Article

Internet Access, Household Welfare, and Disaster Shocks in Indonesia: Evidence from IFLS5

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Abstract

This study examines the relationship between internet access and household welfare in Indonesia. Using micro-level data from the Indonesian Family Life Survey 5 (IFLS5), we investigate the effect of internet access, measured at the household level, on household welfare, proxied by total annual expenditure. Our analysis controls additional variables, including household size, education of the household head, age of the household head, labor force participation, and asset ownership. Using OLS and 2SLS with an instrumental variable, this study finds that internet access is positively associated with household expenditure. This suggests that digitalization improves household economic welfare in Indonesia. However, the interaction between internet access and disaster shocks has a negative and significant effect, implying that the welfare advantage of internet users is smaller in areas that have recently experienced natural disasters. Overall, the findings suggest that digitalization is associated with higher welfare in normal times, but that connectivity alone is insufficient to protect household welfare against disaster-induced consumption losses. These findings reveal the limits of digital connectivity as a resilience mechanism in disaster-prone developing economies and underscore the need for complementary policy interventions to ensure that the welfare gains from digitalization are sustained under adverse shocks.

Keywords: *Internet and household consumption, internet and household welfare, internet and disaster, SDG, internet in developing countries.*

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1. Introduction

In Indonesia, Information Communication and Technology (ICT), especially the internet, has been growing rapidly. According to the World Bank (2024), Indonesia's internet penetration has dramatically increased from 3.6% in 2005 to 69% in 2023. The majority of Indonesians have now been using the internet in their daily life activities to get news, to sell goods and services, to use banking facilities, and even to create social media content (Badan Pusat Statistik, 2024). Nasution (2023) reports that the country's government plans to increase penetration by providing more availability of high-speed internet, stating that good internet is essential for Indonesia's digital transformation.

Many scholars agree that there is a positive relationship between the internet and economic development. At the macroeconomic level, one evidence reported by Salahuddin & Gow (2016) shows that the internet has a positive impact on trade openness in OECD countries. Similar evidence is also seen in Asia, where it is mentioned that the internet promotes economic growth, especially in high-income countries (Kurniawati, 2022). Whilst at the household level, Bahia et al. (2024) illustrate that broadband internet has increased household consumption in Nigeria, which ultimately reduces poverty. Even though there is a large body of research on the internet and the economy, most of it focuses on macroeconomic data from developing countries. A few studies have used micro-level data, but they primarily focus on African countries. For example, Atta-Aidoo et al. (2023), Adams et al. (2021), and Bahia et al. (2024). Moreover, most of these studies focus on other measures of ICT rather than the internet. For example, mobile cellular subscription and mobile money. Therefore, this study aims to fill the gap by investigating the effects of the internet on household welfare.

Indonesia offers a particularly relevant and timely case to study. This country is projected to be among the world's largest economies by 2025, according to the Independent Observer (2025). Yet, Indonesia faces several development challenges. The country is marked by inequalities, complex household structures, and a large informal sector (Hapsari et al. 2023; Ralston et al. 2020). These features make it a critical testing ground for understanding how digital infrastructure, such as internet access, interacts with household-level welfare dynamics in real-world settings. Moreover, policies targeting digital inclusion in Indonesia are still evolving, which makes empirical evidence from household data particularly useful for informing future strategies.

This study attempts to answer the following questions: (1) Does the internet improve Indonesians' household welfare? (2) How does disaster shock affect the internet's impact on household welfare? This study examines a causal relationship between internet access and

household welfare using micro-level survey data from the Indonesia Family Life Survey 5 (IFLS5). It investigates how internet access improves household welfare, measured by expenditure. To address potential endogeneity problems, we use a 2SLS (two-stage least squares) model where household internet access is instrumented by community-level internet availability. Our study contributes to the literature by providing in-depth insight into how ICT, particularly the internet, would be economically beneficial to households. We provide micro-level empirical evidence on the effect of internet access on household welfare in Indonesia, using nationally representative panel data. Also, using community-level internet infrastructure as an instrument allows for more credible identification of causal effects.

2. Literature Reviews

(1) Internet in Indonesia

In Indonesia, the government introduced the internet in mid-1994. However, Hill & Sen (1997) report that in 1996, Indonesia had the lowest number of internet users among ASEAN countries, despite its growing popularity worldwide in 1995. The number of internet users in this country remained low until 1999, when it increased fivefold to 200,000. At the end of 1998, more than 100 cities in Indonesia had access to the internet with public access points in most provincial centers. Hill & Sen (2000) note that during the period of the 1990s, Indonesians accessed the internet mostly through internet telecommunication kiosks (*wartelnet*) that the government owned. *Wartelnet* was initially *wartel* (telecommunications kiosks), established by PT Pos Indonesia, a government-owned postal company. It was then extended to be *wireless* due to the popularity of public access internet after they established an ISP named Wasantara. Net. At this period, in addition to *wartelnet,* there were over 50 commercial public access points. These were mainly cafes or university campuses in major cities (Hill & Sen, 2000).

The number of internet users in Indonesia has been increasing since then. Data from World Development Indicators (WDI) by the World Bank shows that in the early 2000s, only around 2% of Indonesians had access to the internet. The number becomes around 69 % in 2023 (World Bank, 2024). Badan Pusat Statistik (BPS/Statistics Indonesia) (2025) reports that the upward trend in internet penetration has been observed across almost all regions of Indonesia, including rural areas. Riau province had the highest percentage of internet users in 2024, followed by DKI Jakarta with 89.26% and 87.84%, respectively. In Indonesia, the internet can be accessed at home or outside the home. At home, the internet relies on landline cables and mobile networks. While outside the home, people access the internet through offices, internet kiosks, and other types of public internet (Syakilah et al., 2025).

Past studies have shown the great role of the internet in shaping the Indonesian economy. In his paper, Nugroho (2010) writes that Non-governmental Organizations (NGOs) in Indonesia use the internet to support rural development in Indonesia. In 2024, it was found that the internet has improved the well-being of Indonesian fishermen (Putri et al., 2024). The internet has also become a foundation in building smart villages in Indonesia by being the village information system in the government and providing communication access (Susilowati et al., 2025). Yokota et al. (2025) suggest that the internet can be an effective means to alleviate poverty, particularly in provinces with low urbanization rates. Furthermore, recent World Bank survey evidence shows that internet connectivity supports income generation and market participation in both urban and rural Indonesia. According to Ralston et al. (2020), digital platforms have enabled households to access e-commerce, gain customers beyond their locality, and adopt online tools for micro-enterprise management. Moreover, programs such as Palapa Ring have contributed to internet expansion into Eastern Indonesia, allowing communities in remote areas to engage in online learning, telehealth, and financial services (World Bank, 2024; World Bank Blog, 2023). These developments highlight how internet access can reduce transaction costs and facilitate new forms of economic activity.

These growing examples indicate that internet access in Indonesia is not only expanding rapidly but also playing a pivotal role in enhancing rural connectivity, local productivity, and access to economic opportunities. As such, analysing its relationship with household welfare is an important step in understanding the country's broader development trajectory.

(2) Internet and Welfare

According to Mancini & Vecchi (2022), consumption has been the traditional measure of welfare used by economists, under the assumption that an individual's welfare relies on the consumption of food and goods. Deaton & Zaidi (2002) postulate that income, especially from self-employment, tends to be short-term fluctuated, but consumption is smoother and less variable. In addition, observing consumption over a short period could tell us more about annual living standards than income. This is why consumption is an appropriate measure of welfare in developing countries (Deaton & Zaidi, 2002).

