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Rural Information Infrastructure, Household Internet Access and Farmers' Developmental Consumption: An Empirical Analysis Based on CLES Data

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Abstract. Based on household and village data from the China Land Economic Survey (CLES) from 2020 to 2022, this paper examines the relationship between village information infrastructure, household internet access and the share of farmers' developmental consumption. The study finds a significant complementary effect between village information infrastructure and household internet access: the higher the level of household internet access, the stronger the promoting effect of information infrastructure on developmental consumption. The conclusion remains robust after replacing the explained variable, excluding villages with existing digital economy projects, and adopting the Wild cluster bootstrap method. Heterogeneity analysis shows that this effect is more pronounced in villages far from county seats and in families with school-age children. This paper provides micro evidence for understanding how digital village construction affects farmers' consumption structure.

Keywords: Digital Village, Information Infrastructure, Internet Access, Developmental Consumption, Farmers' Consumption Structure

1. Introduction

Expanding rural consumption and optimizing farmers' consumption structure are important parts of smoothing the domestic circulation and advancing rural revitalization. In recent years, with the continuous advancement of digital village construction, information infrastructure, network services and digital application scenarios in rural areas have kept improving, and digital technologies have gradually affected the consumption behavior and consumption structure of rural residents [1, 2]. Compared with subsistence consumption such as food and clothing, developmental consumption such as education and culture is more directly related to household human capital accumulation and long-term development capacity. Therefore, whether digital village construction can promote farmers' developmental consumption deserves further discussion.

Existing studies show that rural e-commerce, digital finance and digital infrastructure can affect rural residents' income and consumption by reducing transaction costs, expanding market scope, improving payment convenience and easing information constraints [1, 3, 4]. However, the impact of digital conditions on household behavior does not occur automatically. Village information

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infrastructure mainly provides an external environment, and whether households can actually use digital resources also depends on their internet access capacity and digital usage conditions [1, 4, 5]. If households lack smart terminals, network access and basic digital usage conditions, the actual effect of improved village information infrastructure may be limited. On the contrary, households with higher internet access levels are more likely to translate village digital infrastructure into access to educational resources, use of cultural services and consumption information search.

Against this background, this paper incorporates village information infrastructure construction and household internet access into the same analytical framework, uses household and village data from CLES 2020–2022 to construct a household fixed-effects model, examines the interactive effect of the two on the share of farmers' developmental consumption, and further analyzes their heterogeneity in village location and household structure. The possible contribution of this paper lies in revealing the conditions under which digital village construction affects farmers' developmental consumption from the perspective of matching village digital infrastructure and household digital access capacity, and providing micro evidence for the precise advancement of digital village construction.

2. Literature review and theoretical analysis

2.1. Literature review

Existing studies mainly discuss the impact of digitalization on rural household behavior from the perspectives of digital village construction, rural e-commerce, digital finance and rural residents' consumption. One strand of research holds that digital infrastructure can improve information flow conditions in rural areas, reduce spatial distance and transaction costs, and promote factor flow and resource allocation efficiency [2, 5, 6]. Another strand focuses on the impact of digitalization on rural residents' consumption, finding that rural e-commerce and digital village construction can unleash rural consumption potential by reducing information search costs, improving payment convenience, enriching product choices and expanding consumption scenarios, and may change the consumption structure of education, culture, durable goods and other items [3, 7]. Other studies point out that the digital dividend does not automatically and equally translate into household welfare, and household internet access and digital usage capacity will affect the actual role of digital infrastructure [4, 5]. Overall, existing studies pay more attention to the direct impact of digitalization on income, consumption and welfare, and the discussion on the complementary relationship between village information infrastructure and household internet access is still relatively insufficient. This paper depicts rural digital conditions from both village and household levels, and examines the impact of their matching relationship on farmers' developmental consumption.

2.2. Theoretical analysis and research hypotheses

Village information infrastructure can improve network connectivity, information dissemination and accessibility of digital services, reduce the cost for farmers to obtain education, culture, consumption and public service information, and provide basic conditions for online educational resources, digital cultural services and online consumption platforms to enter rural areas. Developmental consumption has strong information-dependent characteristics. Especially education and training, cultural services and digital learning resources often require households to obtain sufficient information first before making consumption decisions. Therefore, village information infrastructure construction may affect the share of farmers' developmental consumption.

