AGRARIS: *Journal of Agribusiness and Rural Development Research*

Vol. 8 No. 2 July-December 2022, Pages: 160-180

Article history:
Submitted : January 6th, 2022
Revised : June 19th, 2022
May 31st, 2022
Accepted : August 24th, 2022

Ahmad Saifullah Kamaludin[1,*], Riatu Mariatul Qibthiyyah[2]
[1] Finance and Development Supervisory Agency (BPKP), Jakarta, Indonesia
[2] Institute for Economic and Social Research (LPEM) Faculty of Economics and Business, Universitas Indonesia, Jakarta, Indonesia

*) Correspondence email: *ipung.kamaludin@gmail.com*

Village Road Quality and Accessibility on Transforming Rural Development

DOI: https://doi.org/10.18196/agraris.v8i2.13618

ABSTRACT

Rural road infrastructure in Indonesia has increased significantly, especially during the last decade. This study presents an overview of how rural road quality and accessibility affected village economic transformation. It is the first empirical study in Indonesia addressing rural transformation. Village-level microdata, referring to the smallest administrative official, were utilized. Using a Random-Effects Panel Logit model, this study discovered that improving the type of road surface and accessibility for four-wheeled vehicles significantly increased the probability of village economic transformation. Different types of road infrastructure improvement affected the rural economic transformation both within and outside Java-Bali. Paved or concrete roads in Java-Bali had a higher marginal effect than on other islands, thereby increasing the likelihood of rural economic transformation. However, the road accessibility for four-wheeled vehicles in Java-Bali did not significantly affect the probability of rural economic transformation. Nevertheless, for villages on other islands, it did. Furthermore, the transformation significantly influenced other infrastructures, such as electricity coverage, market presence, information and communication technology (ICT), and flatland topography. Moreover, the road access to villages and the availability of water or irrigation significantly affected the probability of surviving in the agricultural sector. Following these findings, policymakers should prioritize villages' infrastructure by considering different types of infrastructure provision across villages, referring to different infrastructure needs for Java-Bali and other islands.

Keywords: Logit; Non-linear model; Rural; Rural development; Transformation

INTRODUCTION

Rural economic development has become an integral part of an overall country's development strategy, especially in emerging and developing countries such as Georgia, Bangladesh, Ethiopia, Vietnam, China, South Korea, Brazil, and others (Asian Development Bank, 2012; Bakht, 2000; Barrios, 2008; Do & Park, 2018; Khandker et al., 2009; Lokshin & Yemtsov, 2005; Nakamura et al., 2020; Rammelt & Leung, 2017; Wong et al., 2013). In

Indonesia, the government prioritizes improving rural communities (Arham & Hatu, 2020; Arifin et al., 2020; Chalil, 2020; Syafingi et al., 2020).

Existing studies on rural development in developing countries emphasize the importance of basic infrastructure, such as roads, rails, water transportation, and electricity (Bakht, 2000; Do & Park, 2018; Fan & Zhang, 2004; Gafarso & Tufa, 2019; Lokshin & Yemtsov, 2005; Nakamura et al., 2020; Rammelt & Leung, 2017; United Nations Department of Economics and Social Affairs (UN DESA), 2021). In Indonesia, villages' infrastructure has become one of the government's program priorities, indicated by the high allocation of village funds for this sector. The village fund allocation for public infrastructure development reached 67.4% (The World Bank, 2019). The majority of public infrastructure built in the villages in the last five years has been roads and bridges. From the overall village funds allocated to infrastructure, the share of road and bridge construction funds reached 70.6%.

Data on village road quality and accessibility are available from *Potensi Desa* (PODES) or Village Potentials, a village head survey covering all villages in Indonesia. The Statistics Indonesia conducts this survey three times every ten years. Figure 1 exhibits PODES data in 2010, 2013, and 2017 issued respectively in 2011, 2014, and 2018 on the road infrastructure status, including the road quality by type of surface and road accessibility.

