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ORIGINAL ARTICLE

Don't take me for a free-ride: Chinese Agricultural Geographical Indications and firms' export quality

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Abstract

Geographical Indication (GI) is a rising policy in developing countries, which has been relatively neglected in the existing literature. This article studies Chinese agricultural GIs and its impact on firms' exports. By relating newly authorized GIs with firm-product-location-destination level customs trade data according to GIs' geographical coverage and product type, we estimate the impact of these new GIs on firm's exports. Importantly, we can distinguish GIs with and without quality supervision. For the latter we find negative impacts on export quality, which is not the case for GIs with quality supervision. We interpret this in the context of our theoretical framework as evidence for quality free-riding, where individual firms have an incentive to lower the quality of the export product. We show that this negative effect is less, the more concentrated an industry is or the more GIs there are for a particular product. Furthermore, our results suggest that the *China-EU agreement on Geographical Indications* may play the role of quality supervision and prevent the possibility of free-riding.

KEYWORDS
Agricultural Geographical Indications, China, export quality, free-riding

JEL CLASSIFICATION
F10, Q18

1 | INTRODUCTION

Buying a good apple is not that easy. Apples, and food products more generally, are experience goods. Their quality attributes are only revealed once they are consumed – the taste, texture, juiciness, and whatever else makes for a good taste experience. When quality is uncertain before consumption, consumers have to rely on the established reputation of a product. One way of signaling quality attributes and establishing a reputation is to use Geographical Indications (GIs), for example, Champagne or Parma Ham in Europe, or Washington Apples in the U.S. Such GIs are now a frequently used tool, in particular in the food sector. They help to alleviate the informational asymmetry problem, which may be even more severe in an international trade context where consumers may be even less able to judge quality. The implications of GIs for overall trade have been studied extensively in the literature (Cei et al., 2021; Curzi & Huysmans, 2022; Duvaleix et al., 2021; Huysmans, 2022a; Raimondi et al., 2020; Sorgho & Larue, 2014).

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GIs help to create a quality reputation for a particular product from a certain geographic region. However, in many cases this is a collective reputation where regional factors such as climate, soil variables, as well as producer-specific characteristics may influence quality. Such a collective reputation potentially provides incentives for individual producers to free-ride on the established reputation and provide lower quality products. This aspect has been highlighted in a number of theoretical contributions in the context of food products, also suggesting that one way to prevent such free-riding may be the setting and enforcing of high-quality standards (Larue & Lapan, 1992; Winfree & McCluskey, 2005). Empirical evidence on this issue is much sparser, however. Free-riding might be even more severe when agricultural firms source their products from other farmers rather than producing in-house, which has been shown to be a rising production mode in developing countries (Bellemare & Bloem, 2018; Wang et al., 2014). In this case, poor design of GI institutions may lead to an "at-home" regulatory failure and sourcing poorer quality products may thus be more likely.[1]

In this article, we look in detail at the relationship between GIs and the quality of export products. We provide an empirical analysis for China, using detailed firm-product-location-destination level customs trade data for agricultural food products available from 2000 to 2015. This provides us with trade transaction records including information on export values, quantities, prices, detailed product code, export destination, and firm location. We can link the data to comprehensive records on the implementation of GI labels, indicating GI's geographical location and narrowly defined product type.

China implemented a special law on GIs from 2005 onwards, which implies that we have data pre-GI implementation, and afterwards. Importantly, two GI protection systems were introduced during our sample period, one of which includes a quality supervision while the other does not. By combining the data sets we are able to investigate econometrically how the implementation of a GI affects the quality of the export product and test the role that quality supervision played in free-riding behavior. Methodologically, this is done in a difference-in-differences setting where we can follow GI products before and after the implementation of the label, and compare this development with that of a control group of product-locations that are not designated by GIs. We interpret our results in the context of a conceptual framework based on Larue and Lapan (1992), which shows how the importance of a collective reputation (which is what a GI is) may imply that individual producers have an incentive to produce lower quality. The setting of quality standards could alleviate such a problem.

We contribute to the literature in a number of ways. We are, to the best of our knowledge, the first article to focus on the possibility of quality free-riding on GIs – akin to the "Tragedy of the Commons" – in an empirical analysis.[2] Our detailed micro data allow us to do so, as we can calculate an established measure of product quality based on Khandelwal et al. (2013), which, though not without problems, is commonly used for export quality studies (Bas & Strauss-Kahn, 2015; Manova & Yu, 2017; Stiebale & Vencappa, 2018) and for agri-food quality as well (Curzi & Pacca, 2015; Curzi et al., 2015). It is worth noting that Duvaleix et al. (2021) use firm-product level data for the French cheese and butter sector, and investigate the impact of GIs protected by Trade Agreements on export quality and price. They find positive effects on quality. While this result is established for an EU country, China has implemented GI protection for the last few decades and may have experienced very different outcomes. The time dimension of the micro data, which enables us to follow firm-product combinations over time and in particular before and after the introduction of a GI allows us to implement the analysis in a difference-in-differences setting, arguably going some way toward establishing a causal relationship.

A further contribution lies in the focus on China. Traditionally, most empirical studies on the causes and consequences of GIs focus on the EU or the US, where GIs are frequently used (e.g., Agostino & Trivieri, 2014; Duvaleix et al., 2021; Meloni & Swinnen, 2018; Huysmans, 2022a, 2022b). Only very few studies look at developing or emerging countries (e.g., Durand & Fournier, 2017; Nizam & Tatari, 2022), and, even fewer, if any, analyze China. Yet, China is one of the largest exporters of food products in the world. According to World Bank statistics it ranked fourth in 2020, after the US, the UK, and Germany.[3] Hence, our analysis provides a much-needed perspective

[1] This may be illustrated using a well-known GI product in China named Yangcheng Lake Hairy Crab, which is a registered GI in two different GI systems that will be described in more detail in Section 2.1. One is with quality supervision (GAQS), the other without (MoA). The latter thus leaves room for free riding, as shown by the sales volume (800,000 tons), which is multiple times that of the maximum production volume (1500 tons) in 2022 of Yangcheng Lake Hairy Crab.

Information source: https://www.sohu.com/a/623278075_121045220.

[2] In theoretical models, this idea has been studied in many papers, see the recent review paper by Winfree (2023). McQuade et al. (2016) is an example in an international trade context.

[3] See https://wits.worldbank.org/CountryProfile/en/Country/WLD/Year/2020/TradeFlow/Export/Partner/by-country/Product/16-24_FoodProd, accessed June 28, 2023.

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on the use of GIs in a large emerging economy. Besides, the "Chinese-specific" results established in our article may be a point of reference for work on other developing and emerging economies, as they may have difficulties in setting up a high standard GI protection system similar to the EU. Knowing what is critical in setting up an efficient GI protection system and where scarce resources should be allocated to, is of great significance also for other emerging economies.

Furthermore, we add to the wider literatures on trade and GIs. Given the richness of the Chinese customs data, we provide firm-product-destination level evidence of GIs' impact on exports. Most studies that look at GIs and trade use product-destination level or country data to evaluate GIs' impact on trade (Agostino & Trivieri, 2014; Curzi & Huysmans, 2022; Raimondi et al., 2020; Sorgho & Larue, 2014, 2018), with Duvaleix et al. (2021) being a notable exception. Such aggregate data encounters a potential problem in that a GI product may not be accurately identified with the lack of location data. This article uses information on the location of firms and product types and link GIs, which enriches related studies.[4]

Our empirical findings, which distinguish GIs with and without quality supervision show negative impacts on export quality for the latter. This is not the case for GIs with quality supervision. We interpret this in the context of our conceptual framework as evidence for quality free-riding, where individual firms have an incentive to lower the quality of the export product. However, setting high quality standards and enforcing quality supervision may prevent such free-riding. Furthermore, we find that the negative effect is less, the more concentrated an industry is or the more GIs there are for a particular product. Additionally, we argue that the *China-EU agreement on Geographical Indications* can potentially play the role of quality supervision and reduce the possibility of free-riding. There is thus a clear policy implication that an effective GI system must be accompanied by quality standards and supervision, especially in developing economies.

The remainder of the article is structured as follows. Section 2 provides some background on the establishment of GIs in China. We set out a brief conceptual framework in Section 3 to motivate and guide the empirical analysis. Section 4 describes the data and empirical strategy, while empirical results are presented in Section 5. Finally, Section 6 presents some concluding comments and provides policy implications.

[4] Using similar data to ours, Bai et al. (2022) study the externalities in trade of goods with collective reputation in the context of Chinese dairy scandals. While this is a different issue than what we focus on, it is related in the sense of also considering the role of collective reputation.

2 | GIS FOR AGRICULTURAL PRODUCTS IN CHINA: BACKGROUND

2.1 | The evolution of Chinese GI protection system

China's GI protection was established as a two-tier system in 2005 and 2007.[5] Specifically, a special law regarding GI was implemented in 2005 named *The Regulations on Geographical Indications Product Protection*, by the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China (GAQS hereafter).[6] This law defines GI as (i) cultivated and farmed products from a specific region, or (ii) products whose raw materials are wholly or partly sourced, and which are produced and processed according to specific techniques, in the specific region. These GIs that are administered by GAQS are referred to as GIs with quality supervision in what follows.

