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Organic Certification, Online Market Access, and Agricultural Product Prices: Evidence from Chinese Apple Farmers

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Abstract: Motivated by the increasing interest in sustainable agriculture and the potential benefits associated with organic certification, this study employs a multidimensional fixed-effects model to analyze data derived from onsite surveys conducted among 681 apple farmers in the Loess Plateau region of China to explore the influence of organic certification on absolute and relative agricultural product prices given online market access. The findings indicated a significant increase in apple prices among farmers who held organic certifications and engaged in online market sales, with prices rising by CNY1.60 per half kilogram. Additionally, this study highlights that the amalgamation of organic certification with online market access significantly enhances agricultural product prices by facilitating better dissemination of market information among farmers. Furthermore, this research addresses a critical gap in the existing literature by clarifying the differential impact of organic certification across distinct farmer demographics and geographical regions. The more pronounced positive impact of organic certification on prices observed among cooperative members and farmers in the low-altitude areas is particularly noteworthy. These results underscore the crucial role of online market access in achieving premium effects and price stability for organically certified products.

Keywords: organic certification; online market access; absolute price; relative price; farmers; apple; China

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1. Introduction

The escalation of severe environmental damage associated with traditional agricultural practices has driven eco-certification initiatives [1–3]. Various labels, such as Organic, Rainforest Alliance, and UTZ (UTZ kapeh), have been granted to farmers based on their adherence to distinct environmental and social criteria [4,5]. Since the 1970s, increasing public concerns regarding the health and environmental impacts of industrialized farming have propelled the rise of the organic movement [6]; as of 2019, organic agriculture is practiced in 187 countries, with at least 3.1 million farmers managing 72.3 million hectares of agricultural land, and the market size of organic products has reached EUR106.4 billion [7].

Organic farming, being at the forefront of sustainable agriculture, has significantly influenced the e-commerce market dynamics. With the increasing consumer demand for organic products, e-commerce platforms have become crucial channels for farmers to reach a wider audience. The rise of online shopping platforms has provided organic farmers with unprecedented market access, thereby reshaping the landscape of agricultural trade and commerce.

It is worth noting that while North America and Europe currently dominate organic product sales, developing countries, such as China, India, Brazil, and Indonesia, are expected to experience rapid market share growth in the coming years [7]. This growth trajectory underscores the transformative potential of organic agriculture in the evolving e-commerce market.

Organic farming is known not only for its contribution to healthy food production and environmental sustainability but also for its potential to improve the socioeconomic

conditions of farmers. Studies have shown that it has several economic advantages, such as increased profitability and a higher return on investment, over Global GAP-certified (Good Agricultural Practices) farming [8,9]. However, these advantages often depend on robust market demand, which may disappear during market disruptions. Existing research has predominantly overlooked the effects of organic certification on field-level agricultural prices, instead focusing more on consumer-side market variables such as consumer prices and willingness to pay. This study aims to address this gap by examining the impact of organic certification on the prices of agricultural products at the production level.

Additionally, enhancing market access is crucial to increasing agricultural product prices, enhancing farmer income, and ensuring livelihood security. The current rise of e-commerce as a means to significantly improve farmers' access to markets via the Internet warrants attention regarding its impact on the relationship between organic certification and agricultural product prices. Notably, e-commerce, which this study identifies as "online market access", played a pivotal role in China by offering rural farmers a supplemental market channel and expanding their reach to a broad consumer base [10].

The choice of the apple industry as the research focus is primarily justified by the following reasons: (1) From a production standpoint, as of 2022, the apple planting area in China represented 15.03% of the total orchard area in the country. (2) Considering consumption, apples rank as the second-largest fruit by production volume in China, comprising 20.85% of the total production of orchard fruits. Thus, apples constitute a significant subject for study, whether viewed from the perspective of farmer income or consumer welfare.

To sum up, this study focuses on how online market access influences the prices of organically certified high-quality products. The findings will reveal the role of online market access in returns on high-quality agricultural products and thus may confirm or complicate Bold et al. [11] previous finding that market access motivates farmers to enhance product quality and increase income.

This article makes two contributions to the field. First, it offers a fresh perspective on the development of organic agriculture in the digital age by exploring the crucial moderating role of online market access in the relationship between organic certification and prices. Unlike the extensive literature focused on directly examining the organic certification premium effect, there is a notable gap in research concerning the influence of organic certification on agricultural market stability. Second, the analysis presented in this study provides micro-level evidence that can significantly drive the high-quality development of Chinese agriculture. Furthermore, it offers a contemporary approach to enhancing the positive externalities associated with ecological preservation by promoting organic certification.

The following section delves into the background of China's apple industry and the theoretical mechanisms of this article. Section 3 introduces the data and variables and outlines the methodology used for empirical analysis. Section 4 presents the empirical results. Section 5 concludes the study, focusing in particular on the research implications.

2. Background and Theoretical Mechanisms

2.1. Background of the Development of Chinese Apple Industry

In the 2022/2023 season, global apple production reached an impressive 78.41 million metric tonnes (Mt), with China notably contributing 41 million Mt (52.29% of the total global yield) as the most significant global apple producer. As the leading exporter of apples, China shipped 0.77 million Mt, accounting for 14.10% of the world's total apple exports. Meanwhile, as the world's largest consumer of apples, China consumed 40.31 million Mt of apples in the 2022/2023 season, constituting 51.53% of global apple consumption (Data Source: Compiled from data released by the United States Department of Agriculture in June 2023, https://fas.usda.gov/data/production/commodity/0574000, accessed on 20 June 2023).

