INTERNET USE AND HOUSEHOLD WELFARE IN RURAL VIETNAM

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Abstract

This study examines the impact of Internet use on household welfare in rural Vietnam using nationally representative data from the 2018 and 2020 Vietnam Household Living Standards Survey (N = 14,138 households). To mitigate selection bias, propensity score matching with robustness checks is employed. Household welfare is measured by total and per capita income and expenditure. The results show that Internet adoption significantly improves all four indicators: Internet users report higher incomes and expenditures than comparable non-users, suggesting expanded livelihood opportunities, greater labor market access, and enhanced consumption capacity. These findings highlight the Internet's role as a driver of rural welfare improvements and a tool for reducing rural - urban disparities. Policy recommendations emphasize investment in rural digital infrastructure, affordability measures, and digital literacy initiatives, particularly for disadvantaged groups and remote regions. Bridging the digital divide will be crucial for leveraging digital transformation to promote poverty reduction and inclusive rural development in Vietnam. A limitation is that, despite controlling for observable characteristics, unobserved heterogeneity may remain, which should be considered when interpreting the findings.

Key words: *Internet use; Household welfare; Rural development; Propensity score matching; Vietnam.*

SỬ DỤNG INTERNET VÀ PHÚC LỢI HỘ GIA ĐÌNH Ở NÔNG THÔN VIỆT NAM

Tóm tắt

Nghiên cứu này phân tích tác động của việc sử dụng Internet đến phúc lợi hộ gia đình nông thôn Việt Nam, dựa trên dữ liệu Điều tra mức sống hộ gia đình Việt Nam các năm 2018 và 2020 (N = 14.138 hộ), có tính đại diện toàn quốc. Để hạn chế sai lệch chọn mẫu, nghiên cứu áp dụng phương pháp ghép điểm xu hướng (propensity score matching) kết hợp kiểm định tính vững. Phúc lợi hộ gia đình được đo lường qua bốn chỉ tiêu: thu nhập và chi tiêu bình quân toàn hộ, thu nhập và chi tiêu bình quân đầu người. Kết quả cho thấy việc sử dụng Internet có tác động tích cực rõ rệt đến cả bốn chỉ tiêu, hàm ý các hộ dùng Internet có cơ hội sinh kế mở rộng, tiếp cận thị trường lao động tốt hơn và năng lực tiêu dùng cao hơn. Điều này khẳng định vai trò của Internet như một động lực cải thiện phúc lợi và thu hẹp khoảng cách nông thôn – thành thị. Về chính sách, cần ưu tiên đầu tư hạ tầng số nông thôn, triển khai các biện pháp tăng khả năng chi trả và nâng cao kỹ năng số cho nhóm yếu thế. Tuy nhiên, do vẫn tồn tại các yếu tố không quan sát (như năng lực kinh doanh, kỹ năng số), kết quả nghiên cứu phản ánh mối quan hệ có điều kiện hơn là quan hệ nhân quả tuyệt đối.

Từ khóa: *Sử dụng internet, phúc lợi hộ gia đình, phát triển nông thôn, ghép điểm xu hướng, Việt Nam.*
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1. Introduction

The diffusion of the Internet has been one of the defining technological transformations of the twenty-first century, reshaping how individuals access information, markets, education, and social services. In developing economies, digital technologies are increasingly recognized as critical enablers of poverty reduction and inclusive growth (World Bank, 2016; ITU, 2020). A growing body of research highlights that Internet adoption can enhance household welfare by reducing information asymmetries, lowering transaction costs, and expanding opportunities for income diversification (Hjort & Poulsen, 2019; Khalil et al., 2009). Yet, the magnitude and distribution of such impacts often vary across regions and between rural and urban households.

Vietnam provides a particularly relevant context for examining these dynamics. Despite notable achievements in economic growth and poverty reduction, rural–urban disparities remain pronounced, with rural households facing constraints in market access, education, and healthcare (Nguyen & Nordman, 2018). The government's "National Digital Transformation Program to 2025, with a vision to 2030" prioritizes expanding Internet infrastructure to bridge these divides. The study period, 2018–2020, is especially significant: it coincides with the onset of the COVID-19 pandemic, which accelerated digital adoption worldwide but also exposed sharp inequalities in access to and benefits from digital technologies. Understanding how Internet use affected rural households in this period provides timely insights into resilience and adaptation under crisis conditions.

This paper addresses existing evidence gaps by employing nationally representative data from two waves of the Vietnam Household Living

Standards Survey (VHLSS) in 2018 and 2020. To rigorously estimate the causal effect of Internet use on household welfare, we apply the propensity score matching (PSM) method, complemented by robustness checks. The analysis focuses on four key welfare indicators: total household income, per capita household income, total household expenditure, and per capita household expenditure.

