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

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Abstract: This study utilizes data gathered through on-site surveys from 681 apple farmers in the Loess Plateau region to examine the impact of organic certification on both absolute and relative prices of agricultural products in the context of online market access. The results demonstrate a significant increase in apple prices for farmers with organic certification under online market access, with an average increase of 1.6 yuan per jin. Furthermore, the study illustrates that organic certification, when combined with online market access, enhances agricultural product prices by improving the dissemination of market price information among farmers. Notably, the positive impact of organic certification on prices is more pronounced for cooperative members and farmers residing in lower-altitude regions. These findings emphasize the vital role of online market access in the realization of premium effects and price stability for organically certified products.

Keywords: Organic certification; Online market access; Absolute prices; Relative prices

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1. Introduction

The causal relationship between traditional agriculture and severe environmental damage, including aquifer depletion, land degradation, water pollution, soil erosion, deforestation, biodiversity loss, and the spread of invasive species, has prompted the emergence of eco-certification initiatives in response to market dynamics (Laurance et al. 2014; Sebastian & Schulz, 2015). These initiatives, such as Organic, Rainforest Alliance, UTZ, and others, grant labels to farmers based on their fulfillment of specific environmental and social performance criteria (Auld 2010; Cashore et al. 2004). Organic farming is widely regarded as the foremost alternative for reducing the environmental and ecological impact of sustainable development (Gamage et al. 2023).

Since the 1970s, increasing public concerns regarding the health and environmental impacts of industrialized farming have propelled the rise of the organic movement (Lockeretz 2007). 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 organically. Additionally, the market size of organic products has reached 106.4 billion euros (Willer et al. 2021). It is worth noting that while North America and Europe currently dominate organic product sales, developing countries like China, India, Brazil, and Indonesia are expected to experience rapid market share growth in the coming years (Willer, Trávníček, Meier and Schlatter 2021).

Organic farming not only prioritizes healthy food production, soil and plant health, and environmental sustainability but also has the potential to improve the socioeconomic conditions of farmers. Numerous studies have demonstrated the economic advantages of organic certification, indicating increased profitability in organic farming practices. Jones and Gibbon (2011) highlight the crucial role of organic certification in accessing stable premium niche export markets. Kleemann et al(2014) find that organic-certified farming yields a significantly higher return on investment (ROI) compared to Global GAP-certified farmers, primarily due to the price premium

in the organic market. Furthermore, Panneerselvam et al(2010) provide evidence of the longer-term positive impacts of organic conversion on yields, food security, and poverty reduction. These findings collectively suggest the multifaceted benefits of organic farming, encompassing both economic and social dimensions.

Meanwhile, market access plays a crucial role in determining the relationship between high-quality agricultural products and their prices. In the absence of market access, farmers are reluctant to engage in the production of high-quality agricultural products. Even if farmers improve the quality of their agricultural output, the lack of market access hinders them from obtaining corresponding prices (Bold et al., 2022). In recent years, with the increasing penetration of the internet in rural areas of China and the gradual improvement of village connectivity through road infrastructure, e-commerce has gained popularity in rural regions. E-commerce not only brings a wide range of consumer goods to farmers but, more importantly, it establishes a connection between small-scale farmers and the national market. This connection broadens the channels through which farmers can sell their agricultural products. We refer to this channel as online market access.

This study examines the impact of online market access on prices for organic certification, highlighting its crucial role in generating higher returns for high-quality products. The findings support Bold et al.'s (2022) research, employing an randomized controlled trial (RCT) methodology, which reveals a zero causal return to quality. We also find that organic certification alone does not guarantee higher prices unless accompanied by online market access. Only when online market access is available, can organic certification achieve higher price premiums and enhanced price stability. This reinforces the significance of demand-side constraints in limiting rural income growth, building upon the insights provided by Bold et al (2022). By expanding the analysis to the broader real-world context of online market access, this research underscores its instrumental role in enabling producers to obtain higher returns for high-quality products.

In terms of mechanisms, the study establishes that organic certification acts as a signaling mechanism to enhance absolute prices and price stability, but only in the presence of online market access. While existing literature highlights the role of organic certification in increasing prices through improved product quality and signaling, our research uncovers that organic certification alone struggles to boost prices during the COVID-19 pandemic. Notably, this study excludes the channel of quality improvement through organic certification and online market access, providing evidence in support of the signaling effects as the underlying mechanism. These findings contribute to a deeper understanding of the respective roles played by organic certification and market access.