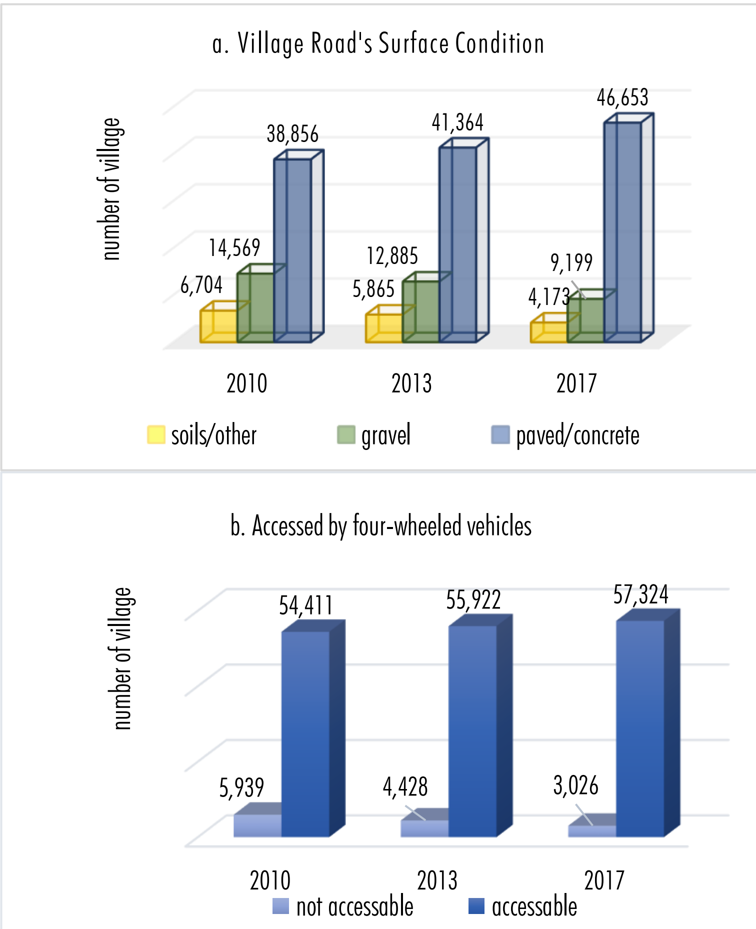

FIGURE 1. VILLAGE ROAD SURFACE CONDITION AND ALL SEASONAL ACCESSIBILITY OF FOUR-WHEELED VEHICLES.

Concerning the surface condition of village roads, Figure 1 panel (a) illustrates an increase in paved or concrete roads, while gravel and earth or other roads with lower quality decreased during 2010, 2013, and 2017. Over the same period, the number of villages with roads accessible for four-wheeled vehicles increased (panel b). Figure 1 depicts an overall improvement in the quality and accessibility of village roads.

The rural economic development in Indonesia can also reflect the evolution of the agricultural sector for village communities. According to PODES data from 2010 to 2017, given that the dominant sector refers to the leading work (sector) for most village residents, the agricultural sector remained dominant in more than 90% of the villages. The PODES data revealed that agriculture-based villages accounted for 94.21%, 93.86%, and 92.89% of all villages in 2010, 2013, and 2017. A decline in the share of agriculture-based villages indicates the rural community transformation. Rural transformation is defined as a comprehensive change in rural communities where they have diverse economic choices and reduce their dependence on agriculture (Barrios, 2008; Berdegué et al., 2013; Jayne et al., 2011; Kruseman et al., 2020). However, the decline in agricultural dominance does not imply a decrease in productivity of the agricultural sector but is more due to the rapid increase in other sectors. Rising productivity should be gained in both agricultural and non-agricultural sectors (the two are interrelated) (Timmer, 2009). In this case, rural transformation is a stage of the rural community development toward a better economy (Kruseman et al., 2020). However, rural transformation without increasing agriculture will not result in development (Majumdar, 2020).

Rural economies can be fast-evolved and driven by urbanization and improvement of agricultural productivity (Asher & Novosad, 2020; Belton & Filipski, 2019; Fan & Zhang, 2004; Hwang et al., 2018; Imai et al., 2017; Shamdasani, 2021; UN DESA, 2021). High-quality infrastructure in a village may not only drive the village's economy, heavily reliant on agriculture, but also encourage the development of the non-agricultural sector (UN DESA, 2021). The success of unlocking agricultural potential through the development of non-agricultural products and services, as explained by Jayne et al. (2011), accelerates the rural economic transformation (Nakamura et al., 2020, United Nations, 2021).