The results demonstrate that Internet adoption has a significant positive impact across all these indicators, suggesting that Internet use is not only a means of communication but also a catalyst for improving livelihoods in rural Vietnam. By situating the findings within the context of the COVID-19 shock and drawing potential comparisons with other developing economies undergoing similar digital transitions, this study contributes to the broader literature on ICT and development. The policy implications are clear: investments in rural Internet infrastructure, affordability measures, and digital literacy programs are essential to promote inclusive growth and reduce rural–urban inequality.

2. Literature review

Internet Use and Socioeconomic Development

The diffusion of information and communication technologies (ICTs) is widely recognized as a key driver of socioeconomic transformation, particularly in developing countries. Internet access reduces information asymmetries, improves market participation, and fosters social inclusion (World Bank, 2016). Empirical studies demonstrate that Internet penetration contributes to higher economic growth (Czernich et al., 2011), greater labor productivity (Clarke & Wallsten, 2006), and broader opportunities for education and skills development (Hilbert, 2016). In rural areas, where geographic isolation constrains households, the Internet plays an especially important role in connecting individuals to markets, services, and information.

Internet and Household Welfare

Household welfare is commonly measured through income, expenditure, consumption, and multidimensional well-being indicators. A growing body of evidence indicates that Internet adoption enhances welfare by creating new livelihood opportunities, improving access to financial and labor markets, and lowering transaction costs (Aker & Mbiti, 2010; Galperin & Viecens, 2017). Studies from China and India show that rural households with Internet access report higher consumption, greater educational investment, and improved health outcomes (Ma et al., 2020; Donner, 2015). Internet use also facilitates remittances, entrepreneurship, and participation in e-commerce all of which directly contribute to household welfare.

Digital Divide and Rural Disparities

Despite these potential benefits, the distribution of Internet gains is uneven. Rural households face barriers such as weak infrastructure, low digital literacy, and affordability constraints (van Dijk, 2006). The literature on the digital divide stresses that mere access is insufficient; effective use depends on complementary factors like education, gender, and institutional support (Hargittai, 2002). Without addressing these gaps, digital exclusion risks reinforcing existing inequalities, particularly in developing economies where rural livelihoods rely heavily on agriculture and informal labor (Qiang et al., 2009).

Evidence from Vietnam

Vietnam has experienced rapid Internet penetration, but rural–urban disparities persist. Internet adoption is closely linked to education, income, and location. Le and Tran (2019) showed that rural Internet users achieved higher non-farm income and greater livelihood diversification. Doan and Nguyen (2021) found that Internet access improves job search efficiency and labor market outcomes for rural youth. Linh et al. (2025) used propensity score matching to demonstrate that online shopping adoption during COVID-19 helped reduce food insecurity. Nguyen et al. (2023) further revealed that Internet use significantly boosted agricultural productivity, with stronger effects for women, ethnic minorities, and households with lower education. Nonetheless, persistent challenges—such as high service costs, low digital literacy, and uneven infrastructure—limit the full benefits of digital transformation (General Statistics Office of Vietnam, 2022).

Research Gaps

Although the literature suggests positive welfare impacts, three key gaps remain. First, few studies use nationally representative data to rigorously assess causal effects of Internet adoption in Vietnam. Second, most research focuses on income or employment, with limited attention to household expenditure patterns. Third, little is known about whether these effects hold consistently across different time periods, especially in the context of rapid digitalization and post-COVID recovery. This study addresses these gaps by employing two waves of the Vietnam Household Living Standards Survey

(2018 and 2020) and applying propensity score matching with robustness checks to provide robust evidence on the welfare impacts of Internet use in rural Vietnam.

3. Data and methodology

3.1. Data

Table 1 summarizes the definitions and descriptive statistics of the variables employed in the analysis. The study draws on two nationally representative rounds of the Vietnam Household Living Standards Survey conducted in 2018 and 2020. Using two survey waves allows the analysis to capture both pre- and post-COVID dynamics in digital adoption, thereby offering a more comprehensive picture of rural welfare outcomes. Relying on pooled cross-sections also strengthens robustness, as it reflects temporal variations in Internet use rather than depending on a single point in time.

Following Ma et al. (2020), household welfare is measured using four indicators: (i) total household income, (ii) per capita household income, (iii) total household expenditure, and (iv) per capita household expenditure. Independent variables are defined in detail in Table 1. On average, 40.8% of household heads reported Internet use in the past three months. However, adoption rates were considerably lower in 2018 compared to 2020, underscoring the rapid expansion of digital connectivity within just two years. This growth aligns with Vietnam's National Digital Transformation Program and the accelerated uptake of online services during the COVID-19 pandemic, which encouraged rural households to adopt the Internet for communication, education, and market access.

