# THE EFFECT OF INNOVATION AND GOVERNMENT SUBSIDIES ON FINANCING CONSTRAINTS OF AGRICULTURAL SMALL AND MEDIUM-SIZED ENTERPRISES IN CHINA: THE INTERACTION EFFECT OF DIGITAL FINANCE

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**by**

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## LIST OF SYMBOLS

| | |
|---|---|
| FC(A) | Score A of Financing Constraint Multivariate Index |
| FC(B) | Score B of Financing Constraint Multivariate Index |
| RDI | Research and Development Investment to Total Asset |
| RDS | Research and Development Investment to Total Sales |
| Patent | Logarithm of One plus the Number of Total Patent Application |
| Invention | Logarithm of One plus number of Invention Patent Application |
| Non-invention | Logarithm of One plus number of Utility Patent and Design Patent Application |
| Subsidy | Government Subsidies Receipt to Total Asset |
| Size | Logarithm of the Total Assets |
| Age | The number of years since the enterprise has been established |
| Income | Operating Income to Total Asset |
| Growth | Revenue Growth Rate |
| Collateral | Fixed Asset to Total Asset |
| SOE | State Owned Enterprise |

## LIST OF ABBREVIATIONS

| | |
|---|---|
| FC | Financing Constraint |
| SME | Small and Medium-Sized Enterprises |
| R&D | Research and Development |
| DF | Digital Finance |
| FinTech | Financial Technology |
| DIF | Digital Inclusive Finance |
| SDGs | Sustainable Development Goals |
| GDP | Gross Domestic Product |
| NEEQs | National Equities Exchange Quotations |
| FAO | Food and Agriculture Organization |
| OECD | Organization for Economic Co-operation and Development |
| CSA | Climate Smart Agriculture |

**KESAN INOVASI DAN SUBSIDI KERAJAAN TERHADAP KEKANGAN PEMBIAYAAN PERUSAHAAN KECIL DAN SEDERHANA PERTANIAN DI CHINA: KESAN INTERAKSI KEWANGAN DIGITAL**

## ABSTRAK

Sektor pertanian adalah penting untuk mencapai 17 Matlamat Pembangunan Mampan (SDG) Pertubuhan Bangsa-Bangsa Bersatu. Walaupun pengeluaran pertanian yang baik telah dicapai, China masih perlu mengubah sektor pertanian menjadi lebih mampan, dimana memerlukan Perusahaan Kecil dan Sederhana (PKS) pertanian untuk memainkan peranan masing-masing. Namun, masalah kekangan pembiayaan mengehadkan kesan PKS pertanian. Sementara itu, inovasi yang mantap penting untuk transformasi kemampanan pertanian, berkemungkinan akan memburukkan lagi kesulitan pembiayaan. Oleh itu, sebagai objektif utama, kajian ini menyiasat kesan inovasi terhadap kekangan pembiayaan menggunakan 186 perusahaan pertanian yang disenaraikan dalam sebagai Papan Ketiga Baru di China (juga dikenali NEEQ) dari 2011 hingga 2021. Dengan menggunakan anggaran GMM, keputusan menunjukkan bahawa inovasi membantu mengurangkan kekangan pembiayaan PKS pertanian. Di samping itu, analisis heterogen ke atas kesan pelbagai jenis inovasi menunjukkan bahawa paten ciptaan, berbanding bukan paten adalah efektif dalam mengurangkan kekangan pembiayaan. Dalam menyokong pembangunan pertanian, kerajaan China telah memberikan subsidi untuk perusahaan yang layak. Menggunakan anggaran GMM, kajian ini membuktikan bahawa subsidi

kerajaan adalah efektif dalam mengurangkan kekangan pembiayaan. Sejajar dengan itu, kewangan digital sepatutnya mengurangkan maklumat asimetri, oleh itu sebagai elemen tambahan, kajian ini meneroka kesan interaksi kewangan digital dalam inovasi dan kekangan pembiayaan, dan keputusan menunjukkan bahawa pembangunan kewangan digital di China boleh meningkatkan peranan pelaburan R&D dalam mengurangkan kekangan pembiayaan untuk pertanian PKS. Kajian ini mewajarkan keperluan untuk menggalakkan inovasi firma, keberkesanan subsidi kerajaan dan kepentingan pembangunan kewangan digital.

# THE EFFECT OF INNOVATION AND GOVERNMENT SUBSIDIES ON FINANCING CONSTRAINTS OF AGRICULTURAL SMALL AND MEDIUM-SIZED ENTERPRISES IN CHINA: THE INTERACTION EFFECT OF DIGITAL FINANCE

## ABSTRACT

The agricultural sector is crucial for achieving many of the 17 Sustainable Development Goals (SDGs) of the United Nations. While impressive agricultural production has been achieved, China still needs to transform the agricultural sector to be more sustainable, which requires the agricultural Small and Medium-sized Enterprises (SMEs) to play an essential role. However, the problem of financing constraints limits the effect of agricultural SMEs. Meanwhile, firm innovation, which is important for agricultural sustainability transformation, is likely to exacerbate financing difficulties. Therefore, as the primary objective, this study investigates the impact of innovation on financing constraints using 186 agricultural enterprises that are listed in the New Third Board of China (also known as NEEQs) from 2011 to 2021. Using GMM estimation, the results show that innovation helps to alleviate the financing constraints of agricultural SMEs. Furthermore, heterogeneous analysis on the effects of different types of innovation indicates that the invention patent, compared with non-patent, is more effective in alleviating financing constraints. In supporting agricultural development, the Chinese government has granted subsidies for eligible enterprises. Adopting GMM estimation, this study

proves that government subsidies are effective in alleviating financing constraints. Furthermore, because digital finance is supposed to mitigate information asymmetry, this study explores the interaction effect of digital finance in innovation and financing constraints, and the results demonstrate that digital finance development in China can enhance the role of R&D investment in alleviating financing constraints for agricultural SMEs. This study justifies the need to encourage firm innovation, the effectiveness of government subsidies and the importance of digital finance development.