Additionally, a special law for agricultural GIs was released in 2007 and came into force in 2008 named *Measures for the Administration of Geographical Indications of Agricultural Products*, by the Chinese Ministry of Agriculture (MoA).[7] This special law is for primary agricultural products only. This agricultural GI is defined as "*agricultural products originating from and named after a specific geographical area, whose quality and characteristics are mainly dependent on the natural ecological environment, historical or human factors of such areas*". The responsible department is MoA, and we label this GI without quality supervision, which will be explained in Section 2.2.

An institutional and functional adjustment was made during 2018 to 2024 concerning GIs, and a unified protection system was established. An official document released in 2024 made the State Intellectual Property Office (SIPO) responsible for the management and protection of all GIs nationwide.[8] As part of this, the activities and

[5] To be precise, China amended the Trademark Law and added the protection Geographical Indication mark in 2001 to comply with TRIPS before accessing the WTO. GIs are protected as collective mark or certification mark in the Trademark Law system. The GI trademark was administered by the Trademark Office of the State Administration for Industry and Commerce. For original policy content, please check https://ggfw.cnipa.gov.cn/PatentCMS_Center/info/483. We do not consider these Trademark GIs in this paper, as these trademarks are not evaluated by any reviewer committee, which means that the authorization process is very different from the GIs considered here. Trademarks are therefore not really comparable to the GIs in our paper.

[6] For original policy content, please check https://www.gov.cn/gongbao/content/2006/content_292138.htm.

[7] For original policy content, please check http://www.scs.moa.gov.cn/zcjd/201006/t20100606_1532979.htm.

[8] For original policy content, please check https://www.gov.cn/gongbao/2024/issue_11226/202403/content_6940042.html.

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TABLE 1 Comparison between GI protection systems in China.

	GIs with quality supervision	Agricultural GIs without quality supervision	GIs managed by SIPO
Responsible department	General Administration of Quality Supervision, Inspection and Quarantine (GAQS)	Ministry of Agriculture (MoA)	State Intellectual Property Office (SIPO)
Valid time	2005–2018	2007–2022	2018–now
Applicant	Institution or firm designated by local government	Institution or association designated by local government	Institution or organization designated by local government
Scrutiny and authorization	An expert reviewer committee is responsible for the evaluation.	An expert reviewer committee is responsible for the evaluation.	An expert reviewer committee is responsible for the evaluation.
Utilization	Producers located in the specific area could apply to the provincial quality and technical supervision departments or Administration of Entry-Exit Inspection and Quarantine with a quality test report.	Any producer located in a specific area and is able to produce GI product could apply to the holder and use for free.	Any producer located in a specific area could apply to the local Intellectual Property Office with a quality test report.
Quality standard and supervision	Yes. Supervised by provincial branch office of General Administration of Quality Supervision, Inspection and Quarantine.	No	Yes. Local government should be responsible for the formation and implements of standard systems and testing systems.

responsibilities of GAQS were transferred to SIPO in 2018. Those of MoA ceased in 2022.[9] Hence, by 2024, a unified framework was established in China with a single authority (SIPO). The definition of GIs by SIPO is the same as that used by GAQS.

2.2 | The application, authorization, utilization, and supervision of GI in China

To get a better understanding of how GI protection works in China, we list the responsible departments, application, utilization, and supervision procedures for the above types of GI protection systems in Table 1.

In terms of applications, applicants should be designated by their local government when applying for a GI to GAQS or MoA. This designation process means that the GI-designated area is decided by both the characteristics of the terroir as well as the administrative boundary of a city. It is free of charge to apply for a GI to GAQS or MoA.

As for authorization, both GAQS and MoA have expert reviewer committees in charge of the technical details. The experts provide professional reports evaluating the geographical coverage, unique quality character, culture and history, reputation, potential, and market demand of a GI application. The authorization process takes 6 months for GIs approved by MoA, while it may take 3 years for GIs approved by GAQS[10]. This difference is mainly due to the rigor of the expert checks.

GIs protected by GAQS distinguish themselves from the other GI because they have set quality standards and also require mandatory checks and supervision. The quality standard illustrates how a GI product should be planted, produced, what character it should have, and so on. MoA approved GI have no such setting on quality standards and consequently hardly any quality supervision, which leaves room for "bad drives out good" and causes a "lemons" problem in the sense that only inferior goods apply. The absence of quality control may be a reason why this MoA administered GI system ceased in 2022.

Applying for GIs from the two systems is generally free. Producers are required to apply to the local quality supervision department when trying to use a GI with quality supervision (GAQS), while they only need to apply to the GI holder when trying to use a GI without quality supervision (MoA).

GIs managed by GAQS are, overall, fairly similar to the EU's GI protection, though there are also differences. Take France, for example, where the National Institute of Origin and Quality (INAO) is charged with regulating French

[9] The Trademark Office of the State Administration for Industry and Commerce was transferred to SIPO as well.

[10] According to an interview with local officer in charge of the local GI application work

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agricultural products with protected designation of origin (PDOs) and Protected Geographical Indications (PGIs)[11]. Only industry associations formed by producers can send their GI application to INAO, which is somewhat different from China. Among all the application forms, the quality standard is most crucial and mandatory, which needs to be complied with by all producers. A flexible way of quality supervision in France for PDOs is that an industry association may identify a third party from authorized quality control agencies. Hence, possible applicants and the quality control agency are two major differences between the Chinese GI system with quality supervision and France's GI system.

2.3 | The protection of Chinese GI globally

There are two ways for Chinese GIs to enjoy protection globally. The first is using Trade-Related Aspects of Intellectual Property Rights (TRIPs). TRIPs define GIs as "*indications which identify a good as originating in the territory of a [WTO] Member, or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographical origin*" (Taubman et al., 2012). Though TRIPs is not a perfect institutional arrangement for GI protection globally, they still provide comprehensive provisions.

Also, trade agreements signed by China with its partner countries often have terms related to intellectual property rights protection, of which GI are one type. Moreover, the negotiations of the *China-EU Agreement on Geographical Indications*, which started in 2011 included 550 GI products (275 for each side). It was signed in 2020 and came into force in 2021. According to the *China-EU Agreement on Geographical Indications*, the included Chinese GI products are protected in the same way as other GIs authorized by the EU.

2.4 | Number of GIs in China

We focus on primary agricultural products, and disregard processed food. We do this to be comparable across those two GI systems with and without quality supervision, as GIs managed by MoA (without quality supervision) are only for primary agricultural products. To be consistent with our sample period 2000–2015 (limited by the availability of firm level custom data), we report GI numbers registered from 2005 to 2015 in Figure 1. [12] The numbers of GIs by product type registered between 2005 and 2015 are shown in Table A1.

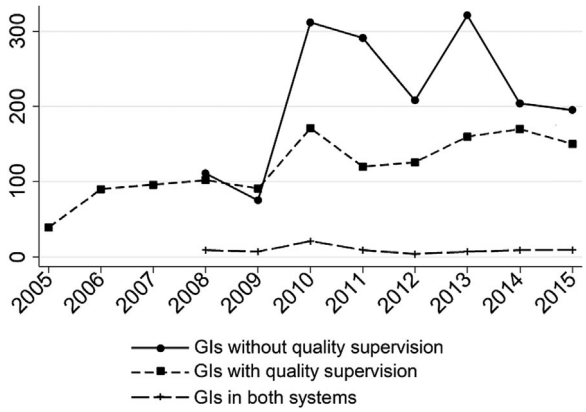

FIGURE 1 Newly registered GIs from 2005 to 2015.

The number of newly registered GIs with quality supervision is rather stable during 2005–2015, with a slightly upward trend. The number of newly registered GIs without quality supervision surged in 2010 and is generally larger than the number of GIs with quality supervision. This may indicate that it is more difficult to obtain a GI registered by GAQS than by MoA, as it requires quality standard setting and an evaluation by an expert committee. There are only few GIs registered in both systems.

Vegetable and fruit have most GIs in both systems, likely reflecting China's long history of farming and the preference for farming products, as shown in Table A1. Meat and fish have many GIs as well, ranked just behind vegetable and fruit. Not surprisingly, coffee and tea (mostly tea) have over 100 GIs in both systems. Two-digit products with code "12" are not negligible either, among which are mostly medicinal plants, reflecting the effort to protect Chinese medicine.

Figure 2 shows the distribution of GIs (with quality supervision in Figure 2a, without quality supervision in Figure 2b) across provinces. There is a clear imbalance of GI registrations across regions, with Sichuan, Shandong, Hubei, Shanxi, Heilongjiang, Guizhou, and Guangdong having the most GIs and leaving the other regions behind. Coastal regions, which are the most developed areas in China, have no clear advantage in this.

2.5 | The trade performance of GI products

We divide products into three groups, that is, GI products with quality supervision, GI products without quality supervision and non-GI products, and chart their yearly

[11] Information about INAO and how GI in France is protected under INAO could be found here: https://www.inao.gouv.fr/eng/The-National-Institute-of-origin-and-quality-Institut-national-de-l-origine-et-de-la-qualite-INAO

[12] The data sources are described below in Section 4.1.

