



Research article

Internet use, income mobility and the expansion of the rural middle-income group: Evidence from China

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ABSTRACT

The expansion of the rural middle-income group has been a global focus as it contributes to narrowing income gaps and reducing social inequality. Using data from the China Family Panel Studies (CFPS), this study examines the impact of Internet use on the mobility of rural low-income groups to the middle-income group from the perspective of income mobility. Controlling for household and provincial-level variables, the results of this study indicate that Internet use significantly promotes the mobility of rural low-income groups to the middle-income group, thereby facilitating the expansion of the rural middle-income group. These conclusions hold even after conducting endogeneity and robustness tests. Mechanism analysis shows that household entrepreneurship and non-agricultural employment are crucial pathways through which Internet use facilitates the mobility of rural low-income groups to middle-income groups. Further investigation shows that mobility from rural low-income to middle-income groups is more difficult in central-western regions and among those with lower levels of education. Internet use exacerbates the “digital divide” between different areas and education groups. In particular, the effect of Internet use in promoting mobility from rural low-income to middle-income groups is more pronounced in the eastern regions and among those with higher levels of education. The results of this study provide new evidence on the role of Internet use in expanding the rural middle-income group.

1. Introduction

The middle-income group in rural areas plays a crucial role in promoting rural economic development, facilitating urban-rural integration, and stabilizing social order. First, the increase in the rural middle-income group helps elevate rural consumption levels (Brueckner et al., 2018) [1], stimulating rural market activity and economic growth (Li, 2017; Dartanto et al., 2020) [2,3]. Second, the rural middle-income group is critical in advancing urban-rural integration. They facilitate the flow of resources and information, enhancing economic and social connections between urban and rural areas (Tang et al., 2022) [4]. Expanding the rural middle-income group also helps reduce the urban-rural income gap (Shaban, 2021) [5], enhancing overall social inclusivity and stability (Tang et al., 2022) [4].

The rural middle-income group has unique formation backgrounds and developmental paths compared to the urban middle-income group. The existing literature explores various factors contributing to the formation of the rural middle-income group, including policy support, industrial restructuring, education and skill enhancement, and improving social security systems. Regarding policy support,

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Table 1
Definition descriptive statistics (N = 3530).

Variables	Definition	Mean	Std. Dev.
Dependent Variables			
Upward	1 if rural households are middle-income group, 0 if rural Households are low-income group	0.436	0.496
Independent Variables			
Internet use	1 if household using the Internet, 0 otherwise	0.407	0.491
Control Variables			
Edu	Average years of education of households	5.985	3.067
Age mean	Average age of the household	46.174	11.325
Gov	Number of persons employed in the government sector in the household	0.116	0.369
Lnfinance	Household finance by natural logarithm value	4.255	4.877
Lnhouse	Households own house value by natural logarithm value	10.637	2.598
Famsize	Number of people residing in a household	4.537	1.962
Healthy	1 if the householder is healthy, 0 if the householder is unhealthy	0.787	0.409
Gender	Gender of householder: 1 = male, 0 = otherwise	0.582	0.493
Marry	Marital status of householder: 1 = married, 0 = otherwise	0.902	0.297
Age	Age of householder (years)	50.503	12.392
Age2	Square of the age of householder/100	27.040	12.703
Urban ration	Urbanization rate by province	0.505	0.094
Primary sector	Percentage of primary sector by province	0.088	0.052
Lngdp	GDP per capita by province, take natural logarithm form	10.562	0.332
Lnexpend	Government expenditure by province, take natural logarithm form	26.792	0.398
Mediator variables			
Entre	1 if entrepreneurship by rural households, 0 if otherwise	0.061	0.239
Nonagri num	Number of rural household members engaged in non-agricultural employment	0.882	0.926

the government promotes rural economic development and increases farmers' incomes through infrastructure construction, agricultural subsidies, and rural financial services (Charlery et al., 2016) [6]. Regarding industrial restructuring, efforts to modernize agriculture and develop non-agricultural industries in rural areas create more employment opportunities and income sources (Chen and Ma, 2022) [7]. Enhancing education and skills improves the educational level and skills of the rural population, thereby increasing their employment competitiveness and earning potential (Liu et al., 2023) [8]. Improving social security systems helps mitigate income drops caused by risks such as illness and unemployment, ensuring stable living conditions (Yu et al., 2021) [9]. Although these studies discuss various measures to expand the rural middle-income group, the economic structure and income sources in rural areas differ significantly from those in urban areas. Agriculture remains the primary component of the rural economy, and the instability of agricultural income poses additional challenges for forming the rural middle-income group.

In recent years, the increasing prevalence of the Internet has significantly advanced rural informatization. As a major agricultural country, China's rural internet usage promotes agricultural modernization, fosters rural economic development, and improves farmers' quality of life. 2013, the State Council of China launched the "Broadband China" strategy and a national broadband network coverage implementation plan. According to the 53rd Statistical Report on Internet Development in China released by the China Internet Network Information Center (CNNIC), as of December 2023, the number of Internet users in China reached 1.092 billion, with rural users accounting for only 29.8 % of the total.¹ This indicates that the proportion of rural residents using the Internet remains relatively low. The Internet offers numerous benefits as a vital channel for accessing and exchanging information. It provides educational and training resources (Beard et al., 2012) [10], creates employment opportunities (Bloom et al., 2015) [11], and reduces transaction costs (Tack and Aker, 2014; Kabbiri et al., 2018) [12,13]. Additionally, integrating modern information technology into every aspect of agricultural production, operation, management, and services facilitates precision, intelligence, and efficiency in agriculture (Jiang et al., 2022) [14]. This process not only enhances agricultural productivity and reduces production costs but also optimizes the allocation of agricultural resources, thereby boosting economic vitality and social stability in rural areas (Jiang et al., 2022) [14]. These studies suggest that expanding internet usage among rural residents can positively impact their income, contributing to the growth of the rural middle-income group.