Descriptive statistics also reveal notable patterns in welfare indicators. Average total household income is approximately 420,567 thousand VND, with per capita household income around 119,255 thousand VND. Total household expenditure averages 189,627 thousand VND, while per capita expenditure is about 52,486 thousand VND. The relatively large standard deviations suggest considerable heterogeneity in rural livelihoods.

Household characteristics further reflect the diverse rural context. The average age of household heads is 51.8 years, with 22.5% being female. More than half of households (51.6%) belong to ethnic minority groups, highlighting the geographical and cultural diversity of the survey. Education levels remain modest at just over seven years of schooling. Most household heads are married (79.5%), and nearly half (48.2%) engage in off-farm employment, emphasizing the importance of income diversification. On average, households include 0.7 children under 15 and 0.65 elderly members, pointing to dual pressures of youth dependency and elder care.

Resource variables show that the logarithm of farm size averages 8.15, reflecting variation in agricultural landholdings. The regional distribution spans all major areas of Vietnam, with the largest shares in the Red River Delta (20.6%) and the North West (15.4%), followed by the North Central Coast (11.6%), South Central Coast (9.4%), South East (8.5%), and Central Highlands (7%). Only 5.2% of households are located in the North East. The survey year variable indicates that 48.1% of households were observed in 2018 and 51.9% in 2020, enabling meaningful cross-period comparisons.

In summary, the descriptive statistics highlight the rapid rise in Internet adoption between 2018 and 2020, alongside modest education levels and diverse demographic characteristics. These patterns provide a solid foundation for examining the welfare implications of Internet use in rural Vietnam.

Table 1: *Definition and descriptive statistics*

Variable	Definition	Mean	Std. Dev.
Dependent variables			
Internet use	1 if the household head accessed the Internet in the past 30 days; = 0 otherwise.	0.408	0.491
Total household income	Total household income (Thousand VND)	420566.9	1261315
Per capita household income	Per capita household income (Thousand VND)	119254.6	259436.3
Total household expenditure	Total household expenditure (Thousand VND)	189627.2	1153545
Per capita household expenditure	Per capita household expenditure (Thousand VND)	52485.83	229709.6
Independent variables			
Age	Age of household head (years)	51.843	13.940
Gender (Female)	Gender of household head: 1=Female, 0=otherwise	0.225	0.418

Variable	Definition	Mean	Std. Dev.
Ethnicity (Minority people)	Ethnic characteristics of household head: 1=Minority group, 0=otherwise	0.516	0.499
Years of schooling	The schooling years of household head (years)	7.046	3.673
Current married	Marital status of household head: 1=current married, 0=otherwise	0.795	0.403
Off-farm work	1 if household head participated in off-farm work, 0 otherwise	0.482	0.499
Number of kids	Number of children under 15 years old in household	0.709	0.971
Number of elders	Number of old people above 60 years old in household	0.654	0.939
Farm size	Logarit of total farm size (m2)	8.152	1.452
Red River Delta	1=Red River Delta, 0=otherwise	0.206	0.404
North West	1=North West, 0=otherwise	0.154	0.361
North East	1=North East, 0=otherwise	0.052	0.223
North Central Coast	1=North Central Coast, 0=otherwise	0.116	0.320
South Central Coast	1=South Central Coast, 0=otherwise	0.094	0.292
Central Highlands	1=Central Highlands, 0=otherwise	0.070	0.256
South East	1=South East, 0=otherwise	0.085	0.279
Year	1 if the year equals 2018, otherwise 0	0.481	0.499

Source: The authors' calculations are based on the VHLSS survey data in 2018 and 2020

To provide a clearer understanding of the differences between rural households with and without Internet access, the data were divided into two subsamples, as presented in Table 2.

Household welfare differences. Table 2 highlights substantial disparities in welfare outcomes between the two groups. Households with Internet access report significantly higher total and per capita income compared to their counterparts without access. Expenditure patterns follow a similar trend, with both total and per capita spending levels among Internet users nearly twice those of non-users. These differences are statistically significant at the 1% level, indicating a strong association between Internet use and improved household welfare.

Demographic and educational characteristics. The results further show that Internet users tend to be younger, with an average household head age of 45 years compared to 56 years among non-users. Education levels also differ markedly: Internet-using household heads average over eight years of schooling, while non-users average just above six years. Moreover, a higher proportion of Internet users are currently married, whereas non-users are disproportionately older and less educated factors that may hinder their ability to adopt digital technologies.