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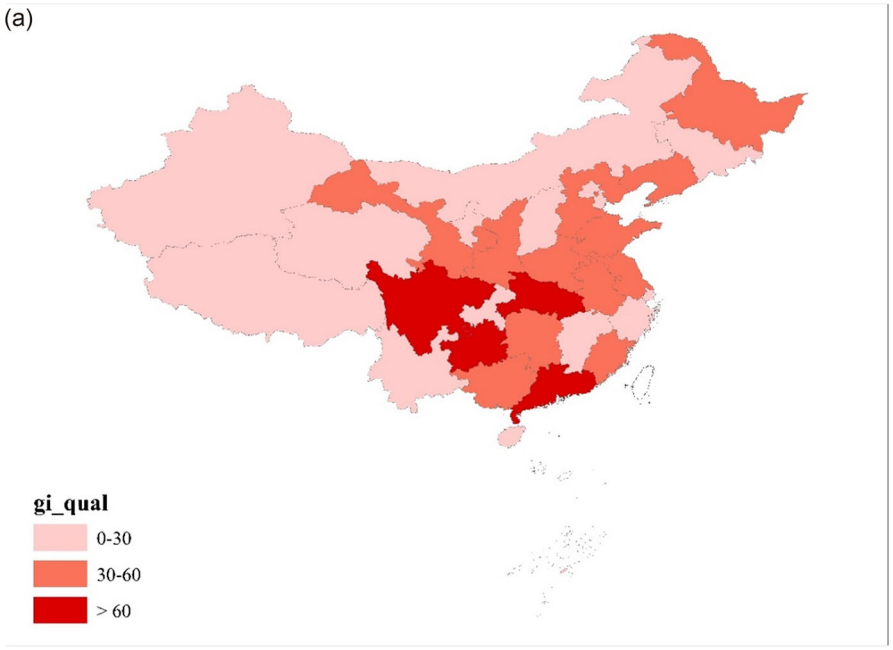

FIGURE 2A Spatial distribution of GIs with quality supervision among provinces.

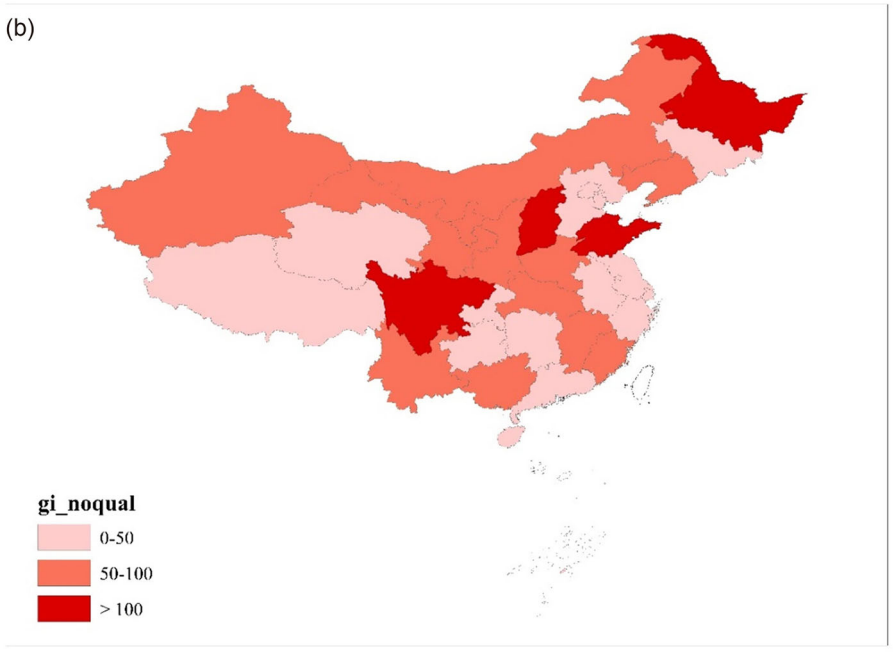

FIGURE 2B Spatial distribution of GIs without quality supervision among provinces.

exports in Figure 3. Before 2005, all three kinds of products share a similar trend. However, GI products with quality supervision have a higher growth rate than the other two after 2005, which is the year the GAQS-administered system was set up. The gap between GI products without quality supervision and non-GI products has grown after 2008, which is the year that the MoA GI system was introduced. These different export trends may indicate that GI products without quality supervision are losing competition even compared with non-GI products.

To have a better understanding of the export performance of GI products, we list them by product and province in Tables 2 and 3. By looking at values, the most export-oriented GI products are vegetables, coffee and tea (mostly tea), fish, oil seed, and Chinese medicinal plants. Indeed, vegetables, coffee and tea, oil seed, and Chinese

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TABLE 2 The export performance of GI products by product type.

		Export of GI without quality supervision		Export of GI with quality supervision	
HS code	product	Export value (million)	Ratio to total export (%)	Export value (million)	Ratio to total export (%)
01	Live animals	–	–	–	–
02	Meat and edible meat offal	10.16	5.53	.61	.33
03	Fish and aquatic invertebrates	330.48	4.21	156.25	1.99
04	Dairy and egg	–	–	25.77	8.11
05	Other products of animal origin	–	–	13.36	.93
06	Live trees and other plants	–	–	.09	.05
07	Vegetables	539.16	11.63	961.71	20.74
08	Fruit and nuts	43.09	2.06	185.89	8.89
09	Coffee and tea	214.23	15.83	297.62	21.99
10	Cereals	–	–	–	–
11	Products of the milling industry	1.00	.29	.97	.28
12	Oil seeds and oleaginou	147.34	10.91	165.15	12.23
13	Lac and gums	7.32	.65	4.92	.44
14	Other vegetable products	–	–	–	–
Total		1292.79	6.14	1812.34	8.61

Note: Results are calculated using data of 2015.

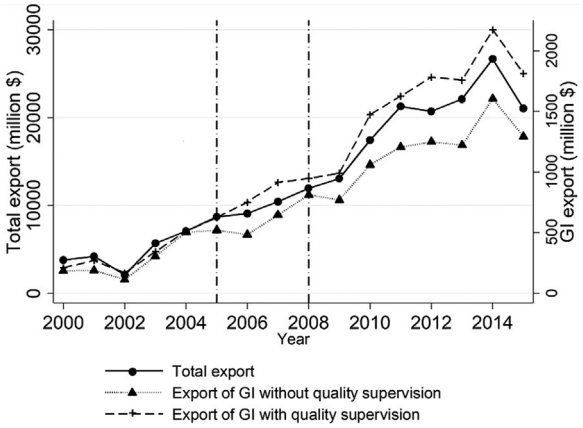

FIGURE 3 The export trend of GI products with and without quality supervision.

medicinal plants also have quite high percentage values in terms of exports of GI products. As for provinces exporting GI products the most, they are Shandong, Jiangsu, Liaoning, Fujian, Jiangsu, and Henan, which are coastal provinces mainly.

Another interesting cut at the data is to see how many Chinese GIs are exported. We identified GIs that have export records in the custom database and calculated the ratio to the total number of GIs. It turns out that about 29.68% of GIs managed by GAQS and 53.84% of GIs managed by MoA are exported. It is noteworthy that the export rate of GI with quality supervision is much lower than that of GI without quality supervision. A possible explanation is that GAQS is in charge of quality examination when goods are transported cross borders. GIs that have a quality standard are faced with strict quality control when they cross the border, while GIs managed by MoA often have no quality standards and they cross borders easily. These differences in export rates are in line with our discussion in the policy background above.

3 | CONCEPTUAL FRAMEWORK

In the literatures, GI labels are generally modelled as a signal of specific quality of a product (Desquilbet & Monier-Dilhan, 2015; Merel, 2009; Moschini et al., 2008).[13] This reflects the general challenge of delivering information about product quality to consumers in the agricultural sector, which may lead to possible market failure in the sense of the well-known lemons problem (Akerlof, 1970). Such a problem may be more severe in international markets, due to geographical and cultural distance. To overcome such an information problem a GI label may

[13] This is, e.g., reflected in evidence showing that consumer's willingness to pay is greater for GI than non-GI products (Menapace et al., 2011).

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TABLE 3 The export performance of GI products by province.

Province	Coastal	Export of GI without quality supervision		Export of GI with quality supervision	
		Export value (million)	Ratio to total export (%)	Export value (million)	Ratio to total export (%)
Beijing	No	2.94	1.08	1.48	.54
Tianjin	Yes	4.90	1.84	2.98	1.12
Hebei	Yes	4.94	1.02	49.94	10.32
Shanxi	No	.40	1.15	13.62	38.80
Inner Mongolia	No	.28	.38	1.49	2.04
Liaoning	Yes	154.38	8.21	144.53	7.69
Jilin	No	21.75	5.73	8.54	2.25
Heilongjiang	No	12.10	6.71	49.57	27.48
Shanghai	Yes	–	–	.98	.22
Jiangsu	Yes	11.48	1.11	365.56	35.22
Zhejiang	Yes	73.91	3.70	68.99	3.45
Anhui	No	10.10	2.68	93.44	24.81
Fujian	Yes	250.31	9.53	24.51	.93
Jiangxi	No	.41	.38	3.15	2.91
Shandong	Yes	654.42	11.33	709.00	12.28
Henan	No	59.73	7.59	104.76	13.31
Hubei	No	10.33	1.65	33.71	5.40
Hunan	No	9.48	2.80	11.15	3.29
Guangdong	Yes	–	–	45.35	4.39
Guangxi	Yes	.04	.01	11.99	3.30
Hainan	Yes	–	–	–	–
Chongqing	No	.15	.53	.17	.58
Sichuan	No	8.54	7.29	13.99	11.94
Guizhou	No	–	–	.96	5.91
Yunnan	No	.34	.03	23.24	2.18
Xizang	No	–	–	–	–
Shaanxi	No	.81	.42	11.74	6.08
Gansu	No	.70	.35	15.60	7.78
Qinghai	No	–	–	–	–
Ningxia	No	.04	.13	–	–
Xinjiang	No	.29	.18	1.91	1.18
Total		1292.79	6.14	1812.34	8.61

Note: Results are calculated using data of 2015.

help. By linking product quality and unique characteristics with its location and know-how, a GI provides consumers with the knowledge of products' attributes. Hence, a GI label is seen as an efficient way to alleviate such information problems and market failures when quality cannot be credibly signaled otherwise (Lence et al., 2007; Marette & Crespi, 2003; Moschini et al., 2008).

