Food Policy 117 (2023) 102455

Contents lists available at ScienceDirect

Food Policy

journal homepage: www.elsevier.com/locate/foodpol

Growing exports through ISO 9001 quality certification: Firm-level evidence from Chinese agri-food sectors

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ARTICLE INFO

Keywords:
Quality certification
ISO 9001
Exports promotion
Agri-food sectors
China

ABSTRACT

The adoption of ISO 9001 quality certification for agri-food products may promote China's relatively weak competitiveness in agri-food exports compared with industrial sectors. To explore this, we construct a panel data set of Chinese listed firms in agri-food sectors from 2000 to 2016 and use staggered Difference-in-Difference (DID) method to investigate the causal relationship between the adoption of ISO 9001 quality certification and agri-food exports. Three main findings are obtained in this study. First, we find that the adoption of ISO 9001 certification is positively associated with exports for agri-food listed firms. Second, we find that ISO 9001 certification promotes firms' exports by increasing their innovation activities. Third, the export effects are greater for food (vs. non-food) manufacturing firms and non-SOEs (vs. SOEs). Identification problems are addressed by utilizing randomly generated certification status, two-part fractional regression model, controlling and excluding other quality certifications, etc. This study provides important implications for China's food and agricultural development strategy, which emphasises the transition from quantity expansion to quality enhancement.

1. Introduction

China has the largest trade scale and the second largest consumer market in the world, and also one of the largest beneficiaries and recipients of foreign investment according to the Ministry of Commerce of China (MCC)[1]. However, compared with its large volume of industrial exports, China exports relatively less agricultural products, most of which are primary products.

One reason for China's low level of agricultural exports may be lack of quality or efficient quality signals. Unlike industrial products, agri-food products including primary agricultural products, food, processed food, and agri-sideline products, have attributes of credence goods (Nelson, 1970, 1974). The quality information on credence products cannot be easily ascertained by consumers compared to search and experience goods. For search and experience goods, consumers can evaluate quality information either by searching for information before purchasing or by experiencing the product during their purchase and consumption process. According to Stigler (1961) and Nelson(1970), consumers cannot ascertain quality information on credence goods even if they have purchased and consumed the goods. Most food and agricultural products designated to be organic, healthy, pollution-free, or other attribute relating to the production process are credence goods.

Quality certification is considered as a key approach to solve this issue for agri-food manufacturers in developing countries (ITC, 2018; Meemken et al., 2017). The credible quality signals conveyed by certification can give mutual recognization of complex quality information with low transaction cost, given the physical and cultural distance between buyers and sellers in global market. For instance, quality certification such as ISO 9001 conveys information on product's structure, specifications, processes, utility, and other characteristics; the Pollution-free Agricultural Products Certification, OGA (Organic Product Certification) and GFC (Green Food Certification) clearly indicate the dosage of fertilisers, pesticides, and synthetic hormones in agricultural products through the AA and A ratings on product labels[2]. The Hazard Analysis

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[1] https://fec.mofcom.gov.cn/article/tzhzcj/xgzx/202110/20211003211495.shtml.

[2] Since 1996, China's green food has been divided into AA and A class. Compared to A class of green food, which can use some chemicals specified in the standard, AA class of green food prohibits the use of any chemical compounds in the production process. In addition, the production environment quality standards of AA class green food are more strictly. Because of the production process of AA class green food is completely standardized to organic food, the AA classification of Green Food was officially suspended in June 2008 when the OGA (Organic Product Certification) certification formally implemented in China.

https://doi.org/10.1016/j.foodpol.2023.102455
Received 10 January 2022; Received in revised form 16 April 2023; Accepted 18 April 2023
Available online 4 May 2023

Table 1
Certification and year distribution in agri-food sectors from 2000 to 2016.

	Certification types	No. of Certified Firms	% of Certified Firms
1	ISO 9001 (Quality Management Systems)	66	57%
2	ISO 14001 (Environment Management Systems)	37	32%
3	ISO 22000 (Food Safety Management Systems)	32	28%
4	HACCP (Hazard Analysis and Critical Control Point)	26	23%
5	ISO 45000 (Occupational Health and Safety Management System)	21	18%
6	OGA (Organic Product Certification)	12	10%
7	GAP (Good Agricultural Practice)	9	8%
8	GFC (Green Food Certification)	6	5%
9	Pollution-free Agricultural Products	5	4%

Source: WIND Financial Database (https://www.wind.com.cn) and China's Standardization Administration (http://www.sac.gov.cn).

and Critical Control Point Certification (HACCP) specifies the food production environment, the use of additives, and the hygienic conditions of product transportation and sales environments.

While the total market for certified manufacturers is growing, there is still a gap between the quality-process production and exports in agri-food sectors. In this paper, we studied the impact of ISO 9001, which refers to Quality Management Systems introduced by the International Organization for Standardization (ISO) in 1987. According to the latest ISO Survey 2021, ISO 9001 is still the most popular standard with 1,077,884 certificates in 193 countries. China hase the largest number of ISO 9001 certificates with 426,716 certificates, followed by Italy with 92,664 certificates and Germany with 49,298 certificates[3] in 2021.

However, the quality certification adoption rate in Chinese agri-food sectors is relatively low. According to the data of Chinese listed firms, agri-food sectors only accounts for 1.98% of all the China's ISO 9001 certificates in 2020[4]. Table 1 is the adoption rate of all types of quality certification obtained by these listed companies between 2000 and 2016. It shows that almost all the quality certification adoption rate are below 50% except for ISO 9001. It is worth noting that this is the data of listed companies. If we look into the entire agri-food sectors, the adoption rate maybe even lower.

It is worth noting that, agri-food sectors are more sensitive to crises related to quality issues, and such incidents often have more lasting and devastating consequences for producers than other sectors. For example, during the 2008 Sanlu milk powder incident, in which milk powder was found to have caused kidney stones in infants, the chemical raw material melamine was discovered in the milk powder produced by Sanlu Group. The incident in China not only led to the bankruptcy of the Sanlu Group but also damaged the overall market reputation of China's domestic milk powder sector. The mad cow disease crisis of the early 21st century in Europe was also caused by inappropriate food additives in animal feed, leading Food and Agricultural Administrations in Europe to re-examine their safety assurance systems. Report shows that in Asia, Latin America and Africa, 30 percent of medicines sold in market are counterfeit, compared to that of 1% in developed countries (OECD, 2008). Lacking effective quality signal, food and agricultural products cannot gain quality premium, which may lead to collapse of high-quality market in developing countries. For the foreseeable future, with the development of agricultural science and technology, the demand for high-quality agri-food products in the international market keeps increasing, which creates urgent need for efficient quality certification in exports. Meanwhile, as the largest economy in global trade, the export impact of quality certification in Chinese agri-food sectors gained more and more attention not only from international market, but also from policy makers and scholars.

There are substantial literatures analyzing the economic consequences of quality certification such as ISO 9001. The main method and key findings of the previous studies are as follows:

First, the difference in premium of quality certification adoption in developed and developing countries has been found in previous studies. Some authors find that in the credence product market, consumers who have difficulty in judging product quality information may simply choose products based on the positive relationship between "price-quality", arguing that the perception of high price must be high quality (Bagwell and Riordan, 1991; Jiang and Yang, 2019). Some research also found that the quality certification conveys the signal of high quality to the consumers, so that they are willing to pay a higher price. That is, there exists premium for quality certification (Abate et al., 2021; Balogh et al., 2016; Jaffry et al., 2004).

However, research in recent years has refined this conclusion. For example, in the credence goods market, profit-oriented firms may deceive consumers by increasing prices without enhancing product quality. If consumers believe that there is a positive relationship between price and quality, this may result in the collapse of the high-quality credence products market. Even in low-income regions of developed countries, high-quality and expensive products with high quality may be not competitive in market. Some scholars therefore propose that the positive relationship between certification and exports is only valid in developed countries or regions with high income. In regions with lower income levels, high-quality products with high price cannot be accepted by consumers, which will eventually lead to the collapse of the high-quality market (Auriol and Schilizzi, 2015).

