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Has e-commerce program affected the development of agribusiness in rural China

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Has e-commerce program affected the development of agribusiness in rural China?

Abstract:

China's government launched the e-commerce program in 2014 as a part of an integrated measure to increase farmers' income, promote consumption among farmers, and enhance the new momentum for high-quality economic development. This study is devoted to examining the effects of the e-commerce program on the development of agribusiness. To this end, the China Academy for Rural Development-Qiyang China Agri-research Database (CCAD) for the period 2008–2020 are analyzed. The difference-in-difference (DID) method is employed to address the endogeneity inherent in program participation. The results show that the e-commerce program participants increase significantly agribusiness entrepreneurial activity. Furthermore, even though the e-commerce program has effectively fostered agribusiness entrepreneurship among participating counties, the extent of its impact has been notably more significant in certain regions, within specific industries, and across particular ownership models when compared to others.

Keywords: E-commerce; Agricultural enterprise; Entrepreneurial activity; China

JEL:

1. Introduction

With the explosive development of internet information technology in the world, China also has been experiencing a rapid development of e-commerce since the 2010s (Lele and Goswami, 2017). E-commerce as a new engine for China's rural revitalization promotes the integration of internet resources and traditional rural production factors (Couture et al., 2021), which effectively forms an integrated rural industrial support system. Meanwhile, the e-commerce increasingly becomes the key link between industrial revitalization and common prosperity. Therefore, we explore the mechanism of e-commerce development on the generation and development of rural industries exploration of deeply, which is not only an important measure to promote the modernization of agriculture and rural areas, but also a major demand to meet the national rural revitalization strategy.

The rapid development of e-commerce and its wide application in the agricultural field bring new

opportunities and challenges for the development of agricultural industries. Unfortunately, many researches have examined industrial entrepreneurial activities (Urbano et al., 2020; Guo et al., 2022), which ignored the impact on agricultural enterprises. In addition, many scholars' researches on the entrepreneurial activities of agricultural enterprises mostly stays in the theoretical level (Dias et al., 2019; Tang and Zhu, 2020), lacking of strong empirical support. In this context, studying the role and mechanism of e-commerce on county-level agricultural enterprise entrepreneurial activities highlights the theoretical and practical significance of digital economy for promoting China's rural revitalization. This study constructs a pooled cross-sectional dataset composed of approximately 1706 county-level administrative regions from 27 provinces. The raw data of the dataset are mainly derived from China County-level Statistical Yearbook and the agricultural enterprise registration data compiled by the Chinese industry and Commerce Department from 2008 to 2020. Based on the quasi-experiment of "National Rural E-commerce Comprehensive Demonstration Policy" jointly carried out by the Ministry of Finance, the Ministry of Commerce, and the State Council Leading Group Office of Poverty Alleviation and Development in 2014, this study estimates the impact of e-commerce development on county-level agricultural enterprise entrepreneurial activities in China. Specifically, this study mainly examines the following questions: Given the requirement of realizing rural revitalization, can e-commerce promote rural industrial revitalization? How does the implementation and promotion of e-commerce policies affect the development of county-level agricultural industries? Dose e-commerce have different effects on different types of agricultural enterprises? Do any heterogeneity exist? What are the transmission mechanisms through which e-commerce policy affects the generation and development of county-level agricultural enterprises?

The contributions of this study mainly include three aspects. First, this study takes county-level agricultural enterprise entrepreneurial activities as the research object, enriching the current research that mostly takes the perspective of farmers and industrial entrepreneurial activities as the main body. Second, this study carefully explores the "digital divide" problem existing in the impact of e-commerce development on different county-level and different industry types of agricultural enterprise entrepreneurial activities, to deepen the understanding of China's current stage of digital economy

development. Finally, this study focuses on the analysis of the mechanisms of e-commerce affecting China's agricultural enterprise entrepreneurial activities, and reveals the deep logic chain of rural e-commerce development affecting rural industrial revitalization.

The preliminary results of this study find that e-commerce development to some extent increases the growth rate of county-level agricultural enterprises, that is, significantly promotes the generation of county-level agricultural enterprises. At the same time, the policy effect is more obvious in areas with eastern and western regions. In addition, the impact of the policy is inconsistent for agribusiness enterprises with different types of ownership and different industries.

The remainder of this paper is structured as follows. Section 2 details the methodology used in this study. Data are discussed in Section 3. The empirical results are presented and discussed in Section 4. Section 5 concludes the paper and lays out policy implications.

2. Institutional background

China's rural e-commerce policy, a fundamental pillar of its overarching rural revitalization strategy, was initiated subsequent to the promulgation of the "Notice on the Comprehensive Demonstration of E-commerce in Rural Areas" by the Ministry of Finance and the Ministry of Commerce in the year 2014. This policy was strategically designed with a three-year horizon to create exemplary model counties throughout the country, prioritizing the development of a robust and self-sustaining e-commerce ecosystem within rural areas. A particular emphasis was placed on nurturing regions that have been earmarked for poverty alleviation and development initiatives.

