

Article

The Impact of Internet Use on Income Inequality from Different Sources Among Farmers: Evidence from China

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Abstract: The rapid advancement of digital communication and information technologies has significantly influenced rural household income and income inequality. Based on a sample of 2216 farmers from the China Family Panel Studies (CFPS), this analysis combines Ordinary Least Squares (OLS) regression with Conditional Mixed Process (CMP) estimation to account for endogeneity, evaluating how internet adoption affects both income diversification and inequality patterns among Chinese farmers. The findings reveal three key insights: First, internet use significantly increases farmers' household income while reducing overall income inequality. Second, the positive impact of internet use on total income is primarily driven by increases in wage and operating income, while the reduction in income inequality is associated with a more equitable distribution of these income sources. Third, human capital plays a moderating role, with high-human-capital farmers benefiting more from internet use in terms of income growth and inequality reduction. Based on these findings, this study suggests that policymakers should promote internet adoption to enhance farmers' incomes and address income inequality, while paying attention to the varying effects across different human capital groups. These insights provide valuable policy implications for achieving common prosperity in developing countries and regions.



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Keywords: internet use; income sources; income inequality; human capital; rural households

1. Introduction

The development of digital communication and information technology has a substantial influence on the economic growth of both developed and developing countries. According to the International Telecommunication Union's Measuring Digital Development: Facts and Figures 2023, approximately 66% of the world's population had access to the internet in 2023, with penetration rates ranging from 87% to 91% in high-income regions such as Europe and the Americas. However, in least developed countries and landlocked developing nations, internet penetration remains below 40%. Moreover, a significant urban–rural divide persists globally: while 81% of urban residents have internet access, only 50% of rural populations do. In some developed countries, the urban–rural gap in internet access is narrowing, but in low-income regions, this disparity remains stark. For instance, in Africa, 57% of urban residents use the internet, compared to just 23% in rural areas [1]. Challenges such as inadequate infrastructure and low penetration rates continue to hinder internet adoption in rural regions [2]. While existing literature has extensively documented the digital divide between urban and rural areas, critical gaps remain in understanding how

internet adoption differentially affects various income sources within rural communities. Most studies focus on aggregate income effects, neglecting the nuanced ways internet use may reshape income composition and distribution patterns among rural households.

As one of the world's largest developing countries, China has implemented several national strategies, including Internet Plus, Broadband China, and Digital China, to bridge the digital divide and promote rural development. These initiatives aim to leverage internet technologies to drive agricultural modernization and improve rural livelihoods. Existing research highlights that internet adoption not only enhances lifestyles, but also positively impacts information acquisition [3], household income [4,5], and agricultural productivity [6]. It is widely regarded as a critical factor in boosting rural economic development [7,8].

Scholars argue that internet use can increase farmers' income by reducing information asymmetry, facilitating labor migration to urban areas, and enhancing opportunities for non-agricultural employment and wage income [9,10]. Additionally, the internet expands rural households' social networks, enabling greater market participation and entrepreneurial activities [11]. With the declining costs of internet access, the "digital divide" caused by disparities in information technology adoption is gradually narrowing [12,13]. In rural areas, the internet plays a foundational role in promoting equitable access to public services and reducing urban–rural income disparities [14]. However, some scholars caution that the benefits of internet adoption may not be evenly distributed. For instance, limited digital literacy among low-income and marginalized groups in rural areas could exacerbate income inequality [15].

International studies indicate that the impact of internet adoption on rural income distribution exhibits complexity and heterogeneity, being closely associated with digital skills, resource allocation, and government intervention. In Indonesia, while internet diffusion reduces individual income inequality by promoting non-agricultural employment, it simultaneously exacerbates regional disparities due to uneven resource distribution [16]. Similarly, in Yogyakarta Special Region, despite enhancing economic output through high internet penetration rates, income inequality has widened owing to insufficient digital skills [17]. Cross-national research further reveals that although internet access can mitigate inequality through inclusive services (e.g., e-commerce and distance education), its effectiveness critically depends on policy support and complementary resources [18]. These findings collectively underscore the multifaceted nature of the internet's influence on rural income distribution patterns.

However, current research fails to adequately address two key issues. First, while prior studies have consistently demonstrated the positive effect of internet use on rural households' total income, they lack systematic analysis of the differential contribution mechanisms across various income sources (e.g., wage income vs. operational income). Second, current research presents significant gaps in understanding human capital's moderating role in the relationship between internet adoption and income distribution. This study directly responds to these research gaps by systematically examining how internet adoption influences the composition and distribution of different income sources among rural households, while accounting for heterogeneous effects across population subgroups and regional contexts.

According to data from China's National Bureau of Statistics, the per capita disposable income of rural residents has increased from 2700 yuan to 21,700 yuan over the past two decades, with an average annual growth rate of 11.22%. Wage income, operating income, property income, and transfer income account for 41.97%, 34.63%, 2.53%, and 20.88% of total income, respectively. While existing studies have explored the impact of internet use on income growth and urban–rural income gaps, its effects on income structure and inequality

among farmers remain underexamined. This study addresses this gap by analyzing data from the China Family Panel Studies (CFPS) and employing the Kakwani index, Ordinary Least Squares (OLS), and Conditional Mixed Process (CMP) models to investigate how internet use influences income inequality across different sources among rural households. By doing so, this research provides valuable insights for policymakers aiming to promote digital inclusion and reduce income inequality in developing countries.

2. Theoretical Framework and Research Hypotheses

2.1. *The Effects of Internet Use on Different Sources of Rural Household Income*

In the internet-driven economy, digital technologies have differential effects on various sources of household income [5]. First, internet use can increase farmers' wage income by enhancing employment opportunities. The internet serves as a vital resource for expanding social capital, enabling laborers to access employment information, reduce information asymmetry in the labor market, and improve the knowledge and skills of low-skilled farmers, thereby directly increasing non-agricultural employment rates and income [19,20]. Simultaneously, the internet reduces the time and costs associated with job searching, shortens job search durations, and indirectly boosts farmers' non-agricultural income.

In addition to wage income, internet use can also enhance farmers' operating income. In regions with dispersed markets and inadequate infrastructure, farmers face high information search costs [3]. The internet reduces information acquisition costs and facilitates the rapid dissemination of agricultural technologies, pest control methods, and production supplies, thereby optimizing the allocation of production factors and improving agricultural productivity [8,21]. With access to additional agricultural market information, farmers can modify traditional business practices, adopt corporate management and marketing strategies, and ultimately improve operational efficiency and income [22].