However, there is still little research on the relationship between Internet use and the formation of the rural middle-income group, especially the lack of research on the role and mechanism of Internet use in promoting the formation of the rural middle-income group from the perspective of income mobility. The rapid development of the Internet and digital technologies is gradually permeating rural production and daily life, making the Internet increasingly crucial in rural economic development. The integration of the Internet with the economy and society has had significant positive effects on rural consumption, investment, and employment (Siaw et al., 2020; Luan et al., 2023) [15,16]. As a digital infrastructure, the Internet surpasses geographical limitations in information dissemination, enhancing rural residents' ability to access and process information. This efficiency aids in human capital accumulation, reduces transaction costs, and improves employment quality (Zhao, 2020; Zhan and Yang, 2024) [17,18]. These changes create more opportunities for rural residents to increase their income, contributing to the expansion of the rural middle-income group. Furthermore, the rapid development of the Internet diversifies social interaction models in rural areas, promoting more egalitarian social

¹ <https://www3.cnnic.cn/n4/2024/0321/c208-10962.html>. The 53rd Statistical Report on Internet Development in China released by China.

Table 2
Mean difference of selected variables between Internet use and Internet non-use.

Variables	Internet use	Internet non-use	MeanDiff
Upward	0.575	0.340	0.235***
Entre	0.093	0.039	0.053***
Nonagri num	1.182	0.677	0.505***
Edu	7.571	4.895	2.676***
Age mean	40.299	50.207	-9.908***
Gov	0.200	0.058	0.141***
Lnfinance	4.895	3.816	1.079***
Lnhouse	10.989	10.395	0.594***
Famsize	5.164	4.107	1.057***
Healthy	0.825	0.762	0.063***
Gender	0.527	0.619	-0.092***
Marry	0.932	0.882	0.050***
Age	46.711	53.106	-6.396***
Age2	23.096	29.748	-6.652***
Urban ration	0.510	0.503	0.007**
Primary sector	0.091	0.086	0.005***
Lnrdp	10.566	10.559	0.007
Lnexpend	26.775	26.805	-0.030**
Sample size	1437	2093	3530

Notes: ***p < 0.01, and **p < 0.05.

Table 3
Rural income group conversion matrix.

		2020		
		Low	Middle	High
2014	Low	56.46	42.50	1.04
	Middle	27.52	70.02	2.46
	High	0.00	80.00	20.00

interactions. Convenient social exchanges significantly enhance the mobility of rural labor across regions (Campante et al., 2018) [19]. Existing research indicates that the Internet fosters high-quality regional economic development by stimulating entrepreneurship and business innovation (Wang et al., 2022) [20]. It also enhances informatization levels, improves the efficiency of information reception and feedback (Zheng et al., 2022) [21], and reduces underemployment (Zhou et al., 2022) [22], thereby significantly promoting economic growth (Myovella et al., 2020) [23]. These studies underscore the crucial role and impact of the Internet in contemporary social development.

Therefore, in the new digital context, further research is needed to strengthen our understanding of the impact of internet usage on expanding the rural middle-income group. First, does internet usage promote the formation of the rural middle-income group from the perspective of income mobility? Second, what are the possible mechanisms through which internet usage influences the formation of rural middle-income groups? Finally, how can we effectively expand the rural middle-income group through the Internet in the digital age? This study makes several key contributions. First, we incorporate internet usage and the expansion of the rural middle-income group into a unified research framework, examining the positive impact of internet usage on this group's formation and expanding the research on the rural middle-income group. Second, we explore the mechanisms through which internet usage stimulates entrepreneurship and enhances non-agricultural employment levels, providing valuable insights into how to expand the rural middle-income group. Third, the heterogeneity analysis reveals that the impact of internet usage on the rural middle-income group varies by region and education level. Specifically, internet usage significantly affects the eastern regions and higher-educated groups, potentially exacerbating the digital divide and creating a "Matthew effect." This means that rural low-income families in the east areas and with higher education levels are more likely to become part of the middle-income group, widening the gap between the central and western regions and lower-educated groups, thus leading to unbalanced development of the rural middle-income group.

The remainder of this paper is structured as follows. Section 2 briefly reviews relevant literature on middle-income groups and mechanism analysis. Section 3 explains the data and variable design. Section 4 analyses and discusses the results. Section 5 is the conclusion and discussion.

2. Literature review

2.1. Middle-income group

Research on the middle-income group has attracted considerable scholarly attention due to its growing importance in ongoing social and economic development. Scholars recognize its crucial role in driving social consumption and promoting economic growth (Li, 2017) [2]. The expansion of the middle-income group has the potential to alleviate poverty, reduce wealth disparities, and

Table 4
The impact of Internet use on the upward mobility of rural low-income groups.

Variable	(1)	(2)	(3)	(4)	(5)
	Probit				OLS
	Upward	Upward	Upward	Upward	Upward
Internet use	0.226*** (0.015)	0.120*** (0.016)	0.119*** (0.018)	0.116*** (0.018)	0.125*** (0.020)
Age		0.017*** (0.005)	0.009** (0.005)	0.009** (0.005)	0.009** (0.004)
Age2		-0.020*** (0.005)	-0.009** (0.005)	-0.009** (0.005)	-0.009** (0.004)
Gender		-0.060*** (0.017)	-0.045*** (0.016)	-0.039** (0.016)	-0.040** (0.017)
Marry		0.028 (0.028)	0.025 (0.029)	0.024 (0.029)	0.023 (0.029)
Healthy		0.019 (0.020)	-0.001 (0.020)	-0.001 (0.020)	-0.000 (0.020)
Edu			0.023*** (0.003)	0.021*** (0.003)	0.022*** (0.003)
Age mean			-0.003*** (0.001)	-0.004*** (0.001)	-0.004*** (0.001)
Lnfinance			0.005*** (0.002)	0.005*** (0.002)	0.005*** (0.002)
Lnhouse			0.009*** (0.003)	0.008** (0.003)	0.008** (0.003)
Gov			0.100*** (0.022)	0.102*** (0.022)	0.102*** (0.021)
Famsize			-0.017*** (0.005)	-0.015*** (0.005)	-0.016*** (0.005)
Urban ration				0.532** (0.255)	0.525** (0.256)
Primary sector				-0.587* (0.319)	-0.580* (0.318)
Lngdp				-0.091 (0.093)	-0.089 (0.094)
Lnexpend				0.009 (0.035)	-0.007 (0.034)
Pseudo R ² /R ²	0.040	0.051	0.080	0.085	0.468
N	3530	3530	3530	3530	3530

Notes: Marginal effects rather than coefficients are reported; robust standard error is used and is listed in the brackets under the marginal effect coefficient; ***p < 0.01, **p < 0.05, *p < 0.1.