Scholars have discussed the determinants of consumption. Among them is Friedman (1957), who proposes the permanent income hypothesis (PIH). The main components of PIH are permanent income, transitory income, and consumption smoothing. Transitory income is a temporary or one-time change in income, such as a bonus. According to Friedman (1957), households react less to transitory income. They smooth consumption over time. Rather than transitory or measured income, consumption depends on expected lifetime income. Further, what determines this permanent income are non-human wealth, hu-

man wealth, demographics, and preferences for savings or consumption (Friedman, 1957). After Friedman, Carroll (2001) expands this theory due to the argument that PIH does not fully capture real-world evidence. Carroll then instills liquidity constraints, precautionary savings, and income uncertainty into the model. According to the scholar, households do not just consume a smooth share of permanent income. Instead, they target a buffer of wealth to insure against shocks (Carroll, 2001). Building on Carroll's perspective, the ability of households to smooth consumption and maintain a buffer of resources depends heavily on access to timely information, financial tools, and income-generating opportunities. In this context, internet access can serve as a key factor of such mechanisms. For instance, digital connectivity may reduce income uncertainty by broadening access to job markets or facilitating small-scale business activities. It may also ease liquidity constraints through digital financial services such as e-wallets or online credit. Therefore, internet infrastructure may play a crucial role in helping households achieve the kind of consumption resilience envisioned in Carroll's framework. This linkage between internet access and household behavior under uncertainty provides a strong theoretical basis for exploring how digital technologies may influence welfare outcomes, particularly in developing economies where formal insurance and credit markets are limited.

Scholars have elaborated channels through which the internet can affect household welfare or consumption. ICT access can enhance welfare by expanding information flow. Nonvide (2023) writes that ICT creates better access to information. As a result, information asymmetry is reduced, and households can make better economic decisions with greater access to information. Likewise, improved access to information provides households with health-related information (Yang et al., 2021). This can reduce medical expenditures. The internet also helps people to learn new skills at low cost, also leading to better productivity (Banerjee & Duflo, 2014; Barrero et al., 2021). By providing access to information, the internet also supports financial inclusion. The internet provides access to the digital market, thereby giving households more options for goods and services and ultimately increasing their consumption (Luo et al., 2019). Similarly, digital payments supported by the internet have led to higher financial transactions (Calderon, 2025). Therefore, by improving financial inclusion, the internet increases household consumption.

Additionally, internet access affects labor market participation (Johnson & Persico, 2024). The Internet helps job seekers find jobs, thereby reducing the unemployment period (Kuhn & Mansour, 2014). The internet also improves the recruitment process by providing better access to candidate information (Bhuller et al., 2020). According to Masaki et al. (2020), there are four labor outcomes from the use of the internet: (1) employment, (2) wage and salaried employment, (3) formal employment, and (4) earnings per month or wage. From these, it can be concluded that by enhancing labor force participation, the internet helps households earn higher incomes and, in turn, consume more. Further, internet access facili-

tates income diversification by connecting households to multiple income-generating activities. According to Hua & Zhang (2023), internet use at work has significantly increased the income of young Chinese people. This is due to the easy access to work information provided by the internet. These empirical results provide robust support for the argument that internet access functions as a consumption-smoothing and welfare-enhancing mechanism. Digital connectivity directly enhances individual welfare through both greater use intensity and greater inclusion of previously disconnected individuals.

Hence, the internet may influence household welfare through multiple interconnected mechanisms: (1) improved access to information; (2) expanded access to financial services and savings tools; (3)improved job market; and (4)income diversification. These mechanisms suggest a potential positive relationship between internet access and household consumption, thereby improving welfare.

(3) Shocks and Welfare

Hill et al. (2011) write three kinds of economic shocks. First, shocks caused by downturns in the national economy. Second, by downturns in particular industries that constitute an important component of the region's export base. Third, other external shocks, including natural disasters. To support this, Sutton & Arku (2022) elaborate eight broad categories of shocks: economic, institutional, organizational, environmental, man-made, technological, and epidemic. Likewise, scholars have identified various events as shocks to the economy. For example, natural disasters, pandemics, and industrial closures (Arouri et al., 2015; Sutton & Arku, 2022).

Within these broad categories of shocks, natural disasters represent significant events that cause sudden and often widespread damage to lives, infrastructure, and productive capital (Felbermayr & Gröschl, 2013). The disaster economics literature characterizes floods, earthquakes, storms, and droughts as exogenous hazards that can destroy both physical and human capital, disrupt markets, and slow down long-run development, with particularly severe consequences in low- and middle-income countries (Botzen et al., 2019). Because formal insurance coverage and public safety nets are often limited in these settings, the welfare consequences of natural disasters can be substantial and long-lasting, pushing vulnerable households into or deeper into poverty.

According to Sutton et al. (2023), shocks can have immediate negative impacts on the economy. For example, job losses, business closures, and ruined infrastructure. Further, theoretical models of consumption under uncertainty highlight several mechanisms through which disasters affect welfare. In buffer stock models, a disaster can be represented as a large negative shock to both current income and accumulated wealth, reducing the resources households can draw upon to maintain consumption (Carroll, 2001). When liquid assets and access to credit are limited, households are forced to adjust by cutting non es-

sential expenditures, selling productive assets, or withdrawing children from school, all of which have adverse implications for present and future welfare (Baez et al., 2010; Dercon, 2004). Asset-based models of poverty traps similarly emphasize that if a shock pushes a household below a critical asset threshold, it may become difficult to rebuild, leading to sustained low consumption and chronic poverty (Carter & Barrett, 2006).

(4) Empirical Evidence

Recent empirical studies have increasingly focused on the welfare impacts of digital technologies in developing countries, using both macro-level and micro-level data. Most of these studies rely on observational data but apply causal identification strategies such as instrumental variables, system GMM, or entropy balancing. At the macro level, Apeti (2022) investigates whether mobile money adoption reduces household consumption volatility across 76 developing countries. The study uses entropy balancing to create a credible comparison group of countries that had not adopted mobile money. The findings indicate that mobile money significantly reduces welfare volatility, with the strongest effects observed in poorer and less financially developed countries. Although the analysis is at the country level, the outcome variable is based on household consumption trends. This makes the results relevant for understanding aggregate dynamics of household welfare.

At the micro level, Bahia et al. (2024) use panel data from the Nigerian General Household Survey and geospatial information on 3G rollout to analyse the impact of mobile broadband access on household welfare. Using a difference-in-differences approach, they find that 3G access increases household consumption, particularly in urban areas and among female-headed and more educated households. However, they find no significant effect in rural areas, suggesting that the benefits of internet access are unevenly distributed. Similarly, Nonvide (2023) finds that the use of ICT increases agricultural households' consumption expenditure by 89.6 percent in Benin, using an endogenous switching regression model to control for endogeneity and selection bias.

Matching techniques have also been employed to isolate causal effects. Mora-Rivera & García-Mora (2021) analyze the impact of internet access on poverty in rural Mexico. Using propensity score matching (PSM), they find that households with internet access are more likely to escape poverty and have higher education and health outcomes. Similarly, Phan (2023) employs PSM to assess the internet's effect on multidimensional poverty in Vietnam. The results indicate that households with internet access have significantly lower multidimensional poverty scores, particularly in terms of education and living standards.