Furthermore, internet use can promote property income and transfer income among farmers. The internet enhances farmers' understanding of investment and wealth management, expands investment opportunities, and facilitates the rational allocation of unused assets and land within households. This releases the value of household assets, enabling farmers to generate property income through financial instruments and products [23]. Additionally, the widespread adoption of the internet increases farmers' awareness of agricultural subsidy policies, allowing eligible farmers to apply for subsidies and thereby obtain more transfer income.

In summary, internet use may improve wage income, operating income, property income, and transfer income among rural residents. Based on this, the following research hypothesis is proposed:

H1. *Internet use increases farmers' income from different sources.*

2.2. *The Effects of Internet Use on Income Inequality from Different Sources Among Farmers*

The digital dividend generated by the widespread adoption of the internet can alleviate income inequality among farmers. In an era of limited internet access, the unequal distribution of information resources created a significant digital divide. Early adopters of the internet reaped greater benefits, while those without access were excluded from the dividends of the information revolution, exacerbating income disparities among groups [24]. However, with the rapid increase in internet availability, the internet is increasingly playing an essential role in promoting equitable public services and narrowing the urban–rural income gap [14]. In rural China, the digital divide is gradually narrowing as the use of internet-related devices such as mobile phones and computers becomes more widespread, and there is a negative correlation between the Gini coefficient and the digital divide [25].

Internet use primarily affects income inequality from different sources among farmers through the following pathways. First, in the information society, wealth distribution is closely tied to information access. Information-poor individuals often miss opportunities to increase their income. However, as communication technologies such as mobile phones become more prevalent, information asymmetry decreases, and low-income populations' ability to access information improves [21]. The internet's role in information dissemination significantly enhances rural households' social networks, reduces the productive disadvantages of low-income groups, and creates more opportunities for them to engage in economic activities [11]. Additionally, the diffusion of the internet has transformed the financial development landscape in rural areas, creating new income opportunities and improving market access for low-income groups [26]. These factors collectively contribute to reducing inequalities in operating income and property income among farmers.

Second, the internet provides farmers with access to more employment opportunities, improving the employment prospects of low-skilled workers and facilitating the transformation of non-agricultural employment structures, thereby reducing wage inequality among farmers [27,28]. Through information effects, financial effects, and employment effects, internet use can reduce income inequality from different sources among farmers. Based on this, the following research hypothesis is proposed:

H2. *Internet use reduces income inequality from different sources among farmers.*

2.3. Moderating Effect of Human Capital

The "skill-biased technological change" theory proposed by Mincer [29] suggests that high-skilled workers can use new technologies more effectively to increase their labor productivity. Human capital influences how individuals acquire and utilize technology, thereby affecting income disparities between groups. While the internet can improve farmers' income, disparities in information technology access and usage due to differences in human capital may exacerbate income inequality [12]. For example, the contribution of internet use to narrowing the income gap varies depending on education levels, with highly educated groups benefiting significantly more than low-educated groups [30].

The use of the internet represents a form of technological progress. Farmers who integrate information technology with their human capital can enhance their income. However, farmers with low education levels often lack digital skills, resulting in a significant gap in the income-enhancing effects of internet use compared to highly educated farmers [31]. Based on this, the following research hypothesis is proposed:

H3. *Human capital has a moderating effect in the influence of using internet on farmers' income and income inequality.*

2.4. Analysis Framework

Based on the aforementioned mechanism analysis, the analytical framework of this study is constructed (Figure 1). First, internet use may directly or indirectly increase farmers' wage income by improving employment skills and non-agricultural employment opportunities. Second, internet use optimizes farmers' production resource allocation and operational decisions, thereby increasing operating income. Third, internet use improves household asset allocation and increases opportunities to access financial instruments and agricultural subsidy policies, enhancing property income and transfer income. From the perspective of income inequality, the information, employment, and financial effects of internet use also contribute to reducing income inequality from different sources among farmers. Additionally, the mechanism analysis suggests that these effects are influenced by the moderating role of human capital.

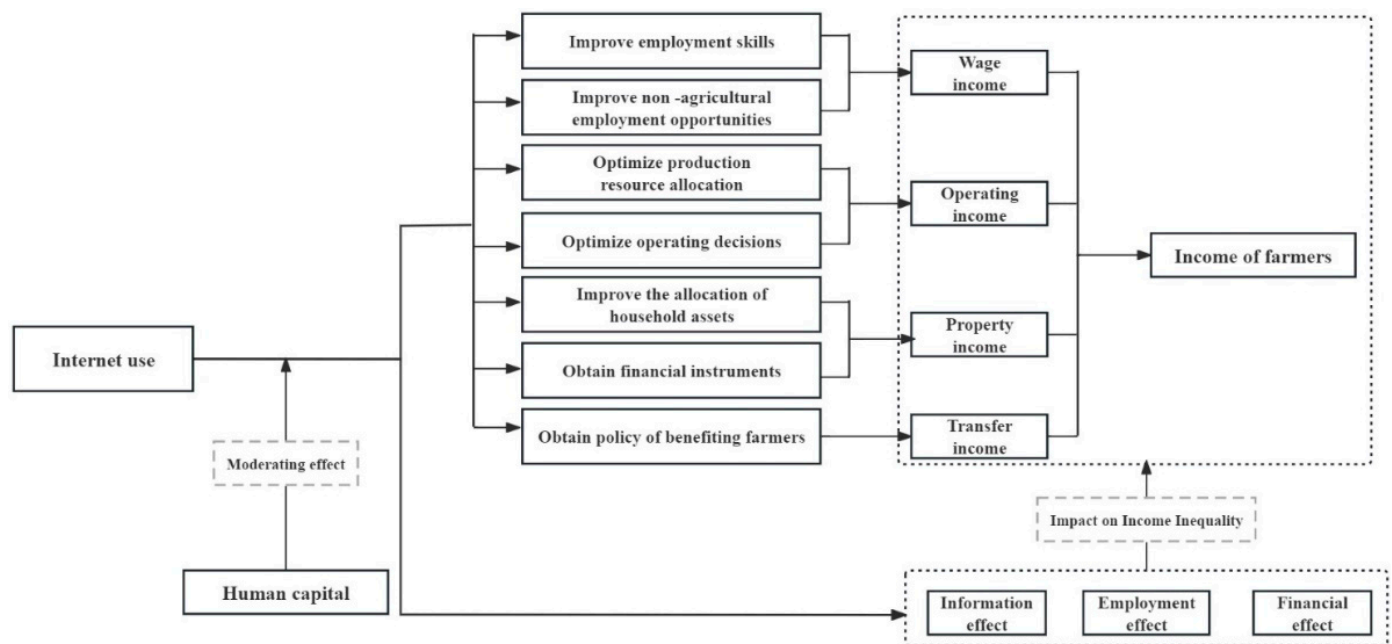


Figure 1. Analysis framework.