Table 5
Analysis of the mediating effect of Internet use on mobility from low-income to middle-income groups.

Variable	(1)	(2)	(3)	(4)
	Entre	Upward	Nonagri num	Upward
Internet use	0.026*** (0.009)	0.113*** (0.018)	0.211*** (0.037)	0.097*** (0.018)
Entre		0.097*** (0.033)		
Nonagri num				0.090*** (0.009)
Sobel test	0.003**		0.020***	
Householder-level	Yes	Yes	Yes	Yes
Household-level	Yes	Yes	Yes	Yes
Province-level	Yes	Yes	Yes	Yes
Pseudo R ² /R ²	0.067	0.087	0.857	0.106
N	3530	3530	3530	3530

Notes: Marginal effects rather than coefficients are reported; robust standard error is used and is listed in the brackets under the marginal effect coefficient; ***p < 0.01, **p < 0.05.

contribute to social stability (Shaban, 2021) [5]. Chen and Lu (2011) [24] highlighted that the ability of the middle-income group to articulate political demands could also facilitate a country's democratization process.

The determinants influencing the emergence of the middle-income group have received considerable attention from researchers. Ravallion (2010) [25] emphasized that economic growth and globalization are essential in developing the middle-income group, especially in Asian countries. Barro (1999) [26] argued that democratization promotes the formation of the middle-income group, as

Table 6
Bootstrap mediation effect test.

		Observed	Bootstrap	z	P > z	Normal	Based
		coefficient	std. err.			[95 % conf.	interval]
Entre	Indirect	0.0031**	0.0014	2.13	0.033	0.0002	0.0059
	Direct	0.1216***	0.0205	5.92	0.000	0.0813	0.1619
	Total eff	0.1247***	0.0205	6.07	0.000	0.0844	0.1649
Nonagri num	Indirect	0.0196***	0.0039	5.02	0.000	0.0120	0.0273
	Direct	0.1050***	0.0188	5.59	0.000	0.0682	0.1419
	Total eff	0.1247***	0.0189	6.58	0.000	0.0875	0.1618

Notes: ***p < 0.01, **p < 0.05.

Table 7
Conversion matrix of rural income groups in different regions.

East		2020		
		Low	Middle	High
2014	Low	50.05	49.22	0.72
	Middle	19.93	78.10	1.96
	High	0.00	0.00	100.00
Central & West 2014	Low	58.54	40.33	1.14
	Middle	31.98	64.19	2.83
	High	0.00	100.00	0.00

Table 8
Conversion matrix of rural income groups with different educational levels.

		2020		
Low-edu		Low	Middle	High
2014	Low	65.07	34.30	0.63
	Middle	40.23	58.65	1.13
	High	0.00	0.00	0.00
High-edu 2014	Low	52.37	46.40	1.23
	Middle	24.69	72.55	2.76
	High	0.00	80.00	20.00

countries with higher levels of democratization tend to have larger shares of this group. In the context of China, Crabb’s (2010) [27] study using Chinese data confirmed the positive impact of education on the formation of the middle-income group. It emphasized the importance of education policy reforms in expanding this group. Based on survey data from Indonesia, Dartanto et al. (2020) [3] identified human and physical capital investment as critical strategies for developing the middle-income group. Chen and Qin (2014) [28] attributed the rapid expansion of China’s middle-income group to urbanization and industrialization, highlighting the influence of factors such as family occupation and education on its formation. Nissanov (2017) [29] examined the mobility patterns of different income groups based on household data in Russia. He emphasized that the mobility of low-income families into the middle-income group is influenced by individual characteristics such as education, urban residence, and marital status. In contrast, existing research pays limited attention to the temporal dynamics of income group mobility, which needs to be explored from the perspective of income mobility to examine the path analysis for the expansion of the rural middle-income group. In particular, the existing research literature lacks a comprehensive analysis of the role of Internet use in expanding the rural middle-income group.

2.2. Analysis of the impact of internet use on mobility from rural low-income to middle-income groups

In recent years, the pervasive integration of Internet use into people’s daily lives has become increasingly prominent (Ma, 2023) [30]. As a primary platform for information exchange, the Internet has significantly impacted individuals’ livelihoods and incomes (Alam and Mamun, 2017; Dettling, 2017) [31,32]. Pradhan et al. (2016) [33] state that Internet use can significantly increase household income. Ghosh (2020) [34] argues that the Internet improves productivity, increasing household income. Hua and Zhang (2023) [35] show that Internet technology plays a significant role in raising workers’ wages, although the income returns associated with the Internet show a declining trend over time. Ma (2024) [36] analyzed the impact of Internet use on the incomes of both urban and rural residents in China and found a significant increase in income for both groups, with a larger effect observed for rural residents, thus narrowing the urban-rural income gap. Zhou et al. (2020) [37] examined the impact of Internet use on the income of rural residents through its effect on rural employment, with results indicating a significant increase in non-agricultural income for rural households. These studies suggest that Internet use contributes significantly to rural household income growth and helps promote the

Table 9
Regional analysis of the impact of Internet use on mobility from rural low-income to middle-income groups.

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	East		Central & West			
	Probit	OLS	Probit	OLS	Probit	OLS
	Upward	Upward	Upward	Upward	Upward	Upward
Internet use	0.135*** (0.038)	0.147*** (0.042)	0.111*** (0.021)	0.119*** (0.022)	0.105*** (0.020)	0.113*** (0.021)
Internet use	*East				0.051* (0.036)	0.054* (0.036)
Householder-level	Yes	Yes	Yes	Yes	Yes	Yes
Household-level	Yes	Yes	Yes	Yes	Yes	Yes
Province-level	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R ² /R ²	0.141	0.459	0.073	0.470	0.086	0.468
N	822	822	2708	2708	3530	3530

Notes: Marginal effects rather than coefficients are reported; robust standard error is used and is listed in the brackets under the marginal effect coefficient; ***p < 0.01, *p < 0.1.

Table 10
Analysis of the impact of Internet use on mobility from rural low-income to middle-income groups with different education levels.