From a policy perspective, government entities should adopt comprehensive and well-designed policy frameworks to genuinely enhance farmers' income. Addressing the issue of agricultural income for small-scale farmers in post-pandemic scenarios is a critical concern in many developing countries, including China. This study reveals that relying solely on organic certification is insufficient to increase prices; the presence of online market access is essential. Furthermore, it highlights that organic-certified farmers, without online market access, may need to explore alternative strategies for brand development to fully leverage the benefits of certification. Therefore, in specific contexts, a single policy measure is inadequate in effectively supporting farmers' development, aligning with the findings of Asher and Novosad (2020) that emphasize the limited impact of road infrastructure alone on rural economic structural transformation.

2. Theoretical Background

Organic certification can bring economic benefits to producers. Firstly, agricultural products certified as organic can receive a price premium compared to conventional products(Bolwig et al. 2009), and organic products have a more diversified sales channels. Secondly, organic certification can increase farmers' market

access and increase their chances of entering high-value markets and thus gaining more benefits (Gómez Tovar et al. 2005). For example, a study conducted by the Food and Agriculture Organization (FAO) found that organic farmers in developing countries have better access to international markets and can achieve higher prices compared to conventional farmers. Additionally, research conducted by the International Trade Center(ITC) showed that organic certification can lead to increased market access and higher premiums for products in the United States and European Union markets. Access to organic markets can create new marketing opportunities and expand the customer base for farmers. Factors such as location, scale, and cost significantly influence the organic certification of agricultural products. Farms that are further from the sales market and have larger scales have a higher likelihood of obtaining certification (Veldstra et al. 2014). In addition, consumers typically perceive organic products to be healthier and of higher quality, resulting in increased demand (Lusk 2011)and a willingness to pay higher prices. The study by Aschemann-Witzel (2018) found that Danish consumers were willing to pay more for organic products due to perceived health benefits. Murphy et al (2022) analyze consumer trust in organic food and organic certifications in four European countries, results identified between country differences in trust and beliefs in the organic of the produce. Overall, consumers had a high levels of trust in certified organic food chain and produce, and strong beliefs in the benefits of certification bodies; however this differed between countries.

Market access is a critically important issue for developing countries, particularly considering that these countries are predominantly characterized by an agrarian economy with farmers as the main stakeholders. Market access plays a significant and positive role in various dimensions, including farming output, farmers' nutritional intake and technology adoption (Kihiu and Amuakwa-Mensah, 2021;Jeff Chan, 2022;Aggarwal et al.,2022). In the context of agricultural product sales, market access serves as a vital guarantee for ensuring fair and favorable pricing of high-quality agricultural products(Arslan et al.,2022). It is through market access that both supply and demand sides can achieve mutually beneficial outcomes, whereby consumers gain

access to a consistent supply of high-quality agricultural products, while farmers receive commensurate returns corresponding to the quality of their agricultural output (Bold et al., 2022; Usman and Haile, 2022).

Scholars in this field have made notable contributions by commonly employing distance to the central market as a proxy variable for market access, yielding meaningful insights. In contrast to the aforementioned scholars, this study posits that online sales represent a form of market access that relies on traditional logistics infrastructure while leveraging internet-based channels for disseminating supply and demand information—an online market access mechanism. For high-quality agricultural products, such as organic produce, online market access offers a more convenient and expedient means of transmitting information compared to traditional market access methods. Through online sales channels, consumers can access other customers' reviews, including text and visual content, thus creating a novel form of market access that facilitates interactions between supply and demand parties.

3. Material and Methods

3.1 Data

This study utilized data from a survey that was carried out by our research team from July to August 2021 among apple farmers in 11 counties/districts within Shaanxi and Gansu provinces. These provinces account for a sizeable apple production area on the Loess Plateau, a region with distinct geographical and climatic advantages for apple production. Recent years have seen continuous increases in apple planting area and production in these provinces, with Shaanxi province alone responsible for a quarter of the national apple production. To account for this diversity, our study areas were four cities namely, Weinan and Yan'an in Shaanxi province, and Qingyang and Pingliang in Gansu province. To ensure representativeness, we employed a stratified and random sampling approach. Focusing on four cities as the primary sampling units, we selected 3 to 7 towns/villages based on the scale of apple production in each county/district.

Ultimately, we utilized a random sampling method to survey between 20 to 50 apple farmers in each of the selected towns/villages. The response rate was 785, with 681 responses considered valid for the analysis in this study.