3. Data and Methods

3.1. Data Sources

The data used in the present study come from the cross-section data of the China Family Panel Studies (CFPS) in 2020. The CFPS is conducted by the Institute of Social Science Survey (ISSS) of Peking University. As a nationwide, large-scale, and multidisciplinary longitudinal social survey, it primarily focuses on both economic and non-economic well-being of Chinese residents, encompassing research themes such as economic activities, educational attainment, family relationships and dynamics, population migration, and health. The survey covers 25 provinces/municipalities/autonomous regions across China. This article selects residents of agricultural household registration in CFPS data in 2020 as a research sample. After processing the lack and abnormal values, the number of samples that retain the complete information is 2216.

3.2. Variable Selection

The explained variables in the present study are farmers' total income, different sources of farmers' income (income includes wage, operating, property and transfer), inequality of farmers' income, and inequality of different sources of farmers' income. Among them, the income is presented in the number of pairs, and the inequality index is evaluated by the following method.

Several established methods exist for measuring income inequality, including the Yitzhaki, Kakwani, and Podder indices. This study employs the Kakwani index based on three methodological advantages [14,32]: (1) superior regularity in handling zero/negative incomes through logarithmic transformation of Lorenz curve deviations, (2) enhanced quantitative rigidity via exact decomposition properties satisfying the Pigou–Dalton transfer principle, and (3) demonstrated robustness in agricultural income analyses through Monte Carlo simulations. Therefore, this article uses the Kakwani index to measure the inequality of farmers' income. For all farmers (Y) in the sample as a group the number of samples is n . Sort the income of farmers in the group in accordance with the increasing

order, and draw the overall income distribution in the group $Y = (y_1, y_2, \dots, y_n)$. Then the income of farmers y_i can be expressed as

$$RD(y, y_i) = \frac{1}{n\mu_Y} \left\{ \sum_{j=i+1}^n (y_j - y_i) \right\} = \gamma_{y_i}^+ \left[\frac{\mu_{y_i}^+ - y_i}{\mu_Y} \right] \quad (1)$$

μ_Y is the average income of all samples in the group Y , $\mu_{y_i}^+$ is the average income of the samples exceeding y_i in Y , and $\gamma_{y_i}^+$ is a percentage of samples that exceed y_i in Y .

The core explanation variable in this study is “internet use”, which is measured by the degree of internet use (farmers use portable devices to connect to the internet every day), and takes the value of pairs in the model.

Based on related research and the actual situation of this study, personal characteristics, family characteristics, and regional differences are selected as the control variables. Among them, personal characteristics include gender [28,30], age [14], and health status [11]; family characteristics include the average education level of family [2], family scale [9,23], and social capital [33]. In addition, considering the disparities in internet development among distinct regions, the provinces in which farmers are located are valued according to the “China province code”, thus controlling the effect of regional differences on the results. Detailed definitions of variables and description of statistical analysis results are shown in Table 1.

Table 1. Variable definition and description statistics.

Type	Variable	Evaluation Method	Mean	Std.Dev.
Explained variable	Total income	Ten thousand yuan	10.994	0.920
	Wage income		10.686	1.032
	Operating income		8.983	1.595
	Property income		7.729	1.630
	Transfer income		7.773	1.583
	Kakwani index of total income	Evaluate using the method described in chapter 3.2	0.447	0.231
	Kakwani index of wage income		0.539	0.324
	Kakwani index of operating income		0.870	0.211
	Kakwani index of property income		0.950	0.138
	Kakwani index of transfer income		0.881	0.160
Explaining variable	Internet use	Hour/Week	4.337	1.198
Personal feature variable	Gender	Male = 1; Female = 0	0.797	0.402
	Age		3.891	0.259
	Health status	A value of 1–5 points was assigned to health status, where 1 stands for “very unhealthy” and 5 for “very healthy”	3.051	1.216
Family feature variable	Family education level	The average education of husband and wife	0.824	0.430
	Family scale	Family population (person)	1.318	0.473
	Social capital	Expenditures on social relations (ten thousand yuan)	7.815	1.007
Provincial control variable	Province	Assignment of values to provinces according to the “China province code”	3.564	0.509

3.3. Model Selection

This study uses the Ordinary Least Squares (OLS) model to examine the influence of using the internet on income structure and inequality of rural households. The model is shown below:

$$income_i = \alpha_1 + \beta_1 internet_i + \lambda_1 X_i + \varepsilon_i \quad (2)$$

Among them, $income_i$ represents the income of the i th farmers, including income from different sources and an index of inequality; $internet_i$ represents internet use by the i th farmers; and X_i represents control variables (including personal, family, and regional characteristics). α_1 and β_1 are estimated parameters. λ_1 is the vector of estimated parameter. ε_i is random disturbance term.

In order to prevent an endogenous bias, this study also uses the Conditional Mixed Process (CMP) for estimates [34]. The CMP framework offers three key advantages for this analysis: First, it simultaneously estimates interrelated equations through full-information maximum likelihood (FIML), addressing selection bias more efficiently than limited-information methods like 2SLS. Second, it explicitly tests for endogeneity via the correlation parameter (atanhrho) between equation errors—a statistically significant value ($p < 0.05$) confirms the necessity of this approach over standard OLS. Third, CMP accommodates mixed process models (continuous, binary, and ordinal variables) that commonly arise in technology adoption studies, where internet use (binary) and income (continuous) require joint modeling. The model is shown below:

$$internet_i = \alpha_2 + \beta_2 Z_i + \lambda_2 X_i + \varepsilon_i \quad (3)$$

$$income_i = \alpha_3 + \beta_3 \hat{internet}_i + \lambda_3 X_i + \varepsilon_i \quad (4)$$

CMP is a two-stage regression based on likelihood estimation, and the endogeneity of the model is determined by the endogeneity test parameter. If the endogeneity test parameter is significantly different from zero, it indicates that the model has an endogenous problem, in which case the estimate of the CMP is better.