# CHAPTER 1

# INTRODUCTION

## 1. 1Background of the Study

### 1.1.1 Economic Condition in China

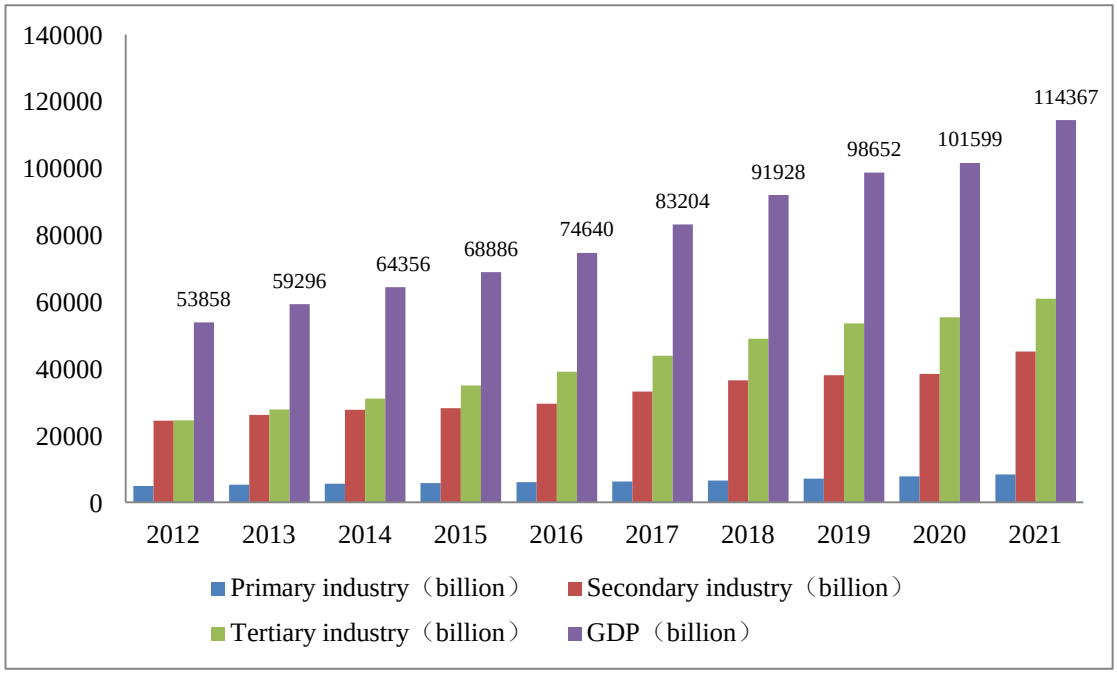
China's economy has achieved outstanding progress since the establishment of the People's Republic of China in 1949; when the People's Republic of China was founded, the economic foundation was weak. The first published statistics reported that the overall GDP (Gross Domestic Product per capita) of in 1952 was only 67.9 billion yuan. With a population of 0.57 billion, the GDP per capita was only 119 yuan in 1952. With a continuous endeavor of over 20 years, China's GDP increased to 367.9 billion yuan in 1978, accounting for 1.8 percent of the world economy and ranking 11$^{th}$ in the world.

Since implementing the policy of “reform and opening up”, China's economy has improved rapidly. The GDP surpassed 1 trillion yuan in 1986, and by the year 2000, it had surpassed 10 trillion yuan, becoming the world's 6$^{th}$ largest economy. With consistent effort and supporting policies, China's Gross Domestic Product reached 41211.9 billion yuan in 2010, ranking second in the world (The State Council, 2021). In 2021, the Gross Domestic Product of China has surpassed 100 trillion yuan and the GDP per capita was more than 60,000 yuan, far more than the GDP per capita of only 119 yuan in 1952. The growth of China’s economy has

significantly solved the poverty problem in China and also made significant contribution to solving poverty problem worldwide as more than 770 million rural residents have overcome poverty during the process, which accounted for more than 70 percent of the world's total that got rid of poverty in the same period (Economic Daily, 2021).

China's economy has been growing steadily in recent years, as depicted in Figure 1.1, with an average growth rate of around 6.53 percent from year to year. The GDP growth rate has remained above 6% from 2012 to 2021, with the only exception in 2020 as impacted by the outbreak of the COVID-19 pandemic.