Four central regions drive apple production in China: the Loess Plateau, Bohai Bay, the old course of the Yellow River, and the cold highlands in the southwest. Cultivation has primarily shifted to the Loess Plateau, spanning the Shaanxi, Gansu, Henan, and Shanxi provinces. In 2022, China's total apple cultivation area reached 19.56 million hectares, with the Loess Plateau region accounting for 11.10 million hectares, representing 56.75% of the national total. Total national production in 2022 was 47.57 million Mt, of which the Loess Plateau contributed 26.18 million Mt, comprising 55.04% of the total. 2023, China's fresh apple exports totaled 0.796 million Mt, valued at CNY6.83 billion. The Loess Plateau contributed 0.127 million Mt to China's 2023 apple exports—this figure comprises 15.98% of China's total apple export volume and is valued at CNY1.04 billion, 15.25% of China's total apple export value (Data Source: General Administration of Customs of the People's Republic of China, http://gdfs.customs.gov.cn/customs/index/index.html, accessed on 11 March 2024).

As of 2023, China has hosted 117 certified bodies specializing in organic agricultural certification and issued 2169 certificates for apple production (an effective rate of 20.65%). Specifically, in China, organic foods are defined as agricultural products cultivated according to specific organic farming standards and certified by legitimate bodies, including organic, pollution-free, green, and geographically sourced agricultural products. In the Loess Plateau provinces, 862 apple production applicants for organic certification accounted for 39.74% of the total. Additionally, the Loess Plateau provinces possess 210 valid organic certifications (an effective rate of 24.36%), with Shaanxi and Gansu boasting the highest number of certifications (Data source: China Food and Agricultural Product Certification Information System, http://cx.cnca.cn/CertECloud/result/skipResultList?certItemOne=Z02, accessed on 11 March 2024).

These data underscore the significance and developmental potential of China's apple industry. The apple sector offers farmers abundant employment opportunities and serves as a stable source of economic income, particularly in rural areas, where apple cultivation has become a primary livelihood for many households. Through the continual elevation of quality standards and promotion of organic certification, China's apple industry not only furnishes high-quality agricultural products for the domestic market but also garners a reputable standing in the international market, thereby fostering additional economic prospects and avenues for farmer advancement.

2.2. Theoretical Mechanisms

The literature suggests various channels through which the organic certification could have affected agricultural product prices. These channels are described below and summarized in Figure 1.

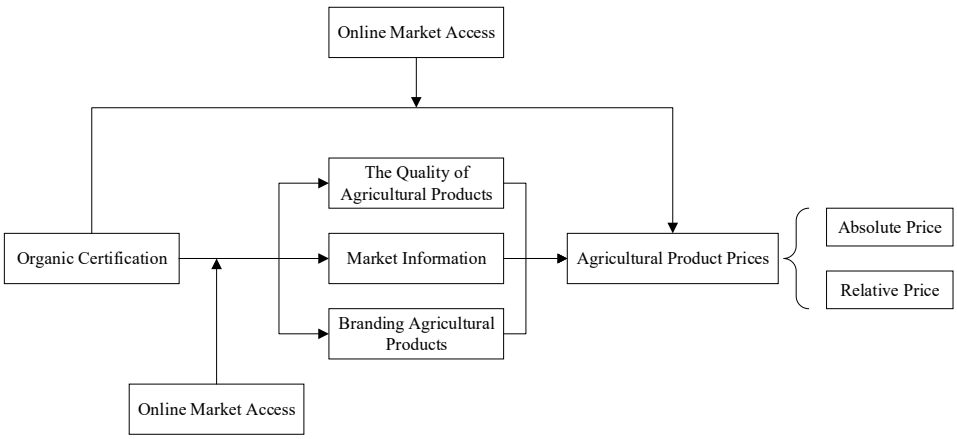

Figure 1. Theoretical mechanism analysis of organic certification on agricultural product prices. This figure highlights how organic certification might affect agricultural product prices through various channels. Source: Authors' elaboration.

2.2.1. Direct Effects of the Organic Certification and Online Market Access

Organic certification has economic benefits for producers [12]. For example, certified organic products can be sold for higher prices than conventional products [13] and boast diversified sales channels. Certification improves market access, enabling entry into high-value markets [14]. For instance, a Food and Agriculture Organization (FAO) study revealed that organic farmers in developing countries can access international markets more effectively and secure higher prices than conventional farmers. Moreover, the International Trade Center (ITC) research showed that organic certification increases market access and higher premiums for products in the U.S. and European Union markets. This may be because organic labels distinguish premium products and increase market competitiveness, with consumers perceiving organic products as healthier and of higher quality, boosting demand [15–17]. Along these lines, J Aschemann-Witzel [18] highlighted Danish consumers' willingness to pay more for organic products due to their perceived health benefits. Meanwhile, Murphy et al. [19] analysis of consumer trust in organic food and certification across four European countries revealed variations in trust and beliefs regarding certified organic food. Consumers generally trust certified organic food, but preferences vary by country. Italian and Polish respondents have higher overall trust and prefer EU certification, while respondents from the UK and Germany show lower trust and prefer national certification bodies.

Market access significantly influences multiple facets of agricultural output, farmers' nutritional intake, and technology adoption, especially in developing economies [20–22]. Distance to the central market is often used as a proxy for market access [23,24]. Market access ensures fair pricing for high-quality agricultural products [11]. Online sales constitute an alternative market access method that leverages Internet channels. Specifically, we argue that online platforms provide convenient and efficient means of information sharing, enabling customers to access reviews and facilitating interactions between supply and demand.