Second, studies from the production-side mostly based on the country-level analysis and obtained mixed conclusions. Many studies focus on the country-level analysis to figure out the impact of quality certification on exports and the most widely used method is the gravity model (Chen, et al., 2008b; Masakure et al., 2009; Goedhuys and Sleuwaegen, 2016). However, the conclusions of these research are diverse. Some studies find that quality certification has positive impact on export (Masakure et al., 2009). But some point out that the results above may only hold in low-income countries (Goedhuys and Sleuwaegen, 2013; Auriol and Schilizzi, 2015). For example, Shepherd and Wilson (2013) find that EU standards may have hurt developed countries more than developing countries. Kim(2021) find that ISO22000 diffusion negatively affects the exports of processed products that are the major export goods of developed countries. Clougherty and Grajek (2008) also come to similar conclusions regarding the relationship between certification and exports in developed and developing countries.

There are also literatures on quality certification adoption from supply side. Most studies support the view of "standards-as-barriers" rather than "standards-as-catalysts". For instance, many products or service such as coffee, seafood, tea, banana and tourism have been studied (Henson and Reardon, 2005; Ruben and Fort, 2012; Jongwanich, 2009). These studies have researched different types of quality certification including Fair Trade (FT) certification, Farmer Equity Practices, Certification for Sustainable Tourism, Rainforest Alliance, etc.

Third, the casual relationship should be more emphasized for the voluntary attribute of ISO 9001. Research methodology in previous studies of ISO 9001 mainly related to survey techniques and the identification strategy based on the cross-sectional survey data analysis. For instance, A review study takes sustainable certification as an example and noted that only 14 of the 37 sample studies attempted to investigate the causal impacts (Blackman and Rivera, 2010). The empirical evidence that the significant benefits of quality certification is limited (Dranove and Ginger, 2010; Purwanto et al., 2020). In this study, the voluntary attribute of ISO 9001 is the key threat of the identification strategy. That is, the relationship between acquisition of a certain

[3] https://www.iso.org/the-*iso*-survey.html.
[4] According to the data of all the Chinese listed firms, authors calculate the consequence manually.

certification and exports may conceal potential feedback effects. Firms with higher levels of exports may pay more attention on quality control and thus obtain quality certification, rather than quality certification obtainment affect exports.

In this paper, we used ISO 9001 certification as an example to study the relationship between quality certification and export in agri-food sectors in China. We define quality as a comprehensive capability and assurance to consistently provide higher quality products with mutual recognization in international market. There are two key points of the definition: first, the quality is a comprehensive capability to produce higher quality products, rather than the quality of a certain product. This feature requires higher level of systematic quality management ability in an organization. Second, the quality information can be recognized and conveyed by authentic signal of mutual consent in international market. In consideration of the quality defined, the reasons why we use ISO 9001 as an example are as follows:

First, ISO 9001 is a quality-process certification that directly aims at firms' quality management system (rather than the products produced by those firms), which is consistent with our definition. ISO standards provide the discipline and infrastructure that are necessary to make a major improvement in an organization's quality system. However, it does not require specific quality control standards for products and technologies firms must adopt in their production processes, or even outcomes they must achieve (such as maximum number of defects per production run). As experts cautioned, "ISO 9001 is a quality-process certification, not a product certification" (Sprow, 1992).

Second, ISO 9001 frequently serves as a credible signal of process quality control with mutual recognition in international market. Quality conveying facilities is highly needed in the stimulation of international trade, which eliminates obstacles arising from widely diverging practices in different countries. Firms need to rely on quality systems, catalyze international coordination, and unify industrial standards to gain more benefit in international trade market (Heras-Saizarbitoria and Boiral, 2013; del Castillo-Peces et al., 2018, ISO, 2019). As an international standard, ISO 9001 is the most widely used standardization facility in the world with mutually recognized in the international market. There is consensus in previous studies that ISO 9001 often used as a credible tool to signal their efforts in quality upgrading practices (Cao and Prakash, 2011; Estampe et al., 2013).

Third, in practice, ISO 9001 is more like BtoB in supply chain which emphasis the stage of production process being standardized. According to Chinese law and regulations[5], the label of ISO 9001 cannot be allowed to be printed directly on the product packaging to avoid misunderstanding with other quality certifications printed on product which can be directly perceived by consumers. Previous studies have pointed out that ISO 9001 is a quality-process certification, not a product certification (Sprow, 1992), but it often regarded as an important milestone of high-quality product production (Prasad and Naidu, 1994; Cao and Prakash, 2011).

In this paper, we use a long-term firm-level panel data to find out the impacts of quality certification on exports using Chinese agri-food sectors as the context. Even though the idea behind quality certification is simple, there are many questions that need to be answered to assess the effects of such systems: (i) does quality certification promote agricultural exports? (ii) If so, how does firms' exports change after adopting quality certifications? what is the mechanism of the above impacts? and (iii) how does this effect differ between different firms? The remainder of this paper is organised as follows. Section 2 is the theoratical framework and the research hypotheses. Section 3 presents the sample, data, estimation framework and identifying assumptions. Section 4 presents the results and a series of robustness checks. Section 5 discusses the mechanisms for impact and examines the different impacts among different industries and types of ownership. Section 6 concludes the paper.

2. Theoretical framework and hypotheses

2.1. The role of ISO 9001 quality certification on agri-food exports

ISO 9001 refers to quality management systems that help organizations improve the products quality and consistently meet their customers' expectations. In China, according to GB/T 19001–2016/ISO 9001:2015, the application of ISO 9001 certification should meet the requirements in practice as follows:

1) the establishment of firms should be legal. Firms should hold business licenses or other legal registration certificate.

2) consistently provide stable product quality and formal mass production. Quality stability refers to that the products produced are qualified in continuous spot inspection for more than one-year. Firms with pilot production cannot represent the stable situation of product quality. Firms that could formally realize mass production are qualified to apply for ISO 9001 certification.

3) needs to demonstrate the products and services that meet regulatory requirements. The requirements include national standards, industrial standards and the supplementary technical requirements, or other standards confirmed by the standardization administrative department. Whether the products meet the standards shall be certified by the sampling inspection by the examination institutions authorized by China's State Administration for Market Regulation.

4) the quality management systems should consistently meet the requirements of GB/T19000-ISO 9000 family and establish applicable quality standard systems with effective operation.

The adoption of ISO 9001 often considered to be a positive signal of high-level quality manufacturer. According to ISO[6], the goal of ISO 9001 is to help organizations improve quality management ability to ensure consistently good quality products and services. ISO 9001 sets out the criteria for a quality management system which helps organizations to improve the quality of their products and services and consistently meet their customers' expectations. There is consensus in previous studies that the ISO 9001 adoption is valuable because it constitutes a credible signal about firms' internal quality assurance practices (Cao and Prakash, 2011). Previous studies have recognized that ISO 9001 accreditation is a reliable tool that contains recognized higher quality production. The nature of ISO 9001 is to provide a series of quality requirements for overall process including product design, manufacturing, transportation, service, and customer support, which establishes the framework required for effective and efficient quality assurance and quality management systems (Naveh et al., 2004; Bhuiyan and Alam, 2005; Cao and Prakash, 2011). Corporations with or without ISO 9001 certificates present different quality management maturity levels, and many international buyers use ISO 9001 certification as a screening device to figure out high quality products (Ferguson, 1996; Estampe et al., 2013).