3.2 Variable Definitions

3.2.1 Agricultural product prices

The focus of the study lies on agricultural product prices, which can be classified into two distinct categories: absolute prices and relative prices. Absolute prices are characterized by the average selling price of apples for farmers in 2020, providing a baseline reference point for analysis. On the other hand, Given the significant impact that the COVID-19 outbreak had on apple sales prices in 2020, the study used the stability of sales prices before and after 2019 and 2020 as an indicator of relative prices. This approach effectively measures the stability of market prices. The computation procedure for relative prices is detailed in Equation (1).

$$relative\ price_{ij} = \left(price_{ij2020} - price_{j2020}\right) - \left(price_{ij2019} - price_{j2019}\right) \quad (1)$$

3.2.2 Organic certification

The explanatory variable in this study is organic certification of agricultural products, which is represented by a binary variable that takes the value of 1 if apple farmers have obtained organic certification for their products and 0 otherwise.

3.2.3 Online market access

The key mediating variable in this study is online market access, which is represented in the questionnaire by whether farmers sell apples through internet platforms such as WeChat, Taobao, Tiktok, etc. A response of "yes" from apple farmers indicates a value of 1, while a response of "no" corresponds to a value of 0.

3.2.4 Control variables

This study employs a range of control variables to account for potential confounding factors that may influence the market resilience of apple farmers. These variables include personal characteristics (gender, age, education, and village cadres), family characteristics (number of laborers involved in apple production and family's social network), and apple production and management characteristics (apple planting scale, land fragmentation level, apple cultivation mode, and participation in organizations).

Specifically, the variable "gender" is a binary variable, where 1 indicates male and 0 indicates otherwise. "Age" is measured in years, "education" is a categorical variable ranging from 1 (no schooling) to 6 (graduate school), and "village cadres" is a binary variable that takes the value 1 if the farmer is a village cadre, and 0 otherwise. The number of laborers involved in apple production is measured in persons, while the family's social network is represented by the 2020 expenses for social interactions among family members. Apple planting scale is measured by the orchard area covered by apple trees, while land fragmentation level is measured by the number of land parcels used for apple farming. Apple cultivation mode is a categorical variable with three levels: 1 for tall-tree planting, 2 for dwarf-tree planting, and 3 for both tall-tree and dwarf-tree planting. Finally, participation in organizations is a binary variable that takes the value 1 if the apple farmer has joined a specialized cooperative for apple farmers, and 0 otherwise.

3.2 Model Construction

To investigate the effect of organic certification on agricultural product prices, this study estimates the following equation:

$$price_{ij} = \alpha_0 + \alpha_1\, organic_{ij} + \beta\, x_{ij} + \delta_j + \varepsilon_{ij} \qquad (2)$$

where $price_{ij}$ represents the absolute price and relative price of apple farmers in town j and i, $organic_{ij}$ represents the organic certification status of apple farmers in town j and i ; x_{ij} represents other factors that may affect the resilience of apple

farmers, including gender, age, education level, village cadre identity, apple farming labour, social network, apple cultivation scale, land fragmentation degree, apple cultivation mode, and organizational participation; δ_j represents fixed effects of the town; and ε_{ij} represents the random error term.

3.3 Descriptive Statistics

Table 1 Descriptive statistics of main variables

Variables	Description	N	Mean	SD	Min	Max
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	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,0=no	681	0.038	0.192	0	1
Mediating variable						
Online market access	1=yes,0=no	681	0.131	0.337	0	1
Control variables						
Gender	1=male,0=female	681	0.984	0.126	0	1
Age	year	681	52.374	8.780	26	77
Education	1=no schooling,2=primary school,3=junior school,4=high school,5=college and undergraduate	681	2.957	0.836	1	5
Village cadres	1=yes,0=no	681	0.125	0.331	0	1
Number of laborers	person	681	2.132	0.651	1	6
Social network	yuan	681	8283.96	20722.25	100	400000
Scale	mu	681	29.605	172.261	1	4000
Land fragmentation level	blocks	681	2.968	2.606	1	53
Apple cultivation mode	1 = tall-tree planting,2 =dwarf-tree planting,3 = both tall-tree and dwarf-tree planting	681	1.338	0.649	1	3
Participation in organizations	1=yes,0=no	681	0.279	0.449	0	1

Table 1 presents the descriptive statistics of the sample of apple farmers used in this study. On average, the absolute price of these farmers is 2.72 yuan/jin, the relative

price is -0.008. About 3.8% of farmers possess organic certification for their agricultural products. Approximately 13.1% of the surveyed farmers engage in apple sales through internet platforms. As for personal and family characteristics, the majority of apple farmers (98.4%) are male, with an average age of approximately 52 years old. Most of them have completed middle school education, and 12.5% hold village cadre positions. Each household has an average of two labour inputs for apple cultivation; social network investment is sourced mainly from personal relationships and has an average value of 8283.96 yuan. The average size of apple cultivation is around 29 mu, consisting of three apple orchards, and the majority of farmers use arborized cultivation mode. Additionally, 27.9% of apple farmers have joined professional cooperatives.