The "Digital Commerce Empowers Agriculture" project is an initiative designed to fully harness the potential of digital technology and data resources to empower rural commerce. Its overarching objective is to comprehensively elevate the levels of digitization, networking, and intelligence in rural commerce, thereby driving the high-quality development of rural e-commerce.

Under the "Digital Commerce Empowers Agriculture" project initiative, rural e-commerce in China has developed into a high-quality marketplace [25–27]. E-commerce channels reduce intermediaries, leading to shorter trading chains and real-time feedback mechanisms between farmers and consumers [28,29]. This interaction streamlines the flow of information in agricultural markets and reduces information asymmetry [30,31].

In China, the advent of e-commerce has profoundly influenced the organic agricultural sector. Primarily, it has expanded the sales channels for organic agricultural products, enabling farmers to transcend geographical constraints and reach a broader consumer base [32,33]. Secondly, e-commerce platforms have enhanced transparency in pricing and product information, facilitating easier comparison for consumers in terms of price and quality and thereby augmenting the competitiveness of organic agricultural products [34]. Additionally, e-commerce has streamlined supply chain management and logistics [35], reducing operational costs and enhancing production efficiency. Lastly, e-commerce fosters product innovation and diversification [36], enabling organic agricultural products to better adapt to market demands.

2.2.2. Indirect Effects of the Organic Certification and Online Market Access

The quality of agricultural products significantly determines their market prices. Stringent production constraints enforced by organic certification play a pivotal role in augmenting product quality during the production phase [37,38]. Organic labels act as a discernible signal for consumers seeking to differentiate and select products of superior quality [39]. Although extensive research in existing literature has delved into the quality premium effect associated with organic certified agricultural goods [9,40–42], the rapid growth of

agricultural e-commerce has emerged as a primary influencing factor of product pricing dynamics [33,43]. By streamlining agricultural transactions and reducing intermediary involvement, e-commerce chiefly bolsters producer and consumer surplus [44], presenting a novel avenue of farming sales and extending the market's reach to accommodate diverse consumer demands [33]. Therefore, in the realm of online market accessibility, the effect of organic certification on prices may not stem solely from the continuous enhancement of product quality.

Market information powerfully shapes agricultural product prices. There has been a significant shift in consumer preferences and demands in recent years. Consumers are now more conscious of their food's quality, safety, and sustainability [45,46]. Certifications for organic agricultural products externalize inherent quality information; certification labels can convey quality information to consumers [47,48]. However, traditional agricultural trade processes are often protracted and may involve information distortions [49]. Directly providing organic certification quality information to consumers through online sales channels can ameliorate losses in information transmission and enrich market demand information [50,51]. Online market access, facilitated by media, such as images, videos, and reviews, gives farmers real-time and varied market demand data, mitigating the phenomenon of poor and distorted information transmission between producers and consumers [52,53]. Hence, organic certification enhances agricultural product prices in online market access by broadening farmers' access to market information.

Further, it is helpful to note that branding agricultural products can enhance their value. Specifically, branding can give a product a distinct market identity [54], which enables consumers to distinguish the product from similar offerings and, crucially, recognize the product's quality [55]. With consumers' growing reliance on brands for online agricultural purchases, brand consumption has emerged as a significant driver of increased demand for these goods [56]. The emergence of e-commerce as a contemporary sales avenue for agricultural products has propelled the branding of such products [57]. Organic certification is widely regarded as a benchmark for the quality of agricultural products, and farmers can use their certification as part of their branding strategies to highlight the benefits and, relatedly, the quality of their products. However, to maintain their competitiveness, farmers without organic certification must establish strong commercial product brands [14,58]. Hence, farmers must pursue organic certification, commercial branding or both.

3. Data and Methods

3.1. Data Sources

In this study, we crafted a questionnaire on the quality and safety of agricultural products within the apple-growing community. Part One of the survey gathered fundamental information about apple growers, encompassing personal and family backgrounds, agricultural production entities, and product certification status. Part Two delved into specifics related to land, labor, and the apple market, covering elements like land leasing, labor recruitment, and apple sales. Part Three explored the Internet engagement of apple growers, concentrating on their Internet infrastructure, information accessibility, and technological applications. Lastly, Part Four scrutinized the extent of farmers' involvement in organized agricultural activities.

Following the initial questionnaire draft, we trained team members and conducted a preliminary investigation in Fufeng County, Baoji City, Shaanxi Province, to validate the questionnaire's feasibility and rationality. During this preliminary investigation, 20 respondents participated in our pre-survey. Subsequent revisions were made based on the actual situation, leading to the final version.

Subsequently, we identified research sample areas with significant apple-producing regions on the Loess Plateau, known for its unique geographical and climatic advantages for apple cultivation. These areas included Weinan and Yan'an in Shaanxi Province and Qingyang and Pingliang in Gansu Province. To ensure representativeness, we employed a stratified and random sampling method. The four cities served as primary sampling units.

Within each county/district, 3 to 7 towns were selected based on apple production scale, with approximately 30 apple growers randomly chosen from each town.

Finally, our 12-member research team conducted one-on-one random interviews in 11 counties/districts of Shaanxi and Gansu provinces from July to August 2021. Before the interviews, participants were informed that the data would be used solely for academic research and that their personal information would be strictly confidential. With participants' consent obtained, our team conducted one-on-one questionnaire interviews. We sampled 784 apple growers throughout the survey process, validating the questionnaires' accuracy. The final number of valid questionnaires used for this study was 681.