The selection process for these pilot counties was rigorous and based on a set of stringent criteria. These criteria included a mandatory annual growth in e-commerce transaction volume of at least 30% to ensure a robust expansion of online commerce. Additionally, there was an expectation of a significant increase in the local retail sales of consumer goods, indicative of a thriving local economy. The policy also aimed to reduce e-commerce logistics expenses, which is crucial for making online commerce more accessible and cost-effective in rural settings. Furthermore, an enhancement in the modernization of rural distribution systems was sought, aiming to streamline and improve the efficiency of goods delivery in these areas.

This comprehensive approach to integrating e-commerce into rural development is reflective of China's commitment to leveraging digital technologies for socio-economic advancement, particularly in areas that have historically been more challenging to reach with traditional development models. The policy's multifaceted goals and stringent benchmarks underscore the seriousness with which China addresses the complexities of rural development in the digital age.

The scope of the initiative broadened after 2015, reaching a notable milestone in 2016 with the involvement of the State Council's Leading Group Office for Poverty Alleviation. This marked an enhanced strategic emphasis on utilizing e-commerce as a pivotal tool for poverty alleviation efforts. The policy framework is intricately woven, encompassing a suite of 14 detailed measures that are strategically aligned across six pivotal domains.

Central to this framework is the establishment of a multi-tiered, comprehensive service platform for rural e-commerce, designed to provide a structured support system for local online commerce. Additionally, there is a pronounced acceleration in the development of a modern logistics and distribution network, which is essential for the efficient movement of goods and services within these regions. The policy also actively encourages the emergence and growth of diverse and innovative e-commerce entities within the rural landscape, fostering a dynamic and competitive market environment. Furthermore, the policy advocates for the establishment of county-level live streaming e-commerce hubs. These hubs serve as critical conduits, facilitating the connection between rural producers and the broader national and international marketplaces. Through live streaming, local producers are able to showcase their products in real-time, reaching a wider audience and tapping into new consumer bases. This policy's comprehensive and multifaceted approach reflects a nuanced understanding of the complexities inherent in rural development. By leveraging the transformative power of e-commerce, the initiative aims to catalyze economic growth, reduce poverty, and integrate rural areas more fully into the global economy. The inclusion of live streaming e-commerce hubs exemplifies the policy's forward-thinking nature, embracing innovative technologies to achieve its objectives.

3. Data

3.1 Data sources

We employ the following three sources of data in our analysis: Firstly, the list of comprehensive demonstration counties for the E-commerce into the rural comprehensive demonstration county and the corresponding implementation years are derived from data disclosed on the official website of the Ministry of Commerce of China.

Secondly, the dataset that encompasses entrepreneurial activities within the domain of agribusiness and associated industries at the county level is predominantly derived from the China Academy for Rural Development-Qiyuan China Agri-research Database (CCAD), which is maintained by the Zhejiang University China Academy for Rural Development (CARD). The CCAD provides a rich vein of information, offering a nuanced perspective on agribusiness entrepreneurship at the county level.

Finally, the control variables utilized at the county level are predominantly abstracted from the ‘China County and City Economic and Social Development Statistical Yearbook.’ This is a comprehensive and authoritative compendium that covers a period spanning from 2008 to 2020. The yearbook presents an exhaustive statistical synthesis of a multitude of key indicators. These include, but are not limited to, population demographics, county-level Gross Domestic Product (GDP), the composition of industries, the progression of the financial sector, and the condition of human capital within the counties of China. Given its extensive coverage and the depth of its statistical synthesis, the yearbook emerges as a robust repository of detailed research data. It is an indispensable resource for the present scholarly investigation, providing a solid empirical foundation upon which our analysis is predicated. The meticulous selection and abstraction of control variables from this source ensure the academic rigor and logical coherence of our study, aligning with the stringent standards of scholarly research in the field.

All the variables defined from the datasets are provided in Table 1. After removing observations with missing data and outliers, we obtained an unbalanced panel of 21,245 responses. The sample has 4359 treatment group variables and 16,886 control group variables.

3.2 Key variable measurements

3.2.1 The e-commerce program

This study primarily investigates the level of e-commerce development, utilizing “e-commerce demonstration counties” as a representative indicator in regression analysis. In light of the gradual

implementation of the “E-commerce Integration into Rural Areas Comprehensive Demonstration County” program, this paper defines the corresponding policy variable as follows: a value of 1 is assigned to any county from the year it initiates the e-commerce pilot program into rural areas, and for all subsequent years; conversely, a value of 0 is set for counties not participating in the pilot or for periods prior to the pilot. This classification method distinctly differentiates between the treatment group, which includes counties participating in the e-commerce pilot, and the control group, comprising counties not involved in the pilot program. Thus, the research design permits the observation of two types of differences: one between the treatment and control groups, and another comparing conditions within the treatment group before and after policy implementation.