Adequate infrastructure provides benefits, such as reducing transaction costs significantly (Adam et al., 2018; Bachewe et al., 2018; Barrios, 2008; Renkow et al., 2004), which will enhance agricultural productivity (Fan & Chan-Kang, 2005; Kamei & Sasaki, 2016). Good quality infrastructure can also expand the market (Bakht, 2000), create job opportunities (Gafarso & Tufa, 2019), increase the growth of small and medium-sized enterprises (SMEs) (Lokshin & Yemtsov, 2005), raise consumption (Wong et al., 2013), and assist in the expansion of other social services and access to them by the rural people (Gafarso & Tufa, 2019). Ultimately, it accelerates village economic transformation (Nakamura et al., 2020, United Nations, 2021).

Given the preceding context, this study tries to determine whether the quality and accessibility of villages' infrastructure in Indonesia affect village development. This study specifically investigated whether road quality and accessibility of other infrastructures have contributed to the evolution of the Indonesian rural economy. The novelty of this study is an assessment of rural infrastructure, disaggregated by type of infrastructure, and how this infrastructure could influence rural development transformation. In this context, a limited number of studies have addressed rural development transformation in Indonesia. Furthermore, this study also constructed longitudinal microdata, the village-level data referring to the smallest administrative level, by merging PODES data from 2011, 2014, and 2018.

RESEARCH METHOD

Data Collection

This study utilized the micro dataset of PODES in 2011, 2014, and 2018, issued by the Statistics Indonesia. PODES data represent the condition of the smallest unit of the village government. The 2011 PODES represents the data from 2010, the 2014 PODES denotes the 2013 data, and the 2018 PODES reflects the 2017 data unless otherwise stated in the survey. The initial PODES compiled panel data totaled 244,083 observation units (villages). After some adjustments to make the sample more robust, only 181,050 (74.18%) of the overall villages in PODES data were employed. These 181,050 villages were derived from the following adjustments: (1) dropping the villages that have changed sub-districts (*kecamatan*), (2) excluding the villages if they are new or have expanded or separated throughout observations, (3) dropping the villages due to a change in their code without a clear explanation, (4) dropping the villages changing government type to urban villages (*kelurahan*) or vice versa, (5) excluding urban villages (*kelurahan*), and (6) dropping the villages with the dominance of the mining sector because this study focused merely on the agriculture sector transformation.

After analyzing quantitatively, the findings were enriched by further discussions with several practitioners from government officials. This study gathered information from the Ministry of Village, Development of Disadvantaged Regions and Transmigration, Coordinating Ministry for Human Development and Cultural Affairs, Finance and Development Supervisory Agency, and local governments. The well-experienced respondents spread across Indonesia's provinces and regencies. Interviews were also conducted with some local governments comprehending regional characteristics, issues, and potential resources. Their experiences benefit this study in providing insights into real cases faced by rural communities.

Variables of Study

This study focused on changes in the dominant agricultural sector in the villages as an outcome variable. Dummy (binary value) variables of the dominant sector were constructed, in which villagers work in agriculture and non-agriculture. This binary value was applied because rural transformation is marked by a change in the dominant working sector from the agricultural sector to non-agricultural goods and services (Berdegué et al., 2013; Jayne et al., 2011). At the country level, economic transformation refers to a change in the economic structure from the primary sector to the secondary or tertiary one. However, this study was primarily concerned with rural development, dominated by agriculture; hence, it focused on changes in the agriculture sector, leaving out other primary sectors, such as mining.