3.2. Methods

To examine the impact of organic certification on agricultural product prices, we estimate the following equation:

$$price_{ij} = \alpha_0 + \alpha_1\, organic_{ij} + \beta\, x_{ij} + \delta_j + \varepsilon_{ij} \quad (1)$$

where $price_{ij}$ refers to agricultural product prices in towns j and i, $organic_{ij}$ represents the organic certification status of apple farmers in towns j and i; x_{ij} represents other factors that may affect the resilience of apple farmers, including gender, age, education level, village cadre identity, number of household members involved in apple farming labor, social network, apple cultivation scale, degree of land fragmentation, apple cultivation mode, and organizational participation; δ_j represents town-fixed effects; and ε_{ij} is the random error term.

3.3. Variable Definitions

This study examines two categories of agricultural product prices: absolute and relative. Absolute prices denote the average selling price of apples for farmers in 2020, whereas relative prices gauge the stability of sales prices before and after 2019 and 2020. This approach measures market price stability using Equation (2).

$$relative\ price_{ij} = \left(price_{ij2020} - price_{j2020}\right) - \left(price_{ij2019} - price_{j2019}\right) \quad (2)$$

Organic certification is represented in binary form, where the value is 1 for apple farmers with organic certification and 0 for those without certification.

Online market access is determined based on the farmers' responses to our questionnaire. We asked the apple farmers whether they sold apples through online platforms, such as ''WeChat", ''Taobao", and ''TikTok". A "yes" response is denoted as 1; a "no" as 0.

This study included multiple control variables for potential factors influencing apple prices. These variables include personal and family characteristics, apple production, and management characteristics. Based on existing literature [59,60], we have selected the personal characteristics of the respondents, including gender, age, education level, and village cadre status. Family characteristics include the number of apple-planting labor force and social network. Apple production and management characteristics include apple planting scale, land fragmentation degree, apple cultivation mode, and organizational participation.

For detailed information on the variables above, please refer to Table 1. On average, absolute prices stand at CNY 2.72 per half kilogram, while relative prices show a marginal change of −0.008. Approximately 3.82% of the farmers possessed organic certifications for their products. Notably, approximately 13.07% of the farmers sold apples through Internet platforms. Personal and family characteristics revealed that the majority (98.38%) of participants were male, with an average age of approximately 52 years. The average educational level of the participants was middle school, and 12.48% held village cadre positions. Each household averaged two labor inputs for apple cultivation. Meanwhile, the average social network investment per household was approximately CNY 8283.96. The average apple

cultivation area was approximately 29 mu (primarily arborized). Approximately 27.90% of the farmers were part of professional cooperatives.

Table 1. Descriptive statistics of main variables.

Variables	Description	N	Mean	SD	Min	Max	Percent (%)
Dependent variable							
Absolute price	the average selling price of apples for farmers in 2020	681	2.716	1.032	0.333	13.233	-
Relative price	the difference in average selling prices in 2020 and 2019 and the average selling price difference in their respective towns	681	−0.008	0.77	−3.32	8.044	-
Independent variable							
Organic certification	1 = yes	26	-	-	0	1	3.82
	0 = no	655					96.18
Mediating variable							
Online market access	1 = yes	89	-	-	0	1	13.07
	0 = no	592					86.93
Control variables							
Gender	1 = male	670	-	-	0	1	98.38
	0 = female	11					1.62
Age	year	681	52.374	8.780	26	77	-
Education	1 = no schooling	27	-	-	1	5	3.96
	2 = primary school	155					33.76
	3 = junior school	336					49.34
	4 = high school	146					21.44
	5 = college and undergraduate	17					2.50
Village cadres	1 = yes	85	-	-	0	1	12.48
	0 = no	596					87.52
Number of laborers	number of household members involved in apple farming labor	681	2.132	0.651	1	6	-
Social network	CNY	681	8283.96	20,722.25	100	400,000	-
Scale	mu	681	29.605	172.261	1	4,000	-
Land fragmentation level	blocks	681	2.968	2.606	1	53	-
Apple cultivation mode	1 = tall-tree planting	518	-	-	1	3	76.06
	2 =dwarf-tree planting	96					14.10
	3 = both tall-tree and dwarf-tree planting	67					9.84
Participation in organizations	1 = yes	190	-	-	0	1	27.90
	0 = no	491					72.10

Note: "Village cadres" refers to grassroots management personnel in rural areas of China. "social network" refers to the gift money paid by families in social relations. "mu" is a unit used to measure land area, typically employed in agricultural production and land management in China. One mu is equivalent to approximately 666.67 square meters.

4. Results

4.1. Impact of Organic Certification and Online Market Access on Apple Prices

This study used Stata 17.0 and a fixed-effects linear regression model to examine the influence of organic certification on apple prices, as presented in Table 2. Results from Columns (1) and (3) of Table 2 indicate that organic certification demonstrates a significant positive correlation with absolute and relative apple prices at the 1% significance level without controlling for other variables. Moreover, the results from Columns (2) and (4) of Table 2 show that even after controlling for other variables, organic certification exhibits a significant positive correlation with absolute and relative apple prices at the 1% significance level. Specifically, considering the influence of relevant factors, participating farmers in organic certification experience an increase of CNY 0.96 per half kilogram in apple absolute price. The rise in the relative price of agricultural products suggests that compared to non-certified farmers, certified organic farmers exhibit greater price stability.