In international market, quality certification can alleviate product quality information asymmetry by conveying accredited quality signals, which helps firms gain premium from international market and increase their exports. A substantial body of literature has examined the influence of certification on exports (Terlaak and King, 2006; Masakure et al., 2009; Goedhuys and Sleuwaegen, 2013, 2016). Most of the discussions originate from the theory of information economics (Nelson, 1970). This theory divides products into search, experience and credence goods depending on whether product quality can be directly perceived by

[5] The full name of the document is "China's General Requirements for Third-party Compliance Marks for Conformity Assessment (GB/T27030-2006)", which was transformed from the document of ISO/IEC 17,030 "General requirements of Assessing the Conformity of the Third Party Symbols" (the first version issued in 2003).More details see https://std.samr.gov.cn.

[6] https://www.iso.org/*iso*-9001-quality-management.html.

consumers. Under this theory, most food and agricultural products are credence goods. For example, food and agricultural products may be farmed organically, pollution-free, considerate of animal welfare, or genetically modified. These attributes cannot be perceived through simple observation, even by experienced consumers.

Quality certification is therefore more important for food and agricultural products than products from other industries. Agri-food products often related to safety health, and sustainable, which consumers cannot easily identify quality information, so they tend to trust in the positive relationship between price and quality. For example, Monroe (1973) found that consumers believe that the prices of products indicate quality levels in a perfectly competitive market. Some authors find the positive relationship between exports and international quality certification acquisition (Gerstner, 1985; Tellis & Wernerfelt, 1987; Kim, 2021).

Therefore, in agri-food market which has asymmetric information problem (Albano and Lizzeri, 2001), quality certification obtainment raises export through efficiency gains and quality signalling. Motivated by the premium of certified products in international market, firms tend to adopt quality certifications. Research focused on consumers' willingness to pay (WTP) also support this idea. Most of the literature has shown that consumers can identify certification, which results in direct market premiums and export (Abate et al., 2021; Balogh et al., 2016; Jaffry et al., 2004).

However, the above conclutions are different in regions of income status, institutions and more importantly, the particularity of quality certification. Studies based on country level analysis point out that the positive effect is larger in countries with weak institutions and low income (Auriol and Schilizzi, 2015; Goedhuys and Sleuwaegen, 2016). What's more, the food safety certifications imposed by importing countries are often found to have negative effect on export. Chen et al. (2008a) used a gravity model to investigate the impact of food safety standard imposed by importing countries on China's agricultural export and find a negative effect.

With this concern, we use ISO 9001 as proxy for quality certification for three main reasons:

First, ISO 9001 accreditation is a reliable tool containing recognized high-quality production (Cao and Prakash, 2011). ISO 9001 is an international quality certification that contains a series of quality management guidelines to verify the quality status. The nature of the ISO 9001 is to provide a series of quality requirements for overall process including product design, manufacturing, transportation, service, and customer support (Naveh et al., 2004). Second, ISO 9001 is the most widely used quality certification in China. As it shown in Table 1, the adoption rate of ISO 9001 quality certification has exceeded half of the listed firms, which demonstrates that the ISO 9001 has a good reputation and the quality information conveyed behind it can be recognized by the market. Third, ISO 9001 is a dynamic quality certification system that collaboratively developed. According to International Organization for Standardization (ISO), ISO 9001 has experienced 4 revises since it was first published in 1987, which including 2 minor changes (1994, 2008) and 2 major changes (2000, 2015). These revisions have made ISO 9001 more inclusive. For example, the main purpose of ISO 9001:2008 version changes is to state the content more clearly of the 2000 edition and be more compatible with ISO 14001:2004. Therefore, ISO 9001 builds mutually recognized quality signal in international market which helps improve firms' quality reputation, ensure consistent quality management strategies and strengthened exports (Curkovic and Sroufe, 2011; Heras-Saizarbitoria and Boiral, 2019).

Accordingly, we propose the main hypothesis of this paper:

Hypothesis 1. *Obtaining ISO* 9001 *certification has a direct positive effect on firm export in agri-food sectors*.

2.2. The mechanism of innovation on export

We hypothesize that innovation mediates the positive relationship between ISO 9001 adoption and export, such that quality certification obtainment also has a positive indirect impact on agri-food export. We hold that the sustainable premium of quality certification lies in the innovation improvement via quality certification. The reasons are as follows:

First, the production instructions in ISO 9001 can promote export with the effect of "learning by doing". As discussed before, ISO 9001 contains a series of production and quality management instructions which helps organizations improve their innovation in the form of "learning by doing". It has been identified by previous studies. For instance, Moser and Voena (2012), Costa et al. (2019), Sa et al. (2022), Santos et al. (2021) have found that the obtainment of quality certification requires firms and organizations execute consistent criteria and instructions in production process, which help firms gain self-innovation in the process of certification obtaining.

Second, the compliance practices of quality certification help firms to gain independent innovation as well. Some authors find that the quality management specifications and requirements detailed in quality certifications can thereby encourage firms to engage in complementary research and related investment in innovation, which promote self-innovation in the end. For example, Pekovic and Galia (2009) argue that quality practices, in both their human and technological dimensions, help to create an environment and culture that support innovation. Ullah (2022) finds that firms that implement quality certification standards such as ISO standards are more innovative than uncertified firms, both in invention-oriented innovation and imitation-oriented innovation.

Based on the analysis above, we formulate the following hypothesis.

Hypothesis 2. *ISO* 9001 *quality certification may affect exports by improving firms' innovation activities*.

3. Empirical strategy, model and data

3.1. Sample and data

To investigate the effect of ISO 9001 quality certification on firms' exports, we assemble a unique panel data set of Chinese listed firms in agri-food sectors between 2000 and 2016 as research sample[7], containing quality certification, export and financial indicators. We collect data mainly from three key databases in China, including WIND Financial Database, China Customs Database (CCD) and China Stock Market & Accounting Research (CSMAR) database. The CCD database covers all Chinese exports from 2001 to 2016 at the Harmonized System (HS) eight-digit level, and the WIND and CSMAR are the two key databases for researchers to study Chinese firms' economic behaviour, covers all the listed firms in China. Drawing on the China Securities Regulatory Commission Trade Classification (CSRTC)[8], we identify three agri-food related broad sectors (at the one-digit CSRTC) including food, agricultural and agri-sideline manufactural sectors.

The certification data are in the form of text, which obtained from the qualification certification section of the WIND Financial Database containing firms' name, stock code and all the valid period of each certification. Besides ISO 9001, the certifications used in empirical study including ISO 14001, ISO 22000, HACCP, ISO 45000, OGA, GAP, GFC, Pollution-free Agricultural Products, and Enterprise Intellectual Property Management System, which are listed in Table 1. Since the

[7] As the core dependent variable of exports data exists up to 2016, our sample period is between 2000 and 2016.

[8] The criteria for industry classification are obtained from the China Securities Regulatory Commission (CSRC) in the fourth quarter of 2016.

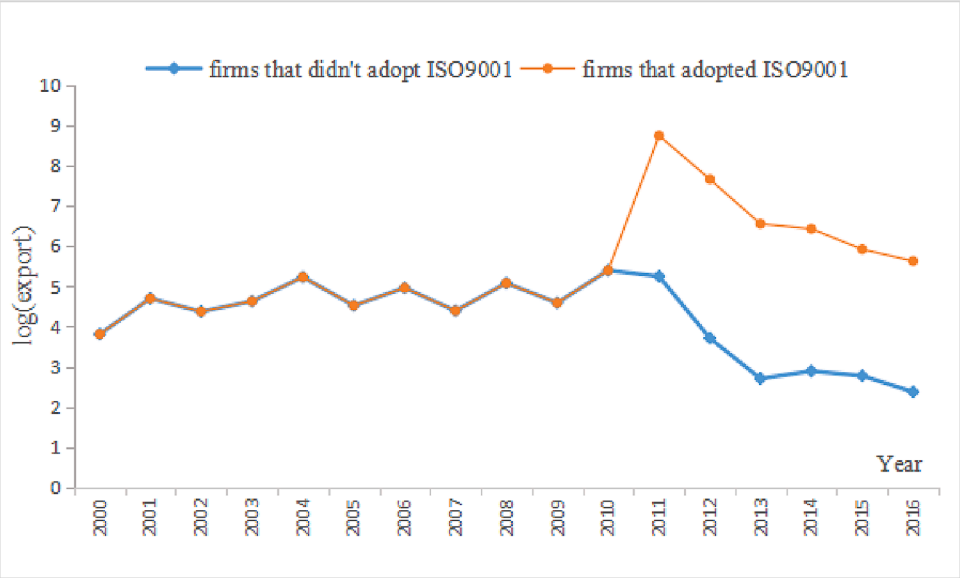

Fig. 1. Exports of certified vs. uncertified firms, 2000–2016.

certification information of the obtainment and the valid period of each certification in each firm are in the form of text, we manually collect and clean the quality certification data.