4. Results

4.1 Baseline regression results

This study first employs a fixed-effects linear regression model to examine the impact of organic certification on apple prices, as shown in Table 2. The results indicate a significant positive correlation between organic certification and apple prices. Columns (1) and (3) of Table 2 demonstrate that, without considering control variables, apple absolute prices for certified organic farmers are on average 1.21 yuan/jin higher compared to non-certified conventional farmers, leading to greater price stability. Columns (2) and (4) of Table 2 show that, after including control variables, apple absolute prices for certified organic farmers are, on average, 0.96 yuan/jin higher than those for non-certified farmers, indicating continued price stability.

Controlling for other variables, larger scale of cultivation, more dispersed land ownership, and diverse types of crops cultivated are associated with higher absolute prices of apples for farmers. On the other hand, as farmers' age increases, the absolute prices of apples decrease. Moreover, the more labor is devoted to apple production within a household, the more stable the relative prices of apples become. Additionally, higher levels of education among farmers lead to greater fluctuations in relative prices.

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, * p<0.1.

This study further investigates the impact of organic certification on apple prices under online market access, as shown in Table 3. The results reveal that the premium effect and price stability associated with organic certification are only evident when accessing online markets. Comparing the results in columns (1) and (2) of Table 3, it is found that apple absolute prices for farmers participating in organic certification under online market access are significantly higher, with an increase of 1.6 yuan/jin, compared to non-certified farmers. This indicates that organic certification can only lead to higher absolute prices for apples when accessing online markets. Comparing the

results in columns (3) and (4) of Table 3, it can be observed that, under online market access, apple prices for farmers participating in organic certification are more stable relative to non-certified farmers. This suggests that the stabilizing price effect of organic certification can only be realized when accessing online markets. In this study, the results in columns (1) and (3) of Table 3 are used as the baseline regression.

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.

4.2 Robustness tests

Table 4 Robustness Test Results

Variables	Highest price	Relative price	Absolute price	Relative price	Absolute price	Relative price
	(1)	(2)	(3)	(4)	(5)	(6)
Organic certification	1.876**	1.216***	1.604**	1.216***	1.919**	0.984*
	(0.850)	(0.436)	(0.621)	(0.436)	(0.756)	(0.530)
Gender	-1.564	0.623	-1.225	0.623	-2.309	-0.727
	(2.660)	(1.363)	(1.944)	(1.363)	(2.226)	(1.559)
Age	-0.043	0.001	-0.051**	0.001	-0.054*	-0.000
	(0.034)	(0.018)	(0.025)	(0.018)	(0.031)	(0.022)
Education	0.192	-0.381*	0.223	-0.381*	0.476	-0.149
	(0.419)	(0.215)	(0.306)	(0.215)	(0.383)	(0.268)
Village cadres	-0.674	0.137	-0.406	0.137	-0.168	0.252
	(0.737)	(0.378)	(0.539)	(0.378)	(0.692)	(0.485)
Number of laborers	-0.376	0.316	-0.199	0.316	-0.051	0.364
	(0.444)	(0.228)	(0.325)	(0.228)	(0.417)	(0.292)
Social network	-0.000	0.000	-0.000	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Scale	0.003	0.003***	0.008***	0.003***	0.010***	0.005***
	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)
Land fragmentation level	0.054	-0.075	0.157*	-0.075	0.198	-0.163*
	(0.109)	(0.056)	(0.080)	(0.056)	(0.121)	(0.085)
Apple cultivation mode	0.252	0.055	0.389	0.055	0.161	-0.139
	(0.448)	(0.230)	(0.328)	(0.230)	(0.435)	(0.305)
Participation in organizations	0.411	0.209	0.594	0.209	0.647	0.363
	(0.717)	(0.368)	(0.524)	(0.368)	(0.667)	(0.467)
Town FE	YES	YES	YES	YES	YES	YES
Constant	8.651**	0.009	3.979	-0.473	5.275	0.777
	(3.487)	(1.786)	(2.727)	(1.911)	(3.127)	(2.189)
Observations	85	85	85	85	54	54
R-squared	0.427	0.621	0.649	0.526	0.649	0.528

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

1.Taking into consideration the measurement influence of the dependent variable, from the perspective of the mechanism for premium pricing of agricultural products, organic certified agricultural products are considered high-quality products and can command higher absolute prices in the agricultural market. Therefore, we use the highest selling price of apples for farmers as a new dependent variable to represent absolute prices, in order to examine the robustness of the baseline regression results.