Figure 1.1: China's GDP Trend

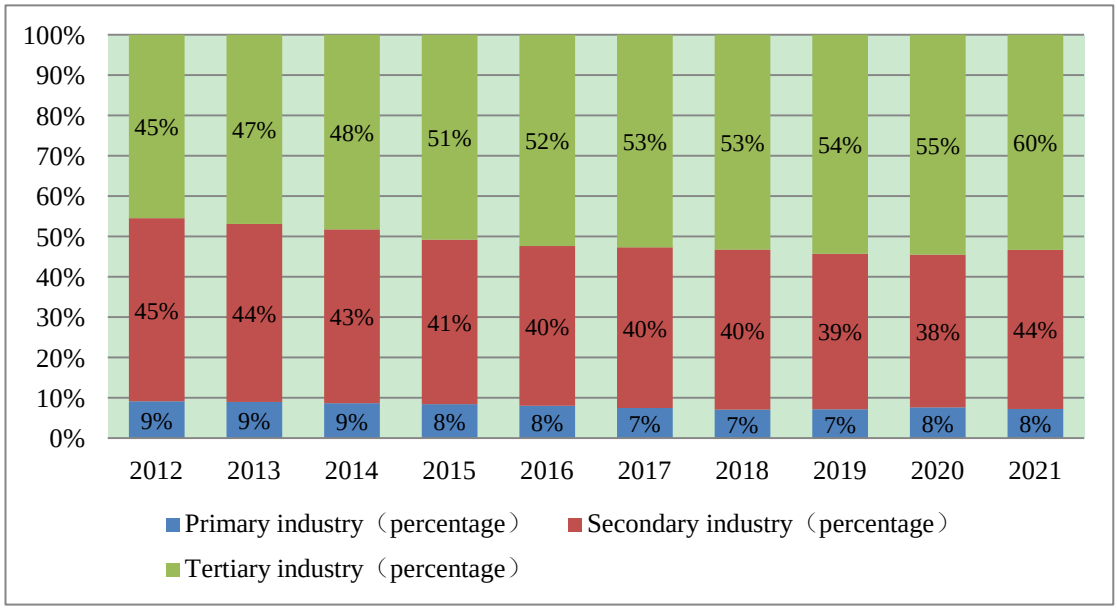



Data Source: National Bureau of Statistics (2022)[1]

[1]In a broad sense, the primary industry is equivalent to the agricultural sector. Therefore,

Concurrent with the overall growth, China's economy has been undergoing industrial restructuring in recent years. As demonstrated in Figure 1.2, the proportion of tertiary industry has been steadily increasing while the proportion of primary industry is relatively low. In addition, the growth rate of the primary industry has been slower than the overall GDP growth rate in recent years. However, the role of the agriculture sector in China does not suggest as small as the proportion of its output. Agriculture has been and continues to be the primary source of food and nutrients for human survival (FAO et al., 2022; Godfray et al, 2010; Hallet al., 2017). Sufficient agricultural production is essential to supply the necessary food for the increasing population. According to the most recent census, China's population has exceeded 1.41 billion in 2021, accounting for 17.91 percent of the world's population. Therefore, the sustainable growth of the agricultural sector in China is important for achieving SDG No.2, which is "Zero Hunger".

Figure 1.2: China's Decomposition of GDP

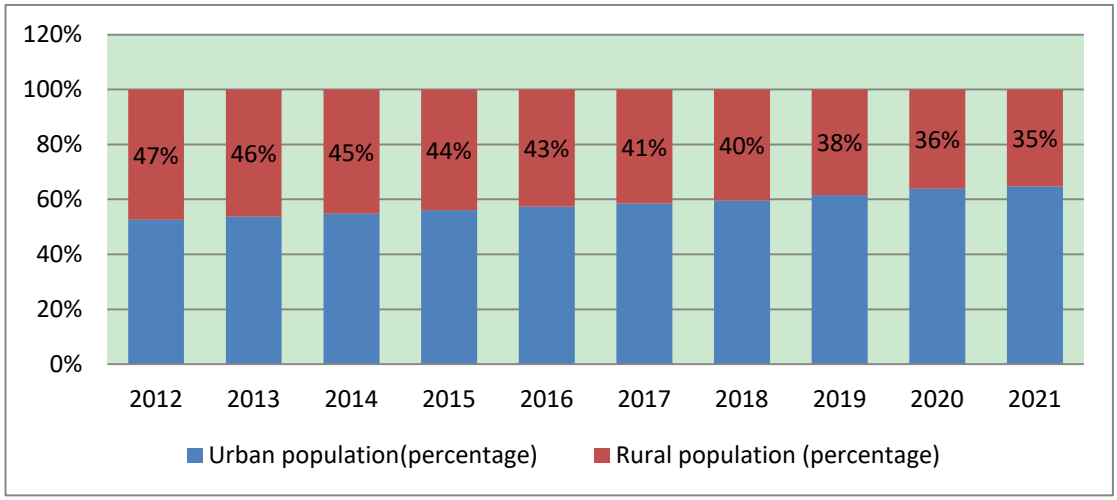



Data Source: National Bureau of Statistics (2022)

In addition, agriculture provides the most essential products for human and social reproduction. Agriculture provides an important source of raw materials for the industry, especially light industries such as textiles, glaziers etcetera (Moorey, 1999). With the development of biotechnology and other technologies, agricultural products have become an important raw material of new energy and new materials. Therefore, agriculture plays an important role in industrial production. As Adam Smith stated in “The Wealth of Nations: An inquiry into the nature and causes of the wealth of nations (A. Smith, 1869) the agricultural sector provides the raw materials and means of living and is therefore the prerequisite for industrialization and urbanization.

Furthermore, a healthy development of agriculture is essential in raising the incomes of rural residents, which accounts for the majority of poverty in China, although the proportion of the rural population is shrinking as urbanization progresses in China. As shown in Figure 1.3, the rural population still accounts for 35% of China’s total population, and a healthy growth in the agricultural sector is important to realize SDG No.1, “Zero poverty” in China. A large proportion of the rural population also brings huge market demand potential in the rural areas of China. Therefore, increasing the income of rural residents can also support economic development in terms of stimulating the consumption and demand of rural residents in China (National Bureau of Statistics, 2022b).