Several recent studies apply instrumental variable (IV) techniques to address endogeneity issues. Xue & Liu (2024) explore the effect of internet use on health outcomes using community-level internet use frequency and broadband speed as instruments. Their findings reveal significant improvements in self-reported health among older adults, indicating

broader welfare effects. Kharisma (2022) examines the effect of internet access on social capital in Indonesia using the Indonesia Family Life Survey 5 (IFLS5) data and an IV strategy that leverages the geographic rollout of access. They find that internet usage improves bridging social capital, especially in Java and urban areas.[1] Similarly, J. Ma & Njangang (2025) employ a two-stage IV approach to investigate how gender inequality in internet access impacts household energy poverty, demonstrating that digital exclusion among women can exacerbate welfare gaps. Similar results have also been reported in Indonesia by Nurarifin & Ridena (2020). This study uses macro-level data derived from the Badan Pusat Statistik (BPS/Statistics Indonesia) from 2012 to 2017 to determine whether ICT development and human capital can improve welfare. After employing 2SLS with IV and System GMM, the results show that ICT is positively associated with higher GDP, but it must be supported by human capital (skills, health, and productivity). ICT development index, the endogenous variable, is instrumented with life expectancy and expected years of schooling.

Further, a study by Miyajima (2022) employs Fixed Effects Model with IV, along with pooled OLS and GMM, to investigate the impact of mobile phone ownership on individuals' consumption in South Africa. Using data from the National Income Dynamics Study (five waves during 2008 to 2017), it is found that mobile phone owners tend to consume 13 percent more than those without. In this study, mobile phone ownership, as an endogenous variable, is instrumented using an interaction term between geography-level mobile phone ownership and individual characteristics.[2] Another similar study uses data from the 2017 China Household Finance Survey to examine whether mobile payment use increases rural household consumption (Zhang et al., 2022). The authors employ 2SLS with IV, instrumenting mobile payment with the household's number of smartphones, arguing for strong relevance (phones enable mobile payments) and exclusion from consumption except via channels such as mobile payments/online shopping. The results show that mobile payment users have approximately 30% higher consumption than non-users.

Regarding the effect of disasters, empirical studies provide consistent evidence that natural disasters reduce household welfare. Using cross-country data, Noy (2009) finds that disasters significantly lower short-run GDP growth, with stronger effects in developing economies. At the micro level, Baez et al. (2010) document that exposure to natural disasters in Latin America leads to declines in consumption, schooling, and health outcomes, particularly among poorer households. Studies on Asian countries also show that floods and droughts decrease household consumption and increase poverty, while recovery is often slow and incomplete (Sawada & Takasaki, 2017). Arouri et al. (2015) report that storms, floods, and droughts are negatively associated with household income and expenditure in rural Vietnam. This finding is obtained by employing the Fixed Effects model on panel micro-level data from the Vietnam Household Living Standard Survey for the years 2004, 2006, 2008,

and 2010. Likewise, Wu et al. (2022) examine the impact of natural disasters on household wealth. After using multiple regression analysis and PSM to analyze data from the China Family Panel Survey for the years 2014, 2016, and 2018, the authors conclude that natural disasters negatively affect household wealth, particularly among households with more family members and higher consumption.[3] Another study by Dartanto (2022) uses data from the Indonesian Family Life Survey (IFLS) years 2000 and 2007 and regresses them using OLS and ordered logit models to determine whether households' consumption and poverty status can change due to natural disasters. The results show that natural disasters reduce consumption, hence lower welfare, and influence poverty status. These findings are consistent with the view that disasters act as major negative shocks to income and assets, and that incomplete insurance and credit markets translate these shocks into substantial welfare losses.

Our literature review yields several conclusions. First, while many studies have examined the impact of ICT on welfare, few focus specifically on the benefits of the internet. Second, these studies have used diverse samples and econometric methods, yet more evidence based on micro-level data from Asian countries is needed. Our study fills this gap by examining the impact of internet access on household welfare using data from Indonesia. In addition, there is a dearth of studies that include disaster shocks as a factor influencing the internet's impacts on welfare. Our review suggests that disasters can affect the positive welfare effects of the internet, as we will examine below.

3. Data and Methodology

(1) Data

This study aims to investigate the impact of the internet on the welfare of Indonesian households. We draw our sample from the fifth round of the Indonesian Family Life Survey (IFLS) conducted between 2014 and 2015. IFLS is a longitudinal survey in Indonesia organized by the RAND Corporation (United States) in collaboration with several local institutions, such as Universitas Indonesia. Among organizations that have funded IFLS are the United States government, United States Agency for International Development (USAID), the Government of Australia, the World Bank, and the National Institute of Aging (NIA) (RAND Corporation, 2025). According to Strauss et al. (2016), IFLS represents approximately 83% of the Indonesian population and covers 13 provinces in 1993. The fifth round of IFLS (IFLS5) was conducted in late 2014 on almost the same set of samples, which were 16,204 households and 50,148 individuals. The analytical sample for this study was constructed by integrating several IFLS5 modules. The integration process allows the combination of information on household welfare, internet access, and community-level char-

Table 1 List of variables and definitions.

Variable	Description	Unit of Measurement
Internet access	Household has internet access at any location	0 = No internet access, 1 = Household has internet access
Netvillage	Availability of internet at the village office	0 = No internet, 1 = Internet available
Shock	Household exposure to a severe natural or other disaster in the last five years.	0 = No disaster, 1 = Experienced disaster
Household size	Household size (number of members)	Continuous number
Head_age	Age of household head	Continuous number
Head_edu	Education level of household head	1 = No/Not yet in school, 2 = Elementary, 3 = Junior high, 4 = Senior high, 5 = University/Diploma, 6 = Postgraduate
LFP	Labor force participation rate per household[4)]	Continuous number
Anyone_worked	Any household member worked	1 = yes, 0 = no
Total expenditure pc	Per capita expenditure (total)	Natural log of total expenditure per capita
Asset ownership	Household owns its house	1 = own house, 0 = not owning the house

acteristics.

The main explanatory variable in this study is household-level internet access. This information was obtained from Book 3A (Section DL—Education), particularly question DL03d ("Do you have internet access?"). Because this item is collected at the individual level, responses were aggregated to the household level using the household identifier (hhid14). We assign a value of 1 if any member reported internet access and 0 otherwise. The resulting binary variable represents whether any household member had internet access in 2014. The dependent variable in this study is household welfare, proxied by total consumption expenditure per capita. The data are derived from Book 1 (Sections KS0-KS3), which records detailed expenditures on food, non-food items, self-produced goods, and education. These components are summed to obtain total household expenditure, which is expressed in millions of Indonesian Rupiah. To reduce heteroskedasticity and improve interpretability, the natural logarithm of total expenditure is used in the regression model. Hence, the variable is named as ln (Consumption), representing the log of total household expenditure.

These household datasets are merged with other variables in Book 1 (Community Characteristics) and Book 2 (Community Facility and Household Economy). Book 1 also includes village-level infrastructures, such as internet availability at the village office (A9A), road types, and electricity coverage. Book 2 contains data on loan access (BH Section) and other community attributes. From Book 1 and 2, several household-level control variables are constructed. These include the age and education level of the household head, house-

hold size, labor force participation, house renovation, and house ownership.[5] Our instrumental variable is community-level internet availability, measured by whether the village office in the community had internet access in 2014 (A9A = 1, Book 1). These datasets are merged using the household and community identifiers (hhid14 and COMMID14). Households with missing or implausible expenditure values, inconsistent identifiers, or missing community-level ICT information were excluded. After merging and cleaning, our final merged dataset initially contains 8,192 observations with valid consumption and community identifiers. Due to missing observations in some explanatory variables, the estimation sample used in the regression analysis differs across model specifications, ranging from 4,268 to 5,187 observations. This variation reflects listwise deletion performed automatically by Stata, as households with incomplete data on included variables are excluded from estimation. This is typical for micro-level data, particularly IFLS, which combines household and community modules with partial response coverage. Table 1 demonstrates the variables used in our regressions.