Occupational and household composition factors. Engagement in off-farm work is considerably more common among Internet users (60%) than among non-users (40%), underscoring the role of economic diversification in digital adoption. Internet-using households also report fewer elderly members and slightly smaller farm sizes, suggesting that traditional agrarian households are less likely to embrace Internet use. Interestingly, ethnic minority households are more represented among Internet users, potentially reflecting the influence of regional development programs and improved connectivity in minority-populated areas.

Regional and temporal variation. Clear regional patterns also emerge. Internet adoption is more prevalent in economically advanced regions such as the Red River Delta and the South East, while non-users are disproportionately concentrated in disadvantaged regions such as the North East. Finally, the distribution across survey years indicates a sharp increase in Internet adoption between 2018 and 2020, with a higher share of Internet users observed in the latter wave, consistent with Vietnam's accelerated digital transformation during this period.

Table 2: *Mean difference of selected variables between Internet users and nonusers*

	Internet user		Non-internet user		Diff.
	Mean	**SD**	**Mean**	**SD**	
Dependent variables					
Total household income	578184.9	1307926	311725.2	1216310	266459.7***
Per capita household income	159357.1	324118	91562.1	198429.6	67795.0***
Total household expenditure	271800.5	1160594	132883.1	1145285	138917.4***
Per capita household expenditure	73601.64	286017	37904.48	179444.9	35697.2***
Independent variables					
Age	45.148	10.931	56.466	13.917	-11.32***
Gender (Female)	0.160	0.366	0.2709554	.4444797	-0.111***
Ethnicity (Minority people)	0.595	0.490	0.4621547	.4985955	0.133***
Years of schooling	8.122	3.547	6.30182	3.572934	1.821***
Current married	0.894	0.307	0.7273706	.4453385	0.167***
Off-farm work	0.603	0.489	0.4008097	.4900926	0.203***
Number of kids	0.776	0.972	0.6625613	.9683924	0.114***
Number of elders	0.499	0.859	0.7615688	.9764366	-0.262***
Farm size	8.035	1.540	8.222188	1.393345	-0.187***
Red River Delta	0.250	0.433	0.1752959	.3802428	0.0756***
North West	0.155	0.362	0.153653	.3606374	0.00167
North East	0.039	0.195	0.0615808	.2404069	-0.0218***
North Central Coast	0.107	0.310	0.1219658	.3272659	-0.0141*
South Central Coast	0.090	0.286	0.0975726	.2967537	-0.00753
Central Highlands	0.071	0.257	0.0703097	.2556835	0.00138
South East	0.103	0.304	0.0732991	.2606423	0.0299***
Year	0.350	0.477	0.5718044	.4948469	-0.221***
Observations	**5775**		**8363**		**14138**

*Source: VHLSS; Note: Diff is t statistics; * significant at 0.1 level; ** significant at 0.05 level; *** significant at 0.01 level; Standard deviation is in parentheses.*

3.2. Methodology

Based on the available data, households can be classified into two groups: those with Internet access and those without. Following Linh et al. (2025), this study applies the propensity score matching method to estimate the causal impact of Internet use on household welfare in rural Vietnam. Since Internet adoption is not randomly distributed but instead shaped by socioeconomic, demographic, and regional factors, simple comparisons between users and non-users may be biased. PSM addresses this issue by constructing a control group of non-users that is statistically comparable to Internet users based on observable characteristics.

Step 1: Propensity score estimation

The first stage involves estimating the probability of Internet use using a probit model. The dependent variable takes the value of 1 if the household head reported using the Internet in the last three months, and 0 otherwise. Explanatory variables include household head's age, gender, ethnicity, years of schooling, marital status, participation in off-farm work, household composition (children and elderly), farm size, regional dummies, and survey year (2018 or 2020). The predicted probabilities from this model represent each household's propensity score, i.e., the likelihood of Internet adoption conditional on observable characteristics.

Step 2: Matching procedure

In the second stage, households with Internet access (treated group) are matched with non-users (control group) based on similar propensity scores. Several matching algorithms are employed to ensure robustness, including: Nearest neighbor matching; Radius matching; Kernel matching and Local linear regression (LLR) matching. These methods balance the trade-off between bias and efficiency in estimating treatment effects.

Step 3: Balancing and common support tests

Before estimating treatment effects, the balancing property is tested to confirm that after matching, the distribution of covariates between treated and control groups is statistically similar. In addition, the common support condition is examined to ensure sufficient overlap in propensity scores between groups, so that each treated household has an appropriate counterpart in the control sample.