Figure 1.3: China's Decomposition of Demographic



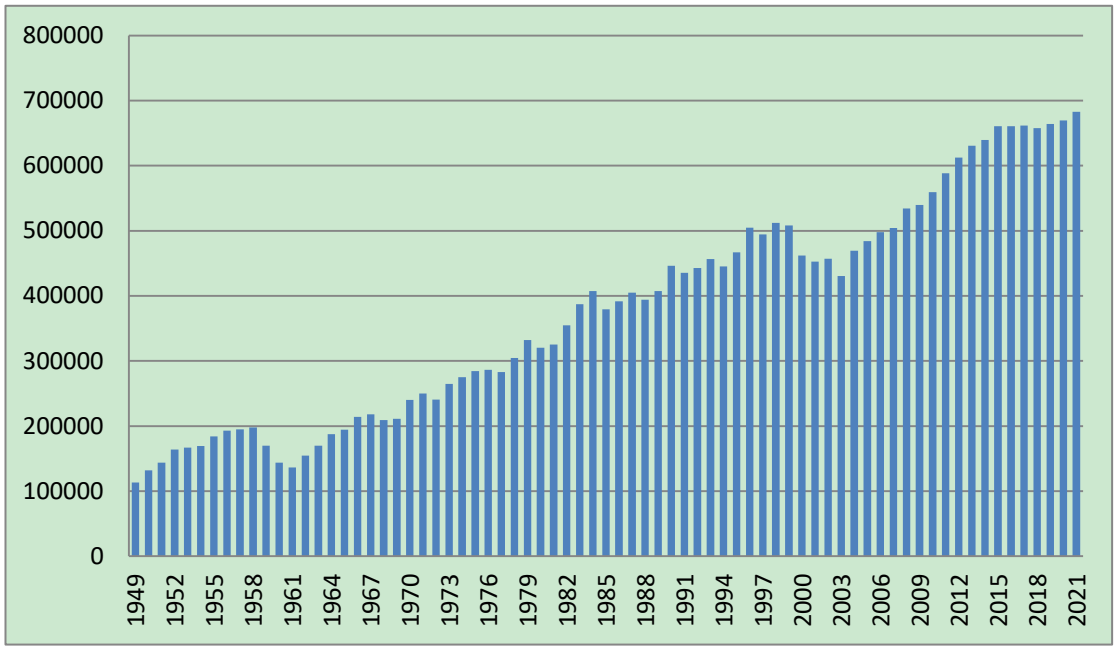

Data Source: National Bureau of Statistics (2022)

The primary position of agriculture in China's national economy suggests that the sound development of Chinese agriculture not only promotes the development of other industries, but also the optimization and upgrading of China's economic structure. The healthy and sustainable development of China's agriculture is essential for the well-being of the people and also the foundation of national economic growth.

### 1.1.2 Agriculture Development in China

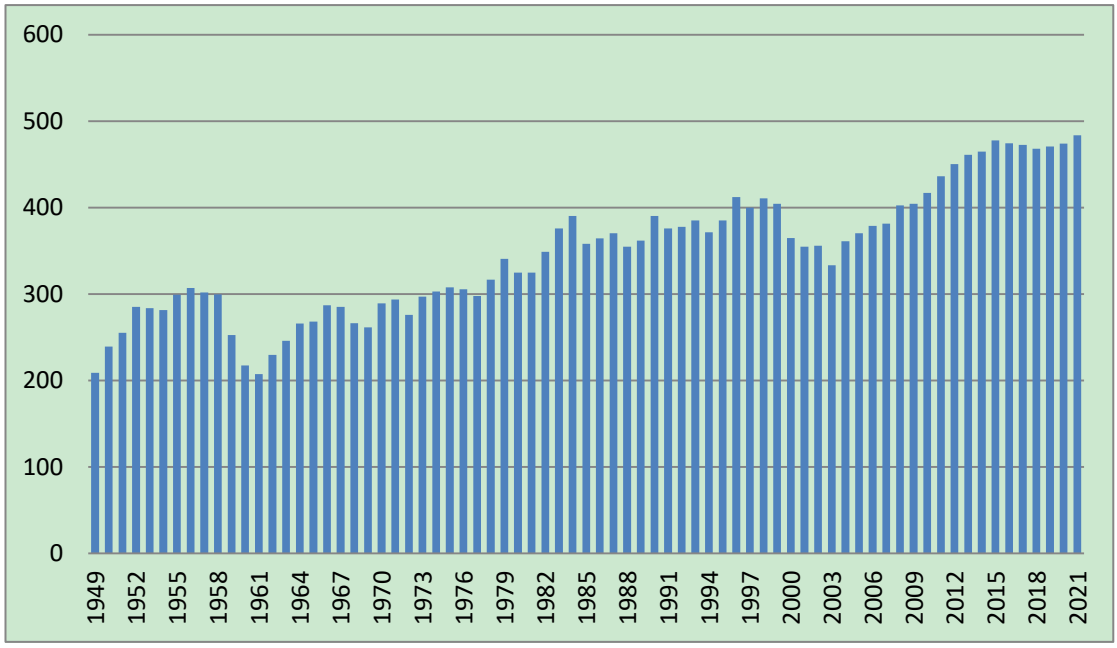
Since the establishment of the People's Republic of China, China's agricultural production has advanced to a new level, and people's dining tables have become more abundant and of higher quality.

Figure 1.4: Grain Output in China (in Thousand tons)




Data Source: : National Bureau of Statistics (2022)

Figure 1.5: Grain Output per Capita in China




Note: The unit is kg/person in this figure

Data Source: : National Bureau of Statistics (2022)

As demonstrated in Figure 1.4 and Figure 1.5, based on grain output in 1949, with little change in the arable area, the annual grain output in China has increased by around five times from 113.18 million tons to 682.85 million tons from 1949 to 2021 and the grain output per capita has increased by around 1.3 times from 208.95 kg per person to 483.40 kg per person. In terms of period, it took 21 years from 1949 to 1970 for the grain output to double again, and another 12 years from 1970 to 1982 for grain output to double. In the early period since the implementation of the "reform and opening up" policy in 1978, it took only 9 years for the grain output to triple to that of 1949. Subsequently, it fluctuated, and it took 20 years for the grain output to quadruple to that of 1949. Since the 18$^{th}$ CPC National Congress, grain production has increased rapidly, nearly doubling in six years. China uses less than a tenth of the world's arable land to produce a quarter of its food and feed a fifth of its people (CCTV, 2019).