The exports and financial data are derived from CCD and CSMAR respectively, including the firms' export volumn, firm size, age, net profit, total assets, debt to asset ratio, shareholding ratio of top ten shareholders, and the ratio of business income to inventory balance. The definition and descriptive statistics of all the variables in all the models are shown in Table 1A in the Appendix.

The data processing method is as follows: (1) merge the financial data from CSMAR database with the export data from CCD database at the last 7 digits of the company's address, legal representative, postal code, and telephone number[9]. (2) match the quality certification into the export and financial data we merged by firms' stock code, name and zip code. (3) remove the delisted and special treatment listed companies. Finally, we obtain a sample of 115 listed firms in agri-food sectors on the Shanghai and Shenzhen stock exchanges between 2000 and 2016. The sample is an exhaustive list of all the listed firms in agri-food related sectors in China, covering all the export vs. non-export firms, private vs. state-owned firms, and firms that with vs. without quality certifications.

Fig. 1 below shows the export difference between certified and uncertified firms of Chinese agri-food manufacturers from 2000 and 2016. It shows that firms have been adopted ISO 9001 export more than those that have not.

3.2. Estimation framework

Our estimation strategy exploits two sources of variation. The first is time variation arising from the introduction of ISO 9001 in China as a quality certification system. We apply staggered DID strategy that compares exports between firms before and after ISO 9001 adoption. We consider the ISO 9001 introduction as a quasi-natural experiment and define quality certification as a treatment obtained by some firms but not by others. Since ISO 9001 is valid for three years as a cycle, those certified firms must be rechecked every year and recertified after three years of adoption. During the sample period, some firms may give up rechecking or reapplication and lose their certification. Our measure identifies the treated firms as they have ever adopted ISO 9001, regardless of whether they lost their certification during the sample period. Firms have never adopted ISO 9001 certification would be considered as the control group.

The second source of variation is cross-sectional and arises from differences in firms' characteristics, as determined by time-invariant conditions. Conditional on access to ISO 9001, firms that are more capable to obtain high quality certification will be more likely to enhance product quality management. Thus, we control those factors by adding a fixed effect term of α_i. We then estimate the effect of this treatment through a DID regression by exploiting both time series and cross-sectional variations in the data. If a firm obtains a certain kind of quality certification in a specific period, we consider it to be a treated firm. We compare the change in exports for the treated food and agricultural firms before and after the treatment. Staggered DID procedure is used to estimate the impact of quality certification on exports.

Therefore, the staggered DID estimation is specified as:

$$lnexport_{it} = \alpha_0 + \beta ISO9001_{it} + \gamma \sum X_{it} + \delta_i + \lambda_t + \varepsilon_{it} \quad (1)$$

Where i and t indicate firm i and year t; $lnexport_{it}$ denotes the logarithm of exports in firm i in year t. $ISO9001_{it}$ takes a value of 1 if firm i obtained ISO 9001 quality certification in the valid time of t. The parameter β is the efficient of our interest, indicating the export effects of ISO 9001.

X_{it} contains a set of control variables: (1) age_{it}, the age of the firm – equal to the difference between the current year and the year the firm was established; (2) roa_{it}, return on assets – the ratio of the company's net profit to total assets; (3) $size_{it}$, the size of the company – the logarithm of the total number of company employees in time t; (4) lev_{it}, the company's asset-liability ratio – the ratio of the company's total liabilities to total assets; (5) ten_{it}, the shareholding ratio of a company's ten largest shareholders in time t. (6) $turnover_{it}$, inventory turnover rate – the ratio of the company's current operating costs to average inventory balance. The summary statistics are shown in Table A1 in the Appendix.

δ_i is the firm level fixed effect representing all the time-invariant difference across firms which might affect exports; λ_t is the year fixed effect, controlling other effects in a certain year that might influence all firms in a similar manner. ε_{it} is the error term.

[9] There are 22 firms have undergone industry changes during our sample period. We consider the latest industry category as the firms' industry attributes. The detail changing information are in Table 2A.

Table 2
Effect of ISO 9001 on agri-food exports.

	Dependent variable: ln(export)				
	(1)	(2)	(3)	(4)	(5)
ISO 9001	2.7113***	2.1169***	1.3095***	1.5580**	1.4575***
	(0.411)	(0.420)	(0.348)	(0.502)	(0.386)
Size		0.3215***	0.4116***	0.3282***	0.4081***
		(0.044)	(0.070)	(0.046)	(0.072)
Lev		−2.5172***	0.4946	−2.4012***	0.5682
		(0.575)	(0.472)	(0.585)	(0.490)
Ten		−2.5060*	−3.7234*	−2.5248*	−3.9445*
		(1.027)	(1.610)	(1.016)	(1.638)
Age		0.0096	0.0377	−0.0670	0.0173
		(0.031)	(0.029)	(0.044)	(0.045)
ROA		−2.2064	0.1756	−1.9924	0.2203
		(1.589)	(0.633)	(1.594)	(0.642)
Turnover		−0.1473***	−0.0835*	−0.1536***	−0.0987**
		(0.027)	(0.035)	(0.026)	(0.036)
Constant	2.0288***	−1.1951***	−7.0940***	−1.9767***	−6.7851***
	(0.133)	(0.156)	(0.745)	(0.584)	(1.006)
Firm-fixed effects	No	No	Yes	No	Yes
Year-fixed effects	No	No	No	Yes	Yes
Observations	1797	1797	1797	1797	1797
R-squared	0.0362	0.0793	0.5463	0.0922	0.5513

Notes: (1) This table reports estimated results based on Eq. (1). (2) Robust standard errors in parentheses. (3) ***, ** and * indicate significance at 0.1%, 1%, and 5% levels, respectively.

3.3. Identifying assumptions and checks

Eq. (1) allows us to control for both firm and time-period fixed effects so that all the time-invariant differences across firms and secular changes over time are controlled. The basic identifying assumption of the DID estimation in Eq. (1) is that the certified firms and uncertified firms have a same time trend if they did not adopt the ISO 9001.

One threat of the assumption is that the ISO 9001 adoption may not be randomly assigned among firms. This means that the divergence in Fig. 1 between certified and uncertified firms may have been caused by some other pre-existing differences. To address this issue, we control a series of variables to balance the different characteristics of the two groups as much as possible. And then conducted a parallel trend test to check the robustness of the results of Eq. (1). For details on these checks, see Section 4.3.

Another concern is that other quality certification or policy shocks around the same time of ISO 9001 adoption might be correlated with firms' exports. That is, Eq. (1) requires that there are no other shocks during the ISO 9001 adoption period. As further checks on our identification assumption in Eq. (1), we use a series of placebo test and robustness checks for Eq. (1), including creating a kind of imaginary events, randomly assigned firms' ISO status, and alternative estimating approach of two-part fractional regression model. For details of these checks, see Section 4.3.