(2) Model and Methods

Drawing on the consumption-smoothing and vulnerability literature, as well as empirical evidence on the welfare effects of digital technologies and natural disasters, this study formulates the following hypotheses.

1. H1: Households with internet access have higher consumption expenditure per capita than otherwise similar households without access.
2. H2: Exposure to natural disasters weakens the welfare-enhancing effects of internet access on household expenditures.

Our empirical models examine the relationship between internet access and household welfare. The baseline specification is as follows.

$$ln(consumption)_{ih} = \beta_0 + \beta_1 Internet\ Access_{ih} + \beta_2 X_{ih} + \gamma_p + \varepsilon_{ih} \quad (1)$$

In this model, ih indexes households, and p denotes the province. $Internet\ Access_{ih}$ is a binary indicator equal to one if at least one household member has Internet access. X_{ih} is a vector of household characteristics, including age and education of the household head, household size, and asset ownership. γ_p captures province fixed effects that control for time-invariant differences across provinces, such as overall development level, infrastructure, or prices. In equation (1), the OLS estimate β_1 may be biased because unobserved factors that affect both internet access and household consumption are omitted from the model. For example, better-educated household members may both earn higher income (raising consumption) and be more likely to adopt the internet. Likewise, unobserved local infrastructure and economic opportunities can simultaneously increase internet availability and household spending. If these unobserved factors are not fully captured by X_{ih} and γ_p,

the error term ε_{ih} remains correlated with *Internet Access*$_{ih}$ which leads to omitted variable bias. In addition, households with higher incomes are more able to access the internet as they can purchase electronic devices and data plans. Thus, household consumption can influence internet access and create simultaneity bias between the regressor and error terms in equation (1). This potential reverse causality problem reflects another endogeneity bias that needs to be addressed.

To address these issues, we employ an instrumental variable (IV) model that affects internet access but is not affected by consumption expenditure. According to Angrist & Krueger (2001), an instrumental variable should be correlated with the endogenous regressor for reasons the researcher can verify and explain, but uncorrelated with the outcome variable. In our study, we select "the availability of internet access in the village office" (netvillage) as the instrument variable for the following reasons. First, netvillage represents local infrastructure driven by the government rather than household choices. Angrist & Krueger (2001) believe that valid instrument variables often come from institutional details or policy environments that generate quasi-experimental variation. Second, netvillage can influence household internet access. Yet, netvillage does not directly affect the household expenditure, nor is it directly affected by it. In other words, netvillage is endogenous to household internet access and exogenous to household consumption.

Instrumental Variables (IV) is widely used to examine causal inference, and scholars have combined it with 2SLS (Angrist & Krueger, 2001; Mogstad et al., 2019). Among previous studies that have employed this method are those by Zhang et al. (2022) and Zhao et al. (2025). Hence, we employ 2SLS-IV in our analysis. The first-stage regression relates household internet access to the instrumental and control variables. The predicted values are then used in the second stage to estimate the impact on household welfare. Our 2SLS-IV specifications are:

$$Internet\ access_{ih}=\alpha_0+\alpha_1 Netvillage_c+\alpha_2 X_{ih}+\gamma_p+\upsilon_{ih} \quad (2)$$

$$ln\ Consumption_{ih}=\beta_0+\beta_1 \widehat{Internet\ access}_{ih}+\beta_2 X_{ih}+\gamma_p+\varepsilon_{ih} \quad (3)$$

Equations (2) and (3) are respectively the first and second stage of regressions, where $Netvillage_c=1$ if the village office has internet access, and $\widehat{Internet\ access}_{ih}$ is the fitted value from the first-stage regression. The vector X_{ih} and province fixed effects γ_p are defined as in equation (1).

4. Results and Discussions

(1) Main Results

Our study aims to examine the effect of the internet on Indonesian households' consump-

tion. Table 2 displays regression results using OLS, the second stage of 2SLS, and the first stage of 2SLS, with household consumption as the dependent variable and internet access as the main explanatory variable. The data we use are cross-sectional Indonesian household data derived from IFLS5. From Table 2, the coefficients of the household head's education are positive. This implies that education positively influences welfare, measured by consumption expenditure, as Becker (1964) argued. Likewise, Ma et al. (2020) report that education is an important component of household expenditure. Further, household size has a positive influence on household expenditure because larger households tend to have higher consumption (Deaton & Paxson, 1998). Asset ownership is proxied by owning a house; this means we assume that households that own their homes are generally richer. Therefore, the positive coefficients of asset ownership are aligned with our assumption. Likewise, the labor participation rate has a positive and significant coefficient. This supports the findings of Amadi et al. (2024) and Chu & Zhang (2023).

In the last column of Table 2, in the first stage regression, internet access is regressed with netvillage and the same set of controls as the second stage (2SLS). The results display that netvillage is positively associated with internet access, with a coefficient of 0.09. This means households in villages with internet availability at their village office are roughly 9% more likely to report internet access than those living in villages without such infrastructure. In other words, netvillage is related to our endogenous variable (internet access). In addition, the F-test result in column 2SLS of Table 2 reveals the validity of netvillage as an instrument variable, showing that netvillage is a predictor of internet access. These two factors confirm that netvillage is a proper instrument variable for our model. The first-stage results further describe how community-level internet infrastructure is associated with household-level internet access. Beyond the instrument netvillage, the control variables in the first stage also show patterns consistent with expectations. The education of the household head (head_edu) is positively associated with internet access, suggesting that more educated households are more likely to adopt the internet. This is likely because they have a greater ability to use and benefit from digital services. Household size is also positively associated with internet access, which may reflect that larger households have more members with varying employment and educational backgrounds, increasing the probability that at least one member has internet access. By contrast, the age of the household head (head_age) is negatively associated with internet access, consistent with the general finding in the literature that older household heads are less likely to adopt digital technologies (Xue & Liu, 2024). Asset ownership shows a positive association, indicating that wealthier households, proxied by home ownership, are more likely to have internet access. The labor force participation (LFP) rate, however, enters with a negative sign, which may reflect that households with higher shares of working-age members engaged in labor are spending more time in physical work settings rather than in digital activities. The R-

Table 2 Impacts of internet access on household welfare

IFLS5 2014 VARIABLES	OLS Total expenditure pc	2SLS Total expenditure pc	First Stage Internet access
		IV: Netvillage	
Internet access	0.392***	0.644***	
	(0.0186)	(0.229)	
Netvillage			0.0937***
			(0.0242)
Head_edu	0.0782***	0.0628***	0.0576***
	(0.00653)	(0.0154)	(0.00675)
Household size	−0.104***	−0.109***	0.0197***
	(0.00298)	(0.00549)	(0.00265)
LFP rate	0.0136	0.0333	−0.0739***
	(0.0217)	(0.0284)	(0.0153)
Head_age	−0.00468***	−0.00522***	0.00206**
	(0.000789)	(0.000943)	(0.000847)
Asset ownership	0.102***	0.0997***	0.0139
	(0.0238)	(0.0243)	(0.0193)
Constant	15.87***	15.81***	0.197***
	(0.0590)	(0.0764)	(0.0414)
Observations	5,187	5,187	5,187
R-squared	0.328	0.304	0.087
Province fixed effects	Yes	Yes	
F test		35.25	

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

squared of the first stage is 0.087, which is modest but typical for cross-sectional IV regressions with binary endogenous variables where the instrument captures only one dimension of infrastructure variation (Kharisma, 2022; Miyajima, 2022). Overall, the first-stage results confirm that netvillage satisfies the relevance condition, and the pattern of control variable coefficients is broadly consistent with the prior literature on the determinants of internet adoption in developing countries.