Utilizing this stratification, the treatment group emerges as an indispensable benchmark for assessing the influence of the e-commerce initiative on rural economic development. Concurrently, the control group establishes a foundational baseline, instrumental in discerning the policy’s effects from extraneous confounding factors. This methodological delineation is paramount for mitigating the influence of unobserved heterogeneity, which, if unaddressed, could potentially distort the interpretation of the policy’s impact. By employing this analytical framework, the objective is to furnish a more nuanced and precise evaluation of the policy’s contribution to the escalation of e-commerce in rural settings. This, in turn, is expected to enhance our comprehension of the initiative’s capacity to catalyze rural revitalization.

3.2.2 Agribusiness entrepreneurial activity

We use business-level data from the China Academy for Rural Development-Qiyuan China Agri-research Database (CCAD). The database collects data on agriculture and related businesses from 1987 to 2024, which include over 1.3 million businesses and cover 2828 counties. The database includes an administrative dataset that covers the business registration date, business name, registered address, industry classification, and business closing date if applicable. It also provides the businesses’ legal status, e.g., sole proprietorship, limited liability corporation, or corporation. We consolidate it at the county level and take the natural logarithm of the number of new enterprises registered in each county. To ensure data integrity and availability, our analysis was confined to newly acquired agribusiness data

from each county within the period from 2008 to 2020.

3.3 Descriptive statistics

Table 1 shows the descriptive statistics of the variables.

Table1
Variable definitions and descriptive statistics.

	Observation	Mean	SD	Median	Min	Max
The number of agribusiness entrepreneurial activity	21245	3.972	1.187	4.043	0	8.836
The e-commerce program	21245	0.205	0.404	0	0	1
Degree of financial development	21030	0.616	0.385	0.526	0	7.635
Per capita consumption level	18382	0.330	0.136	0.314	0.023	2.027
Primary industry structure	21062	0.210	0.117	0.197	0.002	0.875
Secondary industry structure	21061	0.420	0.157	0.420	0.013	0.939
Tertiary industry structure	21061	0.370	0.111	0.364	0.041	0.910
Social Welfare	20943	6.604	1.292	6.758	0.693	9.942
Fixed Telephone Subscribers	21110	2.337	0.110	2.349	0.970	2.624
Economic Density	21058	6.073	1.471	6.139	-1.044	10.871
Gross Domestic Product (GDP) per Capita	19394	10.089	0.763	10.085	7.727	13.046
Government Size	21061	0.285	0.271	0.207	0.005	5.432

4. Effects of the e- program on entrepreneurial activities

4.1 Empirical strategy

To identify the effect of the e-commerce program on entrepreneurial activity, we use time and geographic variations in the e-commerce program since 2014. Specifically, DID estimation involves comparing the outcome variables of counties before and after they adopted the e-commerce policy with that of counties which had not yet adopted it during the same period.

Fig. 1 illustrates the validity of our identification strategy. It shows the time trends of the logarithm of agribusiness entrepreneurial activity of the counties that adopted the e-commerce policy since 2014 and those that did not adopt it during the sample period. The treatment group and the control group show similar trends before 2014, a year before the start of the e-commerce policy. But they diverge

significantly after 2014, when the growth in e-commerce counties lagged behind that in non-e-commerce counties.