Table 2. Baseline regression results.

Variables	Absolute Price		Relative Price	
	(1)	(2)	(3)	(4)
Organic certification	1.213 ***	0.957 ***	0.701 ***	0.691 ***
	(0.205)	(0.209)	(0.166)	(0.174)
Gender		0.024		−0.014
		(0.287)		(0.240)
Age		−0.009 **		−0.004
		(0.004)		(0.004)
Education		0.058		−0.110 ***
		(0.047)		(0.039)
Village cadres		−0.107		−0.012
		(0.112)		(0.094)
Number of laborers		0.059		0.105 **
		(0.058)		(0.048)
Social network		−0.000		−0.000
		(0.000)		(0.000)
Scale		0.001 ***		0.000
		(0.000)		(0.000)
Land fragmentation level		0.044 ***		−0.012
		(0.015)		(0.012)
Apple cultivation mode		0.157 **		0.064
		(0.066)		(0.055)
Participation in organizations		0.271 ***		0.055
		(0.093)		(0.077)
Town FE	YES	YES	YES	YES
Constant	2.670 ***	2.439 ***	−0.035	0.242
	(0.037)	(0.406)	(0.030)	(0.339)
Observations	681	681	681	681
R-squared	0.187	0.255	0.038	0.065

Note: Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$.

These findings strongly support the assertion that organic certification positively impacts apple prices. Despite accounting for potential confounding variables, the substantial and consistent price premium associated with organic certification underscores its importance in enhancing the economic value of apples. The observed increase in price stability further underscores the benefits of organic certification for participating farmers, providing a competitive advantage in the market.

Beyond organic certification, factors such as a larger cultivation scale, dispersed land ownership, and diverse apple cultivation modes are associated with higher apple prices for farmers. Conversely, advanced age among farmers corresponds to a decrease in apple prices. Additionally, increased household labor for apple production correlates with more

consistent apple prices. Further, higher levels of education among farmers are associated with more significant price fluctuations.

This study employs a fixed-effects linear regression model to examine the influence of organic certification on apple prices under online market access, as presented in Table 3. We first categorize the sample into two groups based on whether farmers sell apples through online platforms (Columns 1 and 3 of Table 3) or traditional offline channels (Columns 2 and 4 of Table 3).

Table 3. Online market access results.

Variables	Absolute Price		Relative Price	
	(1)	(2)	(3)	(4)
Organic certification	1.604 **	−0.131	1.216 ***	−0.052
	(0.621)	(0.176)	(0.436)	(0.208)
Gender	−1.225	0.086	0.623	0.043
	(1.944)	(0.181)	(1.363)	(0.214)
Age	−0.051 **	−0.009 ***	0.001	−0.007 **
	(0.025)	(0.003)	(0.018)	(0.003)
Education	0.223	0.025	−0.381 *	−0.095 ***
	(0.306)	(0.030)	(0.215)	(0.036)
Village cadres	−0.406	0.019	0.137	0.032
	(0.539)	(0.076)	(0.378)	(0.090)
Number of laborers	−0.199	0.015	0.316	0.026
	(0.325)	(0.038)	(0.228)	(0.045)
Social network	−0.000	−0.000 **	0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Scale	0.008 ***	0.001 ***	0.003 ***	0.000
	(0.002)	(0.000)	(0.001)	(0.000)
Land fragmentation level	0.157 *	0.012	−0.075	−0.004
	(0.080)	(0.010)	(0.056)	(0.012)
Apple cultivation mode	0.389	0.076 *	0.055	0.075
	(0.328)	(0.043)	(0.230)	(0.051)
Participation in organizations	0.594	0.094	0.209	−0.014
	(0.524)	(0.062)	(0.368)	(0.073)
Town FE	YES	YES	YES	YES
Constant	5.152 **	2.718 ***	−0.354	0.441
	(2.548)	(0.260)	(1.786)	(0.308)
Observations	85	591	85	591
R-squared	0.642	0.366	0.520	0.080

Note: Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Column 1 of Table 3 results indicate a significant positive correlation between organic certification and absolute apple prices under online market access at the 5% significance level. Conversely, the results in Column 2 suggest that organic certification does not have a significant effect on absolute apple prices under traditional market access. Farmers participating in organic certification under online market access experience an increase of CNY 1.60 per half kilogram in apple prices compared to those not participating in organic certification, whereas participation in organic certification under traditional market access does not lead to a price increase. Thus, the premium effect of organic certification is more pronounced under online market access.

Column 3 of Table 3 results indicates a significant positive correlation between organic certification and relative apple prices under online market access at the 1% significance level. Conversely, the results in Column 4 suggest that organic certification does not significantly affect relative apple prices under traditional market access. Farmers participating in organic certification under online market access experience more excellent price stability than those not participating in organic certification, whereas participation in organic certification under traditional market access does not stabilize apple prices. Thus, the risk mitigation effect of organic certification is more pronounced under online market access.

These findings highlight the nuanced relationship between organic certification and apple prices, contingent upon the mode of market access. While organic certification leads to price premiums and enhanced price stability under online market access, its impact is negligible under traditional market access. This underscores the importance of considering market dynamics when evaluating the economic benefits of organic certification for farmers.

4.2. Robustness Tests

The preceding analysis validated the significant positive impact of organic certification on apple prices under online market access. In this section, we conduct robustness checks from two perspectives: measuring apple prices and considering the influence of geographical indications on apple prices.

