages and secure profits, some greedy suppliers in the Chinese food value chain start to replace ingredients with inferior substitutes or even unapproved chemical materials, which could severely threaten public well being. A series of food scandals has raised public

awareness of food supply management and increased their demand for the transparency of processing procedures so as to get involved in monitoring the food safety and quality. Data sharing among stakeholders is one of the important characteristics of food value chain to improve information symmetry and the transparency in the food industry (Deloitte, 2013). However, for an emerging market like China, it is relatively hard to manage its supply chain's transparency since millions of suppliers in the value chain are highly fragmented all over the country and many of the transaction are conducted without formal contracts (Roth et al. 2008). On the other hand, along with more engagement in the global environment, under double pressure from domestic and international markets the improvement of transparency in the food chain will be inevitable in China.

Demand Trend

In Chinese market, there are more than 1.3 billion mouths waiting to be fed with the food picked from the store shelf, though the number will continue to grow. At first glance, it seems to raise some thorny issues for the food companies to narrow down their direction of operating innovation activities. However, as a civilization with the history of thousands of years, social consciousness of Chinese people is more homogenous, namely collectiveness serving throughout the history as the main stream moral standard and value criterion. As a result, the Chinese consumer's demand for innovative products would not be sporadic but rather directional.

The development speed of Chinese economy has remained high in the last two decades. With the increase of per capita disposable incomes, Chinese consumer is no longer merely content to fill the stomach. Whether the nutrition is enough in the food, whether food is being healthy or whether the process of making food is sustainable are now all taken into consideration by Chinese consumers. Currently, the biggest concern that bothers them the most is about food safety. According to a survey

conducted by Horizon Research (2014), 80% of the respondents were worried about food safety in China, among which 60% blamed food companies for performing badly in controlling food safety. With the expansion of higher quality education, growing awareness of health is gradually changing the patterns of food consumption among Chinese consumers. Particularly, young and middle class Chinese consumers express a greater tendency of shifting consumption from traditional food to premium and healthier food (BMI Research, 2017). Under the circumstances, safe and high quality food like green and organic food comes on the market and is increasingly favored by consumers.

4.13 Food Traceability Systems

Through the analysis of food value chain, a major trend of food industry has been pointed out that it is the requirement of food transparency. As transparency becomes the common goal that every stakeholder in the food system shares, food traceability systems were created as innovative measures to make sure the process integrity and boost interrelationship between stakeholders in the value chain. Food traceability means the ability that the movement of a food could be followed through each specified stages of production, processing and distribution (Codex Alimentarius Commission, 2004). When food safety problem is presented, traceability allows the immediately identification, withdrawal, and exclusion of non-safe food from the market (Duan et al. 2017). In United Kingdom, European Union, Japan and such countries, food traceability system are enforced as a method to supervise and manage the quality and safety of food (Tang et al. 2015), while in China, the introduction of food traceability systems is still voluntary and it is only encouraged as effective tools to maintain the competitiveness of Chinese food products in the global market.

With the development of electronic data analysis, traceability is no longer only paper-based systems but also IT-based systems that are combined with lots of

advanced technologies, such as information and communication technologies (ICTs) and artificial intelligence (Zhang et al. 2010). The application of this type of innovative information systems on the food industry is based on the high technology end, in spite of the fact that the food sector traditionally is considered as low-tech industry. The successful implementation of this innovation does not depend upon one of the stakeholders who wants to increase its competitiveness and decides to adopt the systems, but it requires an organizational response through the whole supply chain. This promotes multi-layer interactions within individual, enterprise, and society, while the interrelationships between different factors that ensure the success of implementing traceability systems are also very important as individual factor (Duan et al. 2017; Fortune and White, 2006). At present, the innovation of food traceability system in China is primarily either dominated by the government or independently directed by enterprises to satisfy their own customers (Wu et al. 2015).

As one of the main forces, the Chinese government has attempted to launch initiatives to explore the development and implementation of food traceability systems decades ago. Since 2002, the government has already established system to identifying the origin of agro-food in certain developed regions (Zhou & Jin, 2013). In 2004, the State Food and Drug Administration proposed to start a meat traceability system project; at the same year, Beijing Municipal Agriculture Bureau and Hebei Province's Agriculture Department jointly launched a pilot project of tracing vegetable products (Tang et al. 2015). Starting from 2010, the Ministry of Commerce and Ministry of Finance of China have been supporting the creation of a meat and vegetable circulation traceability system, and until 2014, an overall system has been formed (Wu et al. 2016). Now the meat and vegetable traceability system is still under the pace of establishing in the pilot cities and it will continue to connect the whole country and achieve the ultimate goal of covering all cities in China. According to 110 samples of traceability systems survey on agribusiness (Zhang et al. 2010), there were

more than half of the adoption (56.5%) of the systems in those companies are driven by the government.