The results, as shown in column (1) of Table 4, are consistent with the previous findings. Moreover, considering the construction of a relative price index for farmers, the changes in selling prices over two consecutive periods can also reflect the stability of relative prices. Hence, we use the difference between the average selling prices of apples over two periods as a new dependent variable to represent relative prices. The results, as shown in column (2) of Table4, remain robust.

2. Considering the influence of regression models, the baseline regression results were obtained using a multidimensional fixed-effects linear regression model. Next, we employ a multiple linear regression model to examine the impact of organic certification on agricultural product prices under online market access. The results, as shown in columns (3) and (4) of Table 4, are consistent with the baseline regression results discussed earlier.

3. Considering the influence of geographical indication certification on agricultural products. Geographical indication, as a means to promote high-quality development in agriculture and facilitate industrial revitalization, holds significant importance for enhancing the market competitiveness of agricultural products. Therefore, in this study, we consider the premium effect of geographical indication certification and analyze a sample that does not include regions with apple geographical indications. The results, as shown in columns (5) and (6) of Table 4, remain robust.

4.3 Endogeneity Discussion

After conducting the benchmark regression and robustness tests mentioned above, we have essentially confirmed the positive correlation between organic certification under online market access and agricultural product prices. By re-measuring the dependent variable, employing a multiple linear regression model, and considering the influence of geographical indications certification on agricultural products, we further confirmed the robustness of the benchmark regression. Regarding endogeneity, the

previous regression analysis has comprehensively considered various factors that may affect apple prices at the individual farmer level, household level, and agricultural production and operation level, thus minimizing the possibility of omitted variables. As agricultural product prices are a key influencing factor for farmers' profitability in agricultural production, with higher prices leading to higher profits and reduced financial constraints on agricultural investment, the discussion on endogeneity in this study mainly arises from reverse causality.

Table 5 Instrumental Variables (IV) Estimation Results for Absolute Price

Variables	Organic certification First stage	Absolute price Second stage	Organic certification First stage	Absolute price 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)
Gender	-0.067	-0.759***	0.025***	0.136
	(0.293)	(0.289)	(0.000)	(0.179)
Age	-0.001	-0.016	-0.000	-0.015***
	(0.002)	(0.016)	(0.000)	(0.001)
Education	0.083	0.199***	-0.000	0.031
	(0.088)	(0.000)	(0.002)	(0.022)
Village cadres	-0.010	-0.647***	0.025*	-0.013
	(0.033)	(0.101)	(0.014)	(0.022)
Number of laborers	-0.051**	-0.117*	-0.013*	0.092***
	(0.023)	(0.064)	(0.007)	(0.003)
Social network	-0.000	-0.000***	0.000	-0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
Scale	0.001*	0.004	0.000***	0.001*
	(0.000)	(0.002)	(0.000)	(0.000)
Land fragmentation level	-0.019	0.113***	0.000	0.022**
	(0.017)	(0.024)	(0.000)	(0.009)
Apple cultivation mode	-0.025	0.615***	0.016***	-0.079
	(0.045)	(0.075)	(0.002)	(0.123)
Participation in organizations	0.079	0.719***	0.038**	0.072
	(0.131)	(0.049)	(0.016)	(0.111)
Constant	-0.066	2.970***	-0.021	2.993***
	(0.045)	(0.958)	(0.014)	(0.092)

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<0.05, * p<0.1.

In this section, we primarily used the organic certification status at the county level, using data up until the year 2020, as an instrumental variable to verify the existence of a reverse causal relationship between organic certification under online market access and agricultural product prices. The regression results are reported in Table 5 and Table 6. Table 5 presents the results of the subsample two-stage regression, showing that organic certification under online market access still has a significant positive impact on absolute prices. Table 6 presents the results of the subsample two-stage regression, demonstrating that organic certification under online market access still has a significant positive impact on relative prices.

The above instrumental variables have passed the weak instrument test. Empirical results demonstrate that, after adequately considering the potential effects of endogeneity, under online market access organic certification significantly enhances agricultural product prices.