Farmers usually sell apples multiple times, and the absolute price in the benchmark regression is the average price of all apples sold by farmers multiple times in 2020. In order to improve the robustness of our research, we have chosen the highest unit price among multiple sales of apples by farmers in 2020 as the absolute price of alternative agricultural products. We use the difference in apple sales prices between farmers in 2020 and 2019 as a substitute for the relative prices of agricultural products. The geographical indication of Chinese agricultural products refers to the geographical name, symbol, or other identification used by certain agricultural products that have a specific quality, reputation, or other characteristics due to China's specific geographical environment, climate conditions, soil characteristics, cultural history, and other factors, and are produced, processed, and manufactured within a specific geographical area. We identify whether the county where the farmers are located belongs to the scope of apple geographical indication certification.

Firstly, we measure absolute apple prices using the highest sales price of apples in 2020 and relative apple prices using the difference in average sales prices of apples between 2020 and 2019. The results in Column 1 of Table 4 reaffirm the significant positive correlation between organic certification and absolute apple prices under online market access at the 5% significance level. Farmers participating in organic certification under online market access experience an increase of CNY 1.88 per half a kilogram in the highest sales price of apples compared to non-participating farmers. This result is consistent with the findings in Column 1 of Table 3, indicating the robustness of the effect of organic certification on absolute apple prices under online market access.

Table 4. Robustness test results.

Variables	Absolute Price	Relative Price	Absolute Price	Relative Price
	(1)	(2)	(3)	(4)
Organic certification	1.876 **	1.216 ***	1.919 **	0.984 *
	(0.850)	(0.436)	(0.756)	(0.530)
Control variables	YES	YES	YES	YES
Town FE	YES	YES	YES	YES
Constant	8.651 **	0.009	5.275	0.777
	(3.487)	(1.786)	(3.127)	(2.189)
Observations	85	85	54	54
R-squared	0.427	0.621	0.649	0.528

Note: Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Secondly, considering the influence of geographical indications on apple prices, we conduct tests by excluding samples located within geographical indication protection areas. The results in Column 3 of Table 4 demonstrate that after excluding the influence of geographical indications, the effect of organic certification on absolute apple prices under online market access remains significant at the 5% significance level. In areas outside geo-

graphical indication protection zones, they are participating farmers in organic certification under online market access experience an increase of CNY 1.92 per half a kilogram in the highest sales price of apples compared to non-participating farmers. Similarly, the results in Column 4 of Table 4 show that after excluding the influence of geographical indications, the effect of organic certification on relative apple prices under online market access remains significant at the 10% significance level. In areas outside geographical indication protection zones, participating farmers in organic certification under online market access demonstrate higher price stability for apples than non-participating farmers. These results align with the findings in Columns 1 and 3 of Table 3, indicating the robustness of the effect of organic certification on apple prices under online market access.

4.3. Endogeneity Analysis

Following the baseline above regression and robustness checks, we have substantiated the positive correlation between organic certification and apple prices under online market access. Regarding endogeneity concerns, our previous analysis has comprehensively accounted for factors that could influence apple prices, including individual characteristics of apple farmers, household features, and apple production and management characteristics, thereby reducing the likelihood of omitted variable bias. One aspect to consider is that higher apple prices lead to higher profits for farmers, reducing financial constraints on agricultural investments and increasing the likelihood of participating in organic certification. Thus, the endogeneity issue in this study may stem from the potential reverse causality between organic certification and agricultural product prices.

To address this, we employ the organic certification status of agricultural products in the counties where farmers are located as an instrumental variable to examine whether a reverse causality exists between organic certification and apple prices under online market access. The rationale for selecting this instrumental variable is two-fold. Firstly, the apple industry is a significant component of agricultural production in the sampled counties, and its organic certification status is highly correlated with the overall organic certification status of agricultural products in these counties. Secondly, we consider the timing of field surveys when selecting instrumental variables, opting to use data on the organic certification status of agricultural products in the counties before 2019 to construct the instrumental variable. Our apple price data span from 2019 to 2020, ensuring no direct correlation between them, thereby satisfying the exogeneity assumption of instrumental variables. The results in Tables 5 and 6 indicate that the selected instrumental variables pass the weak instrumental variable test (Cragg-Donald Wald F = 10.273), confirming that it is not a weak instrument.

Table 5. Instrumental variables (IV) estimation results for absolute price.

Variables	Organic Certification	Absolute Price	Organic Certification	Absolute Price
	First Stage	Second Stage	First Stage	Second Stage
	(1)	(2)	(3)	(4)
County's organic certification	0.050 *		0.005 ***	
	(0.025)		(0.001)	
Organic certification		1.797 ***		−0.747
		(0.338)		(1.354)
Control variables	YES	YES	YES	YES
Town FE	YES	YES	YES	YES
Cragg-Donald Wald F	10.273		3.683	
Observations	85	85	592	592
R-squared		0.352		0.080

Note: Standard errors in parentheses, *** $p < 0.01$, * $p < 0.1$.

Table 6. Instrumental variables (IV) estimation results for relative price.