Step 4: Estimating treatment effects

The primary measure of interest is the Average Treatment Effect on the Treated (ATT), which captures the difference in welfare outcomes between Internet users and comparable non-users. Welfare is measured through four indicators: (i) total household income, (ii) per capita household income, (iii) total household expenditure, and (iv) per capita household expenditure. By focusing on ATT, the analysis isolates the welfare benefits experienced by households that actually adopted the Internet.

Step 5: Robustness checks

To strengthen the validity of results, the study compares ATT estimates across different matching algorithms. Consistency of results across methods indicates that the findings are not sensitive to the choice of estimator and therefore robust.

4. Result and discussion

4.1. Probability of the internet use in rural, Vietnam

Probit analysis results are presented in Table 3. The results show that demographic characteristics play an important role in Internet adoption. Age has a strong negative effect, with older household heads significantly less likely to use the Internet, reflecting a clear generational digital divide. In contrast, gender and ethnicity are not statistically significant once other variables are controlled, suggesting that differences between men and women or between ethnic groups are largely explained by education, income, and regional factors.

Human capital, especially education, emerges as the most important determinant of Internet use. Each additional year of schooling increases the probability of adoption by more than 3 percentage points, highlighting the strong link between digital literacy and connectivity. Marital status and occupational diversification also matter: married household heads and those engaged in off-farm work are more likely to use the Internet, indicating that family responsibilities and exposure to non-agricultural activities encourage digital adoption. Conversely, households with larger farm sizes are less likely to connect, underscoring the divide between traditional farm-based livelihoods and digital participation.

Regional disparities are pronounced. Households in the Red River Delta and South East economically advanced and better connected regions are significantly more likely to adopt the Internet, while those in the disadvantaged North East face substantial barriers. Other regions, such as the Central Highlands, show weaker but positive effects. Finally, the strong negative coefficient for 2018 compared to 2020 demonstrates how rapidly Internet use expanded during this period, reflecting both infrastructure improvements and the accelerating push for digital transformation, especially in the context of COVID-19.

Overall, the findings confirm that education, economic diversification, and regional development are key drivers of Internet use, while age, farm dependency, and regional disadvantage act as barriers. These results imply that policies should prioritize rural education and digital literacy, promote non-farm opportunities, and invest in infrastructure in lagging regions to ensure inclusive digital transformation.

Table 3: *The impact on the probability of internet use*

	dy/dx	**Std. err.**	**P>|z|**
Age	-0.014***	0.001	0.000
Gender (Female)	-0.008	0.018	0.635
Ethnicity (Minority people)	-0.015	0.011	0.207
Years of schooling	0.031***	0.001	0.000
Current married	0.135***	0.016	0.000
Off-farm work	0.073***	0.010	0.000
Number of kids	-0.007	0.006	0.195
Number of elders	0.003	0.007	0.586
Farm size	-0.020***	0.003	0.000
Red River Delta	0.103***	0.17	0.000
North West	0.016	0.016	0.328
North East	-0.139***	0.019	0.000
North Central Coast	-0.001	0.018	0.974
South Central Coast	0.026	0.021	0.020
Central Highlands	0.037*	0.022	0.094
South East	0.141***	0.027	0.000
Year	-0.256***	0.027	0.000
Observations	**10137**		
LR chi2(17)	2771.80		
Prob > chi2	0.0000		
Pseudo R2	0.2079		

*Note: Coefficients have been transformed to marginal effects. * p<0.10, ** p<0.05, *** p<0.01.*

Source: Authors' calculations using VHLSS 2018-2020.

4.2. Sample matching results

Before estimating the effect of Internet use on rural household welfare, it is essential to verify the balance of propensity scores to ensure that the treated and control groups share comparable characteristics at each propensity score value. The results of this balancing test are presented in Table 4.

The findings confirm that propensity score matching effectively reduced observable differences between Internet users and non-users. Prior to matching, significant imbalances existed in key variables such as age, years of schooling, and marital status, which could have biased the welfare estimates. After matching, however, these differences were substantially minimized, consistent with the balancing hypothesis. This indicates that the balance condition was successfully achieved in the study.

Table 5 reports the statistical diagnostics used to evaluate the quality of the matching procedure. The mean bias dropped sharply from 22.3% before matching to 3.5% after matching. Likewise, the pseudo R^2 from the probit model decreased considerably, suggesting that, post-matching, the treatment and control groups were statistically comparable. This strengthens the credibility of the estimated treatment effects.