Infrastructure accessibility as the variable of interest was included as an explanatory variable. Village road infrastructure, in several studies, has been empirically proven to positively affect village development and transformation (Asher & Novosad, 2020; Bakht, 2000; Gafarso & Tufa, 2019; Lokshin & Yemtsov, 2005; UN DESA, 2021). As the proxies for infrastructure accessibility, the accessibility in the villages, the type of road surface, and all seasonal accessibility for four-wheeled vehicles, were included. Concerning the first proxy—the accessibility in the villages, a dummy variable of traffic traversed by land access (1) and water (0), was designed, considering Indonesia's geography being an archipelago. The second proxy deals with the type of road surface, divided into three categories: paved or concrete, gravel or hardening stone, and earth or others such as wood or board. The third proxy represents the road affordability for four-wheeled vehicles throughout the season. It was based on Calderon & Serven (2010), measuring the accessibility of transportation by looking at the affordability of citizens to access transportation, whether it can be accessed all-season or not. In this context, access to four-wheeled vehicles throughout the year is essential to increase the benefits of using roads for economic activities.

Other types of infrastructure as explanatory variables encompassed electricity coverage, economic facilities, ICT infrastructure, flatland topography, and availability of water or irrigation. Electricity coverage becomes the critical infrastructure influencing the development of non-agriculture business units (Gibson & Olivia, 2010; UN DESA, 2021). A favorable agro-climatic condition would benefit farmers (Davis et al., 2017). Moreover, expanding market access would increase village economic growth (Bakht, 2000; Rammelt & Leung, 2017; UN DESA, 2021). Aside from physical infrastructure, ICT also plays a vital role in village development (UN DESA, 2021).

Estimation Model

Measuring the impact of infrastructure development is difficult for economists and policymakers (Asher & Novosad, 2020). It is because infrastructure policies involve various administrative levels of government and identify the type of infrastructure that can directly affect the outcome of interest, as the impact of infrastructure is mostly through complex channels. Regarding the interconnected level of government policies that may play a role, it can be recognized that many policies at the central and local levels influence village development policies. For example, the construction of village roads can be funded by various programs and sources of funds. However, since this study did not evaluate a specific type of program, the interrelated issues of government policies were irrelevant.

On the issue of the appropriate level of data and type of infrastructure, this study provided adjustments by assessing the output of rural infrastructure as an aggregate. This study employed micro-level PODES data to capture the general condition of rural infrastructure output every three years. The data were presented up to the smallest level of government, at the village level, considered to have less bias than the aggregated higher administrative level data, given that the outcome assessed was village agricultural sector transformation. Furthermore, this study explored and included the extensive type of rural infrastructure to incorporate the plausibility of different channels through which it could affect rural development.

For the analysis, an estimation was conducted as Formula 1.

$$ln\left(\frac{Pr(agri)_{it}}{1\text{-}Pr(agri)_{it}}\right)= \begin{array}{l}\alpha_0+\alpha_1\ land_{it}+\sum_{n=1}^{k-1}\ \alpha_k\ \ \delta surface_{it}+\alpha_4\ 4wheels_{it}\\ +\boldsymbol{\Sigma}\alpha_i X_{it}+\sum_{n=1}^{t-1}\lambda_t+\sum_{n=1}^{p-1}\zeta_p+u_i+e_{it}\end{array} \quad (1)$$

The panel logit model was applied for this equation, where the ln $\left(\frac{Pr(agri)_{it}}{1\text{-}Pr(agri)_{it}}\right)$ is the natural logarithm of the odds ratio in the observation villages i in the period of t. Land represents the accessibility to reach the villages. The *4wheels* denotes the accessibility of four-wheeled vehicles in all seasons, both in the binary value. For the δ surface representing the type of road surface, dummy (*k-1*) variables were utilized as they contained categorical values. The X signifies control variables, encompassing electricity coverage, economic facilities, ICT infrastructure, flatland topography, and availability of water or irrigation. To control the potential bias, the year dummy of the (*t-1*) PODES period and the (*p-1*) provincial dummy were employed. The idea of using this control aimed to accommodate the possibility of differences in the characteristics of each province and period. The u_i indicates a random effect assumed to be independent, and the e_{it} refers to an error term.

In this study, a Random-Effect (RE) Panel Logit model was utilized to estimate residual variables' relationship with time variance and observation characteristics. The unit of analysis (N) totaling 181,050 villages was undoubtedly higher than the time series (T) of only three periods. The RE model helps accommodate other things or uncertainties affecting the dependent variable but cannot be explained by the explanatory variable (Mok et al., 2010).