However, there is also a potential downside to GIs. They provide a common label that is typically accessible to a large number of firms producing similar (and possibly competing) products. Food products can be generally thought of as experience goods, as quality is difficult to judge just by observing a particular food item. Hence, consumers may rely on the reputation of the particular producer group as established by past experience of the product. This implies that a GI establishes a collective, rather than a private, single-producer specific reputation. Product reputation and consumer's willingness to pay for it is then often determined by the average quality based on past consumption experiences. Therefore, single GI users may have an incentive to act as a free rider, shirking on quality in the current period.

Larue and Lapan (1992) are one of the first to show how a region-specific reputation mechanism may lead to

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free-riding on quality by individual producers.[14] Their model can serve as an appropriate theoretical framework for our further empirical work. The crucial idea in the model is that the expectation of quality is decided by both a region's collective reputation– that is, reputation for the industry/region as a whole rather than for an individual producer – and by an individual firm's quality margin. In this set-up, they show that the larger the number of firms in the industry – that is, the less concentrated the industry, and the higher the relative importance of collective reputation, the higher the incentive of an individual firm to provide a low quality good. The rationale is that production of a high quality good is costly, and these costs incur to the firm alone. While the returns to quality accrue to all firms equally. Hence, producers have an incentive to shirk on quality compared to a situation where there is private brand reputation.

Larue and Lapan (1992) show that a firm may increase profits by behaving as a free rider and choosing low quality, when the relative importance of the collective reputation is large. In their model setting – which focuses on exports of wheat – the industry has to fulfil a minimum contractual obligation in terms of quality that is set by the importing nation. If it exceeds these minimum standards, this builds a positive reputation abroad. But it is costly and difficult for the importing country to verify the quality of an individual producer. They show that, when the number of producers is large, all will eventually choose quality at a level to meet only the minimum obligation. In the case of GI, quality is very much related with geographical or ecological factors shared with the region, that is, the collective reputation is of paramount importance for the expected quality. Hence, firms producing GI products may have an incentive to behave as free riders to maximize profits.

In a similar model set-up, Winfree and McCluskey (2005) show that setting a high and enforceable minimum quality standard may prevent the free-riding problem, as producers have to meet the quality standard instead of choosing a profit-maximizing quality. As pointed out in the previous section, however, the Chinese GI system managed by the MoA does not provide for such binding quality standards, that is, there is no clear and legally binding quality standard and supervision mechanism. In contrast, the GI system managed by the GAQS requires such a minimum quality standard and it implements quality supervision accordingly. Hence, if the above mechanism works, such a "tragedy of the commons" problem with producers shirking on quality may be more likely for the GI system managed by the Ministry of Agriculture, but not for the GI system with quality standard and supervision. This, and the implications this may have for exports of GI products, is what we look at in the further empirical analysis.

[14] Similar mechanisms are discussed in more recent papers by, e.g., Winfree and McCluskey (2005) and Costanigro et al. (2012).

4 | DATA AND EMPIRICAL STRATEGY

4.1 | Data sources

For our empirical analysis we combine data from three different sources: (i) Firm-product-destination level export data, obtained from China's General Administration of Customs; (ii) GI information from the National Geographical Indication Search System of Agricultural Products provided by the Chinese Ministry of Agriculture and Rural Affairs, and from the official website of SIPO; and (iii) Country level data to calculate control variables from WGI database and CEPII database.

Firm level export data from China's General Administration of Customs includes all Chinese trade transactions with export values, quantities, product information (names and HS code), and destinations.[15] Generally, each record reports the exporting firm with firm name, firm code, firm type, and city of location.[16] For our purposes, we keep only information on firms exporting agricultural products, that is, whose 6-digit HS code is less than "150000". In order to deal with the problem that exporters may source their products from many other different provinces (which would be done mainly through trade intermediaries), we also drop trade intermediaries in our sample, following Ahn et al. (2011) and Fan et al. (2015).[17] The trade data is then aggregated to firm-product-country-year level, defining products at the 6-digit HS code level.[18] This firm level trade data is only available from 2000 to 2016. As the 2016 sample does not have location information, the data used for our analysis relates to 2000–2015.

Concerning data on GIs, we have two sources corresponding to the two GI protection systems. The first one is the Chinese National Agricultural Geographical

[15] Data source: http://microdata.sozdata.com/login.html?page=customs. Access is confidential. Prices can be calculated by dividing export value by quantity.

[16] In our data, a "firm" relates to an establishment in one location. If a company has affiliates in multiple cities, then each affiliate has a unique firm-code that it obtained when registering for tax reasons in the city. This means that in our data set, a firm represented by its firm-code only has one location.

[17] We only consider direct exporters, that is, firms who plant or cultivate, in this paper. We treat firms with keywords such as "trading", "importing and exporting", "business and trading", "foreign trade", "industrial trade", "business", "logistic", "economic cooperation", "technology cooperation", in their names as intermediaries and exclude them from our analysis.

[18] To allow for changes in the standard HS code over the years, we adjust HS 1996, HS 2002, HS 2007 to HS 2012 according to the conversion tables from UN Statistics.

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Indication Search System updated by MoA from 2008 to 2022. The second is the official website of SIPO,[19] which contains the announcement of GIs by GAQS. We use web spider technology to get the names, locations, announcement years of each GI record from 2005 to 2015 for GIs with quality supervision, and from 2008 to 2015 for GIs without quality supervision.

A GI name consists of the location and product name. Thus, the nature of the GI name offers us the opportunity to match GIs with custom data by product and location (city). We link each GI product to a HS 6-digit code and then mark its origin city[20]. It is worth to note that, sometimes a GI could have more than one 6-digit HS code. Take mushrooms as an example, they could be fresh, or frozen, or dried, which are different types of products with HS codes 070959, 071080, 071239[21]. In this case we mark all of these 6-digit codes as having a GI. We use the data to generate a city-product-year panel with GI information. Then we match this data with customs data by HS 6-digit code and city name to form a combined dataset.

Recall that our customs data covers the period 2000–2015. For our research purpose it is necessary to have data before and after GI authorization, as we aim to identify a causal effect. GIs were only authorized from 2005 for GI with quality supervision and 2008 for GI without quality supervision. We thus use GI information from 2005 to 2011 and 2008 to 2011, respectively, to ensure that the customs trade data covers at least 4 years before and after those GI products were authorized. Further, to exclude the possible interference caused by GI products authorized after 2012, we exclude those GIs and related firm level trade records from our sample.

4.2 | Measuring quality

Our main focus is on the impact of introducing a GI on the quality of the export product. "Quality" is generally defined as unobserved attributes of a variety that increase consumers' willingness to pay (Fan et al., 2015). We apply the method proposed by Khandelwal et al. (2013) to estimate "effective quality" and a quality-adjusted price.

We start off by considering exports from firm f of product p shipped to destination country d in year t, which is determined by the following equation:

$$q_{fpdt} = \lambda_{fpdt}^{\sigma-1} p_{fpdt}^{-\sigma} P_{dt}^{\sigma-1} Y_{dt} \quad (1)$$

where, q_{fpdt} denotes country d's demand for firm f's export of product p in year t. λ_{fpdt} denotes the export quality, p_{fpdt} represents the product price. P_{dt} and Y_{dt} are the destination country d's price index and income, respectively. We take logs of the above equation and get:

$$lnq_{fpdt} + \sigma ln\, p_{fpdt} = \varphi_p + \varphi_{dt} + \epsilon_{fdpt} \quad (2)$$

The country-year fixed effect φ_{dt} captures both the destination price index P_{dt} and income Y_{dt}. φ_p is the product fixed effect and captures the difference in quantities and prices across product categories. The residuals are used to infer quality:

$$ln\, \hat{\lambda}_{fpdt} = \hat{\epsilon}_{fpdt} / (\sigma - 1) \quad (3)$$

The quality adjusted prices are:

$$ln\, \tilde{p}_{fpdt} = lnp_{fpdt} - ln\hat{\lambda}_{fpdt} \quad (4)$$

To estimate this, a choice needs to be made concerning the value of σ. Head and Ries (2001) suggest that a reasonable range of σ is [5, 10]. Broda and Weinstein (2006)'s estimated result show that country and HS 3-digit level σ is about 4. According to Ossa (2015), the σ of most agriculture products range from 2 to 6. Hence, we take σ= 4 to estimate agricultural product quality and quality adjusted price, and use σ= 3 and σ= 5 as robust checks.

While the Khandelwal et al. (2013) approach has been used extensively in the literature (Bas & Strauss-Kahn, 2015; Manova & Yu, 2017; Stiebale & Vencappa, 2018), it is not free from criticism. Feenstra & Romalis (2014), for example, show that it neglects supply-side effects (particularly entry on new markets and exits from existing markets), which may bias measures of quality. In order to control for such supply-side effects, we add firm-year fixed effects and firm-destination-year fixed effects, respectively, to allow for any general time varying firm and firm-destination specific variables. This is done in a robustness check and allows us to estimate alternative quality measures.

[19] Data source: https://dlbzsl.hizhuanli.cn:8888/Product/Search.

