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E-commerce and Rural Household Debt Expansion:

--A Quasi-Natural Experiment from a National Rural E-commerce Comprehensive Demonstration Policy in Rural Areas

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Abstract: In recent years, the risk of rural household debt has risen rapidly, and the development and diffusion of e-commerce in rural areas has the tendency to promote the expansion of household debt. Using the sample data of the China Family Panel Survey (CFPS) from 2014 to 2020,and taking the "Comprehensive Demonstration of E-commerce in Rural Areas" project as a quasi-natural experiment, this paper analyzes the impact and mechanism of e-commerce on rural household debt by using the staggered DID model. The results show that e-commerce significantly increases the debt size and risk of rural households. Mechanism analysis shows that e-commerce mainly alleviates the financial exclusion problem, stimulates household consumption-based expenditure and agricultural production, and thus promotes household consumption and borrowing debt. Based on this, it is important to pay attention to the debt risk of low-income newly indebted households in rural areas, to strengthening the upgrading of the consumption structure in rural areas, raising the standard of living of the rural population. This paper provides a new perspective for understanding the indebtedness of rural residents and identifying the impact of e-commerce and the digital economy on rural debt, which is of some significance for further improving the development of e-commerce in rural areas.

Keywords: e-commerce, rural household debt, borrowing and lending, quasi-natural experiment, staggered DID.

1. Introduction

With the rapid development of China's economy, the living standards of Chinese residents have gradually improved. However, the household debt levels of Chinese residents have also shown a rapid upward trend in recent years. Over the past decade, the annual growth rate of household loans in China has reached 18.3%, far exceeding that of other countries. In 2023, the household leverage ratio in China reached 61.3%, equaling or even surpassing the leverage levels of many developed countries[1]. Rural residents, as an important demographic group in China, although having a smaller absolute household debt scale compared to urban households, have exhibited an excessively fast debt

[1] Data source: https://tradingeconomics.com/china/households-debt-to-gdp

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growth trend in recent years. Compared to urban residents, rural residents have lower incomes, fewer assets, and weaker risk resistance, making them more susceptible to financial crises. The debt risk of rural areas, especially among low-income households, is concerning and warrants in-depth analysis and research.

Over the past decade, the rapid development of digital economy technologies has become an important economic model in China. Among these, the development of e-commerce has provided new opportunities and ideas for China's economic development and rural revitalization. However, the advancement of e-commerce may also bring certain negative impacts. Especially in underdeveloped small and medium-sized cities and rural areas, the problem of financial regulation deficiencies is severe, and non-compliant phenomena such as multiple credit lines are prevalent, laying the hidden danger of excessive borrowing in consumer finance in China, which can easily trigger systemic financial risks. Therefore, studying the impact of e-commerce on the debt levels of rural households is of significant practical importance.

Household debt issues have always been an important topic of concern for scholars. Existing literature mainly focuses on the influencing factors of household debt and the consequences of household over-indebtedness [1]. Micro-level influencing factors of household debt include demographic characteristics, human capital characteristics [2], household risk attitudes, and financial expectations [3]. The impact of household income levels on household debt has a dual effect: most scholars believe that income and debt present a substitution relationship, while some scholars argue that high-income households face smaller financing constraints, hence income and debt exhibit a complementary relationship [4].

The contribution of e-commerce to rural development has attracted considerable research attention. At the macro level, e-commerce promotes high-quality economic development in rural areas [5], narrows the urban-rural income gap [6], promotes environmental sustainability [7], and fosters common prosperity within rural areas [8]. For micro-level farmers and rural residents, studies have found that e-commerce can enhance farmers' production scales [6], attract labor back to rural areas [9], encourage rural entrepreneurship [10], and stimulate rural residents' consumption capabilities [11]. Numerous studies have shown that the introduction of e-commerce in rural areas can effectively improve the economic conditions and living standards of rural residents. Nevertheless, most existing literature focuses on the positive impacts of rural e-commerce, while there is little attention to the potential negative impacts that the rapid development of e-commerce may bring to rural households. Additionally, research based on micro-level data on the impact of e-commerce on rural households is relatively scarce, especially studies addressing rural household debt issues, which need further improvement.

2. Theoretical Analysis

In rural China, financial exclusion remains pronounced, with rural households often struggling to access formal financial services, leading them to rely on informal lending channels when in need of funds [12,13]. The expansion of e-commerce and digital economy in rural areas has introduced emerging digital platform finance with lower interest rates and more flexible repayment terms. This has effectively alleviated financial exclusion and enhanced residents' debt repayment capabilities [14,15]. However, without adequate financial literacy and management knowledge, rural households may fall into high debt traps [16]. Therefore, this paper proposes Hypothesis 1: E-commerce alleviates credit constraints, encouraging residents to borrow from formal financial platforms, thereby expanding rural household debt.