4. Results and robustness checks

4.1. Empirical findings

4.1.1. Main results

Table 2 reports the main results of the DID estimation using exports as the dependent variable. Columns (1) and (2) report the "unconditional" and "conditional" export effects respectively by adding the vector of covariates X_{it} to control for firm characteristics. In columns (3) and (4), we estimate the effect of certification on exports by adding firm fixed effects and year fixed effects respectively. In column (5), we control for both firm and year fixed effects.

The results show a significantly positive relationship between ISO 9001 certification and exports. Firms with ISO 9001 certification exported more than firms without this certification in the sample period. After control variables and fixed effects, the coefficients remain significantly positive. We find that the positive promotion effect of quality certification ISO 9001 on exports is significant at the 1% level, which indicates that ISO 9001 certification is associated with an increase in exports by listed agricultural and food companies in China.

Table 3
Regression of two-part fractional response model.

	PartI: export (Yes = 1)	PartII:share of export value
	(1)	(2)
ISO 9001	0.6202***	0.5597***
	(0.152)	(0.122)
Control variables	Yes	Yes
Constant	−6.9267***	2.2438
	(0.981)	(2.397)
N	1797	314

Notes: (1) The control variables are the same as Eq. (1). (2) Robust standard errors are indicated in parentheses. (3) ***, ** and * indicate significance at the 0.1%, 1%, and 5% levels, respectively.

4.1.2. Consideration of the probability to export

The reason why firms get certified are closely linked to the probability to export. Some research found that export has a significantly positive relationship with the adoption of ISO 9001 certification both at the country and firm level (Fikru, 2014; Kalani et al., 2013).

Concerned with this issue, we conducted a two-part fractional regression model which includes the dependent variables of the probability and the specific logarithm of exports. Following Ramalho et al. (2011), the results can identify the relationship between export volume and ISO 9001 obtainment on conditional of the decision to export.

Table 3 presents the results estimated using a two-part fractional regression model. Part 1 of the two-part model from column 1 suggests that firms with ISO 9001 certification are more likely to export. The results of Part 2 from column 2 show that, on conditional of the decision to export, obtaining ISO 9001 increases the share of exports. The results of the two parts are consistent with our main results in Table 2, suggesting that the obtainment of ISO 9001 certification has significantly positive effects on firms' export volume after we control the probability to export, and the results in Table 2 are reliable.

4.1.3. Mechanism of innovation

To test Hypothesis 2, we use the innovation activities as mechanism

Table 4
Regression of mechanism analysis.

Dependent variable	(1)	(2)
	lnexport	*lnpatent*
ISO 9001	1.4575***	0.1412*
	(0.386)	(0.082)
Constants	−6.7851***	−5.6086***
	(1.006)	(0.980)
Control variables	YES	YES
Firm-fixed effects	YES	YES
Year-fixed effects	YES	YES
Observations	1797	1145
R-squared	0.5513	0.7065

Notes: (1) Column (1) to (2) show estimated results based on Eq. (2) and Eq. (3), respectively. The control variables are the same as the Eq(1). (2) Robust standard errors are indicated in parentheses. (3) ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 5
Parallel trend test.

	Dependent variable: ln(export)			
	T = 0		T = -1	
	(1)	(2)	(3)	(4)
pre_4	−1.0429*	−0.6294	−1.0386*	−0.7409
	(0.570)	(0.570)	(0.548)	(0.547)
pre_3	−0.7122	−0.4230	−0.7079	−0.5345
	(0.648)	(0.650)	(0.620)	(0.622)
pre_2	−0.5083	−0.1325	−0.5040	−0.2440
	(0.675)	(0.669)	(0.654)	(0.648)
pre_1	−0.0043	0.1115		
	(0.659)	(0.661)		
current			0.0043	−0.1115
			(0.659)	(0.661)
post_1	1.4427**	1.3895**	1.4470**	1.2780*
	(0.697)	(0.691)	(0.712)	(0.705)
post_2	1.8817**	1.8427**	1.8860**	1.7312**
	(0.766)	(0.773)	(0.790)	(0.797)
post_3	1.8349**	1.7278**	1.8393**	1.6163*
	(0.848)	(0.846)	(0.868)	(0.865)
post_4	1.6824**	1.4656*	1.6867**	1.3541
	(0.836)	(0.827)	(0.847)	(0.839)
_cons	−0.4605	−6.3384***	−0.4605	−6.3384***
	(0.498)	(1.041)	(0.498)	(1.041)
Controls	No	Yes	No	Yes
Firm-fixed effects	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes
Observations	1797	1797	1797	1797
R-squared	0.5330	0.5538	0.5330	0.5538

Notes: (1) This table reports estimated results based on Eq. (4). (2) Robust standard errors in parentheses. (3) ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

variable. About the specific test methods of mechanism, we follow the practice of Dell (2010), Acemoglu et al. (2019), the basic model is specified as:

$$\text{In export}_{it} = \alpha_0 + \beta_1 \text{ISO9001}_{it} + \gamma \sum X_{it} + \delta_i + \lambda_t + \varepsilon_{it} \quad (2)$$

$$\text{In patent}_{it} = \alpha_0 + \beta_2 \text{ISO9001}_{it} + \gamma \sum X_{it} + \delta_i + \lambda_t + \varepsilon_{it} \quad (3)$$

where ln*patent*$_{it}$ is the innovation variable representing the logarithm of the authorizations of design, invention and utility patents for firm *i* in year *t*. The control variables are the same as in Eq. (1). We also control the firm and year fixed effects.

Table 4 shows the results of the mechanism analysis. Column (1) is the benchmark regression results. Column (2) shows that the adoption of ISO 9001 certification promotes firms' innovation activities significantly. Many literatures have reached a basic consensus that innovation can promote export growth. In the endogenous growth theory, Grossman and Helpman (1993) emphasize that innovation determines the firms' technological competitiveness and export performance. Some empirical research also found that the innovation activities have positive impact on the firms' export performance (Roper and Love, 2002). We can therefore infer that ISO 9001 certification promotes exports by increasing innovation activities, thereby verifying Hypothesis 2.

4.2. Parallel trend test

We apply a parallel trend test to check the robustness of the results above. The common trend assumption is the key assumption underpinning the use of a DID regression to estimate the treatment effect. This assumption requires that changes in the treatment group and in controlled group are the same in absence of certain policy shocks. Before the obtainment of ISO 9001, the treatment and control groups should experience consistent, or parallel changes, indicating that the results are driven by obtaining the certification and not by an underlying trend between the two groups. Following Beck et al. (2010), the parallel trend test equation is spcified as:

$$lnexport_{it} = \alpha_0 + \sum_{k=-4}^{4+} \beta_k ISO9001_{i,t+k} + \gamma \sum X_{it} + \delta_i + \lambda_t + \varepsilon_{it} \quad (4)$$

Where $ISO9001_{i,t+k}$ is a series of dummies jointly denote a window of four periods around the ISO 9001 obtainment. Specifically, k = −4,−3,−2,−1, 0, 1, 2, 3, 4 +. Other variables are the same as Eq. (1). To make it more convincible, we take t = -1 and t = 0 as base group respectively to conduct the parallel trend tests. β_k is the parameters of our interest, it identify the effects of ISO 9001 adoption *k* years following its occurrence.

Table 5 reports the estimation results. Column (1) and (2) are the results of the t = 0 baseline, and column (3) and (4) are the results of the t = -1 baseline. Column (1) and (3) are the results without control variables X_{it}, and column (2) and (4) are the results with control variables. The results are also illustrated in Fig. 1A of the Appendix.

The four pretreatment indicators are insignificant statical power, indicating that certified and uncertified firms followed similar time trend at least four years before the adoption of ISO 9001. Meanwhile, after adoption of ISO 9001, the coefficients become significantly positive. This point estimates support that the difference in exports between certified and uncertified firms come from the ISO 9001 adoption.

4.3. Robustness checks

In this section, we conduct a series of robustness checks, including control the effects of other quality certifications, control predetermined characteristics and time trend, changes of certification adoption time, randomly assignment of ISO 9001 status, and alternative regression method.