[20] This implies that we may mis-classify some firms that are registered at a GI city and produce agricultural GI products but that choose not to use the GI label. It is impossible to know how serious this mis-measurement might be since, in contrast to Duvaleix et al. (2021) we do not have firm-level information on the use of GI. However, since registering for a GI is free, it is unlikely that many firms choose not to register. In our analysis, any such mis-classified firm is treated in the same way as a GI-user, given that they have a choice to label. And the treatment effect is simply an estimated average effect. Still, given the setting and data availability, this is the best we can have to provide an analysis of GI for China, which arguably provides insightful and interesting findings

[21] Of course, a 6-digit code may contain more than one product that may be quite different from each other. This would bias our estimation result. We drop 6-digit products with more than 3 8-digit products from the regression in a robust check

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4.3 | Empirical model

We use the combined firm-product-destination-year level trade data to investigate the impact of GIs on firms' export activity. Given the expected differences between GIs with and without quality supervision, we estimate separate models for the two types.

The baseline empirical models are difference-in-differences specifications as follows:

$$lnexp_{fpdt} = \beta GI_{cpt}^{noqual} + \mu_{fpd} + \vartheta_t + \delta_d \times \vartheta_t + \epsilon_f \times \vartheta_t + \pi_p \times \vartheta_t + \varepsilon_{fpdt} \quad (5)$$

for GIs without quality supervision and

$$lnexp_{fpdt} = \gamma GI_{cpt}^{qual} + \mu_{fpd} + \vartheta_t + \delta_d \times \vartheta_t + \epsilon_f \times \vartheta_t + \pi_p \times \vartheta_t + \varepsilon_{fpdt} \quad (6)$$

for those with.

In both equations, the dependent variable exp_{fpdt} is the export of product p by firm f to country d in time t. Initially, exp_{fpdt} will be defined in turn as export value, quantity, price, quality, and quality adjusted price. In subsequent regressions we focus on our measure of quality. A firm f, identified by its register code, locates in one city c and has potentially several products p that are exported to multiple destinations d. GI_{cpt}^{noqual} and GI_{cpt}^{qual} are our main variables of interest and capture the effect of the introduction of a GI in city c of product p on export activity and, especially quality. To aid identification of this effect, both equations include a battery of fixed effects: μ_{fpd} capturing firm-product-destination fixed effects[22], $\delta_d \times \vartheta_t$, destination-year, $\epsilon_f \times \vartheta_t$, firm-year, and $\pi_p \times \vartheta_t$ product-year fixed effects. These dummies capture the possible impact of any unobservables along these dimensions, that may otherwise be subsumed in the error term. Both equations are estimated using a fixed effects estimator.

Equation (5) looks at the effect of GIs without quality supervision on exports. $GI_{cpt}^{noqual} = 1$ for GIs authorized by MoA (requiring no quality standard and no quality supervision), otherwise 0. As shown in Figure 1, there are a small number of GIs registered in both systems. We exclude GIs registered also in the GAQS system and keep only GI products registered in MoA as treatment group, in order to not bias our results. Non-GI products are the control group.

In Equation (6), $GI_{cpt}^{qual} = 1$ when GIs were authorized by GAQS, requiring quality standards and enforcing quality supervision. Again, we exclude GIs also registered in the MoA system, and define non-GI products as the control group.

From our discussion above, we would expect free riding on quality to be an issue for GIs without quality supervision, hence we expect β in Equation (5) to be significantly negative. This may not be the case for γ in Equation (6) due to quality standards being enforced.

5 | EMPIRICAL RESULTS

5.1 | The impact of GI on export and its margins

The results of estimating the baseline Equations (5) and (6) are reported in Table 4. The table reports the coefficient estimates indicating the effect of establishing a GI on various dimensions of exports – value, quantities, price and quality. We divide GIs into two types, without and with quality supervision as shown in Table 4a,b.

Overall, the results show that, if anything, a new GI without quality supervision tends to affect exports negatively, in particular quality. This is somewhat at odds with many empirical studies on European GIs, which mostly show that GI products are associated with higher prices and higher quality (e.g., Agostino & Trivieri, 2014; Duvaleix et al., 2021; Raimondi et al., 2020). By contrast, a new GI with quality supervision tends to show a positive impact on export, quantity, price, and quality, though the coefficients are not statistically significant. These opposite coefficients are in line with our hypothesis that GI without quality standards and supervision could lead to a free-riding problem.

Furthermore, it would be interesting to have a look at how firms performed with GIs registered in both systems. In theory, firms could also choose to free-ride and label their product with the MoA GI (which is the case for Yangcheng Lake Hairy Crab) as GAQS cannot enforce a quality standard if the product is labeled with a MoA GI. Results are shown in Table A2 and are similar to results for MoA GIs in Table 4a, in line with our hypothesis.

In our case, GIs are authorized at different years from 2005 to 2011, which implies that we have staggered treatments. When it comes to such treatments with multiple time periods, recent literature suggests that standard DID estimators may potentially be biased (Goodman-Bacon, 2021). To avoid this, we use the recent method proposed by Callaway and Sant'Anna (2021).[23] The results are shown in Table 5. It turns out that our findings on quality and

[22] Usually, firm contains information on city, as a firm's affiliates located in different cities should registered locally and have new firm code for tax.

[23] In Stata, this is implemented using the csdid command. With this method we cannot consider the multidimensional fixed effects included in equation (5), which control for unobserved time varying country, firm

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TABLE 4 The impact of GI on firm's export activities.

	Export	Quantity	Price	Quality	Quality-adjusted price
Table 4a GI without quality supervision					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
GI_{cpt}^{noqual}	−.0689	−.0402	−.0259*	−.0525**	.0190
	(−1.22)	(−.72)	(−1.70)	(−2.02)	(1.00)
Observations	315209	315209	315209	315209	315209
Table 4b GI with quality supervision					
	(6)	**(7)**	**(8)**	**(9)**	**(10)**
GI_{cpt}^{qual}	.0951	.0838	.0231	.0486	−.0345
	(1.44)	(1.26)	(1.26)	(1.58)	(−1.51)
Observations	314024	314024	314024	314024	314024
Country-product-firm fixed effects	YES	YES	YES	YES	YES
Country-year fixed effects	YES	YES	YES	YES	YES
Firm-year fixed effects	YES	YES	YES	YES	YES
Product-year fixed effects	YES	YES	YES	YES	YES

Note: We use Khandelwal et al. (2013)'s method decompose price into two parts, that is, quality and quality-adjusted price.
T-statistics reported in parentheses. ***, **, * denote statistical significance at 1, 5, 10 percent level. Robust standard errors clustered at firm level.

TABLE 5 The impact of GI on firm's export activities considering staggered treatment time.

	Export	Quantity	Price	Quality	Quality-adjusted price
Table 5a GI without quality supervision					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
GI_{cpt}^{noqual}	−.2111**	−.0432	−.1585***	−.2019***	.0438
	(−2.11)	(−.47)	(−5.15)	(−3.92)	(1.40)
Observations	266766	266766	266766	266766	266766
Table 5b GI with quality supervision					
	(6)	**(7)**	**(8)**	**(9)**	**(10)**
GI_{cpt}^{qual}	.1178	.0823	.0253	.0813*	−.0469
	(1.13)	(.77)	(.94)	(1.72)	(−1.16)
Observations	274031	274031	274031	274031	274031
Country-product-firm fixed effects	YES	YES	YES	YES	YES

Note: T-statistics reported in parentheses. ***, **, * denote statistical significance at 1, 5, 10 percent level. Robust standard errors clustered at firm level.

price are rather robust, shown by the same sign and higher t value of the coefficients of GI_{cpt}^{noqual}.

5.2 | Free-riding problem

5.2.1 | The pre-trend and lagged effects of GI authorization

An important assumption for the validity of the difference-in-differences method is that of similar trends in the treated and control group before treatment. To check this, we conduct a pre- and post-trend analysis using Callaway and Sant'Anna (2021)'s method, as shown in Figures 4 and 5. We do not observe any indication that firms export products with lower or higher quality before GI authorization, compared to the control group of no GI. Exporters tend to lower their quality after the introduction of a GI without quality supervision, shown in Figure 4. The decline in quality is most obvious for the first 2 years after GI authorization, suggesting that firms make quick quality decisions. By contrast, we do not observe any decline in quality for GIs with quality supervision for any periods after GI authorization. This suggests that quality standards and supervision may prevent free-riding.

and product annual shocks. For this reason, we only use this method for a robust check and for pre-and post- trend analysis.

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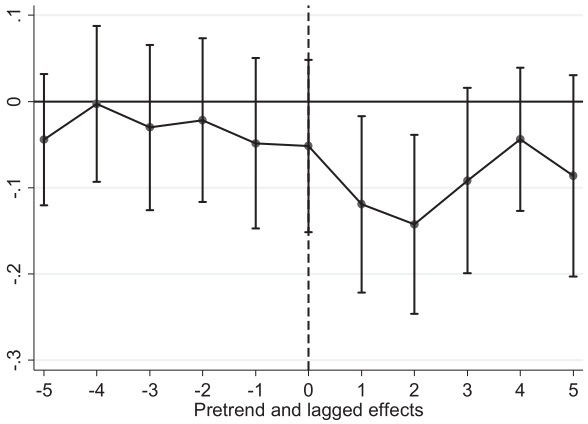

FIGURE 4 The pretrend and lagged effects of GIs without quality supervision.
Note: The estimated coefficients and their 99% intervals are shown.