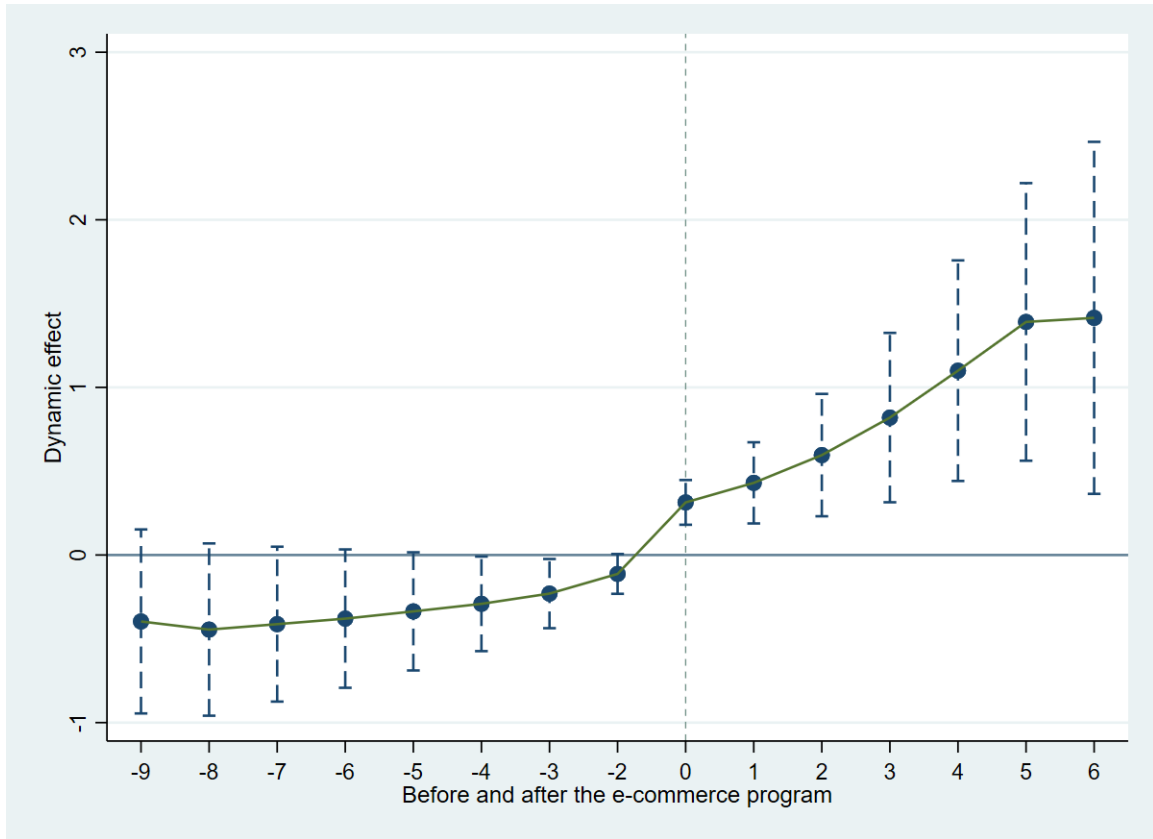


Fig. 1. Year-by-year dynamic effects of e-commerce program on entrepreneurial activity.

We begin by examining whether the implementation of the e-commerce program affects agribusiness entrepreneurial activity. Our empirical strategy exploits the implementation of the program across counties to identify the causal effect. Our baseline specification employs a difference-in-differences estimator that compares the outcome variables in the counties that started the e-commerce program relative to other counties without the program in each year. The regression is specified as below:

$$y_{ct} = \beta_0 + \beta_1 ecommerce_{ct} + X_{ct} + \gamma_c + \tau_t + \varepsilon_{ct} \quad (4.1)$$

Where y_{ct} refers to the outcomes of agribusiness entrepreneurial activity for county c in year t . $ecommerce_{ct}$ is the regressor of interest, indicating the county's e-commerce status. Specifically, $ecommerce_{ct} = treatment_c * post_{ct}$, where $treatment_c = 1$ if county c carried out the e-commerce program during the sample period, and 0 otherwise. $post_{ct}$ is a post-treatment indicator, taking a value

of 1 if $t \geq t_{c0}$ where t_{c0} is the year county c implemented of the e-commerce program, and 0 otherwise. The indicator variable $ecommerce_{ct}$ equals one for the years the program was implemented or following the implementation of the program; otherwise, it is zero. The coefficient β_1 thus provides the DID estimate, which states the difference in y_{ct} between the (program) treated and non-treated samples. We control for economic conditions (e.g., degree of financial development, per capita consumption level, primary industry structure, secondary industry structure, tertiary industry structure, social welfare, fixed telephone subscribers, economic density, gross domestic product (GDP) per capita, government size) for county-level regressions. We also control for county (γ_c) and year (τt) fixed effects. γ_c is the county fixed effect, capturing all the time-invariant characteristics of the counties, which might influence the outcome of interest. τt is the year fixed effects, controlling for nation-wide shocks in a particular year likely to have affected all counties in a similar manner; and ε_{ct} is the error term. To address the potential serial correlation and heteroscedasticity, we cluster the standard errors at the city level.

A potential concern with the DID estimates is that the estimates are susceptible to the biases created by potential differences in other characteristics, such as the implementation of the e-commerce program may take into account certain specific criteria. If such criteria also influence the trend of economic development, then the differences in economic development between the treatment group and the control group after the implementation of the policy may also be caused by these selection criteria, thereby leading to bias in the estimation results of the aforementioned equation.

To control for differences in the chronological evolution of the outcome variables whose correlation with e-commerce program is caused by the endogenous pattern of e-commerce program selection, we experiment with three specifications, which increasingly allow more flexibility in the estimation. The selection variables S are first interacted with a thirdorder polynomial function of time in Eq. (4.2), assuming the effect of S on the outcome variables to follow specific time trends. The interactions between S and $post_{ct}$ then allow the effect of S on the outcome variables to differ between the pre- and post-treatment periods. Lastly, the S variables are interacted with the year dummies τ_t , which more flexibly control for the time effects of S on the outcome variables. Beyond that, we include the

interactions between county dummy γ_c and the year trend to control for the differences in time trends between the treatment and control groups. This produces the augmented DD specification:

$$y_{ct} = \beta_0 + \beta_1 e_{commerce} e_{ct} + (S \times f(t))\theta_1 + X_{ct} + \gamma_c + \tau_t + \varepsilon_{ct} \quad (4.2)$$

Where S denotes whether a county is designated as a national-level impoverished county prior to the pilot program; The function $f(t)$ represents a temporal function, it could be a third-order polynomial function of t , or $post_{ct}$, or τ_t .