Variables	Organic Certification	Relative Price	Organic Certification	Relative Price
	First Stage	Second Stage	First Stage	Second Stage
	(1)	(2)	(3)	(4)
County's organic certification	0.050 *		0.005 ***	
	(0.025)		(0.001)	
Organic certification		1.111 **		1.200
		(0.502)		(2.075)
Constant	−0.066	−1.177 ***	−0.021	0.527 *
	(0.045)	(0.048)	(0.014)	(0.293)
Control variables	YES	YES	YES	YES
Town FE	YES	YES	YES	YES
Cragg-Donald Wald F	10.273		3.683	
Observations	85	85	592	592
R-squared		0.291		−0.045

Note: Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The impact of organic certification on absolute apple prices under instrumental variable analysis is presented in Table 5. Columns 1 and 2 of Table 5 reveal that, after using instrumental variables, organic certification under online market access demonstrates a significant positive correlation with absolute apple prices at the 1% significance level. Organic certification significantly increases apple sales prices, consistent with the findings in Column 1 of Table 3. Columns 3 and 4 of Table 5 show that, after using instrumental variables, organic certification under traditional market access does not significantly affect absolute apple prices, consistent with the results in Column 2 of Table 3.

The impact of organic certification on relative apple prices under instrumental variable analysis is presented in Table 6. Columns 1 and 2 of Table 6 show that, after using instrumental variables, organic certification under online market access demonstrates a significant positive correlation with relative apple prices at the 5% significance level. Organic certification significantly enhances the stability of apple prices, consistent with the findings in Column 3 of Table 3. Columns 3 and 4 of Table 6 show that, after using instrumental variables, organic certification under traditional market access does not significantly affect relative apple prices, consistent with the results in Column 4 of Table 3.

4.4. Mechanisms Analysis

As discussed in the theoretical mechanisms section, organic certification can, directly and indirectly, affect agricultural product prices under online market access. The latter operates through several mechanisms, including improving the sensory quality of agricultural products, conveying market information about agricultural products, and promoting the commercial branding of agricultural products. In what follows, we discuss and, when possible, test these potential mechanisms.

In the apple sales market, distributors determine the price of apples based on their size, surface, color, taste, and shape. Therefore, we use factor analysis to obtain a factor that characterizes the quality of apples based on the evaluation scores of farmers in five aspects: size, surface, color, taste, and shape. The impact of organic certification on agricultural product quality is illustrated in Table 7. The findings in Column 1 of Table 7 indicate that organic certification does not significantly affect agricultural product quality under online market access. Conversely, the results in Column 2 demonstrate that organic certification positively correlates with agricultural product quality at the 5% significance level under traditional market access. These results suggest that organic certification under traditional market access facilitates improvements in agricultural product quality. These findings imply that there is no significant difference in the quality of agricultural products with online market access, dismissing this mechanism.

Table 7. Impact on the quality of agricultural products results.

Variables	Quality of Agricultural Products	
	(1)	(2)
Organic certification	0.313	0.550 **
	(0.283)	(0.280)
Control variables	YES	YES
Town FE	YES	YES
Constant	−0.324	−0.384
	(1.159)	(0.415)
Observations	85	591
R-squared	0.425	0.121

Note: Standard errors in parentheses, ** $p < 0.05$.

In perfectly competitive markets, product prices can reflect all market information. In economics, agricultural product markets are considered representative of perfectly competitive markets. Therefore, we use farmers' perception of apple prices to measure market information for agricultural products. The impact of organic certification on market information is shown in Table 8. Column 1 of Table 8 results indicate that organic certification has a significant positive correlation with market information at the 5% significance level under online market access. Conversely, the results in Column 2 demonstrate that organic certification does not significantly affect market information under traditional market access. These findings suggest that organic certification under online market access significantly improves farmers' awareness of apple prices, indicating that organic certification enhances agricultural product prices by improving market information dissemination, as discussed in the theoretical mechanism analysis above.

Table 8. Impact on market information results.

Variables	Market Information	
	(1)	(2)
Organic certification	1.055 **	0.336
	(0.420)	(0.342)
Control variables	YES	YES
Town FE	YES	YES
Constant	6.170 ***	2.104 ***
	(1.723)	(0.507)
Observations	85	591
R-squared	0.477	0.176

Note: Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$.

The impact of organic certification on the construction of agricultural product commercial brands is shown in Table 9. The results in Column 1 of Table 9 indicate that under online market access, organic certification does not significantly affect the construction of agricultural product commercial brands. However, the results in Column 2 demonstrate that under traditional market access, organic certification exhibits a significant positive correlation with the construction of product commercial brands at the 1% significance level. These findings suggest that organic certification under traditional market access significantly promotes the construction of commercial agricultural product brands. This suggests that farmers may not need to build commercial brands to access online markets, but that work is critical to be competitive in traditional markets. Therefore, online market access can be an alternative route for improving market competitiveness by alleviating the need for extensive brand building.

Table 9. Impact on commercial brand-building results.

Variables	Commercial Brand Building	
	(1)	(2)
Organic certification	0.072	0.208 ***
	(0.127)	(0.047)
Control variables	YES	YES
Town FE	YES	YES
Constant	−0.632	−0.027
	(0.522)	(0.070)
Observations	85	591
R-squared	0.572	0.220

Note: Standard errors in parentheses, *** $p < 0.01$.

4.5. Heterogeneous Analysis

These empirical results confirm the positive effect of organic certification on agricultural product prices under online market access. As mutual economic organizations, farmer cooperatives play a pivotal role in modernizing agriculture by providing services that enhance households' production cognition and abilities. Altitude plays a crucial role in constructing regional transportation infrastructure, with regions boasting favorable transportation conditions typically experiencing lower agricultural product transportation costs. Building upon the analysis above, this study conducts heterogeneity tests by grouping the sample based on farmers' organizational participation and the altitude of their respective regions.