Further evidence is provided by the common support test (Figure 1). The distributions of propensity scores for treated and control households show substantial overlap after matching, with unmatched cases excluded from the analysis. This overlap ensures that each treated household has an appropriate counterpart in the control group, thereby satisfying the common support condition and enabling reliable estimation of the Average Treatment Effect on the Treated (ATT).

Table 4: *Balancing hypothesis test showing the variable characteristics before and after matching*

Variable	Unmatched	Mean		%bias	%reduct	t-test	
	Matched	Treated	Control		|bias|	t	p>|t|
Age	U	46.476	55.608	-75.7	94.8	-35.70	0.000
	M	46.476	45.997	4.0		1.86	0.063
Gender (Female)	U	0.123	0.237	-30.0	98.4	-14.12	0.000
	M	0.123	0.121	0.5		0.25	0.805
Ethnicity (Minority people)	U	0.551	0.455	19.4	50.7	9.40	0.000
	M	0.551	0.504	9.5		4.11	0.000
Years of schooling	U	8.219	6.449	51.6	92.1	24.86	0.000
	M	8.219	8.079	4.1		1.88	0.061
Current married	U	0.907	0.761	40.1	91.5	18.58	0.000
	M	0.907	0.920	-3.4		-1.90	0.058
Off-farm work	U	0.559	0.385	35.5	90.9	17.27	0.000
	M	0.559	0.575	-3.2		-1.38	0.168
Number of kids	U	0.730	0.688	4.4	54.7	2.12	0.034
	M	0.730	0 .75	-2.0		-0.87	0.386
Number of elders	U	0.469	0.697	-27.1	83.9	-12.90	0.000
	M	0.469	0.433	4.4		2.13	0.033
Farm size	U	8523	8973.6	-1.5	38.3	-0.68	0.494
	M	8523	8244.9	0.9		0.77	0.443
Red River Delta	U	0.257	0.185	17.4	59.4	8.57	0.000
	M	0.257	0.228	7.1		2.94	0.003
North West	U	0.196	0.177	5.0	76.6	2.44	0.015
	M	0.196	0.192	1.2		0.50	0.619
North East	U	0.042	0.070	-12.0	62.3	-5.67	0.000
	M	0.042	0.053	-4.5		-2.12	0.034
North Central Coast	U	0.123	0.129	-1.9	70.3	-0.92	0.358
	M	0.123	0.125	-0.6		-0.25	0.806
South Central Coast	U	0.086	0.099	-4.5	73.6	-2.19	0.029
	M	0.086	0.090	-1.2		-0.53	0.596
Central Highlands	U	0.082	0.075	2.3	-136.0	1.13	0.258
	M	0.082	0.096	-5.5		-2.23	0.026
South East	U	0.058	0.046	5.5	-7.9	2.70	0.007
	M	0.058	0.071	-5.9		-2.31	0.021
Year	U	0.405	0.628	-45.8	94.7	-22.30	0.000
	M	0.405	0.416	-2.4		-1.04	0.300

*** if variance ratio outside [0.94; 1.07] for U and [0.94; 1.07] for M**

*Note: k-Nearest neighbors matching was used for the balancing test. "The performance of matching quality was relatively good among the samples. A statistically significant difference between unmatched (U) and matched (M) variables was indicated by an asterisk. * p<0.10, ** p<0.05, *** p<0.01.*

Table 5: *Test of selection bias after matching*

Sample	Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
Unmatched	0.206	2744.87	0.000	22.3	17.4	115.6*	0.57	100
Matched	0.005	53.09	0.000	3.5	3.4	16.9	0.85	80