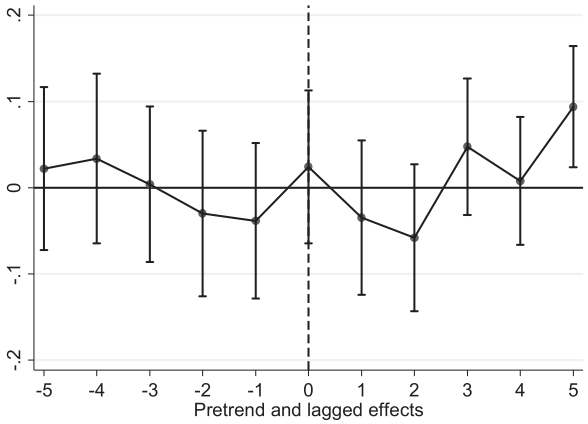

FIGURE 5 The pretrend and lagged effects of GIs with quality supervision.
Note: The estimated coefficients and their 99% intervals are shown.

Further, we look at the dynamics of the treatments by yearly cohorts to investigate whether the effects vary depending on the year when the GI was registered. We apply the method proposed by Wooldridge (2021) and report the dynamic effects of GI without and with quality supervision in Figures 6 and 7, respectively.

Figure 6 shows that the dynamic effects of GIs without quality supervision do vary by cohorts. The effects for cohort 2008 and 2010 present no particular trend, but there are clearly negative effects for cohort 2009 and 2011. The negative impact for cohort 2009 on quality became larger over time. For the 2011 cohort, we find initially strong negative effects, though this is only visible in the first year after the authorization of the GI.

We also look at the dynamic impacts of GIs with quality supervision, as shown in Figure 7. First of all,

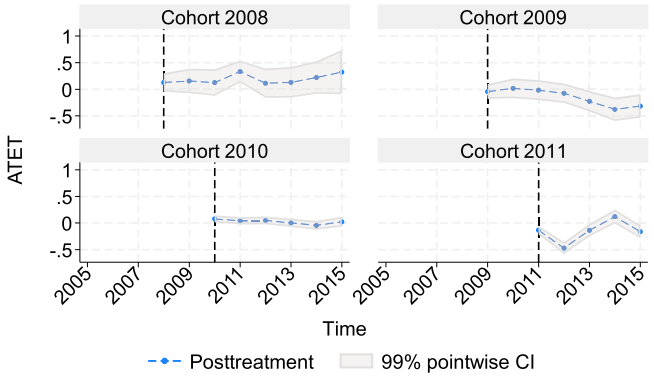

FIGURE 6 The dynamic impacts of GIs without quality supervision.

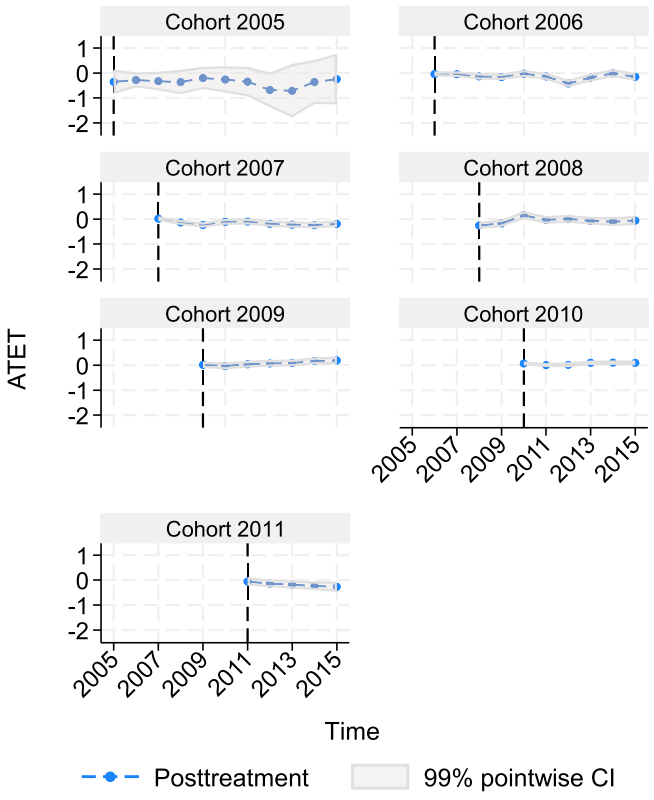

FIGURE 7 The dynamic impacts of GIs with quality supervision.

the coefficients of treatments by cohorts are mostly statistically insignificant and small in scale, compared to Figure 6. Furthermore, there is no clear pattern of increasing or decreasing effects after the authorization of the GI. This is consistent with our baseline results that quality supervision can prevent free-riding on GIs.

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TABLE 6 Robust checks on free-riding result.

	Quality measurements							
	Quality measure considering firm-year effects	Quality measure considering firm-country-year effects	Quality measure with $\sigma = 3$	Quality measure with $\sigma = 5$	Quality measure using product trade elasticities	Excluding products of hs6 with hs8 products more than 3	Keep all gravity variables	Export to developed countries
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GI_{cpt}^{noqual}	−.0481**	−.0445*	−.0612*	−.0481**	−.0178*	−.1067***	−.0511**	−.0919***
	(−2.15)	(−1.67)	(−1.79)	(−2.15)	(−1.76)	(−2.68)	(−1.96)	(−2.76)
Observations	315209	179426	315209	315209	315200	186162	315416	200500
GI_{cpt}^{qual}	−.0058	.0337	.0653	.0411	.0232**	.0324	.0438	.0414
	(−.26)	(1.28)	(1.63)	(1.55)	(2.10)	(.59)	(1.42)	(1.13)
Observations	314024	177277	314024	314024	314024	207010	314227	200832
Country-product-firm fixed effects	YES	YES	YES	YES	YES	YES	YES	YES
Country-year fixed effects	YES	YES	YES	YES	YES	YES	NO	YES
Firm-year fixed effects	YES	YES	YES	YES	YES	YES	YES	YES
Product-year fixed effects	YES	YES	YES	YES	YES	YES	YES	YES

Note: T-statistics reported in parentheses. ***, **, * denote statistical significance at 1, 5, 10 percent level. Robust standard errors clustered at firm level.

5.2.2 | Robustness checks

We carried out a series of robustness checks concerning quality measurement. Firstly, to allow for possible supply-side effects affecting firms we include firm-year and firm-destination-year fixed effects to get alternative quality measures, which we use to replace our initial quality estimates. The results are shown in column (1) and (2) of Table 6. Additionally, we use different values for σ, that is, $\sigma = 3$ and $\sigma = 5$, to get alternative quality measurements as well. These results are shown in column (3) and (4) in Table 6. They are all in line with our previous results.

Thus far, we assume that the elasticity of substitution across products σ is constant across all products. In the next robustness check, we allow for heterogeneous elasticities, using the elasticities provided by Fontagné et al. (2022) at the 2-digit HS code level. We calculate a new measure of quality based on these estimates. The results are shown in column (5) of Table 6. Results are robust and we still find a negative impact on quality for GIs without quality supervision. Interestingly, we now also find a statistically significant positive coefficient for the introduction of a GI with quality supervision. This result is, however, not found in any other of our specifications and is therefore not robust to alternative specifications.

Our product definition based on the 6-digit HS code is potentially coarse as some 6-digit codes contain as many as 32 kinds of 8-digit tariff products (040690 – other cheese). Unfortunately, for our analysis we only have data at the 6-digit level, which is the most detailed data available. One way to deal with such a problem is to keep only 6-digit products with only few tariff products. Hence, we drop 6-digit HS codes with more than three 8-digit products from our regression as a robust check.[24] The result is shown in column (6) of Table 6. Dropping those coarse data from our sample, we get a larger coefficient with higher statistical significance, supporting our baseline finding.

While our destination-year fixed effects capture all time-varying gravity variables, we also perform an additional robustness check where we drop the fixed effects and include explicitly time-varying gravity variables instead. The country-product-firm fixed effect still captures all unobservable time invariant (over the analysis period) characteristics, which includes geographical distance, contiguity, common language, and so forth, that determine trade between China and the partner (e.g., Baier et al., 2014; Rose, 2004). Hence, we consider the log of GDP in the destination country, the absolute difference in GDP per capita

[24] About 91.65% of hs6 products are constructed with no more than 3 kinds of hs8 products, and this number is 91.18% for agricultural products. Taking garlic with 6-digit HS code of "070320" for example, it consists of 07032010 (bulbs of garlic, fresh or chilled), 07032020 (stems or seedlings of garlic, fresh or chilled), 07032090(other parts of garlic, fresh or chilled), which are all garlic products and not different in GI's case. After carefully checking, the two or three kinds of products with the same hs6 code do not appear different in nature.

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TABLE 7 Quality different between product groups before authorized as GI.

	Mean value of GI	Mean value of non-GI	Difference
GI without quality supervision	.0269	.0082	.0188***
GI with quality supervision	.0427	.0082	.0345***

Note: When calculating the mean quality value of GI without quality supervision, the GI products authorized by Quality supervision department are all excluded to avoid disturbance.

between China and destination country, the exchange rate, a measure of political relations between China and destination country, and whether China signed an FTA with the destination country. Country level data are gathered from WDI database, CEPII database, and WTO. Results are shown in column (7). Our baseline results still hold.