Table 6 Instrumental Variables (IV) Estimation Results for Relative Price

Variables	Organic certification First stage	Relative price Second stage	Organic certification First stage	Relative price 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)
Gender	-0.067	0.373**	0.025***	-0.034
	(0.293)	(0.165)	(0.000)	(0.139)
Age	-0.001	0.014***	-0.000	-0.007***
	(0.002)	(0.001)	(0.000)	(0.001)
Education	0.083	-0.274***	-0.000	-0.096*
	(0.088)	(0.026)	(0.002)	(0.051)
Village cadres	-0.010	-0.105	0.025*	0.018***
	(0.033)	(0.108)	(0.014)	(0.003)
Number of laborers	-0.051**	0.384***	-0.013*	0.049***

	(0.023)	(0.058)	(0.007)	(0.017)
Social network	-0.000	0.000	0.000	-0.000*
	(0.000)	(0.000)	(0.000)	(0.000)
Scale	0.001*	0.001	0.000***	-0.000
	(0.000)	(0.001)	(0.000)	(0.001)
Land fragmentation level	-0.019	-0.081***	0.000	-0.004
	(0.017)	(0.021)	(0.000)	(0.003)
Apple cultivation mode	-0.025	0.192*	0.016***	0.020*
	(0.045)	(0.098)	(0.002)	(0.011)
Participation in organizations	0.079	0.172	0.038**	-0.073
	(0.131)	(0.177)	(0.016)	(0.046)
Constant	-0.066	-1.177***	-0.021	0.527*
	(0.045)	(0.048)	(0.014)	(0.293)
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.

5. Discussion

5.1 Mechanism analysis

1. The results of the quality mechanism of organic certification's impact on agricultural product prices under online market access are presented in Table 7. Product quality is an important factor influencing prices. Firstly, factor analysis is used to construct an index representing apple quality based on five aspects: size, surface, color, taste, and shape. From the results in column (1) of Table 7, it is observed that the impact of organic certification under online market access on apple quality is not significant. The results in column (2) also indicate that online market access does not have a significant impact on apple quality. Similarly, the results in columns (3) and (4) demonstrate that online market access does not significantly influence apple quality in both the organic certification and non-organic certification groups. The empirical analysis of the results suggests that organic certification under online market access does not improve agricultural product quality, and online market access does not affect agricultural product quality either. Thus, it can be inferred that agricultural products exhibit homogeneity under online market access, thereby ruling out this mechanism.

Table 7 Impact on Product Quality

Variables	Quality			
	(1)	(2)	(3)	(4)
Organic certification	0.313			
	(0.283)			
E-commerce		0.049	0.057	-0.030
		(0.106)	(0.727)	(0.114)
Gender	0.417	0.250	-	0.203
	(0.884)	(0.272)		(0.271)
Age	-0.014	-0.003	-0.007	-0.002
	(0.011)	(0.004)	(0.064)	(0.004)
Education	0.176	0.115**	-0.028	0.120***
	(0.139)	(0.045)	(0.490)	(0.045)
Village cadres	-0.245	0.139	-1.022	0.154
	(0.245)	(0.107)	(1.144)	(0.110)
Number of laborers	-0.026	-0.041	-0.146	-0.044
	(0.148)	(0.055)	(0.677)	(0.056)
Social network	-0.000	-0.000*	-0.000	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Scale	0.001	-0.000	-0.000	0.002
	(0.001)	(0.000)	(0.000)	(0.001)
Land fragmentation level	-0.003	0.003	-0.185	0.004
	(0.036)	(0.014)	(0.537)	(0.014)
Apple cultivation mode	0.185	0.068	0.682	0.062
	(0.149)	(0.062)	(0.723)	(0.063)
Participation in organizations	0.139	0.263***	0.066	0.212**
	(0.238)	(0.088)	(0.987)	(0.091)
Town FE	YES	YES	YES	YES
Constant	-0.324	-0.464	1.033	-0.472
	(1.159)	(0.385)	(3.504)	(0.387)
Observations	85	681	22	654
R-squared	0.425	0.113	0.615	0.119

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

2.The results of the price information mechanism of organic certification's impact on agricultural product prices under online market access are presented in Table 8. We use the level of farmers' awareness of apple market prices to represent their price information. Comparing the results in column (1) and column (2) of Table 8, it is evident that organic certification under online market access significantly increases farmers' price information, while traditional market access has no effect. This indicates

that organic certification under online market access achieves a premium effect and stabilizes prices by enhancing farmers' price information.