*** if B>25%, R outside [0.5; 2]**

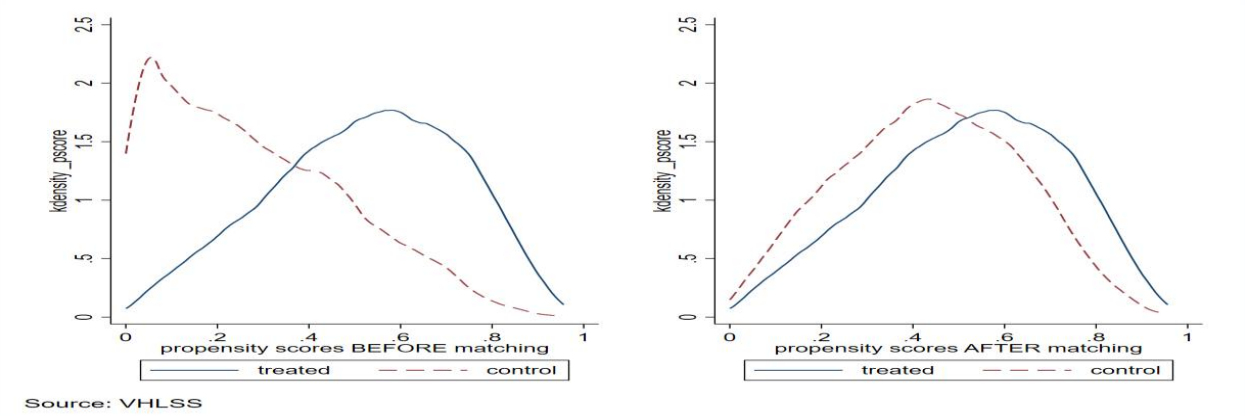

Figure 1. Test of the common support assumption to determine the densities of pre- and post-matching p-scores.

4.3. Impact of internet use on household welfare in rural Vietnam

The results in Table 6 provide strong evidence that Internet use has a significant positive effect on household welfare in rural Vietnam. Across all four matching methods nearest neighbor, radius, kernel, and local linear regression the treatment effects remain highly consistent and statistically significant, confirming the robustness of the findings.

For household income, Internet users earn considerably more than non-users. Total household income increases by roughly 212,000 to 242,000 thousand VND, depending on the method, while per capita household income rises by about 60,000 to 66,000 thousand VND. These gains suggest that Internet access enables households to expand livelihood opportunities, improve labor market participation, and benefit from information-driven activities.

A similar pattern emerges for household expenditure. Total household expenditure among Internet users is higher by about 112,000 to 135,000 thousand VND, and per capita expenditure increases by 31,000 to 36,000 thousand VND. The rise in spending implies not only higher income but also improved capacity to consume goods and services, reflecting enhanced living standards.

Taken together, the consistency across different estimation techniques reinforces the credibility of these results. Internet adoption clearly contributes to both higher income and greater household consumption, highlighting its importance as a catalyst for rural welfare improvement. These findings underline the need for continued investment in digital infrastructure, affordable access, and digital literacy programs to extend these benefits more widely across rural communities.

Table 6: *Estimated the impact of internet use on household welfare*

Variable	Sample	Treated group	Control group	Difference	T-stat
k-Nearest neighbors matching:					
Total household income	Unmatched	571551.966	309093.421	262458.545	19.48
	ATT	571551.966	359793.38	211758.585	10.65
Per capita household income	Unmatched	159942.162	93385.000	66557.161	18.45
	ATT	159942.162	99210.520	60731.640	11.52
Total household expenditure	Unmatched	273924.946	129594.675	144330.271	13.24
	ATT	273924.946	161450.067	112474.879	7.2
Per capita household expenditure	Unmatched	76079.926	39443.869	36636.057	12.53
	ATT	76079.926	44620.393	31459.533	7.76

Variable	Sample	Treated group	Control group	Difference	T-stat
Radius matching:					
Total household income	Unmatched	571551.966	309093.421	262458.545	19.48
	ATT	571646.157	332652.945	238993.212	13.72
Per capita household income	Unmatched	159942.162	93385.000	66557.161	18.45
	ATT	159983.185	94809.257	65173.927	13.93
Total household expenditure	Unmatched	273924.946	129594.675	144330.271	13.24
	ATT	274062.954	140427.969	133634.986	9.50
Per capita household expenditure	Unmatched	76079.926	39443.869	36636.057	12.53
	ATT	76118.421	40561.146	35557.275	9.41
Kernel matching:					
Total household income	Unmatched	571551.966	309093.421	262458.545	19.48
	ATT	571551.966	333064.367	238487.599	13.81
Per capita household income	Unmatched	159942.162	93385.000	66557.161	18.45
	ATT	159942.162	95047.223	64894.938	14.01
Total household expenditure	Unmatched	273924.946	129594.675	144330.271	13.24
	ATT	273924.946	141015.594	132909.351	9.52
Per capita household expenditure	Unmatched	76079.926	39443.869	36636.057	12.53
	ATT	76079.926	40689.918	35390.008	9.44
Local linear regression matching:					
Total household income	Unmatched	571551.966	309093.421	262458.545	19.48
	ATT	571551.966	329386.703	242165.263	13.77
Per capita household income	Unmatched	159942.162	93385.000	66557.161	18.45
	ATT	159942.162	93889.388	66052.772	13.73
Total household expenditure	Unmatched	273924.946	129594.675	144330.271	13.24
	ATT	273924.946	138663.242	135261.704	9.65
Per capita household expenditure	Unmatched	76079.926	39443.869	36636.057	12.53
	ATT	76079.926	39981.715	36098.211	9.37

Notes: * Significant at 10%; ** significant at 5%; *** significant at 1%.