Variable	(1)	(2)	(3)	(4)	(5)	(6)
	Low-edu		High-edu			
	Probit	OLS	Probit	OLS	Probit	OLS
	Upward	Upward	Upward	Upward	Upward	Upward
Internet use	0.098*** (0.033)	0.108*** (0.037)	0.160*** (0.021)	0.167*** (0.023)	0.071** (0.029)	0.075** (0.021)
Internet use	*High-edu				0.101*** (0.030)	0.107*** (0.032)
Householder-level	Yes	Yes	Yes	Yes	Yes	Yes
Household-level	Yes	Yes	Yes	Yes	Yes	Yes
Province-level	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R ² /R ²	0.056	0.461	0.078	0.475	0.078	0.471
N	1128	1128	2402	2402	3530	3530

Notes: Marginal effects rather than coefficients are reported; robust standard error is used and is listed in the brackets under the marginal effect coefficient; ***p < 0.01, p < 0.05.

upward mobility of rural low-income groups to middle-income groups.

Based on the above literature and theoretical discussion, we propose the following hypothesis.

Hypothesis 1. Compared to rural low-income households that do not use the Internet, rural low-income households that use the Internet are more likely to have upward mobility into the middle-income group.

2.3. The impact mechanism of internet use on the upward mobility of rural low-income groups

Undoubtedly, Internet use positively impacts rural residents' income growth, but the underlying mechanisms are still unclear. Internet use transforms rural households' entrepreneurship form and content and increases their entrepreneurial enthusiasm, leading to higher incomes (Zhou et al., 2020) [37]. In particular, for relatively low-income rural households, the use of the Internet can help them understand market demands (Goldfarb and Tucker, 2019) [38], overcome disadvantages in accessing financial services (Morawczynski, 2009) [39], and alleviate credit constraints on financing needs during the entrepreneurial process, thereby greatly facilitating rural household entrepreneurship. As a result, entrepreneurial activities receive substantial support, allowing rural households to expand their development opportunities and increase their incomes (Cumming and Johan, 2010) [40]. Further research clarifies that Internet use provides abundant information channels and informal financing options for entrepreneurial activities, which increases the likelihood of rural household entrepreneurship and the ability to generate more income (Tan and Li, 2022) [41]. Internet development reduces information costs, alleviates financing constraints, improves the entrepreneurial environment in rural areas, encourages rural low-income households to engage in entrepreneurship, and enables them to move into the middle-income group.

Based on the above literature and theoretical discussion, we propose the following hypothesis.

Hypothesis 2. Internet use promotes upward mobility of rural low-income households to middle-income groups by promoting household entrepreneurship.

Chinese farmers' living environment and lifestyle determine that rural residents primarily engage in agricultural production. However, in the Internet era and China's rural revitalization strategy, many rural households are gradually being exposed to and

Table 11
Robustness test.

Variable	Panel A			
	(1)	(2)	(3)	(4)
	2SLS		IV Probit	
	Upward	Internet use	Upward	Internet use
Internet use	0.244*** (0.050)		0.663*** (0.140)	
Internet ratio		0.757*** (0.028)		0.757*** (0.031)
Householder-level	Yes	Yes	Yes	Yes
Household-level	Yes	Yes	Yes	Yes
Province-level	Yes	Yes	Yes	Yes
N	3530	3530	3530	3530
	(5)	Panel B		(9)
		(6)	(7)	(8)
		2SLS		IV Probit
	Upward	Upward	Internet num	Upward
Internet num	0.060*** (0.011)	0.154*** (0.032)		0.420*** (0.089)
Internet ratio			1.199*** (0.053)	1.199*** (0.054)
Householder-level	Yes	Yes	Yes	Yes
Household-level	Yes	Yes	Yes	Yes
Province-level	Yes	Yes	Yes	Yes
N	3530	3530	3530	3530

Notes: Robust standard errors are in parentheses; ***p < 0.01.

utilizing the Internet. The Internet has even brought significant changes to the employment patterns of rural households (Zhou et al., 2020) [37]. On the one hand, some rural households have started entrepreneurial activities through the Internet, such as rural e-commerce and live-streaming sales (Zang et al., 2023) [42]. On the other hand, more rural residents are exploring new job opportunities through Internet platforms, shifting from agricultural to non-agricultural employment (Siaw et al., 2020) [15]. Present-day rural China exhibits a more diversified and extensive non-agricultural employment pattern driven by the Internet. The application and popularization of the Internet improve rural households' non-agricultural employment rate and quality and promote the diversification of labor skills. With the continuous improvement of human and social capital among rural households, the goal of increasing income through non-agricultural employment is realized (Ma, 2024) [36]. Moreover, as the Internet becomes a technology-oriented skill, rural households will likely choose non-agricultural employment because solely engaging in agricultural labor no longer meets their skill requirements and wage expectations. Rural residents with more prominent vocational skills have transitioned from low-yield agricultural to non-agricultural employment (Zhou et al., 2020) [37]. Therefore, this study posits that Internet use can promote non-agricultural engagement among rural low-income households, increasing the likelihood of upward mobility from low-income to middle-income groups in rural areas.

Based on the above literature and theoretical discussion, we propose the following hypothesis.

Hypothesis 3. Internet use promotes upward mobility of rural low-income households to middle-income groups by promoting non-agricultural employment.

3. Data, variables and methods

3.1. Data source

This study examines the impact of Internet use on upward mobility from low-income to middle-income groups. To ensure the representativeness of the survey sample, we utilize data from the China Family Panel Studies (CFPS). The CFPS is a nationwide, interdisciplinary longitudinal survey project conducted by the Institute of Social Science Survey (ISSS) at Peking University. It focuses on various research topics, including economic activities, educational outcomes, family dynamics, population migration, and health. To investigate the long-term effects of Internet use on facilitating upward mobility from rural low-income to middle-income groups, we select a relatively extended period whenever possible. To meet the requirements of this research, we selected the household microdata from CFPS2014 and CFPS2020 as our study sample. By excluding missing values for relevant variables, we retain the sample of low-income households from CFPS2014 and exclude the sample of high-income households from CFPS2020. This allows us to examine the mobility of rural low-income households to the middle-income group from 2014 to 2020.