In addition, due to the reason that currently, China is implementing voluntary traceability, the efficiency of the systems has been doubted (Zhou & Jin, 2013). Food enterprises are mainly motivated by profit, and providing customers food products with additional safety information will inevitably put burden on companies. Because of the high extra cost on the implementation of traceability systems, if some enterprises choose not to update the system, then the existence of food traceability systems will either start to malfunction or provide error identification information. Especially, through the first part of empirical research, the introduction of general information about Chinese food industry has already reminded us of the fact that there are more than 35,000 food companies highly fragmented all over the country. Those small and medium size enterprises are most likely not able to keep up with the technology update. The most important reason is that food traceability system indeed is a high technology information system and a developing country like China is still in its early stage to improve its technological development. The related knowledge available in creating traceability systems is rather limited, and more commonly the tracing equipment and corresponding knowledge are imported from developed countries (Duan et al. 2017). According to the survey conducted by Zhang et al. (2010), an anonymous company in Shandong province shows that the costs of setting up a traceability system in its company reached 510,615 CNY, and due to the lack of funds other examples of other enterprise-driven traceability systems also indicates the major tendency of failures. Therefore, the support received from the government to invest in the development, adoption, and maintenance of food traceability systems becomes relatively important for these innovation activities to be carried out in the long term.

Apart from the requirement of the government support for related traceability technology, when Wu et al. (2016) used non-hypothetical valuation methods to study on Chinese consumers' willingness to pay for traceable meat, one of the main results is that government certification information had the highest coefficient which means government certification information earns the highest willingness from customers to pay for the traceability information certified by the government. Even though the government plays an influential role in the implementation of traceability systems and it has enacted multiple national and local laws, regulations, and standards about food safety and related regulatory systems in the past two decades, China is still new to this type of innovation and lacks effective coordinated enforcement mechanism to regulate food traceability systems. Particularly, the inconsistency that generated from the horizontal engagement of different government authorities, such as the Ministry of Agriculture, Bureau of Quality Supervision, and Ministry of Commerce, leads the creation of traceability systems lack of a clear direction with unified standards and make the quality of the systems rather uneven in China (Tang et al. 2015). As a result of nonstandard regulation, it provides opportunities for profit-driven suppliers to forge certification in the food market and that is also the reason why the public reveals the greatest urge in the previous survey hoping the government could intervene the systems and initiate traceability information. Due to the lack of centralized management of food quality and safety, when manufacturers set up traceability systems for themselves, they could easily fake or modify data without fear of third-party's supervision. Besides, Chinese enterprises also generally lack a long-term business mindset towards the development of the company and the level of the integrity of enterprises still need to be strengthened. Under such circumstance, consumers gradually lose their trust in unauthorized safety information, and the worse result is the fear of untrustworthy traceability information makes the cost that company invested in the traceability systems not able to gain back from establishing a better market competitiveness. In order to regain the trust in traceability information

from the public, a video surveillance based traceability system was innovated in China to satisfy the demand of customers (Mao et al. 2015). Under this system, all the traceability information is automatically extracted from a video surveillance system and all the data is stored as key images in the documents, which makes the forgery of data extremely costly and thus could correspondingly increase the creditability of information.

4.14 "Green" Innovation

Carbon emission and climate change has been the biggest environmental concerns in the world and China as the biggest CO_2 emitter has a great influence on global emission. Facing the double pressure from home and abroad, China has been taking multiple measures to keep its greenhouse emission under control. As a common sector in the economy, food industry is one of the main energy consumers in China, accounting for 2.84% of the total industrial energy consumption (Lin & Xie, 2016). Reducing energy intensity of the food industry is an effective practice to emit less greenhouse gas, but so far, the industry is dominated by fragmented small and medium size enterprises and it causes the problem that due to the lack of resources, some enterprises are not able to meet the energy-saving standard, not even mentioning producing high value added products. Considering from this aspect, in Lin and Xie (2016)'s article, they gave advice that the government should shut down unqualified food companies and provide more chances for the qualified companies to innovate in their processes and products.