3.4. Descriptive Statistics

The descriptive statistical results for each variable are presented in Table 1. The results for the explained variables indicate that the mean annual income of farmers is 10.994 million yuan. Among different income sources, wage income is the highest, with an average of 10.686 million yuan, while property income is the lowest, with an average of 7.729 million yuan. The income inequality index among farmers is 0.447, with wage income inequality being the lowest (average of 0.539) and property income inequality being the highest (average of 0.950). For the core explanatory variable, the statistics show that farmers spend an average of 4.337 h per week using the internet.

Figure 2 illustrates the relationship between farmers' income and their internet usage time. As shown in Figure 2a, farmers' income exhibits an increasing trend with higher internet usage. Specifically, farmers who use the internet for less than 10 min per day have an average annual income of 69,100 yuan, while those who use it for more than 200 min per day have an average annual income of 149,700 yuan. The data on different income sources reveal that wage income shows the most significant growth trend with increased internet usage (Figure 2b). Farmers with less than 10 min of daily internet use have an average annual wage income of 40,200 yuan, whereas those with more than 200 min of daily use have an average annual wage income of 86,400 yuan.

Figure 3 presents the Kakwani index for farmers' income inequality. As depicted in Figure 3a, income inequality tends to decrease as farmers' internet usage time increases. For instance, farmers who use the internet for less than 10 min per day have an annual

Kakwani index of 0.513, while those who use it for more than 200 min per day have an index of 0.315. The data on different income sources indicate that wage income inequality shows the most pronounced decline with increased internet usage (Figure 3b). Farmers with less than 10 min of daily internet use have a wage income Kakwani index of 0.620, while those with more than 200 min of daily use have an index of 0.381.

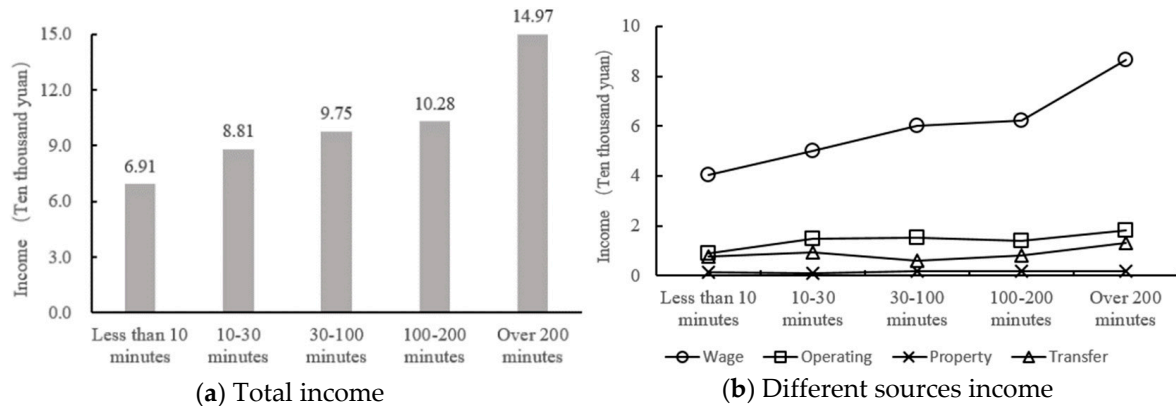


Figure 2. Income levels by internet usage time among farmers.

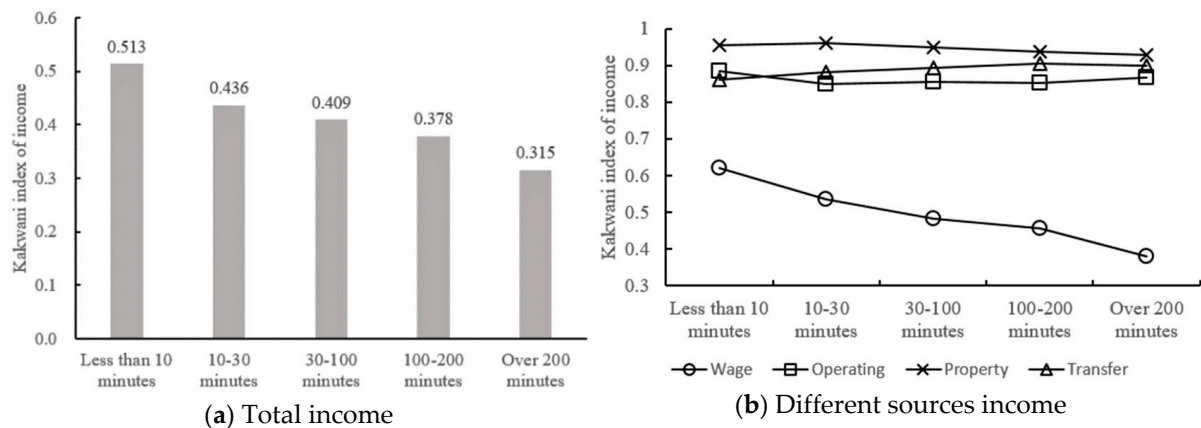


Figure 3. Income inequality (Kakwani index) by internet usage time among farmers.

Based on the descriptive statistical results, it is evident that internet use is positively correlated with income from different sources and negatively correlated with income inequality. However, whether these relationships are causal requires further verification through the econometric analysis model discussed below.

4. Results and Discussion

4.1. The Influence of Internet Use on Income and Income Inequality Among Farmers

To understand the relationship between internet use and farmers' income, this study first examined the impact of internet use on income and income inequality among farmers. The results (Tables 2 and 3) indicate that a 1% increase in internet use is associated with a 0.063% rise in farmers' income and a 0.017% reduction in income inequality. All model results are statistically significant at the 1% level. These findings suggest that internet use positively influences farmers' income while negatively affecting income inequality. The internet provides access to new information, enabling farmers to expand employment opportunities, improve skill quality, and increase the use of financial services, thereby enhancing their income [2]. Furthermore, labor migration to urban areas relies on information dissemination, and internet use can increase farmers' participation in non-agricultural occu-

pations, creating new income sources for rural households and narrowing the urban–rural income gap.