3.1.1. Dependent variables

The dependent variable in this study is whether low-income rural households transition into the middle-income group or remain

within the low-income group. Currently, there are two main methods for defining the middle-income group: the relative standard method and the absolute standard method. The relative standard method determines the lower and upper limits of the middle-income group based on a specific percentage range of the median income. Under the relative standard method, it is more common to define the middle-income group as 75%–125 % of the median income (Pressman, 2010) [43] or 67%–200 % (Grabka et al., 2016) [44]. Defining the middle-income group based on relative income reflects the fairness of income distribution. Still, it does not guarantee that everyone in this range can reach the consumption level of the middle-income group. Therefore, this method has excellent limitations and is unsuitable for developing countries.

The absolute standard method involves sorting income from high to low and directly giving fixed income intervals. Kharas (2010) [45] uses \$10–100 to define the global middle-income group in developing countries. This criterion considers both the basic expenditure needs of the middle-income group to maintain a certain standard of living and the reality of imbalanced world development, where developing countries account for the vast majority of the population. Therefore, this standard has become famous for defining the Asian middle-income group. We use purchasing power parity conversion (2011 PPP) to divide the low-income, middle-income, and high-income groups for 2014 and 2020. In the subsequent regression analysis, we focus on the upward mobility of rural low-income groups to the middle-income group. Therefore, we excluded the high-income group samples and retained the samples from rural low-income and middle-income groups. As a result, the dependent variable in this study is a dummy variable. It takes the value of 0 if rural low-income households in 2014 remain as low-income households in 2020 and 1 if they have moved up to the middle-income group in 2020.

3.1.2. Independent variables

The independent variable in this study is whether low-income rural households use the Internet or not. We utilize approaches based on CFPS2014 data to measure Internet use. Internet use is defined in this paper using the CFPS2014 questionnaire: “Do you use the Internet, including accessing the Internet through telephone lines, local area networks, and wireless networks?” If someone in the household uses the Internet, the use is assigned a value of 1, and the non-use is assigned a value of 0.

3.1.3. Mediator variables

This study utilizes two main mediating variables: whether the family engages in entrepreneurship and the number of family members involved in non-agricultural employment. We follow Sarkar et al. (2018) [46], where family entrepreneurship is categorized and assessed in the CFPS dataset based on the question: “Does your family engage in individual private activities?” A value of 1 is assigned if the family is involved in individual private activities and 0 otherwise. The CFPS survey includes a question about employment type: “Is your job in agriculture or non-agriculture?”² Then, we counted the number of people working non-agriculture jobs in each household.

3.1.4. Control variables

We select rural household and householder characteristics as control variables and include control variables at the province level. The household control variables in this study include the average age of the household, the average years of education of families, the number of individuals engaged in the government sector in the household, the financial assets owned by the household, the value of the house owned by the home, and the size of the family. Householder control variables include gender, marital status, health, and age. Control variables at the provincial level include urbanization rate, per capita GDP, percentage of primary sector, and government expenditure.

We conducted a descriptive statistical analysis of various variables, and the specific statistical results are shown in Table 1. Firstly, in 2014, only 43.6 % of rural low-income families achieved middle-income group status by 2020. Secondly, the proportion of rural low-income families using the Internet was low in 2014, at only 40.7 %, indicating a relatively low Internet penetration rate in rural areas. This finding reflects the continued challenges in achieving widespread Internet access in rural areas despite the efforts of the “Broadband China” policy. Moreover, this result underscores the Internet’s increasing significance in rural Chinese households. This finding reflects the rapid increase in Internet penetration in rural areas, driven by implementing the “Broadband China” policy. The result also highlights Internet use’s growing importance in rural Chinese households.

Table 2 displays the mean difference in selected variables between households using the Internet and those not. The results show that low-income households using the Internet have a higher proportion of upward mobility to middle-income groups than rural low-income households that do not use the Internet. This suggests that Internet use can facilitate upward mobility for rural low-income households to middle-income groups. Furthermore, low-income households using the Internet are more inclined towards entrepreneurship and non-agricultural employment when compared to their counterparts who do not use the Internet. Additionally, Internet-connected low-income households in rural areas tend to possess higher levels of education, are younger, have more significant financial assets and house value, and enjoy better physical well-being.

3.2. Methods

As the dependent variable, the rural middle-income group, examined in this study is a dichotomous variable coded as 0 and 1; we

² Non-agricultural work encompasses industries such as manufacturing, services, retail, construction, finance, technology, and education.

use the Probit regression model to analyze its influencing factors. Its analysis model is:

$$p(y_i=1|x_i) = \Phi(\alpha + \beta internet_i + \gamma X_i) \quad (1)$$

Where p represents the probability of the rural low-income households being middle-income group. Φ is conventionally used to represent the cumulative distribution function of the standard normal distribution, $y_i = 1$ indicates the upward mobility of rural low-income households to middle-income groups, $internet_i$ indicates the independent variable Internet use, X_i indicates a set of control variables, α is a constant term, β measures the impact of Internet use on the upward mobility of rural low-income households into middle-income groups, and γ measures the impact of a set of control variables.

In this study, the dependent variable is a binary dummy variable. Therefore, we use a Probit model. Because the Probit model is a generalized linear model, its regression coefficients are interpreted differently from those in an Ordinary Least Squares (OLS) model. However, the marginal effects in the Probit model are similar to the interpretation of regression coefficients in the OLS model. To simplify the explanation, we present the marginal effects of the Probit model. Given that the Probit model's marginal effects resemble the OLS model's regression coefficients, we also employ an OLS model to verify the significance and directionality of the Probit model, thereby enhancing the interpretability and credibility of the regression results.

4. Results

4.1. Income mobility of different income groups in rural areas

Income groups are not static and stable. Rural low-income groups may experience upward mobility to the middle and high-income groups due to employment or successful entrepreneurship changes. Similarly, middle- and high-income groups may transition to the low-income group due to aging, unemployment, or declining health. To capture the mobility patterns across income groups, we construct an income group conversion matrix based on the income group classification criteria used in this study, as shown in Table 3.

According to the income group conversion matrix in Table 3, among rural households categorized as low-income in 2014, 56.46 % of them remained in the low-income group in 2020, while 42.50 % have moved up to the middle-income group. Only 1.04 % of rural low-income households have transitioned to the high-income group. For rural households classified as a middle-income group in 2014, 70.02 % of them have remained stable in the middle-income group in 2020, but 27.52 % have experienced downward mobility to the low-income group. Additionally, 2.46 % of households have achieved upward mobility and become part of the high-income group. Among the rural families in the high-income group in 2014, 80 % moved downward to the middle-income group, while only 20 % remained in the high-income group.