4.3.1. Control the effects of other quality certifications on exports

Besides ISO 9001, other quality certification such as ISO 14001 (Environment Management Systems), ISO 22000 (Food Safety Management Systems) and other quality certifications as shown in Table 1 may affect export.

There are differences and similarities among those quality certifications. ISO 9001 is a management system-based approach to quality which requires participating firms to establish and document quality assurance practices, to identify managers to implement these practices and train employees, to conduct internal audits, and to get quality management systems audited by an accredited external auditor. The main goals of ISO 9001, ISO 14001 and ISO 22000 are to assure quality, environment performance and food safety respectively. In terms of quality assurance, we hold that ISO 9001 is the most relevant certification concerning product quality. However, there are many similarities between the three ISO standards. For example, they are all voluntary

Table 6
Regression for other certifications.

Dependent variable: ln(export)	(1)	(2)	(3)
	ISO 14001	ISO 22000	Other certifications
ISO 9001	1.2359***	1.2226***	1.2166***
	(0.404)	(0.379)	(0.385)
ISO 14001	0.8311		
	(0.577)		
ISO 22000		3.2508***	
		(0.642)	
Other certifications			1.8220***
			(0.464)
Control variables	Yes	Yes	Yes
Firm-fixed effects	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes
Observations	1797	1797	1797
R-squared	0.5521	0.5628	0.5581

Notes: (1) Other certifications include HACCP (Hazard Analysis and Critical Control Point), ISO 45000 (Occupational Health and Safety Management System), OGA (Organic Product Certification), GAP (Good Agricultural Practice), GFC (Green Food Certification), and Pollution-free Agricultural Products Certification. (2) Robust standard errors are indicated in parentheses. (3) ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

international standards issued by ISO, and built on the Plan-Do-Check-Act (PDCA) process cycle model.

Previous studies have found the interactions effect on export of those quality certifications. For instance, a global review across 15 developed and developing nation directed by Raines (2002) suggests that most organizations satisfied with the capacity of ISO 14001 to trade internationally. Berényi (2018) points out that firms and organizations need to show good business practices in the international market, and those with ISO 14001 accreditation present better business practices than those without this. Ikram et al. (2020) even find that ISO 14001 certification contributes more to economic development than ISO 9001 in both developed and developing countries.

If a firm obtains those quality certifications during the same period, the estimates in Eq. (1) may mistakenly capture the effects of those confounding factors rather than the effect of the ISO 9001. As shown in Table 1, there are several other quality certifications obtained by China's agri-food listed firms. With this concern, to control the effect of other quality certifications, we extended the Eq. (1) by adding more quality certifications as follows in Eq. (5):

$$lnexport_{it} = \alpha_0 + \beta ISO9001_{it} + \theta otherqc_i + \gamma \sum X_{it} + \delta_i + \lambda_t + \varepsilon_{it} \quad (5)$$

where $otherqc_i$ is a dummy variable equalling 1 if a firm i obtained ISO 14001, ISO 22000 or other quality certifications including HACCP (Hazard Analysis and Critical Control Point), ISO 45000 (Occupational Health and Safety Management System), OGA (Organic Product Certification), GAP (Good Agricultural Practice), GFC (Green Food Certification), and Pollution-free Agricultural Products Certification, and 0 otherwise. $ISO9001_{it}$ is the same definition as in Eq. (1). Other variables are the same as in Eq. (1).

As shown in Table 6, the ISO 9001 still has a significant and positive effect on exports, with a modest increase in the magnitude. Since other certifications are all independent quality regulations with its own release agenda, this result implies that the results of ISO 9001 are not contaminated by other certifications.

4.3.2. Control the effects of predetermined factors and time trend

The reason why firms get certified can be closely linked to some predetermined factors or other time trend. For instance, the export decision and other inherent characters such as the firm size between firms may induce different impacts on the export volume over time (Fikru, 2014; Kalani et al., 2013). That is, the treated group and the control group may be determined by prerequisite variables.

Table 7
Control the interactions of predetermined factors and time trend.

	Dependent variable: lnexport
ISO 9001	**0.6192****
	(0.295)
L.export*time trend	Yes
L.size*time trend	Yes
Control variables	Yes
Constants	7.6908
	(10.281)
Firm-fixed effects	Yes
Year-fixed effects	Yes
Observations	1682
R-squared	0.7658

Note: (1) The time trend denotes 16-year dummy variables from 2000 to 2016 with one year as base group. (2) Robust standard errors are indicated in parentheses. (3) ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 8
Change ISO 9001 adoption time.

	Dependent variable: ln(export)			
	t-2	t-3	t-4	t-5
ISO 9001	0.6841	0.1025	−0.0495	−0.0846
	(0.354)	(0.341)	(0.341)	(0.346)
Control variables	Yes	Yes	Yes	Yes
Firm-fixed effects	Yes	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes	Yes
Observations	1797	1797	1797	1797
R-squared	0.5479	0.5469	0.5469	0.5469

Notes: (1) The control variables are the same as Eq. (1). (2) Robust standard errors are indicated in parentheses. (3) ***, ** and * indicate significance at the 0.1%, 1%, and 5% levels, respectively.

To address this problem, following the approach of Edmonds et al. (2010) and Lu et al. (2017), we control those predetermined factors and time trend by adding their interactions into Eq. (1).

First, we extract the predetermined variables that may affect the probability of obtaining ISO 9001 certification, including export decision, firm size. The results are shown in Table 3A in the Appendix. We found that firm's export decision and size have significant positive effect on their ISO 9001 certification adoption. Second, to control those predetermined factors and the time trend, we add the interactions of two predetermined variables to Eq. (1) to control the impact of the original inherent characteristic differences between firms. To some extent, it alleviated the selected bias considering that the treated group and the control group did not randomly assign.The results are shown in Table 7. The coefficients of ISO 9001 have decreased but still significant at the 5% significance level, indicating that our results in Table 2 are valid.

4.3.3. Change the certification adoption time

We change firms' ISO 9001 acquisition time to check the significance of the DID estimator. Specifically, we change the ISO 9001 adoption time forward by 2 years, 3 years, 4 years and 5 years respectively. If it is found to have a significant effect, the differences between the treatment and control groups may have occurred by other factors related to time. Otherwise, the difference between the two groups in Table 2 is robust.

The regression results are shown in Table 8. Columns (1)-(4) represent the ISO 9001 adoption time predated 2, 3, 4, 5 years, respectively. The results show that the coefficients of the core explanatory variables are insignificant, indicating that other potential unobservable factors related to time have no impact on export.

4.3.4. Randomly generated ISO 9001 status

To check the potential bias influenced by other omitted variables, we randomly assign the ISO 9001 status to firms (Chetty et al., 2009; La

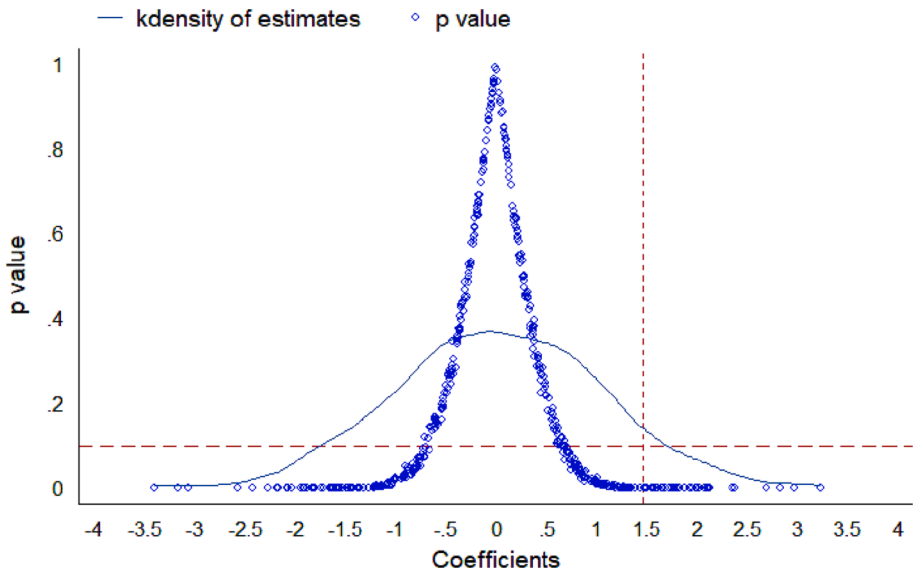

Fig. 2. Distribution of estimated coefficients of falsification test.