Table 2. The impact of internet use on income among rural households.

	Total Income	Total Income	Total Income	Total Income
Internet use	0.115 *** (0.014)	0.085 *** (0.014)	0.059 *** (0.014)	0.063 *** (0.014)
Gender		0.130 *** (0.041)	0.124 *** (0.038)	0.117 *** (0.038)
Age		−0.577 *** (0.071)	−0.165 ** (0.073)	−0.140 * (0.073)
Health status		0.028 * (0.015)	0.025 * (0.014)	0.028 ** (0.014)
Family education level			0.549 *** (0.046)	0.573 *** (0.046)
Family scale			0.339 *** (0.035)	0.324 *** (0.035)
Social capital			0.193 *** (0.016)	0.192 *** (0.016)
Province				0.095 *** (0.030)
Constant	10.720 *** (0.064)	12.840 *** (0.300)	8.893 *** (0.341)	8.449 *** (0.368)
N	2216	2216	2216	2216
R ²	0.029	0.064	0.209	0.212

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

Table 3. The impact of internet use on income inequality among rural households.

	Income Inequality	Income Inequality	Income Inequality	Income Inequality
Internet use	−0.030 *** (0.004)	−0.022 *** (0.004)	−0.016 *** (0.003)	−0.017 *** (0.003)
Gender		−0.031 *** (0.011)	−0.030 *** (0.010)	−0.028 *** (0.010)
Age		0.154 *** (0.018)	0.048 ** (0.019)	0.042 ** (0.019)
Health status		−0.008 ** (0.004)	−0.007 ** (0.003)	−0.008 ** (0.003)
Family education level			−0.141 *** (0.011)	−0.147 *** (0.012)
Family scale			−0.089 *** (0.009)	−0.085 *** (0.009)
Social capital			−0.048 *** (0.004)	−0.048 *** (0.004)
Province				−0.025 *** (0.008)
Constant	0.522 *** (0.016)	−0.046 (0.077)	0.959 *** (0.087)	1.074 *** (0.094)
N	2216	2216	2216	2216
R ²	0.030	0.068	0.210	0.214

Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$.

The regression results for control variables reveal that gender, age, health status, family education level, family size, and social capital significantly influence income and income inequality among rural households. Personal characteristic variables show that age has a significant negative effect on income, while gender and health status have a substantial positive impact. Conversely, their effects on income inequality are the opposite. This suggests that younger and healthier farmers have higher income potential, and income inequality among these groups is lower [11]. Family characteristic variables (family education level, family size, and social capital) positively affect income and negatively impact income inequality. This indicates that as household human and social capital increase, rural households gain better access to information and risk resilience, leading to more development opportunities and income channels, thereby raising farmers' income and reducing income inequality.

4.2. The Influence of Internet Use on Farmers' Income and Income Inequality from Different Sources

Table 4 reveals significant differences in the impact of internet use on farmers' income from various sources. First, internet use has significantly increased farmers' wage income. With the implementation of China's Internet Plus and Broadband China national strategies, information and communication technologies have advanced in rural areas, leading to notable changes in rural employment patterns. On the one hand, rural residents increasingly use the internet to find new employment opportunities, enhancing the likelihood of non-agricultural employment and thereby increasing wage income. On the other hand, internet use improves farmers' knowledge and work skills, boosting their professional competitiveness and indirectly raising wage income [5,20]. Second, internet use has also significantly increased farmers' operating income. The rapid growth of the digital economy in rural areas has expanded rural e-commerce, creating new opportunities for local entrepreneurship [8]. Additionally, the internet provides farmers with information on agricultural operations, production techniques, and marketing services, optimizing agricultural production structures and improving supply chain efficiency [22], thereby increasing operating income.

Table 4. The impact of internet use on farmers' income from diverse sources.

	Wage Income	Operating Income	Property Income	Transfer Income
Internet use	0.048 *** (0.018)	0.133 *** (0.045)	−0.037 (0.070)	0.048 (0.038)
Personal feature variable			Control	
Family feature variable			Control	
Provincial control variable			Control	
N	1934	994	467	1305
R ²	0.108	0.083	0.122	0.054

Standard errors in parentheses. *** $p < 0.01$.

However, Table 4 also shows that internet use has no significant impact on farmers' property income and transfer income. While the internet improves farmers' access to information, property transactions (such as land rentals) often occur within villages or among acquaintances, and online platforms for such transactions remain underdeveloped. Moreover, most farmers exhibit high risk aversion and low willingness to allocate household financial assets [13]. As a result, internet use does not substantially contribute to property income. Transfer income, primarily derived from government agricultural subsidies [23],

is also unaffected by internet use. Although the internet increases farmers' awareness of subsidy policies, it simultaneously encourages non-agricultural employment, offsetting its potential positive effects on transfer income. These findings partially confirm Hypothesis 1.

Table 5 demonstrates that internet use significantly reduces income inequality in wage and operating income. This is because the internet lowers information costs, enabling farmers with lower social capital to access non-agricultural employment opportunities and improve their skills [12]. It also enhances access to agricultural operation information and new technologies [14], thereby narrowing income gaps among farmers, particularly in wage and operating income. These results partially confirm Hypothesis 2.

Table 5. The impact of internet use on farmers' income inequality from diverse sources.

	Income Inequality of Wage	Income Inequality of Operating	Income Inequality of Property	Income Inequality of Transfer
Internet use	−0.013 ** (0.006)	−0.008 * (0.004)	−0.003 (0.003)	−0.003 (0.003)
Personal feature variable			Control	
Family feature variable			Control	
Provincial control variable			Control	
N	2216	2216	2216	2216
R ²	0.091	0.038	0.048	0.084

Standard errors in parentheses. ** $p < 0.05$, * $p < 0.1$.

4.3. Treatment and Analysis of Endogenous Problems

Due to the potential reverse causality between internet use and farmers' income—specifically, farmers with higher income levels are more likely to use the internet—the regression analysis above may suffer from endogeneity issues. To address this, a suitable instrumental variable (IV) is required. Following the approach of Li et al. [35], this study selects the monthly postal and telecommunications expenses of rural households as the instrumental variable. This study employs household postal and telecommunication expenditures as the instrumental variable (IV), which satisfies both the relevance and exclusion conditions. First, this measure demonstrates strong correlation with internet usage, effectively capturing household digital engagement within China's policy context. Second, as fixed access costs unrelated to productive capacity, these expenditures exhibit no direct effect on either farmers' income or income inequality. The standardized pricing under China's "Broadband China" strategy further provides quasi-exogenous variation, strengthening the exclusion restriction. The Conditional Mixed Process (CMP) model is employed to assess the validity of the instrumental variable and the endogeneity of the model.