The income group conversion matrix results indicate two distinct characteristics of income mobility in rural households in China. Firstly, upward mobility is relatively slow for rural low-income households, with only 43.54 % achieving upward mobility from 2014 to 2020. Secondly, high-income groups show insufficient stability, with 80 % of high-income households experiencing downward mobility during the same period. Given the larger size of the rural low-income group, the primary pathway to expanding the middle-income group in rural areas is to raise the income levels of rural low-income households, helping them escape the poverty trap and facilitating mobility to middle-income groups. Therefore, this study primarily examines the impact of Internet use on the mobility of rural low-income groups to middle-income groups from the perspective of income mobility. It investigates the role of Internet use in expanding the middle-income group in rural areas.

4.2. Results analysis of the impact of internet use on mobility from rural low-income to middle-income groups

Table 4 presents the regression results of Internet use on the mobility of rural low-income households to the middle-income group. Column (1) displays the regression analysis results without any controlled variables; the coefficient for Internet use is significantly positive, indicating that Internet use is associated with a significant promotion of mobility from rural low-income households to the middle-income group. Columns (2)–(4) further control for householder, family, and provincial variables, respectively. The regression coefficient for Internet use remains positive and significant at 1 % in these models. The regression coefficient of Internet use in column (5) in the OLS model exhibits the same significance and direction. This suggests that compared to rural low-income households who do not use the Internet, those who utilize the Internet are more likely to experience upward mobility to the middle-income group. Validated Hypothesis 1 of this paper.

In column (4) of Table 4, the coefficients of edu and gov were significant and positive; this suggests that as educational attainment increases, the probability of upward mobility from rural low-income households to the middle-income group also increases, highlighting education as a crucial factor in expanding the middle-income group (Chen and Qin, 2014) [28]. Moreover, increasing the number of family members employed in the government sector enhances the likelihood of rural low-income households transitioning into the middle-income group. This is attributed to the government offering higher salaries and more excellent job stability than non-governmental sectors, facilitating upward mobility for rural low-income households to middle-income groups. The regression coefficients for Infinance and Inhouse are significantly positive, indicating that household assets also facilitate the upward mobility of rural low-income families into the middle-income group. Conversely, the coefficients of famsize were significant and negative, suggesting that larger families have more dependents, such as infants, children, and elderly members, which increases the household burden and decreases the likelihood of rural low-income households being in the middle-income group. Additionally, controlling for other variables, the coefficient for the urbanization rate is positive, indicating that urbanization provides more employment

opportunities and promotes upward mobility for rural low-income households.

4.3. Mediation analysis of internet use on mobility from rural low-income to middle-income groups

To further investigate how Internet use influences the mobility of rural low-income households to middle-income groups, we follow the approach of Wang et al. (2023) [47] and establish a mediation model. This model explores the mediating effects of non-agricultural employment and household entrepreneurship on the mobility of rural low-income households to the middle-income group, and a mediating effects model was constructed as shown below:

$$W_1 = \alpha + \beta \text{internet}_i + \gamma X_i + \varepsilon_i \quad (2)$$

$$p(y_i = 1 | x_i) = \Phi(\alpha + \beta \text{internet}_i + \varphi W_1 + \gamma X_i) \quad (3)$$

$$W_2 = \alpha + \beta \text{internet}_i + \gamma X_i + \varepsilon_i \quad (4)$$

$$p(y_i = 1 | x_i) = \Phi(\alpha + \beta \text{internet}_i + \varphi W_2 + \gamma X_i) \quad (5)$$

Where W_1 represents household entrepreneurship, W_2 represents non-agricultural employment, ε_i represents the disturbance term of the random effect, and other variables are the same as Equation (1).

The mechanisms through which Internet use influences the upward mobility of rural low-income families to middle-income groups include household entrepreneurship and non-agricultural employment. Table 5 presents the relevant regression results. Columns (1) and (3) indicate the impact of Internet use on household entrepreneurship and non-agricultural employment for rural low-income families, with regression coefficients of 0.026 and 0.211, respectively, indicating a significant positive correlation at the 1 % significance level. Columns (2) and (4) demonstrate a significant positive relationship between Internet use and upward mobility of rural low-income families to middle-income groups, and a significant positive relationship between upward mobility of rural low-income households and household entrepreneurship and non-agricultural employment. The results of the Sobel test are shown in Table 5. The Sobel test coefficients in columns (1) and (2) are 0.003, significant at the 5 % level, indicating the presence of a mediation effect through entrepreneurship. In columns (3) and (4) of Table 5, the Sobel test coefficients are 0.020, significant at the 1 % level, suggesting a mediation effect through non-agricultural employment. In Table 6, we present the Bootstrap mediation effect test results. The observed coefficient for Entre is 0.0031, which is significant at the 5 % level, confirming the mediation effect of entrepreneurship. The observed coefficient for Nonagri num is 0.0196, significant at the 1 % level, demonstrating the mediation effect of non-agricultural employment. These findings suggest that Internet use effectively enhances the likelihood of rural low-income families entering the middle-income group by promoting household entrepreneurship and non-agricultural employment. These findings confirm Hypotheses 2 and 3 of this study.

4.4. Heterogeneity analysis of the impact of internet use on mobility from rural low-income to middle-income groups

Due to variations in geographical environment, transportation conditions, and local government management capacity, rural areas in China exhibit significant differences in economic development. Simultaneously, the income mobility of different income groups is influenced by disparities in educational levels within rural households. Tables 7 and 8 present the income mobility patterns of rural households across other regions and educational levels, respectively.

Table 7 reveals that, on the one hand, rural low-income households in the central and western regions face more significant challenges in achieving upward mobility to the middle-income group compared to the eastern part. In 2014, 49.22 % of rural low-income households in the east region could move up to the middle-income group, while the corresponding proportion in the central and western areas was 40.33 %. On the other hand, the stability of rural middle-income households in the central and western regions is relatively weak. In 2014, 31.98 % of rural middle-income households in the west and central areas experienced downward mobility to the low-income group, whereas in the eastern part, this proportion was 19.93 %.