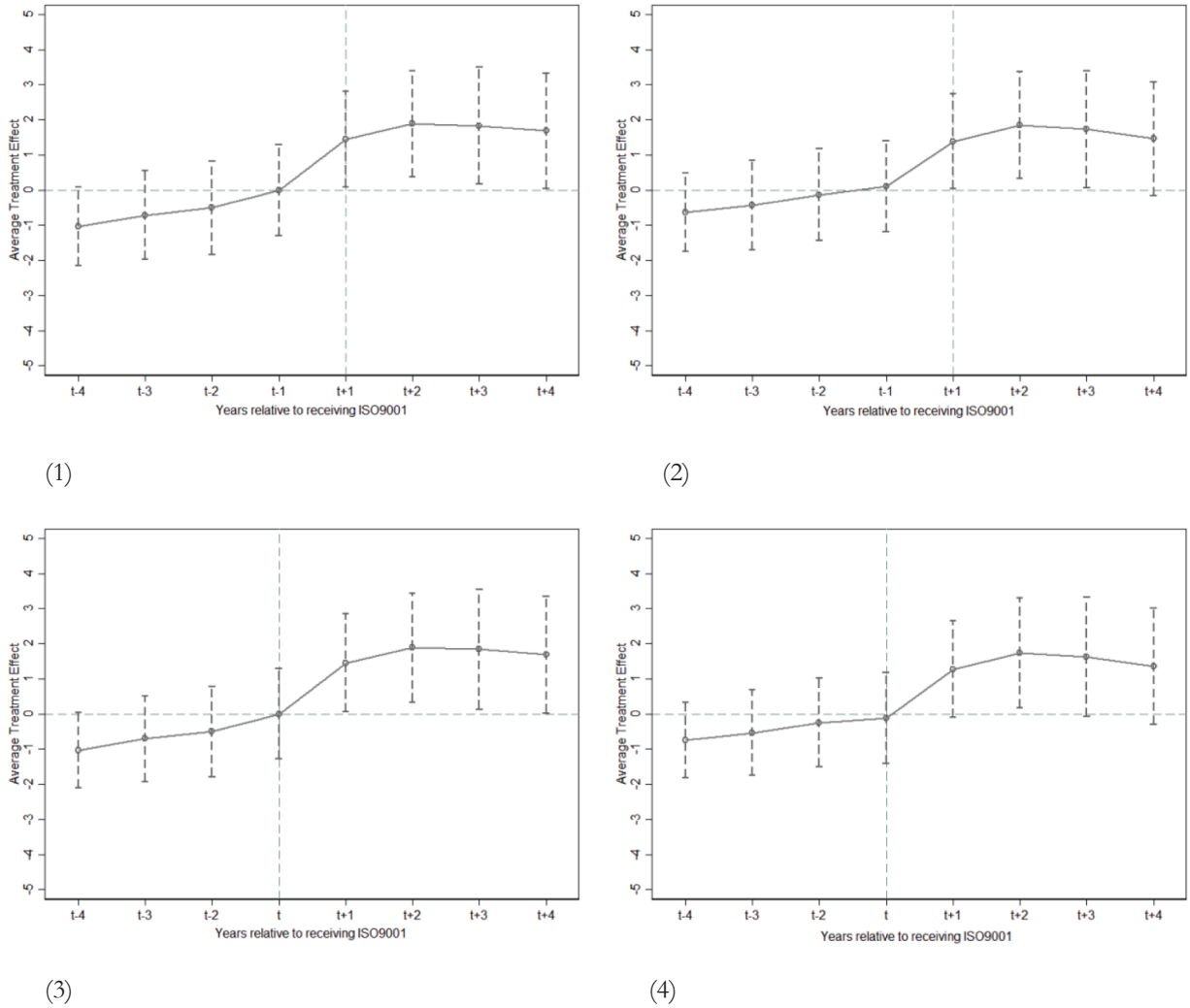

Fig.1A. Parallel trend test.

Table 9
Regression of firms' sectors.

	Dependent variable: ln(export)		
	Agricultural	Agri-sideline	Food
ISO 9001	1.2746**	1.2255	1.4588**
	(0.497)	(0.832)	(0.678)
Control variables	Yes	Yes	Yes
Firm-fixed effects	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes
Observations	651	556	590
R-squared	0.7129	0.4494	0.4650

Notes: (1) The control variables are the same as in Eq. (1). (2) Robust standard errors are indicated in parentheses. (3) ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Table 10
Regression of ownership types.

	Dependent variable: ln(export)		
	(1) all	(2) SOEs	(3) non SOEs
ISO 9001	1.4738***	0.1655	1.6597***
	(0.386)	(0.614)	(0.505)
soe	1.3970**		
	(0.516)		
Control variables	Yes	Yes	Yes
Firm-fixed effects	Yes	Yes	Yes
Year-fixed effects	Yes	Yes	Yes
Observations	1797	634	1163
R-squared	0.5528	0.6272	0.5444

Notes: (1) The control variables are the same as in Eq. (1). (2) Robust standard errors are indicated in parentheses. (3) ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

5. Further discussion

5.1. Effects of firms' sectors

We further explore different effects of firms' sectors on the main results. In consideration of different products with different characters, we divide the sample into agricultural, agri-sideline and food manufactural sectors based on the industry classifications for listed companies developed by CSRC[10]. The main difference between the three sectors are the products they produced. Agricultural firms mainly produce and export primary agricultural products, agri-sideline manufacturers mainly produce, and export processed food products made from primary agricultural products, and food manufacturers mainly produce and export refined products.

We test the Eq. (1) again. The results are shown in Table 9, which confirm that the coefficients on food manufacturers (1.4588 with se = 0.678) are higher than that for the agricultural (1.2746 with se = 0.497). That is, the impacts of ISO 9001 certification on exports are more pronounced for food manufacturers than other firms in agri-food sectors.

5.2. Different ownership types

We further consider the different impacts of the firms' ownership types. We divide firms into state-owned enterprises (SOEs) and non-state-owned enterprises (non-SOEs).

The results in Table 10 show that the impact of ISO 9001 certification on exports is insignificant for SOEs but positively significant for non-SOEs. Column (2) and (3) show that the ISO 9001 adoption helps non-SOEs gain more export than SOEs. The coefficient of *soe* in Column (1) is significant indicating that effects on exports between SOEs and non-SOEs are different. In China, SOEs have a natural tie with the government which are more favored both financially and legally compared to non-SOEs (Huang, 2003; Ren et al., 2022). Therefore, SOEs may have more advantages to export compared with non-SOEs, because they are more likely to pass the ice cost and face lower regulation cost due to the connection with government (Poncet, 2005; Hering and Poncet, 2014). Besides, SOEs depends less on certification to convey quality signals, i.e. technologies, government prizes, etc (Roumasset et al., 2008). Based on the two points above, SOEs benefit less from ISO 9001 certification for their exports. .

Table 1A
Descriptive statistics.