Regarding this study, the RE Panel Logit model incorporated the specific explanatory variable of interest, referring to the road quality (type of road surface) variable. The road surface variable in the PODES referred to the dominant road surface condition in the villages. It did not specify the length or the number of roads. For example, the same data of paved or concrete roads in the 2013 and 2017 PODES could be referred to as an improvement of existing roads in terms of longer roads (i.e., road length). In contrast, there could be deterioration for the same data of paved or concrete roads, even though the dominant condition was still paved or concrete. The data were captured as the same. If using the Fixed Effect (FE) model and this condition is met, and the outcomes are the same, this condition is considered constant; thus, the estimation results will be omitted. As a consequence, the number of observations may drop too much. However, using the RE model provided a more significant number of observations.

RESULTS AND DISCUSSIONS

Effect of Increasing Accessibility of Transportation Infrastructure

This study conducted several steps to estimate the Logit model. Initially, a bivariate analysis was performed to test the candidate of independent variables used to estimate the outcome or dependent variable. In a brief overview, the bivariate analysis revealed that all variables: village accessibility, road surface type, four-wheeled vehicle access, electrical infrastructure coverage, flatland topography, irrigation, marketplace availability, presence of Base Transceiver Station (BTS) towers, and cell phone signal strength, qualified as independent variables. Subsequently, these variables were combined into a multivariate model using an advanced selection technique by gradually adding control variables. Table 1 exhibits the estimation results.

TABLE 1. THE ESTIMATION RESULTS OF THE LOGIT MODEL FOR PANEL DATA

Independent variables	Dependent Variable: Dominant Sector In The Villages						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Land access	-1.254*	-0.774	-0.668	-0.697	-0.788	-0.671	-0.405
	(0.505)	(0.542)	(0.540)	(0.540)	(0.537)	(0.521)	(0.593)
Road surface:							
Earth or others	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
Gravel	0.575***	0.321*	0.306*	0.312*	0.145	0.028	-0.049
	(0.141)	(0.141)	(0.141)	(0.141)	(0.142)	(0.143)	(0.161)
Paved or concrete	2.180***	1.825***	1.812***	1.799***	1.465***	0.748***	0.600***
	(0.135)	(0.135)	(0.135)	(0.135)	(0.136)	(0.137)	(0.153)
Four-wheeler	1.460***	1.087***	1.000***	0.961***	0.728***	0.406*	0.441*
	(0.186)	(0.179)	(0.178)	(0.177)	(0.177)	(0.179)	(0.191)
Electricity		0.047***	0.045***	0.044***	0.038***	0.029***	0.022***
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Flatland			1.558***	1.537***	1.418***	0.843***	0.889***
			(0.069)	(0.069)	(0.071)	(0.075)	(0.088)
Water or irrigation			-0.159***	-0.187***	-0.250***	-0.407***	-0.373***
			(0.048)	(0.048)	(0.049)	(0.058)	(0.068)
Marketplace				0.854***	0.585***	0.255***	0.379***
				(0.051)	(0.052)	(0.064)	(0.074)
BTS					1.212***	0.854***	0.693***
					(0.043)	(0.050)	(0.058)
Celullar signal					1.283***	0.712***	0.824***
					(0.068)	(0.070)	(0.078)
Urrban or rural area						YES	YES
i.year							YES
i.province							YES
Observation	181,050	181,050	181,050	181,050	181,050	181,050	181,050
Sigma_u	4.392	4.208	4.097	4.072	3.841	3.999	3.901
Rho	0.854	0.843	0.836	0.834	0.818	0.829	0.822

Standard errors in parentheses
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Table 1 displays a full model in column 7. The variable of interest, transportation accessibility, was indicated by three variables: land traffic, road surface, and road accessibility for four-wheeled vehicles. The variable of village access to land traffic variable was inadequate to transform the rural agricultural sector due to the insignificant coefficient. The road surface variable (earth or other, gravel, and paved or concrete) generated a different effect. The road surfaced by earth or other was used as a baseline. The road surface of paved or concrete increased the probability of village transformation to the non-agricultural sector, with a significance level of 0.1%. Furthermore, the variable of road accessibility of four-wheeled vehicles enhanced the probability of expanding or shifting village activities to the non-agricultural sector, with a 5% significance level.