E-commerce, as an emerging shopping channel, not only enhances the convenience of accessing goods and services for rural households but also partially changes their consumption behaviors and patterns, significantly boosting consumption levels. The development of e-commerce in rural areas

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has improved logistics, making consumption more convenient and offering rural residents more choices. It has also introduced convenient consumer finance options and expanded borrowing avenues [17]. Moreover, many rural households can use e-commerce platforms to purchase agricultural production goods, thus expanding production scales. Based on this, Hypothesis 2 is proposed: E-commerce stimulates residents' consumption demand, promoting household indebtedness by stimulating both consumption and production expenditures.

3. Data, Variables, and Identification Framework

(1) Data Sources

This study utilizes three sets of data. Firstly, micro-data from the China Family Panel Studies (CFPS) spanning from 2014 to 2020 are used. Control variable data at the county level are derived from the China County Economic Statistical Yearbooks for 2014, 2016, 2018, and 2020. Finally, indicators related to digital inclusive finance are sourced from the Peking University Digital Inclusive Finance Database. The list of Comprehensive Demonstration Villages for E-commerce into Rural Areas from 2014 to 2018, and the list of poverty-stricken counties from 2012, were used for sample selection. After screening, the study obtained a balanced panel dataset comprising 4,160 samples across four periods.

(2)Variable Selection and Descriptive Statistics

Dependent Variable:

This study selects the debt-to-income ratio of rural households as the dependent variable and takes the logarithm of the debt-to-income ratio.

Core Independent Variable:

The core independent variable chosen for this study is the "E-commerce into Rural Areas Comprehensive Demonstration" policy. The value is set to "1" for the year and subsequent years in which the county where the household is located implemented the "E-commerce into Rural Areas Comprehensive Demonstration" policy; otherwise, it is set to "0".

Control Variables:

Referring to previous literature, this study controls for variables in four dimensions: personal characteristics of the household head, household economic and demographic characteristics, and county-level development.

Mechanism Variables:

For mechanism variables, this study primarily selects the overall index, coverage breadth, and coverage depth from the Peking University Digital Inclusive Finance Index, as well as the proportions of household expenditure on consumption and production.

The definitions and descriptive statistics of the main variables are shown in Table 1.

Table 1: Definitions and Descriptive Statistics of Main Variables

Variable Name	Mean	Standard Deviation	Variable Name	Mean	Standard Deviation
Debt-to-Income Ratio	0.378	0.547	Per Capita Income	0.375	8.476
Gender of Household Head	0.540	0.498	Number of Fixed Phone Households	10.384	0.915
Age	51.377	11.038	Number of Enterprises	3.908	1.235

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Table 1: (continued).

Age Squared	0.276	0.113	Financial Development Level	0.507	0.202
Health Status	3.243	1.287	Digitalization Level	85.059	32.681
Years of Education	6.345	4.221	Digital Inclusive Finance Total Index	85.130	26.817
Population Size	4.300	1.869	Breadth of Digital Inclusive Finance	79.308	23.718
Net Assets	25.250	30.117	Depth of Digital Inclusive Finance	95.750	35.934
Mobile Internet Access	0.510	0.500	Digitalization Level of Inclusive Finance	246.407	49.790
Self-Employment	3.504	2.213	Proportion of Consumption Expenditure	0.824	0.173
Mortgage Burden	0.134	0.341	Proportion of Production Expenditure	0.247	0.154

(3) Model Specification

The "E-commerce into Rural Areas" demonstration policy was implemented in 2014 and subsequently expanded to new pilot areas each year, displaying a progressive nature suitable for a quasi-natural experiment. However, this policy paid special attention to national poverty-stricken counties. Therefore, directly using a difference-in-differences (DID) model might introduce certain estimation biases. To address these issues, this study establishes a multi-period DID model, further controlling for whether the sample counties are designated as national poverty-stricken demonstration counties. The model is specified as follows:

$$D_{ijt} = \beta_0 + \beta_1 ecoomerce_{jt} + \beta_2 X_{ijt} + [S \times f(t)]' \Psi + \mu_i + \lambda_t + \delta_j \times T_t + \varepsilon_{ijt}$$

Where D_{ijt} is the dependent variable, representing the total debt and debt-to-income ratio of household i in county j in year t. $ecommerce_{jt}$ indicates whether county j became a demonstration site for the e-commerce policy in year t. It is assigned a value of 1 for the year the policy was implemented and subsequent years, and 0 otherwise. X_{ijt} is a series of control variables that might affect household debt levels and debt-to-income ratios. μ_i represents individual fixed effects, and λ_i represents time fixed effects. $[S \times f(t)]'$ includes interaction terms between the pilot selection variable and various time functions, as well as interactions between county dummy variables and time

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trends, and interactions between national poverty county status and first, second, and third order time trends. ε_{ijt} is the random error term.