As a matter of fact, the environmental concerns has made Chinese government keep working on establishing sustainable agro-ecosystems since the 1980s, and with the growing demand of higher food quality, since the 1990s the Ministry of Agriculture has began to develop a type of food with the characteristics of safety, high quality, free from pollution and full of nutrition, which is called green food (Ling, Zhou, &

Ma, 2010). Green food is a Chinese food production innovation and it is also considered as “one of the most successful eco-labeling programs in the world” (Paull, 2008). In order to conduct green food development and management and implement the Green Food Program, China Green Food Development Center (CGFDC) was founded in 1992 by the government. Since then, the policies and regulations concerning green food have never been stopped. In 1999, Three Green Project was initiated to improve green food knowledge among consumers and promote the development of the green food industry; in 2001, Pollution-free Food Plan was carried out, and a followed up implementation suggestion was published in 2003.

Based on the introduction information of China Green Food Development Center (2017)’s official website, until now CGFDC has 42 local green food management agencies, 46 inspection organizations and 73 environmental supervision and monitoring branches inside this innovative network. Green food not only ensures a safe source of food to domestic consumers but also clears the barrier for the suppliers in the Chinese food industry to head towards international market. It plays the role as being a foundation for the development of organic food in China, and the gradual improvement in its standards has narrowed down the quality gap of Chinese green food with national organic standards and international organic standards (Paull, 2008). Especially, the Grade AA Green Food certification has already been in compliance with authentic organic standards and eliminates global consumer’s worries about the quality of imported Chinese food. Beyond that, the Chinese innovative standards even exported to Canada, Australia and France, where the companies that plan to export food products to Chinese market are attempting to adopt and meet Chinese certification standards.

Green Food label is one successful endeavor of the government engaging in innovation, and it shows the institutional effects on innovation activities. However,

the proof of institutional influence is far more than one example. According to Wang, Wang and Jia (2011)'s empirical research on Green Food Industry in Heilongjiang Province, they noticed that comparing to other provinces in the country, the recent backwardness of the competitiveness of Heilongjiang's green food industry is closely linked to the lack of policy support and policy guidance from the local government; in addition, science and technology is crucial for maintaining the competitiveness of its green food industry and thus the government should create better incentives to benefit scientific and technological innovation. Similar results were also presented in the article of Lin et al. (2014). They built regression models and used the survey data collected from 791 private Chinese corporates to investigate the effects of different factors on green innovation, and the results indicate that regulations and suppliers both play important roles in corporate's green process and product innovation activities, in which regulations encourage and support firms to adopt technologies while supplier provides firms with ready-to-use technologies and technological possibilities through interaction.

The results of Lin et al. (2014)'s regression models also indicate the environmental demand from consumers positively influences the development of green product innovation in the firms. Demand pull of higher environmental standards drives firms to put more effort on absorbing green innovation into business strategy. Besides, according to the research conducted by McCarthy, Liu and Chen (2016), they found that the motivation of Chinese people who purchase green food and certified organic food is no different from that of western consumers. In the survey, high scores go to whether the food is healthy and safe or whether the production of the food is environmental friendly. This result is in accordance with Thøgersen and Zhou (2012)'s research about the Chinese consumers' motivation of adopting green innovation. Increasing purchasing power together with food safety and environmental concerns makes more and more Chinese customers turn to organic food and green

food. The growing market demand, as a result, is accelerating the development of innovations that is closely related to the "green" topic in the food industry.

4.2 Micro Perspective - Firm Level

4.21 Chinese Dairy Sector Overview

Even though dairy products are not categorized as a part of traditional Chinese diets, with the diversified customer preference, the improved domestic cold storage facilities and the growing awareness of nutrition and health, the dairy sector has been undergoing a fast growth. According to the data collected and estimated from National statistics by BMI Research, until 2016 the total sales of Chinese dairy sector had been showing an increasing tendency with a growth rates that is expected to break through 10 percent for the next five years. The most important reason that brings out the positive growth estimate is that in 2015, China officially ended one-child policy and instead it implements a full rollout of the two-child policy, which will have a positive impact on the dairy industry. With the increase of expected fertility, it would lead to a higher demand of dairy products for the newborns throughout the whole country.