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Accordingly, Hypothesis 1 is proposed: Village information infrastructure construction affects the share of farmers' developmental consumption.

However, village-level information infrastructure does not automatically translate into changes in household consumption behavior. Digital infrastructure provides external access conditions, and whether households can translate it into actual consumption behavior also depends on the level of household internet access and digital usage capacity [4, 5]. Households with higher internet access levels are more likely to obtain educational resources, cultural services and consumption information through digital channels, so household internet access may strengthen the impact of village information infrastructure on developmental consumption.

Accordingly, Hypothesis 2 is proposed: The level of household internet access strengthens the impact of village information infrastructure construction on the share of farmers' developmental consumption.

Furthermore, villages far from county seats have relatively weak accessibility to offline markets, educational resources and cultural services, and digital infrastructure is more likely to play the role of spatial substitution and resource compensation [1, 3, 4]. Families with school-age children have stronger demand for educational and cultural resources, and are more likely to translate digital infrastructure into developmental consumption.

Accordingly, Hypothesis 3 is proposed: The complementary effect between village information infrastructure construction and household internet access is more pronounced in villages far from county seats.

Hypothesis 4: This complementary effect is more pronounced in families with school-age children.

3. Data sources, variable measurement and model specification

3.1. Data sources

This paper uses household survey data and village survey data from the China Land Economic Survey (CLES) from 2020 to 2022. The household data provide information on household demographic structure, income and expenditure, internet access and training experience, and the village data provide information on village economic development, location conditions and information infrastructure. This paper matches village variables to household samples based on village identification information and year to form household-year level analysis data, and cleans duplicate records and samples with missing core variables.

3.2. Variable measurement

3.2.1. Explained variable

The explained variable in this paper is the share of farmers' developmental consumption, denoted as devshare. Drawing on existing studies on rural household consumption structure and the consumption effect of digital economy [1, 3], this paper defines education expenditure and cultural expenditure as developmental consumption expenditure, and measures it by the ratio of the sum of the two to total household expenditure. In the robustness test, the share of education expenditure in total household expenditure is further used as an alternative explained variable.

The core explanatory variable is village information infrastructure, which is comprehensively constructed based on items in the village questionnaire related to information network coverage,

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information service accessibility and digital service conditions. The moderating variable is household internet access, constructed based on items such as the number of household smartphones and internet-accessible computers. This paper further constructs an interaction term of the two to test whether household internet access strengthens the impact of village information infrastructure on developmental consumption.

Referring to studies on farmers' consumption and rural digital economy [2-4], this paper controls for household and village level characteristics. At the household level, they include household size, proportion of student population, proportion of elderly population, average household health level, proportion of non-agricultural training and proportion of agricultural training; at the village level, they include village per capita income and village distance to county seat. Among them, household size, village per capita income and distance to county seat take the natural logarithm.

Table 1. Definitions and descriptive statistics of main variables

Variable Name	Variable Definition	Mean	Standard Deviation	Minimum	Maximum
Share of developmental consumption	Sum of education expenditure and cultural expenditure / Total household expenditure	0.117	0.183	0.000	0.971
Share of education expenditure	Education expenditure / Total household expenditure	0.103	0.176	0.000	0.971
Village information infrastructure	Construction level of village information infrastructure	1.384	1.804	0.000	6.000
Household internet access	Household internet access and ownership of digital devices	0.769	0.979	0.016	10.103
Household size	Natural logarithm of household population size	1.263	0.332	0.000	2.303
Proportion of student population	Number of enrolled students / Total household population	0.102	0.148	0.000	1.000
Proportion of elderly population	Number of elderly people / Total household population	0.259	0.291	0.000	1.000
Average household health level	Average health level of family members	4.398	0.665	0.500	5.000
Proportion of non-agricultural training	Number of people receiving non-agricultural vocational education or training / Total household population	0.189	0.269	0.000	1.000
Proportion of agricultural training	Number of people receiving agricultural technical education or training / Total household population	0.215	0.304	0.000	1.000
Village per capita income	Natural logarithm of village per capita income	9.991	0.749	1.141	10.820
Distance to county seat	Natural logarithm of village distance to county seat	2.933	0.676	0.405	4.517