4.4. Discussion

The results from the propensity score matching estimations provide compelling evidence that Internet use exerts a significant positive impact on rural household welfare in Vietnam. Across all matching methods, Internet users consistently show higher levels of income and expenditure than comparable non-users, confirming the robustness of the findings. These results align with earlier studies in both developed and developing contexts, which found that Internet adoption expands livelihood opportunities, reduces transaction costs, and enhances household welfare (Ma et al., 2020).

An important implication is that Internet adoption functions as a catalyst for economic opportunities in rural areas. Higher household income among Internet users may be linked to improved access to agricultural price information, labor market opportunities, and non-farm employment, echoing findings from China and India where Internet access increased rural income, consumption, and educational investment (Li et al., 2019). The positive impact on household expenditure further suggests that higher incomes are being translated into improved consumption, reinforcing results from Doan (2021), who found that Internet use enhances household welfare outcomes in Vietnam.

These results also contribute to the literature on bridging structural rural–urban gaps. Internet adoption helps mitigate geographic isolation and market access barriers, consistent with the arguments of Hilbert (2016) and Qiang et al. (2009) that ICT reduces barriers to participation in modern economies. However, the persistence of the digital divide in Vietnam rooted in infrastructure limitations, affordability issues, and disparities in education and digital skills echoes concerns raised in global studies (van Dijk, 2006; Hargittai, 2002; James, 2020). Without targeted interventions, households unable to adopt the Internet risk falling further behind, exacerbating inequality.

From a policy perspective, the findings highlight the need for investments not only in rural broadband infrastructure but also in affordability measures and digital literacy

programs. Similar to evidence from African and Asian contexts (Nguyen et al., 2023), Internet use in Vietnam can promote inclusive growth only if complementary policies enable disadvantaged groups such as ethnic minorities, the less educated, and older household heads to effectively adopt and use digital technologies.

At the same time, it is important to acknowledge the study's limitations. Propensity score matching addresses selection bias on observables, but unobserved household characteristics such as motivation, risk preferences, or social networks may still influence both Internet adoption and welfare outcomes. Consequently, while the estimates are robust, they should not be interpreted as eliminating all possible endogeneity concerns. Future research could address these limitations through longitudinal data, instrumental variable approaches, or randomized interventions to better capture causal mechanisms.

This study reinforces the view that Internet use is more than a communication tool; it is a critical driver of rural development and poverty reduction. By enabling income growth, enhancing labor market participation, and improving household consumption, Internet adoption contributes directly to inclusive and sustainable growth, confirming earlier global evidence (World Bank, 2016). The Vietnamese case provides new nationally representative evidence and emphasizes the urgency of addressing the rural digital divide to maximize the welfare benefits of digital transformation.

5. Conclusion and policy implication

This study provides robust evidence that Internet adoption is associated with significant improvements in household welfare in rural Vietnam. Using nationally representative data and the propensity score matching method, the analysis shows that households with Internet access report higher income and greater expenditure, both in total and on a per capita basis. These findings are consistent across multiple matching techniques, underscoring their credibility. In essence, Internet use is linked not only to higher household earnings but also to improved consumption, thereby contributing to better living standards.

The findings highlight the transformative potential of Internet adoption in rural development. Digital access helps households overcome barriers of distance and information asymmetry, opening opportunities for non-farm employment, market participation, remittances, and social services. This underscores that Internet access is more than a communication tool it can act as a catalyst for inclusive growth and poverty reduction in rural contexts.

From a policy perspective, several implications emerge. First, expanding rural Internet infrastructure should remain a national priority, especially in disadvantaged regions such as the North East and Central Highlands. Second, affordability programs and subsidies may be necessary to help low-income households adopt digital technologies. Third, digital literacy initiatives particularly targeting older and less-educated household heads are essential to ensure that access translates into effective use. Finally, policies should pay special attention to vulnerable groups such as ethnic minorities, whose adoption rates remain lower, in order to prevent the widening of digital and welfare inequalities.

At the same time, caution is warranted in interpreting these results as definitive causal effects. While propensity score matching reduces selection bias on observable characteristics, unobserved factors such as entrepreneurial ability, risk preferences, or digital skills may simultaneously influence both Internet adoption and welfare outcomes. This suggests that the relationship observed is best understood as a conditional association rather than an absolute causal effect. Future research using panel data, instrumental variables, or experimental designs would provide stronger evidence on the causal mechanisms.

In conclusion, bridging the digital divide in rural Vietnam holds strong potential to enhance household welfare and support the country's pathway toward inclusive and sustainable development, provided that complementary policies address both access and effective use.

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