Other types of infrastructure, such as electricity coverage, land topography, market or grocery facilities, BTS towers, and cellular signal quality, significantly affected the probability of the village shifting to the non-agricultural sector, with a significance level of these six variables of about 0.1%. Nevertheless, the availability of irrigation significantly influenced the probability of surviving in the agricultural sector. Table 2 displays the estimation results of the odds ratio and the marginal effect of the seventh model.

TABLE 2. THE ODDS RATIO AND MARGINAL EFFECT ESTIMATION RESULTS

Independent Variables	Dependent Variable: Dominant Sector in The Villages			
	Odds ratio	*Standard error*	*Margins*	*Standard error*
Land access	0.667	(0.395)	-0.008	(0.012)
Road surface:				
Earth or others	(.)	(.)	(.)	(.)
Gravel	0.953	(0.153)	-0.0009	(0.003)
Paved or concrete	1.823***	(0.279)	0.012***	(0.003)
Four-wheeler	1.555**	(0.298)	0.009**	(0.004)
Electricity	1.022***	(0.0025)	0.0005***	(0.000)
flatland	2.433***	(0.214)	0.018***	(0.001)
Water or irigation	0.689***	(0.0469)	-0.008***	(0.002)
Marketplace	1.461***	(0.108)	0.008***	(0.002)
BTS	2.000***	(0.115)	0.014***	(0.001)
Celluler signal	2.280***	(0.177)	0.017***	(0.002)
Urban or rural area				YES
i.year				YES
i.province				YES
Observation				181,050
Number of villages				60,350

Standard errors in parentheses
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

The odds ratio refers to the probability of shifting to the non-agricultural sector compared to the probability of surviving in the agricultural sector. The higher the odds ratio (more than 1), the more likely the village will evolve into the non-agricultural sector. Table 2 demonstrates that the road surface of paved or concrete had a probability of shifting the village to the non-agricultural sector 1.82 times greater than surviving in the agricultural sector. Similarly, road access to four-wheeled vehicles acquired a 1.56 times higher probability of shifting the village to the non-agricultural sector.

In addition, estimates of marginal effects are also required for policy implications (Karaca-Mandic et al., 2012). Concerning this study's estimation results, increasing the road surface to paved or concrete enhanced the probability of the village expanding to the non-agricultural sector by 1.2%. Changes to the four-wheeled vehicle's road access throughout the year increased the probability of shifting to the non-agricultural sector by 0.9%. These findings are in line with other studies proving that road improvement could accelerate the structural transformation of villages (Asher & Novosad, 2020; UN DESA, 2021). Further discussion with the respondents revealed the simplicity of the transformation. Only a few villages could transform and develop their economy. It can be seen from the low marginal effect. Nevertheless, a high significance level would bring optimism for improving the rural economy.

In order to accelerate transformation, road infrastructure must be supported by other factors, including human resources (education) (Nguyen et al., 2020), government intervention in agriculture (Timmer, 2015), job opportunities (Nguyen et al., 2020), or land reform (Deininger et al., 2014). Other variables in this study, such as increasing electricity coverage, increased the probability of shifting to the non-agricultural sector by 0.05%. This result is consistent with previous studies disclosing that electricity coverage was essential to influence the development of non-agriculture business units (Gibson & Olivia, 2010; UN DESA, 2021). The flatland topography boosted the probability of the village shifting to the non-agricultural sector by 1.8%. The existence of the market or groceries enhanced the probability of transformation to the non-agricultural sector by 0.8%, in line with prior studies (Bakht, 2000; Rammelt & Leung, 2017; UN DESA, 2021). The construction of BTS towers and the improvement of the good cellular signal increased the probability of a change in the non-agricultural sector by 1.4% and 1.7%, supported by a previous study (UN DESA, 2021). On the other hand, the availability of irrigation was more likely to keep the agricultural sector as the leading working sector by 0.8%. It is reasonable to insist that favorable agro-climatic conditions benefit agriculture (Davis et al., 2017).