Considering the different levels of organizational participation, Table 10 shows the findings of the heterogeneity test for the impact of organic certification on agricultural product prices under online market access. Column 1 of Table 10 results indicate that under online market access, organic certification for absolute apple prices exhibits a significant positive correlation with joining the cooperative group at the 5% significance level. Meanwhile, the results in Column 3 demonstrate that under online market access, organic certification for relative apple prices shows a significant positive correlation with joining the cooperative group at the 10% significance level. Conversely, Columns 2 and 4 results show that organic certification does not significantly affect absolute and relative apple prices for those who have not joined the cooperative group under online market access. The results suggest that organic certification in the context of online market access significantly impacts apple prices for households that join the cooperatives. Notably, cooperatives may support farmer success by providing production guidance and services.

Table 10. Heterogeneity results of participation in organizations results.

Variables	Absolute Price		Relative Price	
	Cooperative	Uncooperative	Cooperative	Uncooperative
	(1)	(2)	(3)	(4)
Organic certification	2.961 **	−0.817	1.960 *	0.240
	(1.354)	(0.747)	(0.998)	(0.536)
Control variables	YES	YES	YES	YES
Town FE	YES	YES	YES	YES
Constant	4.804	11.292 ***	0.167	0.238
	(5.214)	(2.718)	(3.844)	(1.949)
Observations	33	39	33	39
R-squared	0.806	0.670	0.739	0.497

Note: Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Considering the different altitudinal regions, Table 11 shows the findings of the heterogeneity test for the impact of organic certification on agricultural product prices under online market access. The results in Columns 1 and 3 of Table 11 indicate that under online market access, organic certification for absolute and relative apple prices in the low-altitude

group shows a significant positive correlation at the 10% significance level. Conversely, Columns 2 and 4 results show that organic certification does not significantly affect absolute and relative apple prices for the high-altitude group under online market access.

The results demonstrate that organic certification in the context of online market access has a significant positive impact on apple prices for households in lower-altitude regions; this finding may be due to the lower transaction costs in these regions. Notably, this impact is insignificant for households in high-altitude areas, suggesting a correlation between the effects of organic certification and reduced transaction costs under online market access. Transportation costs are a significant component of transaction costs in agriculture. With superior road infrastructure in low-altitude areas compared to high-altitude ones, lower altitudes correspond to lower transportation costs for agricultural products, ultimately reducing transaction costs.

Table 11. Heterogeneity results of altitude.

Variables	Absolute Price		Relative Price	
	Low Altitude	High Altitude	Low Altitude	High Altitude
	(1)	(2)	(3)	(4)
Organic certification	1.876 *	0.027	1.070 *	0.441
	(1.039)	(0.768)	(0.563)	(0.521)
Control variables	YES	YES	YES	YES
Town FE	YES	YES	YES	YES
Constant	4.299	4.408 *	−0.690	−0.614
	(4.221)	(2.151)	(2.286)	(1.460)
Observations	42	43	42	43
R-squared	0.656	0.779	0.729	0.667

Note: Standard errors in parentheses, * $p < 0.1$.

5. Conclusions

This study reveals the impact of organic certification on absolute and relative agricultural product prices in the context of online market access. It emphasizes that organic certification's premium effect and price stabilization are only realized when farmers can access the online market.

Using data from a 2021 survey conducted by our research team, this study scrutinizes the influence of organic certification on absolute and relative agricultural product prices in the online market. It effectively controls for individual attributes, farm management variables, and endogeneity concerns. Our findings highlight organic certification's robust and significant positive impact on agricultural product prices with online market access. The findings show a substantial rise in apple prices for farmers with organic certifications in online markets, increasing CNY 1.6 per half a kilogram. Furthermore, our study underscores that organic certification bolsters agricultural product prices by enhancing farmers' market information in the context of online market access.

We also explore the differentiated impact of organic certification on absolute and relative agricultural product prices within the online market, focusing on the impacts of membership in a cooperative and altitude. Specifically, our research illustrates that organic certification with online market access profoundly influences apple prices for farmers who are part of cooperatives and farm in lower-altitude regions. These variations may be due to differences in technological knowledge, adoption, and transactional practices among distinct farmers based on cooperative membership and farming altitude.

This study has several limitations. The relatively small sample size and specific demographic focus may limit the generalizability of our findings and reliance on self-reported data.

Nevertheless, our research augments existing literature on organic certification and online market access by offering empirical evidence supporting the significant role of organic certification in shaping absolute and relative agricultural product prices in online markets.

Future research may consider expanding the sample size to encompass a more diverse population to address these limitations, thereby enhancing the study's applicability. Additionally, data could be integrated from alternative sources to validate the accuracy and reliability of self-reported data. Furthermore, future studies could delve into a more comprehensive exploration of the impact of organic certification on the pricing of different agricultural products in online markets, considering variations across various geographical and economic contexts. This would contribute to a more nuanced understanding of how organic certification and online market access influence the pricing of agricultural products.

In summary, this study underscores the critical role of online market access on the premium effects of organic certification. For policymakers, our study highlights the importance of integrating the Internet with agriculture to foster new e-commerce platforms tailored for agricultural products, such as apples. Promoting organic certification can enhance consumer awareness and demand while reducing certification costs can facilitate broader adoption among apple farmers. For agricultural stakeholders, including apple farmers and cooperatives, the findings suggest the potential benefits of embracing online market access and organic certification. Leveraging these strategies can optimize pricing strategies, improve market access, and foster sustainable agricultural practices.

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