One further concern may be that Chinese agricultural products possibly have a reputation problem, and a GI label draws attention to the origin of the products. In this case, the negative coefficient on GI_{cpt}^{noqual} in column (4) in Table 4 may be due to a change in consumer perception, that is, consumers decreasing their demand for a Chinese product. If this were true, however, a change in perception should equally affect both GIs with and without quality supervision as they both have GI labels. We, however, find different results for the two kinds of GI. Furthermore, the reputation problem may be more likely to be an issue for consumers in developed countries, as they often have higher quality standards. Therefore, as a further robustness check, we use a subsample of exports to developed countries only. Results are not affected by this, as shown in column (8) of Table 6.

5.2.3 | Discussion of endogeneity

The application and authorization of GI could potentially be endogenous. Products from locations with a long history, more influence, more producers or higher quality may potentially be more likely to apply for and be authorized with a GI label. However, pre-existing quality would matter most in this case. To look at this possibility, the mean values of estimated export quality for GI products and non-GI products, before GIs were authorized, are presented in Table 7. One can see that a higher export quality is observed for GI products before they were authorized. Given that our main finding is that the coefficient of GI is significantly negative for GIs without quality supervision, this suggests that our analysis, if anything, potentially underestimates the free-riding problem.

Nevertheless, we attempt to address endogeneity concerns more directly. If location characteristics may indeed drive the selection into GIs, then controlling for such time-varying location specific effects may be important. Our firm-year fixed effects capture such location specific effects, as locations generally do not change. However, in a robustness check we also include city-year fixed effects in addition to firm-year fixed effects, shown in Table 8, column (1). Results are robust.

A further issue related to endogeneity is that it may possibly be caused by one city having more producers or exporters, who are better organized or more motivated to apply for a GI label. This may happen in more developed regions. Hence, we use cities that are the neighbor within the province as control group. This is done as the levels of economic development, quality of institutions, culture, and so forth are likely to be similar between treatment group and control group, which may alleviate endogeneity concerns. The results are shown in column (2) of Table 8 and they are in line with our baseline results.

5.2.4 | The externalities of GIs

What we have not considered yet, is the fact that in many cases there is more than one GI for one product, be it in the same location or not. For example, there are 24 GIs for green tea, 31 GIs for oranges, and 37 GIs for mushrooms according to the GI application records in the GI system of Chinese Ministry of Agriculture. More specifically, Yichang city in Hubei province has four GIs on tea. Having more than one GI for the same product may have implications for how firms adjust their product quality.

If there is more than one GI for a given product, this raises the possibility of substitution. Since the GIs apply to the same kind of fairly narrowly-defined products, consumers can potentially substitute among all GI products according to the similarity of semantic elements in the names of GIs.[25] Therefore, individual producers may have a stronger incentive to raise quality if there are other similar GIs. While there may be a stronger incentive to free ride in the absence of any other GIs. This is a possible externality as the number of GIs increase.

In order to investigate such an externality, we first calculate the number of GIs for each narrow product, $GI_num_{pt}^{noqual}$ and $GI_num_{pt}^{qual}$. $GI_num_{pt}^{noqual}$ represents the number of GI of products p at time t that have no

[25] For example, Livat et al. (2019) show that consumers substitute among wines with similar GI label.

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TABLE 8 Consider endogeneity issue.

	Adding city-year fixed effect (1)	Using neighbor cities as control group (2)
GI_{cpt}^{noqual}	−.0488*	−.0688***
	(−1.85)	(−2.60)
Observations	304363	271950
GI_{cpt}^{qual}	.0531*	.0453
	(1.70)	(1.44)
Observations	303255	270369
Country-product-firm fixed effects	YES	YES
Country-year fixed effects	YES	YES
Firm-year fixed effects	YES	YES
Product-year fixed effects	YES	YES

Note: T-statistics reported in parentheses. ***, **, * denote statistical significance at 1, 5, 10 percent level. Robust standard errors clustered at firm level.

TABLE 9 Externalities of GIs.

	Product GIs (1)	City GIs (2)
$GI_{cpt}^{noqual} \times GI_num_{pt}^{noqual}$	.0032**	
	(2.09)	
$GI_{cpt}^{noqual} \times GI_num_{ct}^{noqual}$		.0013
		(.77)
GI_{cpt}^{noqual}	−.1000***	−.0772*
	(−2.94)	(−1.92)
Observations	315209	315209
$GI_{cpt}^{qual} \times T_t \times GI_num_{pt}^{qual}$	−.0001	
	(−.22)	
$GI_{cpt}^{qual} \times T_t \times GI_num_{ct}^{qual}$		.0124
		(1.53)
GI_{cpt}^{qual}	.0537	.0010
	(1.46)	(.02)
Observations	314024	314024
Country-product-firm fixed effect	YES	YES
Year fixed effect	YES	YES
Country-year fixed effect	YES	YES
Firm-year fixed effect	YES	YES

Note: T-statistics reported in parentheses. ***, **, * denote statistical significance at 1, 5, 10 percent level. Robust standard errors clustered at firm level.

quality supervision. Equally, $GI_num_{pt}^{qual}$ represents the number of GI of product p at time t that have quality supervision. We then interact them with GI_{cpt}^{noqual} and GI_{cpt}^{qual}, respectively, and add them into the baseline equation. The results are reported in Table 9, column (1). They provide evidence for our conjecture that a higher number of GIs per product enhances the quality chosen by given producer, though this is only true for GIs without quality supervision.

While these results look at the number of GIs for the same product, a similar substitution effect may perhaps be expected for GIs in the same city. Summing up all GIs per city (rather than product) and including an interaction in the equation produces results in column (2). As can be seen, we do not find such an effect when we consider GIs in the same city, rather than for the same product. This makes intuitive sense, as consumers would likely substitute similar products with different GIs, but may be less likely to substitute a product with a different product that is from the same city.

5.3 | Extensions

5.3.1 | Product type

In an extension of our analysis, we analyze GI effects for different product groups, as shown in Table 10. Products are divided into five types based on their character and export performance. First of all, we classify all agricultural products into animal, plant, and seed products. Further, vegetable and fruit, tea and coffee are two kinds of products that are exported most. The free-riding problem is more severe for animal products than plant products, as shown in column (1), (2), and (3). A possible explanation is that animal products are often frozen, cut or dried, which leaves less room for consumers to tell quality and more room for producers to shirk on quality.

It is worth to mention that tea and coffee are the most export-intensive among all products. Tea, of course, has a long history and is a very popular beverage in China. Importantly, the standard of producing tea is better developed than any other products. Most of GI tea products apply standards regarding how the GI tea should be planted and processed. While this is less common for

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TABLE 10 Heterogeneity of products.

	Animal products (1)	Plant products (2)	Seeds products (3)	Vegetable and fruit (4)	Tea and coffee (5)
GI_{cpt}^{noqual}	−.2449**	−.0262	−.1319	−.0356	.2282**
	(−2.14)	(−.92)	(−1.20)	(−1.08)	(2.34)
Observations	92571	161965	38589	126132	21761
GI_{cpt}^{qual}	.1684	.0438	.0124	.0782**	−.1085
	(1.42)	(1.28)	(.06)	(2.16)	(−.84)
Observations	92201	166415	33126	131495	21750
Country-product-firm fixed effect	YES	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES	YES
Country-year fixed effect	YES	YES	YES	YES	YES
Firm-year fixed effect	YES	YES	YES	YES	YES

Notes: Products with 2-digit HS code of 01, 02, 03, 04, 05 are classified as animal products. Products with 2-digit HS code of 06, 07, 08, 09 are classified as plant products. Products with 2-digit HS code of 10, 11, 12 are classified as seeds product. Vegetable and fruit are products with 2-digit HS code of 07 and 08. Tea and coffee are the product with 2-digit code of 09.

T-statistics reported in parentheses. ***, **, * denote statistical significance at 1, 5, 10 percent level. Robust standard errors clustered at firm level.

animal, vegetable, and fruit products. This may make tea different from other products regarding free-riding, as indicated by the results in column (5) where we find a positive impact of a GI without quality supervision. Furthermore, our results show a positive impact on quality of GI with quality supervision for fruit and vegetables.

5.3.2 | GIs protected by FTA

During our sample period from 2000 to 2015, China signed Free Trade Agreements (FTA) with 20 countries, all of which contain IPR protection terms. GIs as one kind of IP rights are protected under such terms.

With GI protected in a foreign country, the signaling effect of that GI mark is more valuable when exporting to this country than to non-GI-protected countries. However, IPR protection is only concerned about IP infringement and has no obligation for implementing quality standards. Enjoying more market power and no quality supervision as in the case of GIs authorized by MoA means that exporters may be more motivated to export lower quality products to achieve higher profits. This means that the free-riding problem of GIs without quality supervision may be more severe after an FTA was signed. However, this may not be the case for GI with quality supervision, where quality supervision aims to prevent such behavior.

We interact GI_{cpt}^{noqual} and GI_{cpt}^{qual} with FTA_{dt} (equal to one if there is a trade agreement with the destination country for China) to investigate how such two kinds of GI perform differently under the protection of an FTA. Results are shown in Table 11. The coefficients on $GI_{cpt}^{noqual} \times FTA_{dt}$ and $GI_{cpt}^{qual} \times FTA_{dt}$ are in line with our hypothesis that free riding may be particularly relevant when there is an FTA.

TABLE 11 GI under the protection of FTA.