The results indicate that the estimated parameters of the instrumental variable are statistically significant at the 5% level, confirming that monthly postal and telecommunications expenses can serve as an effective instrumental variable. Additionally, the endogeneity test parameters are significant at the 1% level, suggesting that the regression model indeed has endogeneity issues, and that the CMP model provides a more accurate estimation of the impact of internet use on income and income inequality among rural households. The CMP estimation results (Tables 6 and 7) show that the findings are largely consistent with the previous regression results after addressing endogeneity, indicating that endogeneity does not undermine the validity of the conclusions.

Table 6. The influence of internet use on farmers' income estimated by CMP.

	Total Income	Wage Income	Operating Income	Property Income	Transfer Income
Internet use	3.541 ** (1.714)	2.872 ** (1.462)	5.622 * (2.863)	1.704 (1.861)	2.388 (1.462)
Personal feature variable			Control		
Family feature variable			Control		
Provincial control variable			Control		
N	2216	2216	2216	2216	2216
LR χ^2	856.180	493.470	357.590	324.900	340.650

Standard errors in parentheses. ** $p < 0.05$, * $p < 0.1$.**Table 7.** The influence of internet use on farmers' income inequality estimated by CMP.

	Income Inequality	Income Inequality of Wage	Income Inequality of Operating	Income Inequality of Property	Income Inequality of Transfer
Internet use	−0.880 ** (0.423)	−0.684 * (0.355)	−0.358 * (0.197)	−0.068 (0.069)	−0.010 (0.065)
Personal feature variable			Control		
Family feature variable			Control		
Provincial control variable			Control		
N	2216	2216	2216	2216	2216
LR χ^2	848.600	472.060	359.30	366.600	454.670

Standard errors in parentheses. ** $p < 0.05$, * $p < 0.1$.

4.4. Heterogeneity Analysis

This study examines the moderating effect of human capital through heterogeneity analysis. The data samples are divided into high- and low-educated groups based on the average years of education among farmers, allowing for an observation of the differential impact of internet use on income and income inequality across human capital groups. The results reveal that internet use has a significantly positive impact on total income, wage income, and operating income in the high-educated group at the 5% significance level, while its impact is insignificant in the low-educated group (Table 8). This indicates that the income-enhancing effect of internet use is more pronounced among higher-educated farmers. The reasons for this are twofold: first, highly educated households are more likely to own and utilize the internet [26]; second, higher-educated farmers possess greater learning capabilities and can more effectively leverage the information, employment, and financial benefits of the internet, thereby generating higher incomes [31]. Similarly, internet use significantly reduces total income inequality, wage income inequality, and operating income inequality among highly educated farmers (Table 9).

Differences in human capital lead to disparities in the ability to use information technology. For instance, highly educated groups derive significantly higher income returns from internet use compared to low-educated groups. Internet use markedly increases the income of highly educated farmers, thereby reducing income inequality within this group. These findings confirm Hypothesis 3.

Table 8. The influence of internet use on farmers' income from diverse sources among different human capital groups.

		Total Income	Wage Income	Operating Income	Property Income	Transfer Income
Internet use	High-educated group	3.017 ** (1.353)	1.919 ** (0.922)	5.867 ** (2.754)	2.903 (2.060)	2.003 (1.313)
	Low-educated group	3.847 (3.420)	4.138 (3.759)	3.486 (3.450)	−2.720 (3.809)	2.863 (2.926)
Personal feature variable				Control		
Family feature variable				Control		
Provincial control variable				Control		

Standard errors in parentheses. ** $p < 0.05$.**Table 9.** The influence of internet use on farmers' income inequality from diverse sources among different human capital groups.

		Income Inequality	Income Inequality of Wage	Income Inequality of Operating	Income Inequality of Property	Income Inequality of Transfer
Internet use	High-educated group	−0.740 ** (0.332)	−0.491 ** (0.249)	−0.430 ** (0.215)	−0.092 (0.081)	−0.095 (0.077)
	Low-educated group	−0.968 (0.854)	−0.999 (0.885)	−0.127 (0.184)	−0.046 (0.097)	0.110 (0.150)
Personal feature variable				Control		
Family feature variable				Control		
Provincial control variable				Control		

Standard errors in parentheses. ** $p < 0.05$.

4.5. Discussion

This study contributes to this discourse by revealing nuanced, source-specific effects. Specifically, wage and operating income exhibit marked improvements, while property and transfer incomes remain unaffected. This dichotomy suggests that internet penetration primarily facilitates productive economic activities rather than asset-based or redistributive income streams, highlighting the need for complementary financial and institutional reforms to unlock these channels' digital potential.

Our results align with international observations where internet adoption reduces individual-level inequality through labor market integration [16], yet contrast with cases like Indonesia's Yogyakarta region where high penetration coexists with widening inequality [17]. This divergence may be attributed to China's unique policy environment—the nationwide infrastructure investments under the “Internet +” and “Broadband China” initiatives, coupled with complementary measures such as digital skills training and inclusive financial services—have effectively mitigated the common predicament where digital access disparities (e.g., urban–rural digital divide and variations in digital literacy) typically aggravate income inequality in developing contexts.

Regional disparities persist in the impact of internet use on income inequality across different income sources among farmers. The eastern region is expected to exhibit the “digital amplification effect”. Leveraging the advantage of the highest urbanization level and complete digital infrastructure, the eastern region has witnessed the deep integration of the internet with various industries under the impetus of these strategies [36]. In terms of wage income, the internet platform economy, riding on the momentum of these strategies, has significantly promoted non-agricultural employment. However, since high-skilled workers can better adapt to the new economic model, while low-skilled workers face difficulties in skill upgrading and job matching for new positions, this may further

exacerbate the income gap between high-skilled and low-skilled workers. In terms of property income, empowered by the “Internet Plus” strategy, online property rights trading platforms have greatly improved the efficiency of land transfer. Nevertheless, it may also lead to a more pronounced differentiation in asset returns between some “digital landlords” who are proficient in utilizing network resources and ordinary rural households. In the field of operating income, the digital transformation of agriculture has been accelerated with the support of policies. However, due to limitations such as capital, technology, and market channels, small-scale farmers may be squeezed out of the market, giving rise to a situation dominated by large-scale farms, thus further amplifying the income distribution disparity as a whole.