Most importantly, the coefficients of internet access, our main variable, are positive and significant in both OLS and IV-2SLS regressions. Here, internet access is instrumented by netvillage. The coefficient on internet access is positive and statistically significant, suggesting that households with internet access have higher welfare, measured by total expenditure. In magnitude, the 2SLS estimate of 0.64 implies that internet access is associated with roughly 64 percent higher household expenditure, holding other factors constant. This is a substantial effect, indicating that internet connectivity can play an important role in improving household economic welfare in Indonesia. In addition, the coefficient of internet access in the 2SLS result is larger than the OLS coefficient (0.39), suggesting a causal effect after addressing endogeneity. Further, this larger coefficient in the 2SLS result is consistent with the finding of Acemoglu et al. (2001) that may indicate measurement error in reported internet access and negative selection into internet adoption are more critical than omitted variables that would inflate the OLS coefficient. Given that internet access in

IFLS5 is self-reported and captured only as a 0/1 status rather than as an intensity measure of quality, some degree of measurement error is likely. The 0.64 coefficient on internet access in the 2SLS results implies that households with internet access have 64% higher total expenditure. This is consistent with our arguments that internet access increases household expenditures in Indonesia. These findings are in line with the work of Ma et al. (2020), who find that internet use increases income and expenditure of rural Chinese households. Our results confirm our hypothesis that internet access significantly improves household welfare.

Scholars have postulated several reasons why technology, proxied by internet access, has positive impacts on household expenditures. In accordance with Nonvide (2023), the internet provides better access to information. This includes financial and health information. Hence, it enables households to make better decisions in many aspects of life, ultimately increasing their welfare. Furthermore, the internet also functions as a catalyst for financial inclusion. Scholars report that financial inclusion induces households to consume more (Calderon, 2025; Luo et al., 2019). Beyond these channels, the internet improves labor participation and helps households to diversify their income (Hua & Zhang, 2023; Johnson & Persico, 2024). Collectively, these mechanisms help explain the robust positive relationship between internet access and household consumption observed in our empirical analysis.

While these baseline results establish a robust positive association between internet access and household consumption, they do not yet reveal how this effect varies when households are exposed to adverse events such as natural disasters. Building on the rich IFLS5 information on shocks and disasters at the household level, the next subsection therefore examines interaction terms between internet access and shocks to assess whether connectivity helps Indonesian households better cope with and smooth consumption in the face of negative events.

(2) Interaction Terms with Disaster Shocks

This subsection examines whether the welfare gains from internet access differ between households that were recently exposed to natural disasters and those that were not. We derive our variable from IFLS5 community data from b2_nd1. dta, which records whether the respondent experienced a natural disaster in the past five years and the type of disaster. The analysis augments the baseline specification with interaction terms between internet access and disaster exposure indicators. This allows assessment of whether the internet benefits on the household expenditures remain strong when households experience disaster shocks.

Table 3 displays the regression results of our extended analysis. Our models include the interaction of internet access and shock, proxied by respondents' answers on experiencing natural disasters. Shock is a binary variable, with 1 indicating exposure to any natural di-

Table 3 Internet access, disaster shocks, and household consumption expenditure per capita (interaction effects, OLS, and 2SLS).

IFLS5 2014 VARIABLES	OLS Total expenditure pc	2SLS Total expenditure pc
		IV: Netvillage
Internet access	0.416***	0.784***
	(0.0214)	(0.237)
Shock	0.0274	0.426**
	(0.0329)	(0.167)
Internet access*shock	−0.0359	−0.754***
	(0.0429)	(0.285)
Head_edu	0.0864***	0.0645***
	(0.00657)	(0.0158)
Household size	−0.100***	−0.107***
	(0.00300)	(0.00574)
Head_age	−0.00427***	−0.00547***
	(0.000797)	(0.000959)
Asset ownership	0.0401*	0.100***
	(0.0237)	(0.0248)
LFP	0.0238	0.0276
	(0.0219)	(0.0291)
Constant	15.86***	15.73***
	(0.0483)	(0.0838)
Observations	5,187	5,187
R-squared	0.295	0.276
F test		17.09

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

saster in the last five years and 0 indicating no exposure. In Table 3, the coefficients of internet access*shock are negative in both OLS and 2SLS-IV, and strongly significant in 2SLS. These estimates suggest that internet access is associated with higher per capita total expenditure for all households, but the magnitude of this welfare gain is smaller for those who have recently experienced a disaster. In the 2SLS-IV specification, households without disaster exposure experience a 78% increase in expenditure from internet access, whereas exposed households experience a roughly 0.3% increase, almost zero, once the negative interaction is taken into account.[6] This implies that disasters partially erode the consumption premium associated with internet access, rather than reversing it. A similar pattern appears in the OLS results, although with smaller magnitudes. Additionally, this may suggest that the originally negative effects of shocks are even more pronounced when households have internet access.[7]

These results suggest that disaster shocks may weaken households' ability to translate digital access into higher economic welfare. Our results are contradictory to Do et al. (2025), who state that internet access has positive impacts on household resilience capacity during disasters. Several mechanisms may explain this moderation. First, disaster-affected households typically incur significant recovery costs, such as infrastructure repair, health expenditures, and temporary income losses (Agarwal et al., 2024; Wu et al., 2022). Internet

access may even be the one lost due to disasters. Hence, its benefits during these phases are reduced or even become negative. Second, natural disasters often disrupt digital infrastructure, limiting the reliability or usefulness of internet services during the recovery period (Ayers & Birk, 2024). Third, shocks may shift household priorities away from digitally facilitated economic opportunities toward more immediate coping strategies (Jalili et al., 2025; Padhan & Madheswaran, 2023).

Empirical evidence on the impacts of shocks also supports our results. Arouri et al. (2015) report that natural disasters (storms, floods, and droughts) have negative effects on income and consumption among Vietnamese households, even in the presence of technology. Similar results are found in China, where natural disasters have reduced households' income and thus negatively affect their consumption levels (Wu et al., 2022). More importantly, Dartanto (2022) claims that having experienced natural disasters has reduced Indonesian household consumption. From these studies, it can be concluded that disaster shocks can greatly affect welfare and infrastructure. Our results on Indonesian households add to this literature by showing that internet access improves welfare in normal times, yet disasters still reduce the size of that improvement

5. Conclusions and Policy Recommendations

This study examines whether access to and use of the internet improve household welfare outcomes in Indonesia, using nationally representative IFLS data and 2SLS with instrumental variables. We use netvillage (internet availability at the village office) as the instrument variable. The regression results indicate that households with internet access and more intensive internet use tend to have higher consumption, after controlling for household composition, education, labor status, and community fixed effects. This shows that better access to and use of the internet is associated with higher household welfare in Indonesia.

Our study further aims to test mechanisms to explore whether internet access benefits remain in the presence of shocks such as natural disasters. The interaction term between internet access and shocks enters with a negative coefficient in all models. The IV-2SLS specification shows statistically significant results, which means that the positive association between internet and expenditure is smaller for households that experienced shocks, in line with our hypothesis.