4. Empirical Results Analysis

(1) Baseline Regression Analysis

The baseline regression of the debt-to-income ratio of rural residents on the e-commerce demonstration pilot policy is shown in Table 2. It can be observed that the "E-commerce into Rural Areas" policy significantly increased the debt-to-income ratio of rural households. It can be concluded that the development of e-commerce in rural areas indeed promoted residents' indebtedness, increased household debt risks, and added to residents' repayment pressure.

Table 2: Baseline Regression Results (Debt-to-Income Ratio)

(1) Debt-to-Income Ratio	(2) Debt-to-Income Ratio	(3) Debt-to-Income Ratio	(4) Debt-to-Income Ratio	
E-commerce Demonstration	0.088***	0.103***	0.077***	0.077***
	(0.003)	(0.007)	(0.007)	(0.007)
Control Variables	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
County Dummy Variables × Time Trend		Yes		
Pilot Selection Criteria × Year Fixed Effects			Yes	
Pilot Selection Criteria × T				Yes
Pilot Selection Criteria × T2				Yes
Pilot Selection Criteria × T3				Yes
Constant	-3.139	-4.812**	-3.074	-3.032
	(0.192)	(0.034)	(0.228)	(0.236)
Sample Size	4160	4160	4160	4160
Adjusted R^2	0.210	0.227	0.210	0.210

Note: *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.

(2) Parallel Trend Test

Figures 4 and 5 report the specific estimation results under a 95% confidence level for the "E-commerce into Rural Areas" policy on total debt levels and debt-to-income ratios of rural households. The horizontal axis represents the periods before and after the policy implementation. It can be seen that prior to the introduction of the policy, there was no significant difference in debt levels and debt-to-income ratios between pilot counties and non-pilot counties. However, in the year of policy introduction and in the first and second years thereafter, significant differences emerged in debt levels and debt-to-income ratios between pilot and non-pilot counties. These results indicate that the treatment and control groups selected for this study meet the parallel trend assumption.

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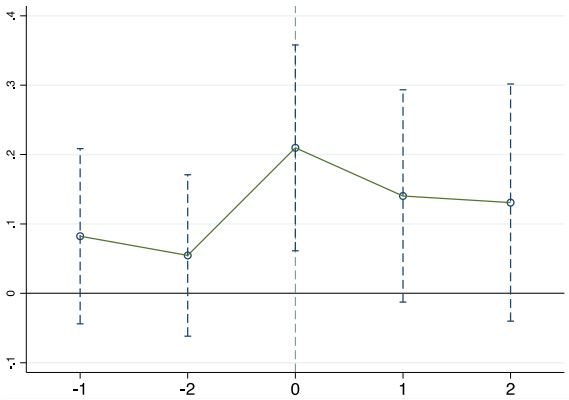

Figure 1: Dynamic Effects Analysis and Parallel Trends Test (Debt-to-Income Ratio)

(3) Robustness Test

Placebo Test: This study constructs a double random counterfactual estimation framework based on the implementation time and regions of the "E-commerce into Rural Areas" demonstration policy. Figure 3 shows the kernel density distribution of the estimated coefficients for the e-commerce policy, generated by repeating the randomization process 1,000 times. It can be observed that the regression coefficients of the randomly generated virtual policies are concentrated around zero. This indicates that the significant impact of the "E-commerce into Rural Areas" demonstration project on the debt-to-income ratio of rural residents is not caused by omitted variables, thus supporting the robustness of the study's estimation results.

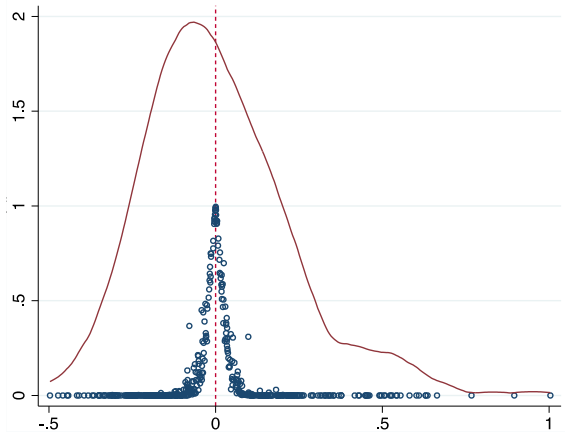

Figure 2: Counterfactual Estimation Results (Debt-to-Income Ratio)