To approach a brief analysis of the rapid progress of the agricultural sector in China since 1949, based on the theory of Cobb-Douglas production function, rural economic development must contain the following basic factors of production which are capital (including land and fund input), labor, and related technology. Besides, the process of rural economic development is essentially the process of organic combination of the basic factors of production (Van der Ploeg et al., 2017). With rapid population growth, the labor input in the agricultural sector was not in shortage, however, it had low efficiency prior to a series of agricultural reforms from 1978 onwards.

The most influential reform was the transition of collective agricultural production to the household-responsibility system (HRS), which distributed arable land together with the assigned production duty to the rural household where participation was voluntary. The household that adopts the HRS has full responsibility for the land and can also take the exceeding production as their own. The HRS overcomes the drawback of the collective system that all agricultural laborers work together and are paid based on their working hours. Instead, the HRS connects the gain of the agricultural laborers with the output of agricultural production directly and therefore initiates the creativity and productivity of labor input in the agricultural sector. As a result, the growth of major agricultural products has accelerated dramatically and caught up with the population growth for the first time since 1949 (X. Dong, 1996; J. Y. Lin, 1992).

Since then, a series of reforms in the mode of operation and distribution of land continuously stimulated the efficiency of agricultural production and management. As a result, there was a surplus of labor in pure farming in the late 1980s. The surplus in labor and supporting economic environment fulfilled the requirement to establish enterprises. Various rural enterprises have established rapidly in this period and are gradually becoming the new pillar of the rural economy (Zhou et al., 2020). Consequently, the growth of agricultural enterprises established the prerequisite of agricultural industrialization. In the middle and late 1990s, agricultural enterprises in various regions in China began exploring modern agricultural management and agricultural technology to realize industrialization that utilizes machinery,

standardization, and professionalism in order to improve the efficiency in the production of agricultural and related products (Babu et al., 2015).

Although agricultural industrialization has been steadily in progress, the rural economy is still dominated by traditional small-scale agricultural production. Compared with the modern large-scale industrial production in urban areas, the dual urban-rural economic structure, which refers to the significant discrepancy between urban and rural economies, is formed. Under this structure, the urban infrastructure such as transportations, communications, health centers and education are developed, however, the rural infrastructure is poor and there is a large income gap between the residents in the urban and rural areas.

According to the 2021 census, the rural population in China is 498.35 million, accounting for 35% of the total population. The population lives in rural areas and relies on agriculture as the main source of income. It is of decisive significance to promote agricultural industrialization in order to realize the modernization of China (S. Liu, 2021). However, several issues have restricted the agricultural industrialization process. First of all, the overall agricultural production is small-scale. According to the third agricultural census, only 28.6% of cultivated land has realized large-scale farming and only 1.92% of agricultural households nationwide have realized large-scale farming. The low percentage of large-scale agricultural operation has restricted the industrialization process and can hardly realize scale economies.

Secondly, agricultural laborers are less educated because of the relatively insufficient educational infrastructure in rural areas. According to the third agricultural census, only 1.2% of the workforce has a junior college degree or above, compared to 37.0%, 48.4%, and 7.1% of those working in the agricultural production and operations who have completed their elementary, middle, high, or technical secondary education. This indicates that the majority of agricultural laborers have primary and junior high school cultural levels.

Undoubtedly, the professionalism of agricultural industrialism will be impacted by the insufficient education level of agricultural practitioners. This is also another important factor in the under-performance of the cultivated land, despite the various forms of large-scale and mechanical management that have been used. Significantly, although China is becoming more environmentally friendly, its agricultural production in China still uses chemical fertilizers and pesticides intensively, which leads to high pollution. Although intensive actions have been taken to reduce the usage of chemical fertilizers and pesticides since 2015, the use of pesticides and agricultural fertilizers was still 1.456 million tons and 54.036 million tons respectively in 2019. According to the data released by the Ministry of Agriculture and Rural Affairs, the utilization rates of chemical fertilizers and pesticides in rice, maize and wheat in China in 2019 were 39.2% and 39.8%, respectively, while they were higher than those in previous years, the rate were still far behind the 50%-60% utilization rates in developed countries. In addition, the 2019 communiqué on the state of the ecological environment shows that by the end of 2019, only 31.24

percent of China's total cultivated land was rated as 1-3 on a scale of 10, which is largely due to agricultural pollution. Thus, it can be concluded that pollution is still a prominent problem in China's agricultural industrialization which also affects the sustainable development of its agricultural sector.

### 1.1.3 Small and Medium-sized Enterprises (SMEs) in China

Agricultural enterprises play an important role in realizing agricultural industrialization. As the connection of agricultural enterprises and rural households helps bring agricultural products to reach the market faster, therefore reducing food wastage during the process of selling (Ilbery & Maye, 2005). Furthermore, the enterprises provide capital, information and technology that support expansion and transition in agricultural production (X. Zhang, 2013).

According to the statistics from the Ministry of Industry and Information Technology (MIIT), by the end of 2021, China has more than 48 million small and medium-sized enterprises, accounting for more than 99 percent of registered enterprises in China (Beijing News, 2022). Based on the definition from MIIT, PRC, small and medium-sized enterprises (SMEs) refer to: "*Enterprises legally established and developed within the territory of China that are medium, small and micro enterprises according to the scale of production and operation. These enterprises include all kinds of ownership and forms. SMEs should meet the social guarantee needs of workers, has a number of employees and thus can promote employment, and is in line with the industrial policy."* According to the newest

Chinese “SME Classification Standards”, small and medium-sized agricultural enterprises are classified as shown in Table 1.1

Table 1.1: Standards of Classification of SMEs in China

| Industry | Medium-size | Small-size | Micro-size |
|---|---|---|---|
| Agriculture, forestry, Animal husbandry & fishery | 5=< R< 200 | 0.5=< R< 50 | R< 0.5 |

Note: R represents Revenue, in million

Source: Ministry of Industry and Information Technology Enterprise (2011)

According to the relevant requirements in Table 1.1 small and medium-sized agricultural enterprises (agricultural SMEs) refers to enterprises with an annual revenue below 200 million yuan. The agricultural SMEs in China have relatively small scale and diversified characteristics. Some enterprises that are engaged in the processing and sales of agricultural products are called agricultural small and medium-sized enterprises. Moreover, some self-employed households and farmers that are not registered as “enterprises” are also engaged in agricultural production and sales. Those that form the production population in rural areas face relatively high operation risk, with low profitability and high credit risk, and thus have difficulties in financing.