These results have several policy implications. First, they support the continued expansion of internet infrastructure to underserved areas, particularly rural and poorer regions. Second, the government should consider measures to lower the effective price of internet access for low-income households. For example, affordable data packages, targeted subsi-

dies, or support for shared access points. Third, improving the quality of connections—especially speed and reliability—is important so that households can use the internet for productive activities such as job search, online business, digital finance, and access to education and health information. These are the main channels through which welfare gains arise. Complementary investments in human capital are also essential. Enhancing basic education and providing community-based digital literacy and financial literacy programs can help households to translate connectivity into concrete welfare improvements.

Further, the negative and significant interaction term suggests that current patterns of internet use do not automatically protect connected households from the welfare impact of shocks. Therefore, disaster-related policies should not assume that connectivity alone increases resilience. Instead, policy needs to explicitly design and promote digital applications for disaster risk management. This includes strengthening early-warning systems that reach households through mobile phones and online platforms, using digital channels to provide timely information on relief and recovery programs, and expanding secure digital payment systems to deliver emergency cash transfers quickly and transparently. Local governments and communities also need support to develop clear procedures and skills for using these tools during crises. By combining broader internet expansion and affordability policies with targeted human capital investments and disaster-specific digital interventions, Indonesia can better ensure that the welfare benefits of the internet are realized in normal times and are not eroded when natural disasters strike.

Finally, it is important to highlight that this study uses cross-sectional data from a single wave of IFLS5 (2014), which precludes dynamic analysis of how internet access affects household welfare over time. However, several features of our design mitigate this limitation. First, the use of 2SLS with a community-level instrument (netvillage) addresses the endogeneity that panel fixed effects would otherwise handle, allowing for credible causal identification in a cross-section. A stronger instrument variable would further improve identification. Second, the richness of IFLS5 provides more granular micro-level evidence than is possible with provincial or aggregate panel data. Future research using multiple IFLS waves (e.g., IFLS4 and IFLS5), or more recent datasets could extend this analysis to capture the dynamic welfare effects of internet adoption.

Notes

1) Social capital contains of trust, cooperation, and social networks. These elements are derived by the author from questionnaire answers of IFLS5 2014 (Kharisma, 2022).
2) Level of education, jobs, and geography (Miyajima, 2022).
3) Wu et al. (2022) derive "household net wealth" from household net assets including financial assets, and non-financial assets, such as real estate and buildings. They sum total household asset and deduct with household liabilities.
4) See footnote 5.

5) Labor Force Participation (LFP) rate in our study is calculated as the number of working age household members (15-64) who worked last week divided by the total number of working age household members in the household.

6) Effects of internet access without shocks = 0.784; effects of internet access with shocks = 0.784 + (−0.754) = 0.03; effects of shocks when there is no internet = 0.426; effects of shocks when there is internet = 0.426 + (−0.754) = −0.33.

7) The first-stage F-statistic in this extended specification is 17.09, which remains above the conventional threshold of 10, confirming that netvillage retains its relevance as an instrument when the interaction term is included (Stock & Yogo, 2005).

References

Acemoglu, Daron, Simon Johnson, and James A. Robinson. 2001. The Colonial Origins of Comparative Development: An Empirical Investigation. *American Economic Review,* 91.

Adams, A., E. T. Jumpah, and L. D. Caesar. 2021. The Nexuses between Technology Adoption and Socioeconomic Changes among Farmers in Ghana. *Technological Forecasting and Social Change,* 173. 〈https://doi.org/10.1016/j.techfore.2021.121133〉

Agarwal, S., P. Ghosh, and H. Zheng. 2024. Consumption Response to a Natural Disaster: Evidence of Price and Income Shocks from Chennai Flood. *Energy Economics,* 131. 〈https://doi.org/10.1016/j.eneco.2024.107323〉

Amadi, D., R. C. Nwikina, and G. Christian. 2024. Labour Force Participation and Household Consumption: Rivers State Experience. *International Journal of Advanced Research and Learning,* 3(3).

Angrist, Joshua D., and Alan B. Krueger. 2001. Instrumental Variables and the Search for Identification: From Supply and Demand to Natural Experiments. *Journal of Economic Perspectives,* 15 (4), 69-5.

Apeti, A. E. 2022. Household Welfare in the Digital Age: Assessing the Effect of Mobile Money on Household Consumption Volatility in Developing Countries. *World Development,* 161, 106110. 〈https://doi.org/10.1016/j.worlddev.2022.106110〉

Arouri, M., C. Nguyen, and A. Ben Youssef. 2015. Natural Disasters, Household Welfare, and Resilience: Evidence from Rural Vietnam. *World Development,* 70, 59-77. 〈https://doi.org/10.1016/j.worlddev.2014.12.017〉

Atta-Aidoo, J., E. C. Matthew, A. O. Saleh, and S. Bizoza. 2023. A Gendered Analysis of the Effect of Financial Inclusion on Household Welfare in Burundi. *Review of Development Economics.* 〈https://doi.org/10.1111/rode.13046〉

Ayers, S., and T. Birk. 2024. *Resilient Telecommunications Infrastructure: A Practitioner's Guide 2024.* Washington, DC: World Bank.

Badan Pusat Statistik. 2024. *Statistik Telekomunikasi Indonesia 2023.*

Baez, J., A. De La Fuente, and I. Santos. 2010. Do Natural Disasters Affect Human Capital? An Assessment Based on Existing Empirical Evidence. IZA Discussion Paper No. 5164.

Bahia, K., P. Castells, G. Cruz, T. Masaki, X. Pedrós, T. Pfutze, C. Rodríguez-Castelán, and H. Winkler. 2024. The Welfare Effects of Mobile Broadband Internet: Evidence from Nigeria. *Journal of Development Economics,* 170. 〈https://doi.org/10.1016/j.jdeveco.2024.103314〉

Banerjee, Abhijit V., and Esther Duflo. 2014. (Dis) Organization and Success in an Economics MOOC. *American Economic Review: Papers & Proceedings,* 104(5), 514-518. 〈https://doi.org/10.1257/aer.104.5.514〉

Barrero, Jose Maria, Nicholas Bloom, and Steven J. Davis. 2021. Internet Access and Its Implications

for Productivity, Inequality, and Resilience. NBER Working Paper No. 29102. 〈http://www.nber.org/papers/w29102〉

Becker, Gary S. 1964. *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education,* First Edition. Cambridge, MA: NBER. 〈http://www.nber.org/books/beck-5〉

Bhuller, Manudeep, Andreas R. Kostøl, and Trond C. Vigtel. 2020. How Broadband Internet Affects Labor Market Matching. IZA Discussion Paper No. 12895. 〈www.iza.org〉

Botzen, W. J. W., Deschenes, O., & Sanders, M. (2019). The economic impacts of natural disasters: A review of models and empirical studies. *Review of Environmental Economics and Policy, 13*(2), 167–188. https://doi.org/10.1093/reep/rez004

Calderon, A. A. 2025. Digital Payments and Their Role in Enhancing Financial Transactions Efficiency. *International Journal of Economics and Financial Issues,* 15(1), 182–189. 〈https://doi.org/10.32479/ijefi.17555〉

Carroll, Christopher D. 2001. A Theory of the Consumption Function, With and Without Liquidity Constraints. *Journal of Economic Perspectives,* 15(3), 23–45.