4.2 Baseline results

We first analyze the growth in agribusiness entrepreneurial activity induced by the e-commerce program. We estimate Eq. (4.2) by using the following dependent variables: the log number of agribusiness created in county c and year t . The results of the estimation with the log number of agribusiness created are reported in Tables 2.

Table 2 reports the results by using CCAD data. The baseline estimation results are reported in column 1 in Table 2. They show a positive and statistically significant effect relationship between the e-commerce program and the log number of agribusiness created. This finding implies that the program may have increase the number of agribusinesses created in the affected counties. Columns 2 to 4 report the results allowing interactions between a flexible function of time and all the major determinants of the e-commerce program introduction, as elaborated in the previous section. Specifically, interactions of the pilot selection of standard variables (S) with a third-order polynomial function of time are included in column 2. Interactions of the pilot selection of standard variables (S) with the year dummies τ_t are included in the estimation reported in column 3. Interactions of the pilot selection of standard variables (S) with the $post_{ct}$ variable are included in the estimation reported in column 4. As shown in Column (4), the introduction of the e-commerce program by a county significantly increases the number of agribusinesses created and the agribusiness entry rate. The parameter estimates imply that the number of newly created agribusinesses is 13.9% more in the counties that have experienced the e-commerce program than in the counties where the e-commerce program has not yet started.

Table 2

Impacts of the e-commerce program participation on agribusiness entrepreneurial activity: DID model

estimation.

VARIABLES	The number of agribusiness entrepreneurial activity				
	(1)	(2)	(3)	(4)	(5)
The e-commerce program	0.132*** (0.029)	0.092*** (0.027)	0.084*** (0.030)	0.139*** (0.039)	0.154*** (0.042)
Degree of financial development	0.067 (0.050)	0.027 (0.049)	0.020 (0.049)	0.106* (0.055)	0.101* (0.054)
Per capita consumption level	0.160 (0.164)	0.148 (0.158)	0.146 (0.159)	-0.340* (0.179)	-0.338* (0.179)
Primary industry structure	0.168 (0.967)	-0.038 (0.962)	-0.023 (0.970)	-0.349 (1.052)	-0.391 (1.072)
Secondary industry structure	-0.016 (0.914)	-0.213 (0.912)	-0.195 (0.918)	0.252 (1.000)	0.208 (1.015)
Tertiary industry structure	0.786 (0.902)	0.597 (0.898)	0.653 (0.905)	0.748 (1.007)	0.755 (1.024)
Social welfare	0.015 (0.015)	0.012 (0.015)	0.012 (0.015)	-0.050*** (0.013)	-0.051*** (0.014)
Fixed telephone subscribers	-0.530** (0.231)	-0.443** (0.222)	-0.446** (0.222)	-0.217 (0.171)	-0.201 (0.171)
Economic density	0.476*** (0.150)	0.411*** (0.143)	0.428*** (0.145)	0.117 (0.132)	0.124 (0.134)
Gross domestic product (GDP) per capita	0.096 (0.123)	0.074 (0.120)	0.058 (0.118)	-0.130 (0.112)	-0.128 (0.110)
Government size	0.145 (0.145)	0.083 (0.143)	0.073 (0.145)	0.071 (0.159)	0.062 (0.158)
Constant	0.716 (1.324)	1.347 (1.301)	1.395 (1.283)	5.035*** (1.452)	17.361 (25.591)
Observations	17,401	17,401	17,401	17,401	17,401
R-squared	0.830	0.833	0.833	0.880	0.880
district FE	YES	YES	YES	YES	YES
year FE	YES	YES	YES	YES	YES
District Dummy* Trend	NO	NO	NO	YES	YES
Povertycounty*Trend	NO	YES	NO	NO	NO
Povertycounty*Trend ²	NO	YES	NO	NO	NO
Povertycounty*Trend ³	NO	YES	NO	NO	NO
Povertycounty*Year Dummy	NO	NO	YES	NO	NO
Povertycounty*POST	NO	NO	NO	YES	YES

Note: Standard errors in parentheses.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

4.3 Robustness checks

To test the robustness of the above results, we apply two strategies: one eliminating the potential interference of other policy variables. We have identified a significant similarity in the implementation timeline between the “Information Enters Villages and Households” policy and the e-commerce program. Specifically, the core objective of the “Information Enters Villages and Households” policy is to refine the agricultural information service network, address the challenge of the “last mile” in agricultural information services, and enhance the access to public service resources within rural communities. The implementation of this policy adopted a gradual expansion strategy, initially selecting 22 districts and counties as the first batch of pilot areas in 2014, which was then further expanded to include an additional 94 pilot districts and counties in 2016 (Ruan et al., 2017).

In order to precisely evaluate the effects of the e-commerce program and to avoid the potential confounding influence of the “Information Enters Villages and Households” policy, we have incorporated corresponding dummy variables into our research model for control. The relevant statistical outcomes are listed in detail in Column (1) of Table 3, indicating that the impact of the e-commerce program was not significantly affected by the implementation of the “Information Enters Villages and Households” policy. Our estimates show that the variable representing the e-commerce program has a positive and significant coefficient of 0.146. This finding confirms our earlier findings that the e-commerce program has significantly increase the agribusiness growth in China.