5. Mechanism Analysis

(A) E-commerce, Financial Exclusion, and Household Borrowing

The policy of e-commerce into rural areas is expected to bring numerous positive effects on the digitalization level in rural regions, especially concerning financial digitalization. To verify the impact of the e-commerce into rural areas demonstration policy on the digitalization level of county regions, this study selects indicators such as the Beijing University Digital Inclusive Finance coverage breadth and depth from 2014 to 2020, and data as intermediary variables. As intermediary variables are not exogenous random intervention variables, including endogenous intermediary variables in the model may lead to estimation bias. Therefore, this study only verifies the impact of the e-commerce into rural areas policy on the digitalization level of county regions, with results shown in Table 3. It

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can be observed that the e-commerce demonstration policy promotes the development of inclusive finance in rural areas. Hypothesis 1 is validated.

Table 3: Mechanism Analysis 1: Financial Exclusion

(1)	(2)	(3)	(4)	
	Total Index	Coverage Breadth	Coverage Depth	Digitalization Level
E-commerce Demonstration	1.019***	1.038***	1.092***	5.989***
	(0.000)	(0.004)	(0.000)	(0.578)
Control Variables	Yes	Yes	Yes	Yes
Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Pilot Selection Criteria × T	Yes	Yes	Yes	Yes
Pilot Selection Criteria × T2	Yes	Yes	Yes	Yes
Pilot Selection Criteria × T3	Yes	Yes	Yes	Yes
Constant	11.351	113.294***	-339.103***	-109.182**
	(0.643)	(0.007)	(0.000)	(52.508)
Sample Size	4160	4160	4160	4160
Adjusted R^2	0.978	0.927	0.986	0.895

Note: *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.

(B) E-commerce, Consumer Demand, and Household Debt

To understand the effect of consumer demand on the impact of the e-commerce policy on household debt, this study incorporates interaction terms in the regression, using the proportion of household consumption expenditure and production expenditure as indicators for validation. The results, shown in Table 4, indicate that the proportion of consumption expenditure significantly enhances the effect of the e-commerce into rural areas policy on the debt-to-income ratio of rural households. This suggests that consumption expenditure is more likely to be influenced by e-commerce, stimulating household spending on consumption. On the other hand, the proportion of household production expenditure also positively moderates the impact of e-commerce on rural household debt, indicating that e-commerce can promote more agricultural production investment by rural households, thereby increasing household debt.

Table 4: Mechanism Test: Consumer Demand

(1)	(2)	
	Debt-to-Income Ratio	Debt-to-Income Ratio
E-commerce Demonstration	-0.113	0.072**
	(0.117)	(0.010)
Consumption Expenditure Ratio	-0.268**	
	(0.011)	
Policy × Consumption Expenditure Ratio	0.272***	
	(0.292)	
Production Expenditure Ratio		0.085***
		(0.008)
Policy × Production Expenditure Ratio		0.066*
		(0.087)

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Table 4: (continued).

Pilot Selection Criteria × T	Yes	Yes
Pilot Selection Criteria × T2	Yes	Yes
Pilot Selection Criteria × T3	Yes	Yes
Control Variables	Yes	Yes
Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Constant	-2.977	-1.058
	(0.292)	(0.651)
Sample Size	4160	4160
Adjusted R^2	0.186	0.2199

Note: *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively.

6. Conclusions and Policy Implications

The rapid development of the digital economy plays a crucial role in improving living standards in rural areas and achieving rural revitalization. E-commerce serves as a powerful means for economic and social development in these regions. However, the continuous rise in household debt levels in rural areas over the past decade is noteworthy. Using the "E-commerce into Rural Areas Demonstration Policy" as a quasi-natural experiment, this study establishes a multi-period difference-in-differences model to explore the impact and mechanisms of e-commerce on rural household debt. The research finds that the e-commerce demonstration policy significantly increases the scale of rural household debt and elevates debt risk. Further mechanism analysis shows that e-commerce, by improving the convenience, low cost, and credit level of financial services, alleviates credit constraints and promotes formal borrowing among rural residents, thus expanding household debt. E-commerce primarily stimulates both consumption and production expenditures of rural households.

Based on these findings, the following three policy implications are drawn:

Addressing Debt Expansion: While strengthening the development of e-commerce in rural areas, attention must be paid to the potential expansion of household debt that it may cause.

Enhancing Financial Services: Continue to develop and deepen digital inclusive financial services in rural areas, improve consumer finance lending standards, and integrate these with e-commerce to provide more formal financial services to rural households, while monitoring excessive debt behavior in some households.

Upgrading Consumption Structure: Strengthen the upgrading of consumption structures in rural areas to improve the living standards of rural residents and provide more lending services to agricultural producers.

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