SMEs play an important role in China’s economic development. As stated in the first meeting of “The State Council Leading Group on Promoting the Development of Small and Medium-sized Enterprises” on August 20$^{th}$, 2018, China’s small and medium-sized enterprises have made significant contribution in economical development, which generated more than half of tax revenue and over 60%

of GDP. In addition, the SMEs in China have realized more than 70% of technological innovations and have provided more than 80% of job positions in urban area.

Small and medium-sized agricultural enterprises are an important bridge connecting rural production and urban markets. They play an important role in the people's basic living standards and economic development. However, as they are relatively small-scaled, having low profitability and weak risk-bearing capacity, small and medium-sized agricultural enterprises are facing many risks and challenges in operations and developments.

During business growth, capital is the key of small and medium-sized agricultural enterprises. Insufficient funds, less accumulation of self-owned funds and narrow financing channels are the inevitable problems for China's small and medium-sized agricultural enterprises in the future. According to the latest statistics, loans outstanding to small enterprises and the agricultural sector accounted for only 15% and 12.5% of the total amount of loan outstanding respectively. In addition to the insufficiency in debt financing, Small and Medium-sized enterprises (SMEs) listed in the National Equities Exchange and Quotations (NEEQs, also called the "New Third Board" market), which are the highly innovative enterprises that search for equity financing but are not qualified for A-share listing, also experience financing constraint. According to the report from the Central University of Finance and Economics, the number and market value of shares outstanding have reduced by 6.4% and 30.19% respectively in 2018 compared with 2017, and the liquidity in the

NEEQs is also at a low point, indicating that SMEs also experienced financing constraint in the "New Third Board" market (Central University of Finance and Economics, 2019).

Formal credit is a crucial component in promoting production and profitability of agricultural enterprises (Tetteh Anang & Amikuzuno, 2015) and debt financing limitation results in severe financing constraints for most firms in China, including listed enterprises (Berger & Udell, 2006; Wei et al., 2014). Accounting for only 12.5% of total loans outstanding, credit support from China's financial institutions is insufficient for agricultural enterprises. But we cannot blame financial institutions for their reluctance to lend. Commercial banks have the essence of profit-seeking and prudent risk management. Driven by this essence, agriculture can hardly be the object of credit because agricultural production has characteristics of long cycles, slow capital operation, concentrated short working days, low labor productivity, and high reliance on the natural condition (Bianco, 2020).

Furthermore, the problem of information asymmetry in rural areas is more severe as they are more remote to financial institutions (Chandio & Jiang, 2018; Dong & Men, 2014; Fletschner et al., 2010). With asymmetrical information and the nature of risk in agriculture, financial resources are more inclined towards urban areas and businesses with relatively low risks (Boucher et al., 2009; Stiglitz & Weiss, 1981). As a result, agricultural businesses are struggling with financing constraints in manners such as higher interest rates, collateral requirements, and etcetera. Some enterprises have refused to get financed because they cannot meet the requirements

(Bester, 1985, 1987; Bester & Hellwig, 1987; Boot et al., 1991; Boucher et al., 2009; Coco, 2000; Thakor & Callaway, 1983) and some become “discouraged borrower” with self-constraint behaviors confronting with these conditions (Kon & Storey, 2003; Levenson & Willard, 2000).

### 1.1.4 Financing Incentive and Agricultural Subsidies in China

The Chinese government has long realized the fundamental contribution of agriculture to economic development. From 1982 to 1986, the Communist Party of China (CPC) Central Committee issued No. 1 Central Documents on agriculture, rural areas and farmers for five consecutive years, making specific plans for rural reform and agricultural development. From 2004 till 2021, the No. 1 Central Government documents on agriculture, rural areas and farmers have been issued for 18 consecutive years, highlighting the “top priority” status of agriculture, rural areas and farmers in China's socialist modernization period.

In 2010 referring to No. 1 Central Documents on agriculture, for the first time, the government proposed to eliminate the gap in basic financial service within three years. In addition, the agricultural supporting business of the Agricultural Development Bank would be expanded, and thus policy funds have greater potential to support the development of agriculture and rural areas. In 2014, since the central No. 1 document proposed to accelerate the innovation of the rural financial system, the Ministry of Agriculture further detailed the measures of innovative financial support for agricultural development in the “Notification on Promoting Financial

Support and Service for Modern Agricultural Development". It put forward financial measures to improve agriculture, including innovating an agricultural credit guarantee mechanism, expanding the scope of agricultural credit guarantee, standardizing the business of farmers' credit cooperatives, promoting agriculture-related direct investment and financing, and standardizing agricultural insurance services.

According to the "Report on China's Rural Financial Services 2018" released by the People's Bank of China (PBOC), since the establishment of statistics on agricultural loans in 2007, the outstanding balance of agricultural loans in all financial institutions has increased by 534.4% by the end of 2018, with an average annual growth rate of 16.5% over the past 11 years. Bonds, stocks and other direct financing have developed rapidly, agricultural futures market gradually developed from scratch. From 2007 to 2018, the premium income of agricultural insurance increased from 5.18 billion yuan to 57.27 billion yuan, and the number of insured rural households increased from 49.81 million to 195 million. The number of financial institutions serving agriculture has been continuously increased in this process. By the end of 2018, it had developed into more than 5,000 organizations, with more than 100,000 branches and nearly 1,000,000 employees.