Additionally, an alternative approach involves reducing the temporal extent of the sample period. The e-commerce program commenced in 2014, and the baseline regression sample discussed earlier in this paper is predominantly based on the years ranging from 2008 to 2020. Considering the substantial duration of the pre-policy sample period, we have re-estimated using a sample that spans from 2010 to 2020. The estimated results reported in Column (2) of Table 3 similarly demonstrate that the e-commerce program has significantly contributed to the agribusiness growth of the county-level regions.

Table 3
Robustness check.

VARIABLES	(1)	(2)
	The number of agribusiness entrepreneurial activity	
The e-commerce program	0.146***	0.125***

	(0.039)	(0.040)
Degree of financial development	0.093*	0.059
	(0.051)	(0.053)
Per capita consumption level	-0.323*	-0.450**
	(0.180)	(0.208)
Primary industry structure	-0.489	-0.214
	(1.064)	(1.247)
Secondary industry structure	0.101	0.098
	(1.003)	(1.141)
Tertiary industry structure	0.693	0.987
	(1.013)	(1.165)
Social welfare	-0.052***	-0.008
	(0.013)	(0.012)
Fixed telephone subscribers	-0.183	-0.139
	(0.169)	(0.172)
Economic density	0.140	0.044
	(0.136)	(0.154)
Gross domestic product (GDP) per capita	-0.122	-0.131
	(0.106)	(0.100)
Government size	0.058	0.013
	(0.161)	(0.152)
Information Enters Villages and Households policy	0.011	
	(0.079)	
Constant	17.414	-39.666
	(32.250)	(68.181)
Observations	17,401	14,112
R-squared	0.881	0.889
district FE	YES	YES
year FE	YES	YES
District Dummy* Trend	YES	YES
Povertycounty*POST	YES	YES

Note: Standard errors in parentheses.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

To check the extent to which the results are influenced by any omitted variables, a placebo test is conducted by randomly assigning the adoption of e-commerce program to counties (Chetty et al., 2009; Ferrara et al., 2012).

Fig. 2 shows the distribution of the estimates from the 500 runs along with the benchmark estimate, 0.154, from column 5 in Table 2. The distribution of estimates from random assignments is clearly centered around zero, suggesting that there is no effect with the randomly constructed e-commerce program. Meanwhile, the benchmark estimate is located outside the entire distribution. Combined, these observations suggest that the positive and significant effect of the e-commerce program on agribusiness

growth performance is not driven by unobserved factors.