Table 8 Impact on Price Information

Variables	Price Information	
	(1)	(2)
Organic certification	1.055**	0.336
	(0.420)	(0.342)
Gender	-2.155	0.291
	(1.314)	(0.353)
Age	-0.027	-0.008
	(0.017)	(0.006)
Education	0.269	0.194***
	(0.207)	(0.059)
Village cadres	0.156	0.462***
	(0.364)	(0.148)
Number of laborers	-0.144	-0.045
	(0.219)	(0.074)
Social network	0.000	-0.000
	(0.000)	(0.000)
Scale	0.001	0.000
	(0.001)	(0.000)
Land fragmentation level	0.049	-0.017
	(0.054)	(0.019)
Apple cultivation mode	-0.029	0.039
	(0.221)	(0.085)
Participation in organizations	-0.280	0.439***
	(0.355)	(0.120)
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, * p<0.1.

3.The results of the commercial brand building mechanism of organic certification's impact on agricultural product prices under online market access are shown in Table 9. We use farmers' registration and use of other brands, apart from the three designated certification labels, to represent their commercial brand building. Comparing the results in column (1) and column (2) of Table 9, it is apparent that

organic certification under online market access does not significantly influence commercial brand building, while organic certification under traditional market access significantly promotes farmers' commercial brand building. The analysis suggests that farmers do not need to focus on commercial brand building when accessing online markets, but it becomes crucial for them to build commercial brands and enhance competitiveness when operating in traditional markets. Thus, online market access can serve as an alternative to commercial brand building in improving market competitiveness.

Table 9 Impact on Commercial Brand Building

Variables	Commercial brand building	
	(1)	(2)
Organic certification	0.072	0.208***
	(0.127)	(0.047)
Gender	-0.031	0.015
	(0.398)	(0.049)
Age	0.001	-0.001
	(0.005)	(0.001)
Education	0.119*	-0.003
	(0.063)	(0.008)
Village cadres	-0.063	0.042**
	(0.110)	(0.020)
Number of laborers	0.079	0.025**
	(0.066)	(0.010)
Social network	0.000	0.000**
	(0.000)	(0.000)
Scale	0.001	0.000***
	(0.000)	(0.000)
Land fragmentation level	-0.002	0.000
	(0.016)	(0.003)
Apple cultivation mode	0.062	0.015
	(0.067)	(0.012)
Participation in organizations	0.213*	0.014
	(0.107)	(0.017)
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, ** p<0.05, * p<0.1.

5.2 Heterogeneous analysis

The above empirical results fully confirm the positive impact of organic certification on agricultural product prices in the online market. Different cognitive abilities in agricultural production and transaction costs of agricultural products exist among different organized groups and households at different altitudes. First, considering the cognitive abilities and capacities in agricultural production of households, farmer cooperatives, as a form of mutual economic organization, play an important role in the modernization of agriculture in China. They provide services necessary for the production and operation of households, thereby enhancing their production cognition and abilities. Therefore, considering the development of new agricultural management entities, does the impact of organic certification on agricultural product prices in the online market vary depending on the participation status of organizations? Secondly, from the perspective of transaction costs of agricultural products, higher-altitude areas tend to have poorer transportation infrastructure, resulting in higher transaction costs for farmers who are located closer to the periphery of market trading radius. As a result, the premium effect of organic certification may weaken or no longer exist. Therefore, does the impact of organic certification on agricultural product prices in the online market vary depending on the altitude of the region? In the following sections, this paper will examine the differentiated impact of organic certification on agricultural product prices under different market access conditions, focusing on the participation of farmer organizations and different groups of households in altitude areas.

First, based on the analysis of different organizational participation. Table 10 presents the heterogeneity test of the impact of organic certification on agricultural product prices under different organizational participation conditions. We conducted a grouping test using a dummy variable indicating whether households joined the apple farmer cooperative. The empirical results in columns (1) and (3) of Table 10 indicate that for households that joined the cooperative, the impact of organic certification on

apple prices is significantly positive under online market access. However, the empirical results in columns (1) and (3) show that the group of households that did not join the cooperative is not significant. This suggests that the impact of organic certification on apple prices under online market access is related to farmers' organizational participation, and the impact of organic certification on apple prices will be strengthened when farmers join the cooperative. One possible reason is that cooperatives provide production technical guidance and other services to their members.