Chu, L., and Q. Zhang. 2023. Do Women's Working Hours Inputs Yield Higher Household Economic Welfare than Men's? *Heliyon,* 9(11). 〈https://doi.org/10.1016/j.heliyon.2023.e21437〉

Dartanto, T. 2022. Natural Disasters, Mitigation and Household Welfare in Indonesia: Evidence from a Large-Scale Longitudinal Survey. *Cogent Economics and Finance,* 10(1). 〈https://doi.org/10.1080/23322039.2022.2037250〉

Deaton, Angus, and Christina Paxson. 1998. Economies of Scale, Household Size, and the Demand for Food. *Journal of Political Economy,* 106(5), 897–930. 〈https://doi.org/10.1086/250035〉

Deaton, Angus, and Salman Zaidi. 2002. Guidelines for Constructing Consumption Aggregates for Welfare Analysis. Living Standards Measurement Study Working Paper No. 135.

Dercon, Stefan. 2004. Growth and Shocks: Evidence from Rural Ethiopia. *Journal of Development Economics,* 74(2), 309–329. 〈https://doi.org/10.1016/j.jdeveco.2004.01.001〉

Do, M. H., T. T. Nguyen, and U. Grote. 2025. Insights on Household's Resilience to Shocks and Poverty: Evidence from Panel Data for Two Emerging Economies in Southeast Asia. *Climate and Development.* 〈https://doi.org/10.1080/17565529.2024.2446358〉

Felbermayr, G., & Gröschl, J. (2013). *Naturally Negative: The Growth Effects of Natural Disasters* (4339; CESIFO Working Paper). www.RePEc.org

Friedman, Milton. 1957. *A Theory of the Consumption Function.* Princeton: Princeton University Press.

Hapsari, I. M., S. Yu, U. J. Pape, and W. Mansour. 2023. Informality in Indonesia: Levels, Trends, and Features. World Bank Policy Research Working Paper No. 10586. 〈http://www.worldbank.org/prwp〉

Hill, David T., and Krishna Sen. 1997. Wiring the Warung to Global Gateways: The Internet in Indonesia. *Indonesia,* 63, 67–89. 〈http://www.jstor.org/stable/3351511〉

Hill, David T., and Krishna Sen. 2000. The Internet in Indonesia's New Democracy. *Democratization,* 7(1), 119–136. 〈https://doi.org/10.1080/13510340008403648〉

Hill, Edward, Travis St. Clair, Howard Wial, Harold Wolman, Patricia Atkins, Pamela Blumenthal, Sarah Ficenec, and Alec Friedhoff. 2011. Economic Shocks and Regional Economic Resilience. Working Paper 2011-03.

Hua, Y., and H. Zhang. 2023. Internet Penetration and Income Inequality: Evidence from the Chinese Young Labor Market. *Applied Economics,* 55(54), 6444–6458. 〈https://doi.org/10.1080/00036846.2022.2156471〉

Independent Observer. 2025, April 23. IMF Forecasts Indonesia as World's 7th Largest Economy by GDP (PPP) in 2025. *Independent Observer.* 〈https://observerid.com/imf-forecasts-indonesia-as-worlds-7th-largest-economy-by-gdp-ppp-in-2025-2/〉

Jalili, R., N. Gilani, B. Najafi, V. S. Gordeev, and L. Doshmangir. 2025. Health Financial Resilience in Individuals and Households: A Scoping Review of Components, Strategies and Outcomes. *BMC Public Health,* 25(1). 〈https://doi.org/10.1186/s12889-025-24467-5〉

Johnson, Kehinde R., and Claudia Persico. 2024. Broadband Internet Access, Economic Growth, and Wellbeing. NBER Working Paper No. 32517.

Kharisma, B. 2022. Surfing Alone? The Internet and Social Capital: Evidence from Indonesia. *Journal of Economic Structures,* 11(1). 〈https://doi.org/10.1186/s40008-022-00267-7〉

Kuhn, Peter, and Hani Mansour. 2014. Is Internet Job Search Still Ineffective? *The Economic Journal,* 124(581), 1213–1233. 〈https://doi.org/10.1111/ecoj.12119〉

Kurniawati, M. A. 2022. Analysis of the Impact of Information Communication Technology on Economic Growth: Empirical Evidence from Asian Countries. *Journal of Asian Business and Economic Studies,* 29(1), 2–18. 〈https://doi.org/10.1108/jabes-07-2020-0082〉

Luo, X., Y. Wang, and X. Zhang. 2019. E-Commerce Development and Household Consumption Growth in China. World Bank Policy Research Working Paper No. 8810. 〈http://www.worldbank.org/research〉

Ma, J., and H. Njangang. 2025. The Effect of Gender Inequality in Internet Access on Energy Poverty: A Preliminary Investigation in Developing Countries. *Telecommunications Policy,* 49(6). 〈https://doi.org/10.1016/j.telpol.2025.102959〉

Ma, W., P. Nie, P. Zhang, and A. Renwick. 2020. Impact of Internet Use on Economic Well-Being of Rural Households: Evidence from China. *Review of Development Economics,* 24(2), 503–523. 〈https://doi.org/10.1111/rode.12645〉

Mancini, G., and G. Vecchi. 2022. On the Construction of a Consumption Aggregate for Inequality and Poverty Analysis. Washington, DC: World Bank. 〈www.worldbank.org〉

Masaki, T., R. Granguillhome, and Carlos Rodríguez-Castelán. 2020. Broadband Internet and Household Welfare in Senegal. World Bank Policy Research Working Paper No. 9386. 〈http://www.worldbank.org/prwp〉

Miyajima, Ken. 2022. Mobile Phone Ownership and Welfare: Evidence from South Africa's Household Survey. *World Development,* 154. 〈https://doi.org/10.1016/j.worlddev.2022.105863〉

Mogstad, Magne, Alexander Torgovitsky, and Christopher R. Walters. 2019. The Causal Interpretation of Two-Stage Least Squares with Multiple Instrumental Variables. NBER Working Paper No. 25691. 〈http://www.nber.org/papers/w25691〉

Mora-Rivera, J., and F. García-Mora. 2021. Internet Access and Poverty Reduction: Evidence from Rural and Urban Mexico. *Telecommunications Policy,* 45(2). 〈https://doi.org/10.1016/j.telpol.2020.102076〉

Nasution, R. 2023, November 21. High Internet Speed Vital for Digital Transformation: Minister. *Antara.* 〈https://en.antaranews.com/news/299181/high-internet-speed-vital-for-digital-transformation-minister〉

Nonvide, G. M. A. 2023. Impact of Information and Communication Technologies on Agricultural Households' Welfare in Benin. *Telecommunications Policy,* 47(6). 〈https://doi.org/10.1016/j.telpol.2023.102570〉

Noy, Ilan. 2009. The Macroeconomic Consequences of Disasters. *Journal of Development Economics,* 88(2), 221–231. 〈https://doi.org/10.1016/j.jdeveco.2008.02.005〉

Nugroho, Yanuar. 2010. NGOs, the Internet and Sustainable Rural Development: The Case of Indonesia. *Information Communication and Society,* 13(1), 88–120. 〈https://doi.org/10.1080/13691180902992939〉

Nurarifin, and S. Ridena. 2020. The Role of ICT and Human Capital Development in Pursuing a Demographic Dividend and Improving Economic Welfare in Indonesia. *The Journal of Indonesia Sustainable Development Planning,* 1(2), 113–124. 〈https://doi.org/10.46456/jisdep.v1i2.19〉