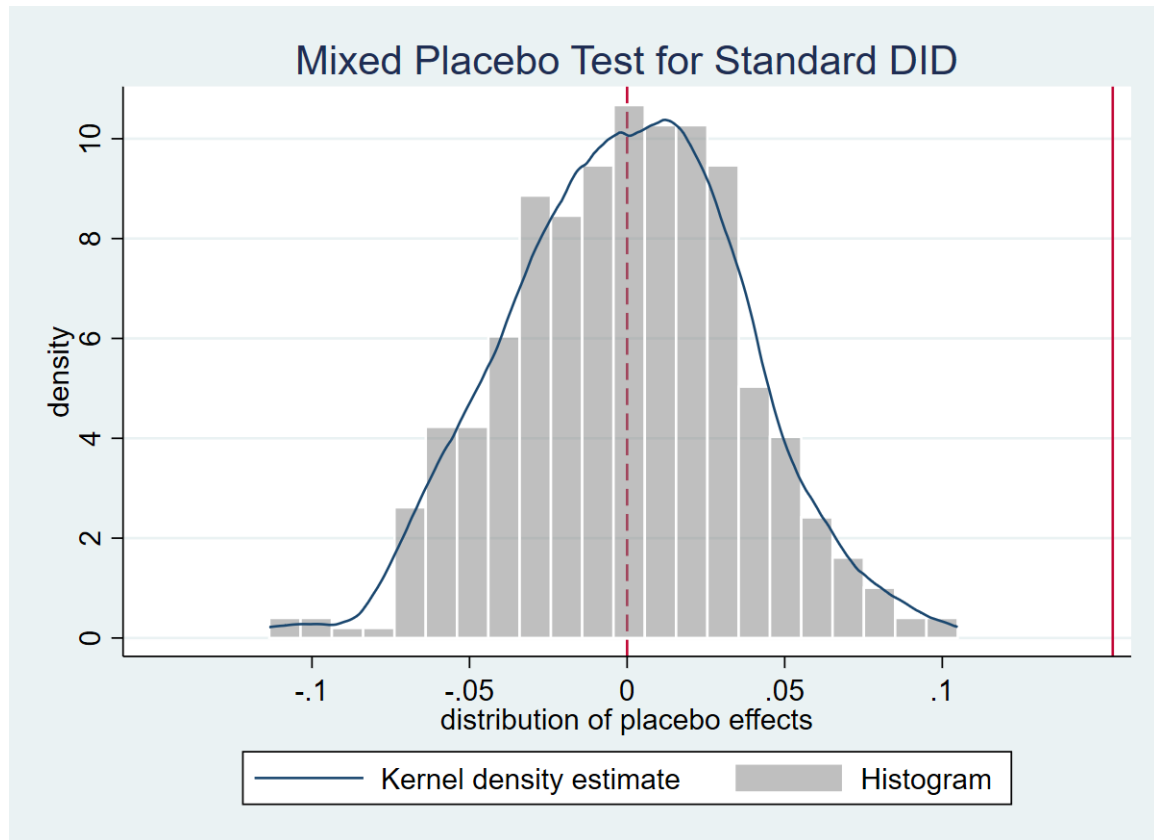


Fig. 2. Placebo Test

Note: The figure shows the cumulative distribution density of the estimated coefficients is from 500 simulations randomly assigning the e-commerce status to counties. The vertical line presents the result of column 5 in Table 2.

4.4 Heterogeneous effects

4.4.1 Effects by geographic locations

Economic activities in China vary regionally (Yang & Liu, 2021), the e-commerce program may affect agribusiness growth differently across counties. For this reason, we estimated the effects of the e-commerce program on agribusiness entrepreneurial activity separately for the eastern, central, and western regions. The results are presented in Table 4 in columns (1)–(3). These findings suggest that the e-commerce program substantially increase the agribusiness growth in China. However, the effects of the e-commerce program differed across geographical locations. Specifically, our findings indicate that the e-commerce initiative exerts the most significant positive impact on counties situated within the eastern region (0.188), followed by the counties in the western region (0.124), and has little effect for

counties in the central region (-0.007).

Table 4
Heterogeneous analysis by geographical locations.

VARIABLES	(1)	(2)	(3)
	Eastearn	Central	Western
The e-commerce program	0.188*** (0.061)	-0.007 (0.064)	0.124* (0.067)
Degree of financial development	0.187* (0.099)	0.325*** (0.123)	0.012 (0.051)
Per capita consumption level	0.391 (0.343)	-0.191 (0.231)	-0.540** (0.222)
Primary industry structure	1.468 (1.800)	-2.073 (1.352)	1.115 (1.636)
Secondary industry structure	2.662 (1.989)	-1.775 (1.427)	1.201 (1.452)
Tertiary industry structure	3.204 (1.991)	-1.351 (1.383)	1.999 (1.402)
Social welfare	0.015 (0.021)	-0.013 (0.016)	-0.088*** (0.020)
Fixed telephone subscribers	-0.590 (0.761)	-0.582*** (0.191)	0.414 (0.264)
Economic density	0.084 (0.265)	0.383 (0.254)	-0.035 (0.150)
Gross domestic product per capita	-0.152 (0.167)	0.068 (0.199)	-0.171 (0.127)
Government size	-0.723* (0.406)	0.364 (0.279)	-0.015 (0.165)
Constant	5.049 (30.261)	24.303 (33.022)	21.466 (107.933)
Observations	4,043	5,061	8,297
R-squared	0.882	0.879	0.875
district FE	YES	YES	YES
year FE	YES	YES	YES
District Dummy* Trend	YES	YES	YES
Povertycounty*POST	YES	YES	YES

Note: Standard errors in parentheses.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

4.4.2 Effects by ownership types and industries

Our sample covers firms of different ownership types (Fan et al., 2021). Given these rich variations in firms' characters, it is interesting to examine the heterogeneous effects of the e-commerce program on different ownership types of agribusiness entrepreneurial activity. The results are presented in Columns (1)-(6) of Table 5. The effects of the e-commerce program participation on agribusiness entrepreneurial activity is significantly positive for private relative to others. Consequently, private-owned businesses

become more booming when exposed to the program.