Furthermore, following the discussion with the respondents, it is clear that many variables influenced rural development, not only those examined in this study. The government's programs, such as government intervention, were highly required to regulate agricultural products, fertilizer subsidiaries, production equipment support, price intervention, education, health care, and labor activities.

Effect of Increasing Road Infrastructure Accessibility in Java-Bali vs Outer Islands

Given the disparity in infrastructure quality and diverse characteristics of Indonesia's territory (Faoziyah & Salim, 2020; Gibson & Olivia, 2010; Sari & Yudhistira, 2021), this study divided the observation into two major groups, villages located in Java-Bali and those outside these islands. Road surface conditions and quality in Java-Bali were relatively higher than those outside these islands. Moreover, Java-Bali is the center of Indonesia's national economy, which fared better than other islands in Indonesia (Afifah et al., 2018; Suprayitno & Pradiptyo, 2017). The respondents' statements unveiled generally deplorable infrastructure outside Java-Bali. As asserted by the West Papuan respondents, the infrastructure in West Papua has deteriorated over the last ten years. Services and infrastructure quality tend to worsen in remote rural areas (Abate et al., 2020; UN DESA, 2021).

Table 3 illustrates Java-Bali's better infrastructure than those outside these islands. The value of 1 for dummy land access indicates that the entire villages in Java-Bali could be accessed by land. The road surface had three categorical values, reflecting the quality of the roads: 1 for roads covered by earth or others, 2 for gravel, and 3 for paved or concrete. The mean values of 2.871 for Java-Bali and 2.435 for outside these islands signify that Java-Bali possessed more areas with paved or concrete roads than other islands. Likewise, other variables, such as roads with four-wheeled vehicle access, were also better in Java-Bali than in other islands. The road infrastructure in Java-Bali was better, but there was also less variation (disparity) in the availability of this infrastructure. It also applied to other types of infrastructure. The electricity coverage, availability of water or irrigation, market economy infrastructure, and ICT infrastructure in Java-Bali were better than those outside these islands.

TABLE 3. THE INFRASTRUCTURE GAP BETWEEN JAVA-BALI AND OUTSIDE

Variables	Java-Bali		Outside Java-Bali	
	Mean	SD	*Mean*	SD
Land access	1.000	0.0171	0.993	0.0819
Road surface	2.871	0.361	2.435	0.757
Four-wheeler	0.989	0.103	0.888	0.316
Marketplace	0.217	0.412	0.155	0.362
Celluler signal	0.836	0.370	0.615	0.487
Water or irigation	0.841	0.366	0.746	0.435
Electricity	98.11	7.319	84.46	27.10
N of observation	68,274		112,776	
N of village	22,758		37,592	

TABLE 4. THE ESTIMATION RESULTS IN JAVA-BALI AND OUTSIDE

Independent Variables	Dependent Variable: Dominant Sector in The Villages			
	Java-Bali		Outside Java-Bali	
Land access	0.000	(.)	-0.540	(0.598)
Road surface:				
Earth or others	(.)	(.)	(.)	(.)
Gravel	0.836	(0.631)	-0.032	(0.167)
Paved or concrete	1.896**	(0.622)	0.399*	(0.158)
Four-wheeler	0.342	(0.380)	0.499*	(0.210)
Electricity	0.010*	(0.004)	0.027***	(0.003)
Flatland	0.837***	(0.108)	0.948***	(0.124)
Water or irrigation	-0.254**	(0.084)	-0.522***	(0.096)
Marketplace	0.177*	(0.085)	0.616***	(0.110)
BTS	0.611***	(0.065)	0.777***	(0.091)
Cellular signal	0.681***	(0.105)	0.878***	(0.102)
Urban or rural area	YES		YES	
i.year	YES		YES	
i.province	YES		YES	
Observation	68,254		112,776	
Rho	0.787		0.809	
Sigma_u	3.485		3.738	

Standard errors in parentheses
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Table 4 portrays the slightly different results of the two sub-sample estimations and displays that the variable of land-road access in Java-Bali obtained an estimated coefficient of close to 0 because traffic access from and to the villages was almost 100% passable by land, and the outcome variance was equal to 0. Furthermore, this access affected the probability of surviving in agriculture in areas outside Java-Bali. However, the effect was insignificant. The variable of road access to four-wheeled vehicles passable throughout the year outside Java-Bali increased the probability of the non-agricultural sector. Nevertheless, the effect was negligible in Java-Bali.