Variable	Defination	Obs	Mean	Sd	Min	Max
lnexport	Logarithm of export	1797	2.56	5.66	0.00	18.92
export	Equal to 1 if a firm export, otherwise 0	1797	0.18	0.38	0.00	1.00
ISO 9001	If a firm ever obtained ISO 9001 = 1, otherwise 0	1797	0.20	0.40	0.00	1.00
ISO 14001	If a firm ever obtained ISO 14001 = 1, otherwise 0	1797	0.08	0.27	0.00	1.00
ISO 22000	If a firm ever obtained ISO 22000 = 1, otherwise 0	1797	0.06	0.23	0.00	1.00
other certifications	If a firm ever obtained HACCP, ISO45000, OGA, GAP, GFC, or PAP = 1, otherwise 0	1797	0.12	0.32	0.00	1.00
size	Total assets	1797	19.63	4.48	1.46	24.45
lev	Debt to asset ratio	1797	0.34	0.24	0.00	2.94
ten	Shareholding ratio of top ten shareholders	1797	0.57	0.18	0.00	0.92
age	Duration of firms	1797	10.88	5.86	1.00	32.00
roa	Net profit to net assets at the end of year	1797	0.04	0.08	−0.62	2.14
turnover	Ratio of operation revenue to inventory balance	1797	4.70	4.88	0.00	62.96
lnpatent	Logarithm of all the patent authorizations	1145	0.71	1.16	0.00	5.78
soe	SOEs = 1, otherwise 0	1797	0.35	0.48	0.00	1.00
year	17 years (between 2000 and 2016)	1797				
firm	115 firms	1797				

Ferrara et al., 2012). Fig. 2 Shows the distribution of estimated coefficients from 500 runs along with the benchmark estimate, 1.4955 from column (5) in Table 2, which are presented in the vertical line. The horizontal axis represents the estimated coefficients of the potential omitted variables, and the vertical axis represents the density value and the p-value. The thin solid line is the Kernel density estimation of the coefficients, the blue dots are the p-values corresponding to the estimated coefficients, and the horizontal dashed line is the significance level of 0.1.

As shown in Fig. 2, the estimated coefficients are mostly concentrated around the zero point, and most of the estimated values have p-values greater than 0.1 (not significant at the 10% significance level), suggesting that our estimated results in Table 2 are convincible. The effects of ISO 9001 on exports are not driven by unobserved factors.

[10] With the industry code A (agricultural), C13 (agri-sideline manufacture), C14 (food manufacture) respectively.

Table 2A
Firms' information that have undergone industry changes between 2000 and 2016.

No	Stock Code	Former industry information and time span	Latest industry information and time span
1	000529	Textile industry (C17, 2000–2008)	Agricultural and sideline food processing industry (C13, 2009–2016)
2	000639	Metal products industry (C33, 2000–2010)	Agricultural and sideline food processing industry (C13, 2011–2016)
3	000893	Electrical machinery and equipment manufacturing (C38, 2000–2009)	Agricultural and sideline food processing industry (C13, 2010–2016)
4	000972	Agriculture (A01, 2000–2009)	Agricultural and sideline food processing industry (C13, 2010–2016)
5	002286	Food manufacturing (C14, 2000–2011)	Agricultural and sideline food processing industry (C13, 2012–2016)
6	600275	Fishery (A04, 2000–2011) Real estate (K70, 2012–2015)	Agricultural and sideline food processing industry (C13, 2016)
7	600438	Agriculture, Forestry, Animal Husbandry and Fishery Services (A05, 2000–2009)	Agricultural and sideline food processing industry (C13, 2010–2016)
8	000716	Comprehensive industry (S90, 2000–2010)	Food manufacturing (C14, 2011–2016)
9	002053	Agricultural and sideline food processing industry (C13, 2003–2010) Chemical raw materials and chemical products manufacturing (C26, 2011–2015)	Food manufacturing (C14, 2016)
10	600298	Agricultural and sideline food processing industry (C13, 2000–2011)	Food manufacturing (C14, 2012–2016)
11	600419	Paper and paper products industry (C22, 2000–2013)	Food manufacturing (C14, 2014–2016)
12	600597	Agricultural and sideline food processing industry (C13, 2000–2011)	Food manufacturing (C14, 2012–2016)
13	600872	Comprehensive industry (S90, 2000–2011)	Food manufacturing (C14, 2012–2016)
14	600873	Electrical machinery and equipment manufacturing (C38, 2000–2010)	Food manufacturing (C14, 2011–2016)
15	600882	Chemical raw materials and chemical products manufacturing (C26, 2000–2011) Ferrous metal mining and dressing industry (B08, 2012–2015)	Food manufacturing (C14, 2016)
16	600313	Agriculture (A01, 2000–2011) Wholesale industry (F51, 2012–2014)	Agriculture (A01, 2015–2016)
17	600371	Agricultural and sideline food processing industry (C13, 2000–2008)	Agriculture (A01, 2009–2016)
18	002200	Public facilities management (N78, 2002–2011)	Forestry (A02, 2012–2016)
19	000592	Real estate (K70, 2000–2007)	Forestry (A02, 2008–2016)
20	600097	Electrical machinery and equipment manufacturing (C38, 2000–2008)	Fishery (A04, 2009–2016)
21	600257	Agriculture, Forestry, Animal Husbandry and Fishery Services (A05, 2000–2011)	Fishery (A04, 2012–2016)
22	000713	Agriculture (A01, 2000–2011)	Agriculture, Forestry, Animal Husbandry and Fishery Services (A05, 2012–2016)

Table 3A
The effect of predetermined factors on iso 9001.

	(1)
	ISO 9001
L.export	0.0836***
	(0.026)
L.size	0.0090***
	(0.002)
L.roa	−0.0533
	(0.069)
constants	−0.3396***
	(0.076)
N	1682
r2	0.5857
Firm	Yes
Year	Yes

Note: (1) Robust standard errors are indicated in parentheses. (2) ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

6. Conclusions

This paper investigates the effects of ISO 9001 quality certification on exports of food and agricultural listed firms in the context of China. We corroborate that the ISO 9001 certification acquisition significantly promote agri-food firms' exports in China, and the possible mechanism of this is the innovation improvement during the ISO 9001 obtaining process. Impacts of ISO 9001 certification on exports are defferent in different sectors and ownerships of various listed firms. Our research develops the study on food quality management and offers new implications to China's high-quality oriented agricultural development strategy.

We propose two policy implications: First, we suggest that listed firms in agri-food sectors increase their quality certification adoption such as ISO 9001 and utilize the low-cost quality information to make more benefits in exports. ISO 9001 obtainment offers high-quality signal and good quality management systems, which helps firms foster innovation activities and boost exports. Governments in developing countries can take positive measures to accelerate ISO 9001 certification process in agri-food sectors to improve high-quality products exports. For instance, expanding the openness of the third-party certification agency market to reduce the cost of firms' certification, provide subsidies for agricultural firms participating in ISO 9001 certification. Besides, other voluntary certifications such as ISO 22000 also have positive effect on export of China's agri-food products, which indicates that voluntary certifications have been an important supplement in agri-food product quality regulation system.

Second, different measures should be emphasized for firms in different sectors and ownerships. The ISO 9001 certification brings more export benefits in food (vs. non-food) manufacturing firms and non-SOEs (vs. SOEs). Thus, we recommend that listed firms in food and non-SOEs more involved in quality certifications such as ISO 9001 to improve innovation activities and exports. We also suggest government in developing countries like China guide and support food manufacturing firms and non-SOEs to apply quality certification such as ISO 9001 to improve the quality of agricultural exports.

CRediT authorship contribution statement

Zhiqing Yang: Writing – original draft, Writing – review & editing, Methodology. **Peiyao Liu:** Software, Data curation. **Lianfa Luo:** Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence

the work reported in this paper.

Acknowledgments

We thank three anonymous referees for insightful suggestions. We gratefully acknowledge financial support from the National Natural Science Foundation of China (Grant No. 7217030601, 71933004) and the Fundamental Research Funds for the Central Universities in China (Grant No. 2022WKYXQN018).

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