3.3. Model specification

To test the impact of village information infrastructure construction, household internet access and their interaction term on the share of farmers' developmental consumption, this paper constructs the

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following household fixed-effects model as shown in (1):

$$devshare\_it = \alpha + \beta 1 v\_infoinfra\_it + \beta 2 h\_internet\_it + \beta 3 (v\_infoinfra\_it \times h\_internet\_it) + \gamma Conrtols\_it + \mu\_i + \lambda\_t + \varepsilon \quad (1)$$

Where i represents the household and t represents the year; μ_i is the household fixed effect, λ_t is the year fixed effect, and standard errors are clustered at the village level. This paper focuses on β3. If it is significantly positive, it indicates that the higher the level of household internet access, the stronger the marginal impact of village information infrastructure on developmental consumption.

4. Empirical results and analysis

4.1. Baseline regression results

Table 2 reports the baseline regression results. Whether control variables are added or not, the interaction term between village information infrastructure and household internet access is significantly positive. Taking the model with control variables as an example, the coefficient of the interaction term is 0.0081 and is significant at the 1% level, indicating that the higher the level of household internet access, the stronger the impact of village information infrastructure construction on the share of farmers' developmental consumption. This result shows that there is a complementary relationship between village information infrastructure and household internet access. Village-level information infrastructure alone is not sufficient to fully explain changes in developmental consumption, and household digital access capacity is an important condition for digital infrastructure to play its role.

Table 2. Baseline regression results

Variable	(1) Without control variables	(2) With control variables
Village information infrastructure	-0.029***(0.010)	-0.028***(0.010)
Household internet access	-0.012(0.015)	-0.007(0.017)
Village information infrastructure × Household internet access	0.008***(0.003)	0.008***(0.003)
Household size	—	0.051(0.048)
Proportion of student population	—	0.147*(0.077)
Proportion of elderly population	—	-0.089(0.058)
Average household health level	—	0.002(0.015)
Proportion of non-agricultural training	—	-0.064**(0.030)
Proportion of agricultural training	—	0.063(0.051)

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Table 2. (continued)

Village per capita income (logarithm)	—	0.004(0.007)
Distance to county seat (logarithm)	—	0.009(0.025)
Constant term	0.171***(0.021)	0.030(0.158)
Control variables	No	Yes
Household fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Observations	503	503
R^2	0.699	0.714

Note: Robust standard errors clustered at the village level are in parentheses; ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively. Column (1) controls for household fixed effects and year fixed effects, but does not add other control variables; Column (2) adds all control variables.

4.2. Robustness checks

Table 3 reports the results of robustness checks. First, after replacing the explained variable with the share of education expenditure, the coefficient of the interaction term is 0.0076 and is significant at the 5% level, indicating that the complementary effect still holds in the dimension of educational developmental consumption. Second, after excluding villages with existing digital economy projects, the coefficient of the interaction term is 0.0109 and is significant at the 5% level, indicating that the results are not driven by villages with already good digital economy foundations. Third, after using the Wild cluster bootstrap method for robust inference, the bootstrap P-value of the core interaction term is 0.0447, which is still significant at the 5% level. Overall, the baseline conclusion has good robustness.

Table 3. Robustness check results

Variable	(1) Share of education expenditure	(2) Excluding villages with digital economy projects	(3) Wild bootstrap
Village information infrastructure	-0.028***(0.010)	-0.038**(0.016)	-0.028*** (0.010)
Household internet access	-0.005(0.017)	-0.022(0.029)	-0.007(0.017)
Village information infrastructure × Household internet access	0.008**(0.003)	0.011**(0.004)	0.008*** (0.003)
Household size	0.059(0.046)	0.074(0.078)	0.051(0.048)
Proportion of student population	0.138*(0.076)	0.223*(0.112)	0.147*(0.077)

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Table 3. (continued)

Proportion of elderly population	-0.085(0.056)	-0.098(0.110)	-0.089(0.058)
Average household health level	-0.002(0.013)	-0.012(0.027)	0.002(0.015)
Proportion of non-agricultural training	-0.065**(0.030)	-0.087(0.057)	-0.064**(0.030)
Proportion of agricultural training	0.060(0.046)	0.086(0.107)	0.063(0.051)
Village per capita income (logarithm)	0.006(0.008)	-0.003(0.008)	0.004(0.007)
Distance to county seat (logarithm)	0.013(0.025)	0.027(0.035)	0.009(0.025)
Control variables	Yes	Yes	Yes
Household fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Sample size	505	260	503
R^2	0.717	0.715	0.714
Bootstrap P-value	—	—	0.0447

Note: Robust standard errors clustered at the village level are in parentheses. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively. Column (3) reports the coefficients of conventional cluster robust regression, and the Bootstrap P-value comes from Wild cluster bootstrap with villages as cluster units and 9999 replications.