We categorized the education level of householders into two groups: low-education level (less than or equal to 6 years of education) and high-education level (more than 6 years of education). Table 8 shows that, on the one hand, rural low-income households with lower levels of education face more significant challenges in upward mobility to the middle-income group than those with higher education levels. In 2014, 46.40 % of rural low-income households with higher education were able to move up to the middle-income group, while the proportion for households with lower levels of education was 34.30 %. On the other hand, rural middle-income households with lower levels of schooling exhibit weaker stability. In 2014, 40.23 % of rural middle-income households with lower levels of education experienced downward mobility to the low-income group, whereas the proportion for households with higher education was 24.69 %.

Despite the accelerated popularization of Internet technologies in society, the accompanying digital benefits have been distributed unevenly (Houngbonon and Liang, 2021) [48]. Specifically, people with higher Internet coverage can enjoy more digital benefits brought by the Internet. The more educated population also achieves higher levels of digital well-being due to more accessible access to the Internet. Therefore, as Internet penetration increases, there may be a digital divide between different groups. Below, we conduct a heterogeneity analysis on the impact of Internet use on the mobility of rural low-income households to the middle-income group; this would explain the digital divide in Internet use by rural low-income households.

Table 9 presents the impact of Internet use on the upward mobility of rural low-income households to middle-income groups in the eastern and central-western regions. Column (1) illustrates the effect of Internet use on rural low-income households in the east area, with a regression coefficient of 0.135, significant at the 1 % level. This suggests that compared to rural low-income households that do not use the Internet, those in the eastern region who utilize the Internet have a 13.5 % higher probability of upward mobility to the middle-income group. In column (3), the regression coefficient for Internet use among rural low-income households in the central-western region is 0.111, significant at the 1 % level. Column (5) further introduces the interaction term between Internet use and a dummy variable for East regions, and the coefficient of the interaction term is significantly positive. This suggests that compared to low-income households in the central-western rural areas, the effect of Internet use in mobility to the middle-income group is more substantial for low-income households in the eastern rural areas. This conclusion is also confirmed in the OLS models in columns (2), (4), and (6).

The reason is that the eastern region has a superior geographical location and convenient transportation system, and the Internet infrastructure is more complete than the central and western regions, with a high Internet penetration rate. The eastern region has a higher urbanization rate, more employment opportunities, and well-developed entrepreneurial policies than the central-western region. Therefore, rural low-income households in the east area are more likely to utilize the Internet's high penetration rate to access non-agricultural job opportunities and have a greater inclination towards entrepreneurship (Zhou et al., 2020) [37]. This increases their chances of transitioning into the middle-income group. The central-western region, characterized by complex terrain, faces more significant challenges in infrastructure development, resulting in a lower Internet penetration rate. As a result, rural low-income households in the central-western region have more challenges in accessing non-agricultural employment and entrepreneurial opportunities through the Internet (Zhou et al., 2022) [22]. Consequently, the probability of rural low-income households in these two regions utilizing the Internet to achieve middle-income group status is lower.

In Table 10, we remove the control variable of education level. The impact of Internet use at different educational classes on the upward mobility of rural low-income households to middle-income groups is presented in columns (1) and (3). Column (1) indicates that low-educated rural low-income families have a 9.8 % higher probability of becoming part of the middle-income group through Internet use. Column (3) reveals that highly educated rural low-income households have a 16.0 % higher likelihood of transitioning to the middle-income group through Internet use. Column (5) further introduces the interaction term between Internet use and a dummy variable for high education levels, and the coefficient of the interaction term is significantly positive. This indicates that compared to low-income households with low education levels, Internet usage's effect on mobility to the middle-income group is more substantial for low-income households with higher levels of education. This conclusion is also supported by the OLS models in columns (2), (4) and (6). This disparity may be because households with a higher education level spend more time using the Internet for learning, working, and obtaining information. In contrast, households with a lower education level spend more time using the Internet for entertainment (Hua and Zhang, 2023) [35]. This results in a significant difference in the returns to Internet use for households with different education levels, leading to the "Matthew effect." Therefore, rural low-income households with higher levels of education are more likely to use the Internet to be in the middle-income group.

4.5. Robustness test

In our study, we acknowledge that the decision to use the Internet is an individual choice, which may introduce potential endogeneity issues due to omitted variables and reverse causality. On one hand, middle-income households may have a higher reliance on Internet information technology compared to low-income households, and we cannot rule out the possibility of reverse causality. On the other hand, there is a potential concern regarding omitted variables, such as an individual's capacity to adapt to new things and their intelligence, and we cannot dismiss the possibility of omitted variable bias.

To control for the effects of endogeneity problems on the regression results, we employ two-stage least squares regression (2SLS) and instrumental variable probit (IV probit) estimation in this subsection to assuage potential endogenous concerns. 2SLS is a structural equation modeling technique to address endogeneity issues in OLS models. IV Probit is an effective method for testing endogeneity in Probit models. We use the Internet penetration rate at the village level as an instrumental variable (IV) for endogeneity testing (Zhou et al., 2020) [37]. We named it the Internet ratio in the following estimations. The validity of the instrumental variable relies on the relevance condition and exogeneity constraint. Firstly, concerning the relevance of the conditions, the village Internet penetration is one of the prerequisites for rural residents to access the Internet. As the village Internet penetration rate increases, the likelihood of rural households using the Internet also increases. Thus, there is a correlation between village Internet penetration rate and Internet use. Secondly, regarding the exogeneity constraint, the village Internet penetration rate is unrelated to individual income. It does not directly impact the upward mobility of rural low-income households to the middle-income group. Therefore, it satisfies the exogeneity assumption of the instrumental variable.

As shown in Panel A of Table 11, we use the same control variables as column (4) of Table 4; in columns (2) and (4) representing first-stage estimation, the coefficients of IV are both positive and significant at 1 %, and the Minimum Eigenvalue is 602.762, far greater than the threshold value 16.38 required to refuse the null hypothesis of existing weak IV (Yi et al., 2023) [49], thus excluding the weak IV concern. As the result of linear 2SLS estimation presented in column (1) and the result of IV Probit demonstrated in column (3), the coefficient of Internet use is positive and significant at a 1 % level; this further illustrates that Internet use can significantly promote the upward mobility of rural low-income groups to middle-income groups.

In Panel B, we replaced Internet use with the number of people using it in the household; we named it Internet num. In column (5) of Table 11, the coefficient of Internet num is positive and significant at the 1 % level. In columns (6)–(9), the coefficients of Internet num remain positively significant, substantiating again that Internet use could effectively increase the probability of a rural low-

income household being in the middle-income group, further supporting our previous empirical findings.