However, the unprecedented melamine scandal in 2008 has created a strong panic driven response to the dairy sector. There were 39,965 infants and toddlers who had been affected by the inferior baby formula (Tang et al. 2015). Due to this reason, the consumption of imported milk products experienced a 13-fold increase from 2010 to 2013, reaching 194.9 thousand tones (Feng & Viksne, 2016). Under the pressure, the Chinese government has continually tightened regulations, and a series of stricter quality standards and new food safety supervision models in the dairy sector has been introduced since then. For example, in 2013 the government reevaluated permits of the manufacturers for producing baby formula, and until the end of 2014, only 120

out of 600 companies passed the examination.

4.22 Case Study of Mengniu Dairy Company

After a series of rigorous evaluation, unqualified enterprises were eliminated from the market in order to prevent quality defects and enhance the competitiveness of the dairy sector. In this context, the case company that this paper chooses to study is one of those 120 companies, and beyond that, in fact China Mengniu Dairy Company Limited is one of the four leading manufacturers in the domestic dairy industry. The company, founded in 1995, is based in the Hohhot, Inner Mongolia and it falls into the business of manufacturing and distribution of dairy products. It has been successfully listed in Hong Kong Stock Exchange since 2004, and overall number of employees is nearly 38,100 (Li & Liu, 2011; MarketLine, 2013). According to its official website, at the end of 2016, the company's annual production capacity had reached 9.21 million tons; in its Interim Report (2016), it also pointed out that the company maintained the largest market share in liquid milk and chilled dairy product market. As a leading dairy company in China, innovation has been playing an important role in its business, and according to the statistics provided by Bei (2012), it shows Mengniu Company in total owns 330 brand registrations and 615 national patents.

When search this company online, the first thing that shows after the dash of its name is a short description, which writes, “focusing on the customers, strive to build a century-old innovation-led health and nutrition food company”. Based on the company’s 2020 strategies, the representative of Mengniu Company promised in this year’s earnings presentation that it would maintain the goal of focusing on health and nutrition and keep the vision of being consumer-centric (Fair Disclosure Wire, 2017). Among the speech, five themes were mentioned as the strategic goals set up to concretize the implementation of company’s strategy and promote the

competitiveness of its dairy products. The plans and action that have a bearing on the future innovation activities are embedded in those themes. One of the most central themes is business division, which means that the company will adopt a new division-based system. Apart from its original competitive part of ultra-high temperature sterilization (UHT) products, now Mengniu has been paying close attention to cheese. Cheese is not a common domestic food in Chinese households, while with the western culture flooded in, Chinese consumers have started to accumulate interests towards cheese and the Chinese cheese industry has been experiencing a generally 19% to 20% growth in recent years. According to the presentation (Fair Disclosure Wire, 2017), for the Cheese division, Mengniu Company has established a cheese joint venture with a Denmark dairy company, Arla Foods, to innovate Chinese flavor cheese and expand cheese market in China. As a matter of fact, this is not the first time that Mengniu cooperate with Arla. Arla Foods is a major overseas R&D partner of Mengniu Company. As early as 2005, a joint venture established by Arla and Mengniu has already been connecting the international dairy business between China and Denmark, and since then, two companies has maintained relationship as partners to further develop the business together (Arla Press Office, 2012). Besides, Arla also signed an agreement to provide support for Mengniu in terms of quality, traceability and production control through an innovation lab. This knowledge center is called China-Denmark Milk Technology and Cooperation Center, which officially opened in 2014 in Beijing. The center plays the role as a platform sharing knowledge and promoting collaborations. Currently, the innovation of a unique taste cheese that caters to Chinese tastes is one of the main joint research and development being conducted in the innovation lab (Arla Press Office, 2014). Through the cooperation, Mengniu adopted advanced ranch management standard from Denmark as well and later formulated its own technology regulations to enhance its capability in milk source management. By its innovative and advanced management capability of technologies, Mengniu was again awarded

"Modernized Outcome Innovation Prize" by the government in 2016 (Interim Report, 2016).