Padhan, N., and S. Madheswaran. 2023. Effectiveness of Post-Disaster Coping Strategies among the Farming Households in the Coastal Districts of Odisha, India. *Natural Hazards Research,* 3(1), 66–75. 〈https://doi.org/10.1016/j.nhres.2022.12.006〉

Phan, V. P. 2023. Is the Internet Penetration Pro-Poor? Evidence from a Panel Data Analysis. *Telecommunications Policy,* 47(8). 〈https://doi.org/10.1016/j.telpol.2023.102612〉

Putri, R. D., M. S. Rahman, A. A. Abdillah, and W. C. Huang. 2024. Improving Small-Scale Fishermen's Subjective Well-Being in Indonesia: Does the Internet Use Play a Role? *Heliyon,* 10(7). 〈https://doi.org/10.1016/j.heliyon.2024.e29076〉

Ralston, L., S. Tiwari, R. E. Al Faizin, M. Borden, J. A. C. Ramon, G. K. A. Endarso, A. U. Lumbanraja, F. R. Moeis, M. O. Rodriguez, M. Pasha, M. S. L. Putri, R. E. Samudra, I. Setiawan, L. D. Setyonugroho, and A. F. Utami. 2020. *No One Left Behind: Rural Poverty in Indonesia.*

RAND Corporation. 2025. Project Teams and Funding for the Indonesian Family Life Survey (IFLS). 〈https://www.rand.org/health/surveys/FLS/IFLS/teamfund.html〉

Salahuddin, M., and J. Gow. 2016. The Effects of Internet Usage, Financial Development and Trade Openness on Economic Growth in South Africa: A Time Series Analysis. *Telematics and Informatics,* 33(4), 1141–1154. 〈https://doi.org/10.1016/j.tele.2015.11.006〉

Sawada, Yasuyuki, and Yoshito Takasaki. 2017. Natural Disaster, Poverty, and Development: An Introduction. *World Development,* 94, 2–15. 〈https://doi.org/10.1016/j.worlddev.2016.12.035〉

Stock, James H., and Motohiro Yogo. 2005. Testing for Weak Instruments in Linear IV Regression. In Donald W. K. Andrews and James H. Stock (eds.), *Identification and Inference for Econometric Models.* Cambridge: Cambridge University Press, 80–108. 〈https://doi.org/10.1017/CBO9780511614491.006〉

Strauss, John, Bondan Sikoki, and Firman Witoelar. 2016. The Fifth Wave of the Indonesia Family Life Survey (IFLS5): Overview and Field Report. RAND Labor and Population Working Paper WR-1143/1-NIA/NICHD. 〈http://www.rand.org/FLS/IFLS〉

Susilowati, A. P. E., R. Rachmawati, and R. Rijanta. 2025. Smart Village Concept in Indonesia: ICT as Determining Factor. *Heliyon,* 11(1). 〈https://doi.org/10.1016/j.heliyon.2025.e41657〉

Sutton, J., A. Arcidiacono, G. Torrisi, and R. N. Arku. 2023. Regional Economic Resilience: A Scoping Review. *Progress in Human Geography,* 47(4), 500–532. 〈https://doi.org/10.1177/03091325231174183〉

Sutton, J., and G. Arku. 2022. Regional Economic Resilience: Towards a System Approach. *Regional Studies, Regional Science,* 9(1), 497–512. 〈https://doi.org/10.1080/21681376.2022.2092418〉

Syakilah, A., K. Maharani, N. Ferdiana, and A. Saifullah. 2025. *Statistik Telekomunikasi Indonesia 2024.*

World Bank. 2024. World Development Indicators. 〈https://databank.worldbank.org/source/world-development-indicators〉

Wu, S., R. Zhang, C. Wang, and D. Feng. 2022. The Impact of Natural Disasters on Rural Household Wealth: Micro Evidence from China. *Frontiers in Environmental Science,* 10. 〈https://doi.org/10.3389/fenvs.2022.993722〉

Xue, Z., and C. Liu. 2024. The Effect of Internet Use on the Health of Middle-Aged and Older Adults: Evidences from China General Social Survey. *BMC Public Health,* 24(1). 〈https://doi.org/10.1186/s12889-024-20313-2〉

Yang, L., H. Lu, S. Wang, and M. Li. 2021. Mobile Internet Use and Multidimensional Poverty: Evidence from a Household Survey in Rural China. *Social Indicators Research,* 158(3), 1065–1086. 〈https://doi.org/10.1007/s11205-021-02736-1〉

Yokota, K., Y. Komaki, A. Komori, S. Nagasawa, and S. Okuaki. 2025. The Internet and Poverty Alleviation in Indonesia: Urban-Rural Disparities in a Dual Economy. *Journal of Asian Economics,* 100, 102024. 〈https://doi.org/10.1016/j.asieco.2025.102024〉

Zhang, J., H. Zhang, and X. Gong. 2022. Mobile Payment and Rural Household Consumption: Evidence from China. *Telecommunications Policy,* 46(3). 〈https://doi.org/10.1016/j.telpol.2021.102276〉

Zhao, X., F. Lan, L. Zhang, M. Guo, and Y. Li. 2025. The Impact of Digital Village Construction on Poverty Vulnerability among Rural Households. *Scientific Reports,* 15(1). 〈https://doi.org/10.1038/s41598-025-91928-7〉

Appendix

(1) Descriptive Statistics

Appendix Table 4 reports descriptive statistics for the main variables. Around 51 percent of households have internet access, while about 41 percent live in villages with internet access (Netvillage). The mean log per capita total expenditure is 15.52, corresponding to an average annual per capita expenditure of about 8.85 million Rupiah. The average household head has completed roughly junior high education (mean 2.95 on a 1–6 scale) and is about 48 years old. Households have, on average, 6 members; one-quarter of working-age members participate in the labor force (LFP), about 80 percent of households own their home, and 23 percent report experiencing a natural disaster shock in the previous five years.

(2) Pairwise Correlation

Appendix Table 5 presents pairwise correlation coefficients among the main variables. Internet access is positively but modestly correlated with the instrument Netvillage (0.12) and with log per capita expenditure (0.25). Correlations between Internet access and the other covariates are generally small in magnitude, and there is no evidence of very high correlation among regressors. This suggests that multicollinearity is unlikely to be a serious concern in the regression analysis.

Table 4 Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Internet access	8192	.507	.5	0	1
Netvillage	8192	.408	.491	0	1
Total expenditure pc (log)	8191	15.519	.848	11.379	22.621
Total expenditure pc	8192	8845972.3	74352087	0	6.671e+09
Head_edu	8144	2.945	1.464	1	6
Household size	8192	6.305	3.188	1	38
LFP	5747	.251	.396	0	1
Head_age	8189	47.989	14.156	17	101
Asset ownership	8192	.796	.403	0	1
Shock	8192	.228	.42	0	1

Table 5 Pairwise correlation

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Internet access	1.000									
Netvillage	0.124	1.000								
Total expenditure pc (log)	0.252	0.102	1.000							
Total expenditure pc	0.034	0.023	0.194	1.000						
Head_edu	0.207	0.153	0.299	0.043	1.000					
Household size	0.142	−0.028	−0.424	−0.040	−0.091	1.000				
LFP	−0.077	−0.040	0.022	−0.006	−0.024	−0.056	1.000			
Head_age	−0.070	0.025	−0.330	−0.012	−0.327	0.293	−0.047	1.000		
Asset ownership	−0.046	−0.126	−0.154	−0.013	−0.194	0.169	0.007	0.284	1.000	
Shock	0.019	0.061	0.032	−0.005	0.047	−0.004	0.014	−0.052	−0.069	1.000