	(1) Quality	(2) Quality
$GI_{cpt}^{noqual} \times FTA_{dt}$	−.0653**	
	(−2.06)	
GI_{cpt}^{noqual}	−.0295	
	(−1.05)	
$GI_{cpt}^{qual} \times FTA_{dt}$		−.0595
		(−1.52)
GI_{cpt}^{qual}		.0648*
		(1.96)
Country-product-firm fixed effect	YES	YES
Year fixed effect	YES	YES
Country-year fixed effect	YES	YES
Firm-year fixed effect	YES	YES
Observations	315209	314024

Note: T-statistics reported in parentheses. ***, **, * denote statistical significance at 1, 5, 10 percent level. Robust standard errors clustered at firm level.

5.3.3 | China-EU agreement on GIs

As pointed out by Sorgho and Larue (2018), some GIs are well-known internationally while many others are not. International GI recognition is conditional on legal

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TABLE 12 China-EU agreement on Geographical Indications.

	(1) Quality	(2) Quality
$GI_{cpt}^{noqual} \times GI_EU_{cpt} \times EU_d$	.2753***	
	(2.88)	
GI_{cpt}^{noqual}	−.0550**	
	(−2.11)	
$GI_{cpt}^{qual} \times GI_EU_{cpt} \times EU_d$		−.0452
		(−.75)
GI_{cpt}^{qual}		.0500
		(1.62)
Country-product-firm fixed effect	YES	YES
Year fixed effect	YES	YES
Country-year fixed effect	YES	YES
Firm-year fixed effect	YES	YES
Observations	315922	314755

Note: T-statistics reported in parentheses. ***, **, * denote statistical significance at 1, 5, 10 percent level. Robust standard errors clustered at firm level.

protection provided for foreign GIs by importing countries. China has been trying to realize recognition of its GIs in the EU since 2011. The *China-EU agreement on Geographical Indications* was initiated in 2011 and came into force in 2021 (as discussed in Section 2). During negotiations, the 275 Chinese GIs concerned were under stricter supervision to make sure they showed their reliability, especially for exporting to EU countries. We therefore hypothesize that the free-riding problem would be less for GIs listed in the agreement when exporting to EU countries.

We identified those GIs listed in the agreement and marked them as $GI_EU_{cpt} = 1$ for 2011 and after, otherwise $GI_EU_{cpt} = 0$. Besides, we generate a dummy EU_d indicating the EU as export destination, $EU_d = 1$. Interacting GI_{cpt}^{noqual} and GI_{cpt}^{qual} with $GI_EU_{cpt} \times EU_d$ and adding it into Equations (5) and (6), we estimate the effect of being included in the *China-EU agreement on Geographical Indications* negotiation. The results are shown in Table 12.

The coefficient of $GI_{cpt}^{noqual} \times GI_EU_{cpt} \times EU_d$ in column (1) of Table 12 is in line with our hypothesis, showing that the export quality of GI products included in the agreement and exported to EU countries is higher than for GIs not included or exported anywhere else. This is only true for GIs without quality supervision, as indicated by the insignificant coefficient on $GI_{cpt}^{qual} \times GI_EU_{cpt} \times EU_d$ in column (2) of Table 12. It suggests that the *China-EU agreement on Geographical Indications* negotiation plays the role of quality supervision that may prevent a free-riding phenomenon for GIs authorized by MoA.

TABLE 13 The impact of market structure on free-riding problem.

	(1) Quality	(2) Quality
$GI_{cpt}^{noqual} \times hhi_{cpt}$	.4581**	
	(2.45)	
GI_{cpt}^{noqual}	−.0748*	
	(−1.75)	
$GI_{cpt}^{qual} \times hhi_{cpt}$		.5338***
		(3.03)
GI_{cpt}^{qual}		.1116**
		(2.26)
Country-product-firm fixed effect	YES	YES
Year fixed effect	YES	YES
Country-year fixed effect	YES	YES
Firm-year fixed effect	YES	YES
Observations	194130	190502

Note: hhi_{cpt} means Hirschman–Herfindahl Index based on firm level export sales for each product. When calculating hhi_{cpt} we drop city-product combinations with less than five firms.
T-statistics reported in parentheses. ***, **, * denote statistical significance at 1, 5, 10 percent level. Robust standard errors clustered at firm level.

5.3.4 | Discussion on market concentration

Market concentration may matter for quality effects of GIs. Take one highly concentrated industry, for example, that consists of a very large player and several small players. In this case, free-riding by small players might be very harmful for this large player and the large player might react by tracing and punishing whoever free-rides on it. The free-riding problem would be alleviated.

It may be insightful to look at a measure of industry concentration, such as the Hirschman–Herfindahl index (HHI). With the data at hand we can look at this and calculate a hhi_{cpt} based on export sales. hhi_{cpt} measures the export market concentration of product p in city c at year t. We interact hhi_{cpt} with our treatment variables and results are shown in Table 13.

Results are in line with the theoretical argument. The estimated coefficient on the $GI_{cpt}^{noqual} \times hhi_{cpt}$ interaction suggests that the negative quality effect of GI without quality supervision is less the more concentrated the export of the product is. In fact, the effect of GI on quality even turns positive for HHI larger than .2. This result makes intuitive sense. The more concentrated an industry is – that is, the more it is dominated by some larger firms – the stronger is the incentive of these large firms to also maintain quality standards and act the role of quality supervision for the GI. For, consumers may be able to associate quality with individual firms in a more concentrated market. This is reflected in our result.

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6 | CONCLUSIONS

We use detailed firm-product-location-destination level customs trade data for agricultural products in China, linked to comprehensive records on the implementation of GI labels, in order to analyze the impact of the introduction of a GI on export activity. This is done in a difference-in-differences econometric analysis where we can follow GI products before and after the implementation of the label, compared to a control group of product-locations that do not have GIs.

Our first finding shows that there is no robust evidence that the introduction of a GI generally positively affects exports of the protected product. Instead, it is important to distinguish GIs with and without quality supervision. For the latter, we find a negative impact on average quality of GIs, while this is not the case for GIs with quality supervision. We interpret this as the evidence for quality free-riding, where individual firms have an incentive to shirk on quality when there is no quality supervision. This finding is still valid after a bunch of robustness checks. We also find that this negative effect is less the more concentrated an industry is, and may eventually even turn positive. Furthermore, we find that the more GIs there are for a particular product, the more positive the quality effects of GIs on export products are, especially for GIs without quality supervision. Besides, the negotiation of *China-EU agreement on Geographical Indications* may have had a positive effect on GI's export quality to the EU, as it may imply more stringent quality supervision.

Our findings on the link between GI establishment and product quality suggest two policy implications. The first is the need for quality supervision mechanisms. In the GI system managed by the Chinese Ministry of Agriculture, there is no setting of quality standards and consequently no valid quality supervision. By contrast, the GI system managed by General Administration of Quality Supervision, Inspection and Quarantine requires the setting of quality standards and their enforcement. We compare these two systems and find that the free-riding problem only exists for GIs without quality standards and supervision. This provides direct evidence on the necessity of quality supervision mechanism for an efficient GI protection system.

While this is a "Chinese" result, it may have wider implications for other developing and emerging economies. Many of those may have difficulties in setting a high standard GI protection system, due to, for example, broken institutions, inadequate financial input and so on. Our analysis shows that establishing a good quality assurance system is highly important. Hence, this finding is especially instructive for developing or emerging economies trying to establish a GI system.

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DATA APPENDIX AVAILABLE ONLINE

A data appendix to replicate the main results is available in the online version of this article. Please note: Wiley-Blackwell is not responsible for the content or functionality of any supporting information supplied by the authors. Any queries (other than missing material) should be directed to the corresponding author for the article.

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SUPPORTING INFORMATION

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APPENDIX

TABLE A1 GI products in China by product type.

2-digit HS code	Product	GI with quality supervision	GI registered in both system	GI without quality supervision
01	Live animals	9	2	72
02	Meat and edible meat offal	82	4	164
03	Fish and aquatic invertebrates	79	2	115
04	Dairy and egg	20	2	42
05	Other products of animal origin	4	0	4
06	Live trees and other plants	8	0	15
07	Vegetables	142	12	344
08	Fruit and nuts	243	26	423
09	Coffee and tea	108	11	135
10	Cereals	58	3	47
11	Products of the milling industry	18	3	81
12	Oil seeds and oleaginou (medicinal plants included)	177	8	148
13	Lac and gums	0	0	2
14	Other vegetable products	1	–	–
Total		936	73	1592

Note: To be comparable between two GI systems, we limit product type to primary agricultural products, that is, 2-digit HS code from 01 to 14.

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TABLE A2 The impact of GI registered in both systems on firm's export activities.

	Export	Quantity	Price	Quality	Quality-adjusted price
	(1)	(2)	(3)	(4)	(5)
GI_{cpt}^{both}	−.1088	−.0235	−.0894***	−.1234***	.0361
	(−1.06)	(−.23)	(−3.59)	(−2.71)	(1.03)
Observations	299085	299085	299085	299085	299085
Country-product-firm fixed effects	YES	YES	YES	YES	YES
Country-year fixed effects	YES	YES	YES	YES	YES
Firm-year fixed effects	YES	YES	YES	YES	YES
Product-year fixed effects	YES	YES	YES	YES	YES

Note: $GI_{cpt}^{both} = 1$ for GIs are registered in both systems, otherwise 0. Only GIs registered in both systems are treatment group, non-GIs are control group. T-statistics reported in parentheses. ***, **, * denote statistical significance at 1, 5, 10 percent level. Robust standard errors clustered at firm level.

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