When a company decides to innovate, it would assimilate the needs and ideas from the market to convert and integrate into its own innovative action. As emphasized in the company's description and strategy, Mengniu consider its business as consumer-oriented, and thus not surprisingly, R&D consumer insight was also listed in the future strategic plan to support the better performance of the division-based system. Along with the increasing awareness in health and nutrition among consumers, Mengniu not only included health and nutrition into its strategic goals but also launched corresponding new products such as plant protein beverages, which was jointly innovated with the WhiteWave Foods Company. What's more, Mengniu also conducts market research annually and adapts its product design based on the result. Among those products, a probiotic lactobacillus drinks called Suan Suan Ru created in 2006 was one of the innovation examples that results from demand force. After conducting market research about this product, the company noticed that the target consumers of Suan Suan Ru are mainly young people and thus Mengniu made corresponding change to make its packaging design become more youth friendly (Bei, 2012). Beyond that, there are similar product innovations generated from the market demand of female consumers. When Mengniu first launched yogurt products with red super fruit and fragrant flower flavors, this Red+ yogurt series hit a big time among the females (Interim Report, 2016). In order to follow up this trend and sustain female consumer's contribution to sales growth, in 2016 Mengniu launched another new product which is called Nourishing Oat and Red Date Flavor Yogurt.

Focusing on star brands is also one of the themes of implementing company's strategy. Mengniu has been boosted the exposure of its brands by collaborating with running events, sponsoring famous Chinese TV programs, and obtaining dairy product

partnership with other world-famous brands. So far, Mengniu has been the only exclusive partner of Universal Beijing Studios in dairy products, and apart from that, it is also the official dairy product partner of Shanghai Disney Resort. However, Mengniu realized that brand promotion only has a limited effect on sales growth. If a company hopes to gain the brand recognition, the high quality products are the only sources to win the trust from consumers. Hence enhancing R&D and innovation activities to add more value in the company's products was also being paid attention as an important strategy to build brand and ensure long-term development. It has launched various product innovations in the chilled product segment and soon it will release a brand new children's super high-end product (Fair Disclosure Wire, 2017). For good measure, there are still some other innovations at the finalizing stage and they are expected to come out to the market in the next two or three years.

4.3 Result

Each innovation activity has been given detailed description above. From the empirical evidence, we saw that although technological changes, demand changes, and institutional changes and technology, market research, and strategy at its respective level are the most influential determinants of innovation, the importance of different variables are varying and mainly depending on the objectives of the innovation activities. For example, the emergence of video surveillance food traceability system is mainly driven by consumer's demand for trusty information, while the creation and development of green food label mainly comes from the strategic changes of the institutional planning. Despite the fact that the influence of those three factors among each level differs, we could not conclude that there is a certain single factor that is better than other ones and always contributes the most to innovation activities. In the most aforementioned cases, those driving forces of innovation are intertwined with each other and the corresponding innovation activities result from the combined effects of more than one factor. Therefore, when it comes to

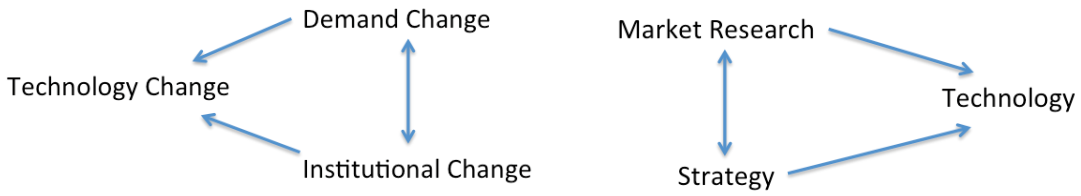
choosing measures for promoting the occurrence and liveliness of innovation, the decisions should be contingent on the certain activities.

Through the analysis of process and product innovation within the food industry, the similar dynamics of the factors that importantly influence the innovation activities was seen both at industry level and firm level. The market force and macro planning was both greatly influencing the development and adoption of technology, which is crucial to the creation of innovation. The empirical examples have been described in detail above, including when Chinese consumers demand for higher quality food and at the same time the government has the ambition to improve the reputation of Chinese food and increase industrial competitiveness, the innovation activity of launching Green Food Development Center to supervise green food took place in 1992, and when Mengniu saw the potential growing demand for cheese products, they chose to conduct strategic cooperation with Arla and the innovation of special Chinese flavor cheese started to carry out in the innovation lab. Through all the examples given in the micro and macro perspective parts, we shall see in those innovation activities demand force more likely takes effect at the beginning, the birth of innovation, pointing out the direction for the agent who plans to make a change, while institutional effort and corporate strategy is the backbone of the whole innovation activities guiding and supporting the activities to head towards the established objectives. Without the vision of being consumer oriented, there will be no China-Denmark Milk Technology and Cooperation Center, and the latest technology won't be imported and further applied to the innovation activities in Mengniu dairy production. What's more, demand and macro planning also influence each other by strengthening one another's impact on innovation activities. At the industry level, the empirical evidence of the institutional strategy change of improving food competitiveness shows that through spreading green food knowledge by the government, consumer demand for this innovative product could be further