5. Conclusions and discussion

5.1. Main conclusions

Expanding the middle-income group in rural areas significantly promotes rural economic development, facilitates urban-rural integration, and stabilizes social order. This study systematically uses CFPS2014 and CFPS2020 data to examine the impact of Internet use on the mobility of rural low-income groups to the middle-income group from the perspective of income mobility. After controlling for household and province-level variables, the results demonstrate that Internet use significantly facilitates mobility for rural low-income groups to the middle-income group, expanding the middle-income group in rural areas. The results of 2SLS estimation and IV Probit estimation confirm a significant positive relationship between Internet use and upward mobility among the rural low-income group. Mechanism analysis reveals that non-agricultural employment and entrepreneurial activities are crucial channels through which Internet use promotes mobility among rural low-income groups to the middle-income group. Further research indicates that compared to the central and western regions and rural low-income groups with lower educational attainment, the eastern part and those with higher education are more likely to achieve upward mobility. Internet use has created a “digital divide” between regions and groups. Specifically, the promoting effect of Internet use on mobility among rural low-income groups to the middle-income group is more significant in the eastern part and among groups with higher education.

5.2. Discussion

In recent years, the rapid development of Internet technology has not only transformed the lifestyle of rural residents but also impacted their living conditions in various ways. According to Li (2024) [50], the Internet facilitates more accessible access to agricultural technology for rural residents, enhancing farm productivity and increasing their income. Chen et al. (2022) [51] found that internet platforms enable the direct sale of farm products to consumers, reducing intermediaries, lowering transaction costs, and boosting farmers' actual income. Wang et al. (2024) [52] discovered that through social media and online communities, rural residents can build and expand social networks, gaining more resources and opportunities. These networks aid information dissemination and can improve economic returns through mutual assistance and cooperation. The studies above primarily explore how the Internet increases the overall income of rural residents but overlook the income mobility of different rural classes and lack research on how Internet use can expand this specific class of rural middle-income groups. Our research employs econometric methods to provide robust empirical evidence on how internet usage expands the rural middle-income group, thereby enriching empirical studies on promoting the development of the rural middle-income group in the digital age.

This study aims to provide policy recommendations to seize the opportunities brought by internet development and expand the rural middle-income group. Based on our findings, we propose the following suggestions: First, our empirical results indicate that improving digital infrastructure in rural areas is essential for expanding the rural middle-income group. It is crucial to increase internet penetration in rural areas and address the obstacles hindering internet development. Currently, internet infrastructure construction in some remote and impoverished regions must catch up, with limited network coverage and poor quality. Rural residents generally have lower internet usage and technical literacy levels than urban residents, resulting in insufficient information access and utilization. The government should increase investment in rural internet infrastructure, particularly in remote and impoverished areas, to ensure better coverage and quality of broadband networks. Accelerating infrastructure development can be achieved through public-private partnerships. Additionally, extensive digital literacy training should be provided to improve rural residents' internet skills and technical proficiency. The training should cover primary internet usage, e-commerce, and online education, helping to boost rural residents' incomes and expand the rural middle-income group.

Second, our research shows that internet usage expands the rural middle-income group by stimulating entrepreneurship and enhancing non-agricultural employment. The government should offer tax incentives and startup subsidies to support rural entrepreneurs in reducing their financial burden. Collaborating with financial institutions, the government should provide low-interest loans and financing options to address funding challenges for rural entrepreneurs. Furthermore, the government and businesses should partner to offer vocational training tailored to rural residents. This training should focus on modern agricultural techniques, manufacturing, and service industry skills, helping rural workers acquire the necessary skills for non-agricultural employment. Establishing a labor market information platform to provide timely job and recruitment information would enable rural residents to find suitable non-agricultural job opportunities through Internet platforms. These measures will help improve the economic outcomes of rural households.

Lastly, our empirical results indicate that regional attributes and educational differences are critical factors influencing the development of the rural middle-income group. These factors significantly impact the mobility of low-income rural families to the middle-income group, especially in the eastern regions and among highly educated groups. For regions in central and western areas with underdeveloped internet infrastructure, the government and businesses should increase investment in building internet infrastructure to ensure high-speed, stable network services. Additionally, the government should provide subsidies for internet access and equipment purchases to lower usage costs for rural residents in these areas. Facilitating collaboration between eastern and central/western regions can promote the transfer of enterprises, technology, and expertise from the east to the central and western regions. This approach helps develop the internet industry and its applications in these areas, promoting balanced regional development. Moreover, enhancing the education level of rural residents is crucial for expanding the rural middle-income group. Improving rural

educational resources and developing online education resources tailored for rural and low-education populations can gradually enhance digital literacy. Various continuing education opportunities, such as online courses and skills training, encourage farmers to continue learning and improve their competitiveness in their spare time.

5.3. Limitations and future research directions

This study provides valuable insights into the relationship between internet usage and the expansion of the rural middle-income group. However, our research has several limitations. First, we focused on the impact of internet usage on expanding the middle-income group in rural China. Since economic and developmental contexts vary across countries, comparative studies extending this research to other nations would enhance its generalizability. Second, due to data limitations, we used data from CFPS 2014 and CFPS 2020, with the latest CFPS data only updated to 2020. The COVID-19 pandemic began in 2020 and has significantly impacted household incomes, particularly in rural areas with fewer income sources. Future research needs post-2020 data to explore the pandemic's effects on rural household income mobility. Third, we acknowledge that the need for a unified standard for defining the middle-income group introduces limitations in our measurement approach, potentially affecting comprehensiveness. Future research could define the rural middle-income group based on total household wealth to explore the relationship between internet usage and the expansion of the rural middle-income group. Finally, we only examined how internet usage expands the rural middle-income group through entrepreneurship and non-agricultural employment. Future research could explore other pathways, such as whether internet usage encourages rural households to participate in financial markets.

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Data availability statement

Data will be made available on request.

CRediT authorship contribution statement

Jie Weng: Writing – original draft, Funding acquisition, Data curation. **Wang Li:** Writing – original draft, Software, Formal analysis, Conceptualization. **Xinru Zheng:** Writing – original draft, Investigation, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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