Table 10 Heterogeneity Results of Participation in Organizations

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)
Gender	-	-0.984		0.281
		(1.333)		(0.955)
Age	-0.068	-0.083***	-0.031	-0.002
	(0.070)	(0.021)	(0.052)	(0.015)
Education	-0.694	0.321	0.045	-0.181
	(1.225)	(0.268)	(0.903)	(0.192)
Village cadres	0.847	-1.075**	1.352	-0.218
	(1.915)	(0.453)	(1.412)	(0.325)
Number of laborers	0.176	-1.340***	0.264	0.133
	(0.773)	(0.414)	(0.570)	(0.297)
Social network	0.000	0.000**	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Scale	0.005	0.003	0.005	0.001
	(0.004)	(0.014)	(0.003)	(0.010)
Land fragmentation level	0.248	-0.254	-0.281	-0.080
	(0.253)	(0.228)	(0.187)	(0.163)
Apple cultivation mode	1.609	-0.430	0.621	0.133
	(1.091)	(0.315)	(0.805)	(0.226)
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.

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)
Gender	-2.231		0.098	
	(2.871)		(1.555)	
Age	-0.070	-0.041	-0.020	-0.001
	(0.043)	(0.033)	(0.023)	(0.022)
Education	0.601	0.192	-0.108	-0.115
	(0.681)	(0.245)	(0.369)	(0.166)
Village cadres	-0.476	-0.654	-0.158	0.508
	(0.986)	(0.564)	(0.534)	(0.383)
Number of laborers	0.158	-0.437	0.362	0.386
	(0.601)	(0.363)	(0.325)	(0.246)
Social network	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Scale	0.010***	0.006**	0.007***	-0.001
	(0.003)	(0.003)	(0.002)	(0.002)
Land fragmentation level	0.432	0.098	0.213	-0.123**
	(0.289)	(0.072)	(0.157)	(0.049)
Apple cultivation mode	0.282	0.598	0.079	0.630*
	(0.583)	(0.497)	(0.315)	(0.337)
Participation in organizations	0.542	0.672	1.349**	1.349**
	(0.901)	(0.622)	(0.488)	(0.422)
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<0.01, ** p<0.05, * p<0.1.

Second, based on the analysis of different altitudinal regions. Table 11 presents the heterogeneity test of the impact of organic certification on agricultural product prices under different altitudinal regions. We constructed a dummy variable indicating whether households' altitudes in their towns exceed 1000 meters for grouping testing. The empirical results in columns (1) and (3) of Table 11 indicate that for households located in lower-altitude regions, the impact of organic certification on apple prices is significantly positive under online market access. However, the empirical results in

columns (1) and (3) show that the group of households located in higher-altitude regions is not significant. This suggests that the impact of organic certification on apple prices under online market access is related to transaction costs, and the impact of organic certification on apple prices will be strengthened as farmers' transaction costs decrease.

6. Conclusions

This study demonstrates the impact of organic certification on the absolute and relative prices of agricultural products in the online market access. The research findings indicate that the premium effect and price stabilization role of organic certification can only be realized under the condition of online market access.

This study investigates the impact of organic certification on the absolute and relative prices of agricultural products in the online market access, using the data collected from a survey conducted by our research team in 2021. By controlling for individual attributes, farm management, and endogeneity, our research findings reveal a strong and significant positive influence of organic certification on agricultural product prices under online market access. We found that apple absolute prices for organic certified farmers in under online market access are significantly higher, with an increase of 0.96 yuan/jin. Furthermore, we demonstrate that under online market access, organic certification increases agricultural product prices by increasing farmers market price information. Lastly, our study delves into the differential impact of organic certification on the absolute and relative prices of agricultural products in the online market, depending on their membership status in cooperatives and the altitude of their respective regions. Specifically, our research findings indicate that organic certification under online market access has a greater positive impact on prices for cooperative members and farmers in lower-altitude regions, primarily due to variations in farmers' technological knowledge and adoption as well as differences in agricultural product transactions among different groups.

However, it is important to note that our study has certain limitations. The sample

size was relatively small and focused on a specific demographic, which may limit the generalizability of our findings. Additionally, the study relied on self-reported data, which may be subject to bias.

Despite these limitations, our research contributes to the existing literature on organic certification and online market access. It provides empirical evidence supporting the significant role of organic certification on the absolute and relative prices of agricultural products in the online market access.

In conclusion, this study emphasizes the significance of online market access in the context of the organic certification premium effect. Firstly, it is imperative for the government to promote the integration of the Internet with the agricultural sector, thereby encouraging the development of new agricultural markets such as e-commerce platforms for agricultural products. Secondly, the government should enhance the promotion and publicity of organic certification, encouraging more farmers to participate in it, and to improve the production level and market share of China's organic agricultural products. Moreover, the government should increase its support for agricultural product quality certification, reduce certification costs and technical barriers, and enhance the market competitiveness and market access of small farmers. Finally, the government should strengthen the construction of rural cooperatives and improve transportation infrastructure, improve farmers' organizational participation and market influence.

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