The central region, on the other hand, may face the “pains of digital transformation”. Constrained by the state of “semi-urbanization” [37], although the strategies of “Internet +” and “Broadband China” have improved network coverage, the insufficient digital skills of rural households have significantly reduced the income-increasing effect of the internet on wage income, plunging them into the dilemma of “having access but no conversion”. In terms of operating income, the traditional agricultural model urgently needs to be transformed under the impact of “Internet Plus”. However, the cultivation of new business entities lags behind due to factors such as talent shortage and lack of capital, resulting in an ineffective connection of income sources. Although the rural property rights trading system has been improved during the advancement of these strategies, it is still not perfect, which greatly restricts the activation of property income elements by the internet, making the digital transformation path in the central region fraught with difficulties.

The western region will exhibit the “policy-regulated digital effect”. Driven by policies, internet labor platforms have helped rural households in the western region break through geographical limitations to obtain wage income. However, due to the weak industrial foundation in the western region [38], there is a high possibility of forming a “low-end employment dependence”. In line with policy requirements, digital precision subsidies have effectively reduced welfare leakage. However, at the same time, they may also, to a certain extent, reduce the safety net effect of policies. Affected by ecological constraints and population outflows, even with the support of these strategies, the space for “digital empowerment” of property income in the western region remains limited, and its overall development is significantly influenced by policy regulation.

5. Conclusions and Recommendations

Using data from the China Family Panel Studies (CFPS) 2020, this study examines the impact of internet use on income from different sources and income inequality among farmers by employing Ordinary Least Squares (OLS) and Conditional Mixed Process (CMP) models. The research also evaluates the heterogeneous effects of human capital. The findings reveal the following: First, internet use significantly increases the total income of rural households while reducing overall income inequality. Second, the positive impact of internet use on total income is primarily driven by increases in wage and operating income, while the reduction in income inequality is associated with a more equitable distribution of these income sources. Third, human capital plays a moderating role in the relationship between internet use and farmers’ income and income inequality. High-human-capital households are more likely to benefit from internet use, achieving higher income levels and narrower income gaps. Overall, the findings confirm Hypothesis 1 and Hypothesis 3, while providing partial support for Hypothesis 2. Further discussion reveals that China’s unique internet policy framework has effectively mitigated the “digital access gap exacerbating inequality” dilemma commonly seen in developing countries. However, internet adoption primarily facilitates productive economic activities rather than asset

appreciation or redistribution channels. While internet penetration has reduced overall income inequality by promoting labor market integration, significant regional disparities persist across eastern, central, and western China.

Based on the findings, this study proposes the following policy recommendations:

First, developing countries should accelerate investments in rural digital infrastructure to improve internet accessibility and ensure high-quality services in farming communities. Priority should be given to digital literacy programs targeting low-income farmers, enhancing their digital competencies. These interventions collectively increase household incomes while mitigating income inequality. Second, governments should develop farmer-specific online recruitment platforms, facilitating urban employment information access for rural–urban migrants. This directly enhances wage income. Concurrently, village-level digital platforms should disseminate agricultural techniques, market data, and technical support, strengthening operating income. Third, policymakers must address the heterogeneous effects of internet adoption across farmer human capital levels. Digitalization strategies require context-specific customization. Infrastructure expansion must be complemented with targeted upskilling programs for low-human-capital farmers, reducing income disparities and democratizing digital dividends.

This study has the following limitations:

First, this study relies primarily on cross-sectional data (CFPS 2020), which limits the ability to capture dynamic causal relationships between internet use and farmers' income. Future research could employ panel data or experimental designs to validate long-term effects and causal mechanisms. Second, this study currently lacks empirical evidence regarding the geographical variability in how internet use affects income inequality among farming households. Future research will strengthen the analysis of regional disparities. In addition, the sample selection may not fully cover the diversity of rural areas in China. Some remote mountainous areas or rural communities with special economic structures may be under-represented, which limits the applicability of the research conclusions when extended to all rural areas across the country.

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References

1. International Telecommunication Union. *Measuring Digital Development: Facts and Figures 2023*; ITU: Geneva, Switzerland, 2023.
2. Vatsa, P.; Li, J.; Luu, P.Q.; Botero-R, J.C. Internet use and consumption diversity: Evidence from rural China. *Rev. Dev. Econ.* **2023**, *27*, 1287–1308. [[CrossRef](#)]