Besides financial incentives, the Chinese government has formulated various subsidy policies (demonstrated in Table 1.2) to encourage agricultural production and to adopt modern and sustainable production methods. Since 2002, government subsidies that are distributed to the agricultural industry have been gradually

enriched, from targeting fine seed usage and grain production to farm-machinery adoption, and were more focused on production in an environmentally friendly and sustainable way. Notably, since 2016, the agricultural subsidies have been focusing on sustainable mode in agriculture, encouraging innovative forms of methods to reduce the use of chemical fertilizer and pesticides to protect the quality of farmland to realize green-ecology-oriented agricultural development.

Table 1.2: Summary of Policies on Agricultural Subsidies in China

| Year | Subsidy | Measures |
|---|---|---|
| 2002 | Improving Seed Subsidy | 70.56 billion yuan subsidies were distributed from 2002 to 2010 in improving seed quality. |
| 2004 | Machinery Subsidy | 35.46 billion yuan was subsidized for purchasing machines in agricultural production from 2004 to 2010. |
| 2006 | Comprehensive Subsidy | 254.4 billion yuan was subsidized for agricultural materials, grain output and improving seed quality from 2006 to 2010. |
| 2015 | Protection Support Subsidy | The comprehensive subsidy was replaced by 'Agricultural Support and Protection Subsidy' that contains the subsidies in 'Comprehensive Subsidy' and also subsidies for protection of farmland. |
| 2016 | Green and Ecologically Subsidy | The "Reform plan for establishing a green-ecology-oriented agricultural subsidy system" was started to establish. |
| 2019 | Farmland Construction Subsidy | 85.9 billion yuan was subsidized in high-standard farmland construction in 2019. |
| 2022 | Farmland Protection Subsidy | In order to provide basis for green and ecological agriculture, 120.5 billion yuan was subsidized for farmland protection. |

Source: Author's compilation from the Ministry of Finance and the Ministry of Agriculture and Rural affairs of China

Based on the statistics that are presented thus far, it is shown that financing constraints exist among agricultural small and medium-sized enterprises in China. In

order to support the sustainable development in the agricultural sector, the Chinese government has put forth a series of incentives and subsidies for the agricultural sector. The subsidies can release the liquidity constraint to some extent and can give positive signal about firm quality to financial market. But the government subsidies still have limited effect on reliving the information asymmetry problem between the investors and the agricultural small and medium-sized enterprises, especially for the enterprises located in rural area that has inconvenient transportation and communication. In order to reduce the discrepancy between urban and rural areas, the Chinese government has also taken advantage of the digital technology in economic development and place emphasis on constructing digital economy. Under the circumstance, digital finance in China has also developed significantly in recent years.

### 1.1.5 Digital Finance in China

The concept of "Digital Finance" in China was initiated from 2004. According to the explanation from Institute of Digital Finance Peking University, "Digital Finance", broadly refers to the adaptation of digital technology in financial innovation to achieve new financial business models that are associated with financing, payment, investment and forms of financial services (Y. Huang & Huang, 2018). This concept is generally similar to the concept of "Internet Finance" defined by the People's Bank of China, which refers to a new financial business mode that realized by applying internet and information technology on traditional financial

services. The concept of “Digital Finance” is also very close to the concept of “Financial Technology (FinTech)” as defined by the Financial Stability Board, which refers to financial innovations that are made possible by technology that result in new business models, applications, procedures and products associated with financial services (Financial Stability Board, 2017). The technology in the concept of FinTech mainly refers to mobile Internet, big data, cloud computing and etcetera. These three concepts seem to be quite common as they all emphasize that technology innovation empowers financial services. The major difference seems to be that compared with the other two concepts, the concept of “Digital Finance” comes first in China and seems to be a broader concept that covers the financial services provided by both financial and non-financial institutions (L. Chen, 2016; Y. Huang & Huang, 2018). Referring to the studies from Ding et al. (2022) and Huang and Huang (2018), this study does not distinguish the minor difference among the concept of “Digital Finance”, “Internet Finance” and “FinTech”.

The initiation of Digital Finance in China could be traced back to 2004 when the Alipay system was brought to the customer, but it is generally regarded that the start of Yu’E Bao wealth management business in 2013 has been the starting point of digital finance in China. Since then, the business of digital finance in China has developed significantly. Digital financial companies such as the top five digital financial companies worldwide, including Ant Financial, JD Finance, Lufax and Zhongan Insurance, provide services containing digital payment, online lending and digital insurance that have change the payment and consumption mode of the

Chinese people. Hundreds of millions of customers in China use Alipay and Wechat Pay for online payment. By the end of 2018, Alipay has more than 1 billion users worldwide and became the world's largest non-social mobile application program (News channel, cctv. com, 2019).

With the large number of users, the digital finance market in China has developed rapidly as a globally leader. Ant Financial from China has raised the largest investment of 14 billion dollars in 2018. Accordingly, Yu'E Bao, as the only wealth management product of Ant Financial, has attracted more than 280 million customers to invest more than 100 billion dollars (China Daily, 2018). Moreover, according to the "2019 Global FinTech Adoption Rate Index" reported by Ernst and Young, China has the Fintech consumer adoption rates of 87%, substantially larger than the global average of 64% (Ernst & Young, 2019).