boosted, and in return, increasing market demand would put more pressure on the government to push them strictly regulating innovation activities in the green food sector. In the firm level, strategy and market research do the same with each other. Technology is also directly linked to innovation and it influences the outcome of innovation activities to a great extent, but it has little effect on the other two factors. Besides, the above examples indicate that technology applied in the food industry is more likely to arise under the pressure of market force and macro planning, and it plays a less important role in the innovation activities than the other two determinants in the Chinese food industry. Together with the contingency of technology, only putting intensive investment in R&D to achieve sustainable growth will no doubt lead to an unsatisfactory result in the food industry. This dynamic process of the interplay between the determinants at each level structures a triangle and shows in the Figure 5. Due the time limit of the research, within the study period there is no evidence in the examples showing the influence of technology on the adjustment of micro-planning or consumer decision.

Figure 5

Dynamics of innovation driving forces in the Chinese food industry



5a. Dynamics of industry level innovation *5b. Dynamics of firm level innovation*

Note. Own elaboration based on the empirical evidence

Even though the food industry is traditional seen as a low-tech industry, through the analysis of this paper we found that the sector is not only built on the end of high technology, such as controlling food safety with the help of ICT, but also embedded in a dynamic and innovative system. The determinants of innovation in the "so-called"

low-tech industries are different from R&D-based sectors. However, it does not mean that the vitality of the innovative activities in the low-tech industries is low and its contribution to the economic growth is insignificant. Low R&D intensity is not a stumbling block to the implement of innovation activities, since other driving forces are able to shoulder the responsibility and play the roles to maintain the industries being innovative.

5 Conclusion

In many countries, low-tech industries are received little attention from the policy makers; as the consequence, the incentives initiated by the government to conduct research on these fields usually remain low. In addition, the theme of low-tech industries, particularly low-tech industries in the developing countries, is not extensively discussed in the research of innovation literature, while those so-called low-tech industries are the major sources for the economic share and employment. Low-tech industries do not lack of successful stories of applying innovations to enhance the sectoral competitiveness in the developed world and it makes the topic worth studying in the developing world context. This research aims at improving the understanding about the innovation activities of those common sectors in the developing countries, and thus the food industry, which is traditionally perceived as a low-tech industry, was chosen as the research object in order to strengthen the further cognition of common sectors' potential and provide an enlightening insight to the sustainable sources for economic growth in developing countries.

When it comes to promoting innovation in low-tech industries, the first question need to be addressed is what the factors that bring opportunities for the emergence of innovation in the sectors are. Through literature review, this paper first captures three most important factors that drive innovation activities in the food industry from previous low-tech industries studies. Those factors are technological changes, demand

changes, and institutional changes in the industry level and technology, market research, and strategy in the firm level. Secondly, the study attempted to assess the constructed model in the context of China and identify the effect of accumulated factors on different innovation activities in the Chinese food industry. By systematical analysis of various activities of product innovation and process innovation in nearly two decade, the result shows the dynamic interaction between different driving forces and their influences on the ongoing innovation activities in a flow chart.

Food traceability systems, “green” innovation and innovation activities carried out in Mengniu all indicates the dynamic interaction between the driving forces of innovation, in which market force and macro planning affect not only each other but also the availability of technology and all three of them are important to the vitality of the innovation activities in the Chinese food industry. As mentioned before, due to the complexity of covering diverse innovation activities and the difficulty of interpreting interrelationship between different factors that drive innovation in the Chinese food industry, this paper chose qualitative method to conduct the study. This paper is a first attempt to fill the gap of the cumulative effect of innovation driving forces study and therefore the chosen innovation activities might not be comprehensive enough. Nevertheless, for the future study attempt could be made to design a quantitative mechanism to verify the cumulative effect of those three factors and further to test the compatibility of this model to other low-tech industries.

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