3. Svensson, J.; Yanagizawa, D. Getting prices right: The impact of the market information service in Uganda. *J. Eur. Econ. Assoc.* **2009**, *7*, 435–445. [\[CrossRef\]](#)
4. Feldman, D.C.; Klaas, B.S. Internet job hunting: A field study of applicant experiences with on-line recruiting. *Hum. Resour. Manag.* **2002**, *41*, 175–192. [\[CrossRef\]](#)
5. Zhou, X.; Cui, Y.; Zhang, S. Internet use and rural residents' income growth Internet use and rural residents' income growth. *China Agric. Econ. Rev.* **2020**, *12*, 315–327. [\[CrossRef\]](#)
6. Fu, X.; Akter, S. The impact of mobile phone technology on agricultural extension services delivery: Evidence from India. *J. Dev. Stud.* **2016**, *52*, 1561–1576. [\[CrossRef\]](#)
7. Munyegera, G.K.; Matsumoto, T. ICT for financial access: Mobile money and the financial behavior of rural households in Uganda. *Rev. Dev. Econ.* **2018**, *22*, 45–66. [\[CrossRef\]](#)
8. Ma, W.; Nie, P.; Zhang, P.; Renwick, A. Impact of Internet use on economic well-being of rural households: Evidence from China. *Rev. Dev. Econ.* **2020**, *24*, 503–523. [\[CrossRef\]](#)
9. Chen, H.; Chen, C.-P.; Li, Y.; Qin, L.; Qin, M. How internet usage contributes to livelihood resilience of migrant peasant workers? Evidence from China. *J. Rural Stud.* **2022**, *96*, 112–120. [\[CrossRef\]](#)
10. Garcia-Mora, F.; Mora-Rivera, J. Exploring the impacts of Internet access on poverty: A regional analysis of rural Mexico. *New Media Soc.* **2023**, *25*, 26–49. [\[CrossRef\]](#)
11. Zou, B.; Mishra, A.K. How internet use affects the farmland rental market: An empirical study from rural China. *Comput. Electron. Agric.* **2022**, *198*, 107075. [\[CrossRef\]](#)
12. Qiu, L.J.; Zhong, S.B.; Sun, B.W.; Song, Y.; Chen, X.H. Is internet penetration narrowing the rural–urban income inequality? A cross-regional study of China. *Qual. Quant.* **2021**, *55*, 1795–1814. [\[CrossRef\]](#)
13. Qiu, L.; Zhong, S.; Sun, B. Blessing or curse? The effect of broadband Internet on China's inter-city income inequality. *Econ. Anal. Policy* **2021**, *72*, 626–650. [\[CrossRef\]](#)
14. Li, C.; Sha, Z.; Sun, T. Rural Households' Internet Use on Common Prosperity: Evidence from the Chinese Social Survey. *Soc. Indic. Res.* **2023**, *170*, 797–823. [\[CrossRef\]](#)
15. Akerman, A.; Gaarder, I.; Mogstad, M. The skill complementarity of broadband internet. *Q. J. Econ.* **2015**, *130*, 1781–1824. [\[CrossRef\]](#)
16. Fointuna, J.I.; Susanto, A.A.; Afifah, E.N. The effect of internet diffusion on income inequality: Cross-regional analysis in Indonesia. *Inf. Technol. Dev.* **2025**, 1–21. [\[CrossRef\]](#)
17. Luthfi, M.; Pudjihardjo, M. The Impact of Internet Usage on Per Capita Income and Inequality in Yogyakarta Special Region Province. *J. Dev. Econ. Soc. Stud.* **2025**, *4*, 142–156. [\[CrossRef\]](#)
18. DeLeon, J.A.; Smith, L.M.; Zeidan, R. Relationship of Internet Activity to Income Inequality and Life Satisfaction. *World Econ.* **2024**, *25*, 45–72.
19. DiMaggio, P.; Bonikowski, B. Make money surfing the web? The impact of Internet use on the earnings of US workers. *Am. Sociol. Rev.* **2008**, *73*, 227–250. [\[CrossRef\]](#)
20. Lee, S.H.; Kim, J. Has the internet changed the wage structure too? *Labour Econ.* **2004**, *11*, 119–127. [\[CrossRef\]](#)
21. Aker, J.C. Dial “A” for agriculture: A review of information and communication technologies for agricultural extension in developing countries. *Agric. Econ.* **2011**, *42*, 631–647. [\[CrossRef\]](#)
22. Nakasone, E.; Torero, M.; Minten, B. The power of information: The ICT revolution in agricultural development. *Annu. Rev. Resour. Econ.* **2014**, *6*, 533–550. [\[CrossRef\]](#)
23. Zhang, A.; Chandio, A.A.; Yang, T.; Ding, Z.; Liu, Y. Examining how internet use and non-farm employment affect rural households' income gap? Evidence from China. *Front. Sustain. Food Syst.* **2023**, *7*, 1173158. [\[CrossRef\]](#)
24. Autor, D.H.; Dorn, D. The growth of low-skill service jobs and the polarization of the US labor market. *Am. Econ. Rev.* **2013**, *103*, 1553–1597. [\[CrossRef\]](#)
25. Zhang, X. Income disparity and digital divide: The Internet Consumption Model and cross-country empirical research. *Telecommun. Policy* **2013**, *37*, 515–529. [\[CrossRef\]](#)
26. Mora-Rivera, J.; García-Mora, F. Internet access and poverty reduction: Evidence from rural and urban Mexico. *Telecommun. Policy* **2021**, *45*, 102076. [\[CrossRef\]](#)
27. Hounghonon, G.V.; Liang, J. Broadband internet and income inequality. *Rev. Netw. Econ.* **2021**, *20*, 55–99. [\[CrossRef\]](#)
28. Kuhn, P.; Mansour, H. Is internet job search still ineffective? *Econ. J.* **2014**, *124*, 1213–1233. [\[CrossRef\]](#)
29. Mincer, J. *Human Capital, Technology, and the Wage Structure: What do Time Series Show?* *Studies in Human Capital*; Edward Elgar Publishing: Cheltenham, UK, 1993; pp. 366–406.
30. Ma, X. Internet use and income gaps between rural and urban residents in China. *J. Asia Pac. Econ.* **2022**, *29*, 789–809. [\[CrossRef\]](#)
31. Vaarmets, T.; Liivamägi, K.; Talpsepp, T. How does learning and education help to overcome the disposition effect? *Rev. Financ.* **2019**, *23*, 801–830. [\[CrossRef\]](#)
32. Kakwani, N. The relative deprivation curve and its applications. *J. Bus. Econ. Stat.* **1984**, *2*, 384–394. [\[CrossRef\]](#)

33. Li, J.; Li, J. Bride price and household income: Evidence from rural China. *J. Asia Pac. Econ.* **2021**, *28*, 1327–1346. [[CrossRef](#)]
34. Roodman, D. Fitting fully observed recursive mixed-process models with cmp. *Stata J.* **2011**, *11*, 159–206. [[CrossRef](#)]
35. Li, Z.; Mirko, C.; D’agostino, M.T.; Jin, J. Comparative analysis of the influence of Chinese urban and rural family cultures on household financial asset allocation. *Front. Psychol.* **2023**, *14*, 1119258. [[CrossRef](#)] [[PubMed](#)]
36. Shi, Y.; Wei, F. Comparative analysis of digital economy-driven innovation development in China: An international perspective. *J. Knowl. Econ.* **2024**, 1–43. [[CrossRef](#)]
37. Zhang, H.; Chen, M.; Liang, C. Urbanization of county in China: Spatial patterns and influencing factors. *J. Geogr. Sci.* **2022**, *32*, 1241–1260. [[CrossRef](#)]
38. Luo, S. Digital finance development and the digital transformation of enterprises: Based on the perspective of financing constraint and innovation drive. *J. Math.* **2022**, *2022*, 1607020. [[CrossRef](#)]

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