In addition to the widespread utilization among individual consumers, digital financial technology is also being promoted in financial inclusion among small and medium-sized enterprises in China. The concept of "Inclusive Finance (Or Financial Inclusion)" was initially proposed by the United Nations in 2005, referring to improving universal financial services to individuals and SMEs at affordable price (United Nations, 2015).The Chinese government has made diligent efforts to promote inclusive finance since 2006, with initiatives including establishing microfinance companies, constructing a "financial inclusion department" within financial institutions and setting up pilot zones in rural areas to issue credit in terms of collateral with land operation rights and housing property rights. However, none

of these initiatives has been significantly or sustainably effective in solving the financing problems (Y. Huang & Huang, 2018). In contrast, digital technology provides a plausible solution to overcome the natural difficulty of inclusive finance.

Internet platforms such as Alipay and WeChat Pay can get in touch with millions of mobile terminal users and credit evaluation can be done by analyzing big data from online shopping and social media platforms. In this way, digital technology empowers inclusive finance to provide convenient credit application procedures with controllable risk at quite a low cost. For example, the FinTech company Ant Financial in China has issued over 680 billion yuan in loans to Small and Medium-sized enterprises in China from 2011-2016. These loans were issued without collateral or guarantee requirement and only took three minutes to apply (L. Chen, 2016). The fast and simple procedure of financing through digital finance has also stimulated the credit process optimization of traditional financial institutions.

Applying information technology to finance, digital finance has improved efficiency while reducing the cost of information collection in the process of crediting and therefore improved the availability and reduced the financing cost of SMEs (Gomber et al., 2017; Z. Huang et al., 2016). Furthermore, in addition to direct financing support, digital finance also supports the agricultural economy in terms of changing consumption mode and promoting online selling (J. Li et al., 2020). The rapid development of digital finance in China has promoted the development of e-commerce in rural areas and supported their economic development (Tang & Zhu, 2020).

Compared with direct government subsidies to agricultural SMEs, the promotion of digital finance, although seemingly indirect, is still a non-negligible condition for studying the financing constraints of agricultural SMEs in China.

### 1.2 Problem Statement

Agricultural development can make an essential contribution to achieving the United Nations Sustainable Development Goals through relieving hunger (SDG 2), and providing diversified nutrition to support health and well-being (SDG 3). And it is especially critical for China to maintain efficient productivity in the agricultural sector because China has only 8% of global arable land but has to feed 18% of the world's population (FAO, 2019). Meanwhile, however, the agricultural sector in China consumed large amounts of chemical fertilizer and pesticides as much as 35% and 42% of the world's total, respectively (FAO, 2019), which leads to severe environmental pollution and hinders the sustainability of the agricultural sector in China. That is to say, the agricultural sector in China faces challenge in terms of maintaining the agricultural development without hampering future potential (Brundtland, 1987).

Nevertheless, the smallholder farmers, who accounted for 98% of farmers in China but with an average farm size of only 0.7 hectares, lack economic motivations to invest in sustainable technologies due to high costs associated with the technological adoption and operation (X. Guo et al., 2022; X. Huang et al., 2022; Kamble et al., 2019). Therefore, innovation from agricultural small and

medium-sized enterprises (SMEs) plays a prominent role in offering technical guidance and support for farmers to product in a sustainable manner (Niu et al., 2021; L. E. D. Smith & Siciliano, 2015). In fact, although relative small in size, more than 88% of nationwide innovation have been conducted by the small and medium-sized enterprises in China (Yearbook China, 2020), and they have contributed in generating employment, reducing income disparity and promoting innovation (OECD, 2017; WTO, 2016). Moreover, the agricultural SMEs help transform products from farmland to consumers and become crucial component in the food supply chain to reduce food waste and maintain food availability (J. Chen & Yang, 2021; Kumar et al., 2021). Therefore, in achieving sustainable development of agricultural sector, it is important to ensure that the agricultural SMEs have incentives to innovate.

However, exiting studies have reached inconclusive results about whether innovation increases or decreases financing constraints (S. Chen & Zhao, 2019; Czarnitzki & Hottenrott, 2011; Y. Zhang et al., 2020). And this issue is particularly important for the agricultural SMEs, because they need sufficient financing to realize sustainable transition (Bartolacci et al., 2020; Havemann et al., 2020) but usually have more difficulties in financing as the agricultural SMEs usually have higher risk in agricultural yield (D'Agostino & Schlenker, 2016; Fletschner et al., 2010b) but lack of sufficient collateral in financing (Cadot, 2013; Wang et al., 2023). Accordingly, the first question this study aims at exploring is the impact of innovation on financing constraints of agricultural SMEs.

In addition, this study concerns about the interaction effect of digital finance on the relationship between innovation and financing constraints. Through digital technology adoption in financial services, digital finance was emerging to make up the shortage of high cost and information asymmetry in traditional finance (Y. Huang & Huang, 2018). Since information asymmetry is one of the major causal factors that innovation may increase financing constraints of agricultural SMEs (Michael et al., 2018), and digital finance is taken to solve the problem of information asymmetry in financing (Erel & Liebersohn, 2022; Gabor & Brooks, 2017; Gomber et al., 2018). Therefore, this study also aims to investigate whether digital finance can help address the information problem during innovation activities and interact with the relationship between innovation and financing constraints of agricultural SMEs.

Furthermore, this study also aims at investigating the impact of government subsidies on financing constraints of agricultural SMEs. The Chinese government has established ecological-oriented agricultural subsidy system, aiming at stimulating the sustainable transition of agricultural sector in China (CGPN, 2023; CSN, 2019). The government subsidies can support agricultural SMEs either through directly cash supplement to relieve their financial burdens (Carboni, 2017; Hottenrott & Richstein, 2020; Mateut, 2018a), or through political connections to reduce the political uncertainty (Cumming et al., 2016; Ovtchinnikov et al., 2020). But pertaining to whether the government can improve financing capability of agricultural small and medium-sized enterprises, existing studies have not well