Table 5
Heterogeneous analysis by ownership types.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Collective	State-owned	Private	Cooperation	Foreign	Foreign_HMT
The e-commerce program	1.046	-0.551	56.732***	-0.004	0.065	-0.085
	(0.860)	(0.606)	(18.735)	(0.004)	(0.134)	(0.120)
Degree of financial development	0.381	0.468	39.992**	0.000	-0.082	-0.166
	(0.896)	(0.481)	(19.713)	(0.009)	(0.099)	(0.113)
Per capita consumption level	-1.104	1.854	40.384	-0.014	0.477	-0.000
	(3.010)	(1.867)	(72.809)	(0.012)	(0.533)	(0.287)
Primary industry structure	-34.891	2.576	-7.011	-0.105	-1.314	-0.584
	(27.890)	(9.815)	(365.791)	(0.106)	(2.434)	(1.480)
Secondary industry structure	-39.805	-0.734	-176.626	0.028	-2.173	-0.967
	(27.405)	(7.946)	(317.381)	(0.032)	(2.374)	(1.300)
Tertiary industry structure	-30.647	2.023	-188.106	-0.022	-2.565	0.070
	(25.173)	(7.794)	(318.976)	(0.043)	(2.447)	(1.360)
Social welfare	-0.007	0.065	-4.021	-0.004	-0.044	0.025
	(0.432)	(0.230)	(6.105)	(0.005)	(0.029)	(0.022)
Fixed telephone subscribers	-4.390	-3.464	-40.105	-0.012	0.342	0.166
	(3.815)	(3.008)	(46.175)	(0.048)	(0.429)	(0.251)
Economic density	5.703	4.242*	199.871***	0.005	0.583**	0.358
	(4.040)	(2.350)	(64.751)	(0.017)	(0.280)	(0.245)
Gross domestic product per capita	-2.175	-2.280	-50.770	-0.016	-0.215	0.112
	(2.782)	(1.685)	(55.827)	(0.012)	(0.290)	(0.211)
Government size	-0.092	1.318*	16.942	0.005	0.384	0.021
	(1.385)	(0.798)	(24.943)	(0.005)	(0.336)	(0.195)
Constant	448.617	222.929	5,303.130	-3.786	4.168	-27.991
	(806.061)	(497.018)	(13,758.642)	(6.188)	(61.629)	(41.947)
Observations	17,401	17,401	17,401	17,401	17,401	17,401
R-squared	0.950	0.967	0.934	0.752	0.980	0.987
district FE	YES	YES	YES	YES	YES	YES
year FE	YES	YES	YES	YES	YES	YES

Note: Standard errors in parentheses.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

In addition to the heterogeneous responses of firms brought by ownership difference, industries might also matter. For this reason, we estimated the effects of the e-commerce program on agribusiness entrepreneurial activity separately for the agriculture, manufacturing, wholesale and retail,

transportation, accommodation and catering, financial, business service, and technology industry. The results are presented in columns (1)–(8) of Table 6. The estimates show that the e-commerce program participation significantly increases the agribusiness entrepreneurial activity of industries which including agriculture, wholesale and retail, accommodation and catering, business service, and technology industries by 15.0%, 17.1%, 6.2%, 9.5%, 9.6% respectively.

5. Conclusion and policy

The research presented in this paper offers a nuanced examination of the impact of China's e-commerce program on agribusiness entrepreneurship across rural counties. Utilizing a robust difference-in-difference (DID) framework and a comprehensive dataset from the China Academy for Rural Development-Qiyang China Agri-research Database (CCAD), our analysis uncovers significant insights into the transformative potential of e-commerce in rural economic development.

Our findings indicate that the e-commerce program has been instrumental in enhancing agribusiness entrepreneurial activity, particularly in counties that have adopted the program. The DID methodological approach, which controls for time-invariant unobserved heterogeneity and nation-wide shocks, reveals a statistically significant increase in the number of agribusiness enterprises in treatment counties relative to control counties. This suggests that the e-commerce program has effectively catalyzed entrepreneurial activity in the agricultural sector.

Furthermore, our study delves into the heterogeneity of the program's impact, uncovering regional disparities in its effectiveness. The eastern region, characterized by higher levels of human capital and digital infrastructure, experiences the most significant boost in agribusiness growth, followed by the western region, with the central region showing minimal change. This underscores the importance of regional context in the successful implementation of digital economy initiatives.

The study also reveals that the impact of the e-commerce program is more pronounced in certain industries, notably agriculture, wholesale and retail, accommodation and catering, business service, and technology. This suggests that the program's success is not uniform across all sectors and that targeted interventions may be necessary to maximize its benefits.

In terms of ownership types, our findings highlight a particularly positive impact on private enterprises, suggesting that these businesses are more responsive to the opportunities presented by the e-commerce program. This underscores the pivotal role of the private sector in driving rural economic development and the need for policies that support private enterprise growth in the digital economy.

The robustness of our findings is further confirmed by placebo tests and sensitivity analyses, which control for the potential influence of other policies and temporal dynamics. The placebo test, in particular, provides strong

evidence that the observed effects are indeed attributable to the e-commerce program and not to unobserved factors.

In light of these findings, we propose several policy implications. Firstly, policymakers should consider regional disparities and tailor the implementation of e-commerce initiatives to local conditions. Secondly, targeted support for private enterprises could be beneficial, given their responsiveness to the e-commerce environment. Thirdly, investments in human capital and digital infrastructure are crucial for amplifying the program's impact.

Moreover, our study underscores the need for further research into the specific mechanisms through which e-commerce development influences agribusiness entrepreneurship. Understanding these mechanisms can inform the design of more effective policies and interventions to promote rural revitalization through the digital economy.

In conclusion, the e-commerce program represents a promising avenue for stimulating agribusiness entrepreneurship and rural revitalization in China. However, the program's success is contingent upon a variety of factors, including regional characteristics, industry-specific dynamics, and ownership structures. Our research provides a solid empirical foundation for policymakers to refine the program and to harness the potential of e-commerce for rural development more effectively.

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