4.3. Heterogeneity analysis

Table 4 reports the results of heterogeneity analysis. After grouping by village distance to county seat, the interaction term coefficient of the near-county-seat group is 0.0051, significant at the 10% level; the interaction term coefficient of the far-from-county-seat group is 0.0131, significant at the 1% level, indicating that the complementary effect is stronger in villages far from county seats. A possible reason is that villages far from county seats have weaker accessibility to offline markets and public services, and digital infrastructure is more likely to play the role of spatial substitution and resource compensation. After grouping by whether households have school-age children, the interaction term coefficient is 0.0110 for families with school-age children, significant at the 5% level; the interaction term is not significant for families without school-age children, indicating that educational demand is an important contextual condition for digital infrastructure to translate into developmental consumption.

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Table 4. Heterogeneity analysis results

Variable	(1) Near county seat	(2) Far from county seat	(3) Without school-age children	(4) With school-age children
Village information infrastructure	-0.017(0.011)	-0.100** (0.034)	-0.002(0.010)	-0.051*** (0.018)
Household internet access	0.009(0.018)	-0.012(0.027)	0.008(0.017)	-0.028(0.036)
Village information infrastructure × Household internet access	0.005*(0.003)	0.013*** (0.004)	-0.001(0.003)	0.011**(0.005)
Household size	0.068(0.105)	0.045(0.088)	0.048(0.053)	-0.115(0.139)
Proportion of student population	0.155*(0.084)	-0.148(0.218)	—	-0.226(0.173)
Proportion of elderly population	-0.073(0.056)	0.016(0.205)	-0.017(0.066)	-0.534*** (0.186)
Average household health level	-0.001(0.015)	-0.036(0.043)	0.005(0.013)	0.066(0.045)
Proportion of non-agricultural training	-0.074(0.045)	-0.114* (0.053)	-0.013(0.032)	0.048(0.111)
Proportion of agricultural training	0.054(0.058)	0.160(0.103)	0.045(0.033)	-0.135(0.188)
Village per capita income (logarithm)	0.007(0.008)	-0.138* (0.068)	0.051***(0.017)	-0.015**(0.006)
Distance to county seat (logarithm)	0.034(0.020)	0.140*** (0.042)	0.012(0.027)	-0.001(0.044)
Control variables	Yes	Yes	Yes	Yes
Household fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Sample size	257	128	284	123
R^2	0.803	0.701	0.595	0.753

Note: Robust standard errors clustered at the village level are in parentheses; ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively. The proportion of student population is always 0 in the group without school-age children, so it is not included in the regression of this group.

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5. Conclusions and policy implications

Based on household and village data from CLES 2020–2022, this paper examines the relationship between village information infrastructure, household internet access and the share of farmers' developmental consumption. The study finds a significant complementary effect between village information infrastructure and household internet access: the higher the level of household internet access, the stronger the impact of village information infrastructure on developmental consumption. The conclusion still holds after replacing the explained variable, excluding villages with existing digital economy projects and adopting the Wild cluster bootstrap method. Heterogeneity analysis shows that this complementary effect is more pronounced in villages far from county seats and in families with school-age children.

The above conclusions have two policy implications. First, digital village construction should continue to improve rural information infrastructure, and give appropriate inclination to villages with weak spatial accessibility such as those far from county seats, so as to make up for the insufficient supply of offline markets and public services. Second, digital village construction should not only attach importance to the supply of village infrastructure, but also improve farmers' household internet access and digital usage capacity, and promote the combination of digital infrastructure with the supply of educational and cultural resources, so that digital infrastructure can be more effectively translated into farmers' developmental consumption and long-term development capacity. Limited by the data years, this paper has not further examined the long-term dynamic effects. Future research can be expanded with more detailed data on internet usage behavior and digital public service usage.

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