Following the marginal effect measurement, the effect on road-related infrastructure differed in Java-Bali and outside these islands (Table 5). Road-land access to and from villages in Java-Bali did not have any effect because the areas accessible by land reached almost 100%. Likewise, for roads with four-wheeled vehicle access, the effect was insignificant. The respondents agreed that road accessibility in Java-Bali villages was adequate.

TABLE 5. THE MARGINAL EFFECT ESTIMATION RESULTS IN JAVA-BALI AND OUTSIDE

Independent Variables	Dependent Variables: Dominant Sector in The Villages			
	Java-Bali		Outside Java-Bali	
	margins	*se*	*margins*	*se*
Land access	(.)	(.)	-0.00693	(0.00767)
Road surface:				
Earth or others	(.)	(.)	(.)	(.)
Gravel	0.0219	(0.0148)	-0.000374	(0.00196)
Paved or concrete	0.0573***	(0.0145)	0.00501***	(0.00188)
Four-wheeler	0.0126	(0.0140)	0.00640**	(0.00270)
Electricity	0.000370**	(0.000151)	0.000346***	(4.09e-05)
Flatland	0.0308***	(0.00395)	0.0122***	(0.00160)
Water or irigation	-0.00933***	(0.00311)	-0.00669***	(0.00124)
Market place	0.00650**	(0.00314)	0.00790***	(0.00141)
BTS	0.0225***	(0.00240)	0.00996***	(0.00118)
Celluler signal	0.0251***	(0.00385)	0.0112***	(0.00132)
Urban or rural area	YES		YES	
i.year	YES		YES	
i.province	YES		YES	
Observation	68,254		112,776	

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

Improving the road surface quality of paved or concrete was one of the policies applicable in the villages both within and outside Java-Bali. However, the marginal effect of road surface improvement in Java-Bali was higher, at 5.73%, than outside these islands, solely 0.501%. This result implies that the elasticity of the paved or concrete road improvement in Java-Bali was higher in affecting the transformation of the rural agricultural sector (Abate et al., 2020; UN DESA, 2021). A discussion with the respondents revealed that these findings seemed reasonable. The better infrastructure and resources, the faster the village economy accelerated. There is a possibility of a faster transformation in Java-Bali due to better economic resources, distance to urban markets, flows of goods and services to and from cities, the quality of local infrastructure and public services, the natural resource base, population density, and higher people's capacity (UN DESA, 2021).

Meanwhile, substantial infrastructure requirements and lower human resource capability have resulted in low infrastructure utilization outside Java-Bali, requiring inclusive and equitable development (Abate et al., 2020; Calderon & Serven, 2010). Despite the low marginal effect, the high significance level fostered optimism to boost the rural economy.

For other infrastructure variables, the marginal effects of the two regions were more similar. The increase in electricity coverage both within and outside Java-Bali escalated the probability of the non-agricultural sector as the villages' dominant sector by 0.037% and 0.034%, as affirmed by previous studies (Gibson & Olivia, 2010; UN DESA, 2021). The flat topography of the villages increased the probability of the non-agricultural sector as the dominant sector of each village in Java-Bali by 3.08%, slightly higher than outside Java-Bali by 0.122% (Bakht, 2000; Rammelt & Leung, 2017; UN DESA, 2021). In both regions, increasing the availability of market or groceries facilities enhanced the probability of the non-agricultural village dominant sector by 0.65% and 0.79%, respectively. Moreover, the availability of BTS towers in Java-Bali increased the probability of the non-agricultural sector by 2.25%, slightly higher than outside Java-Bali by 0.1%. Similarly, improving the cellular signal quality increased the probability of the dominant non-agricultural sector by 2.51% in Java-Bali, slightly higher than outside these islands by 1.12%. The availability of water or irrigation advanced the probability of the agricultural sector as the villages' dominant sector by 0.93% in Java-Bali and 0.67% outside these islands.

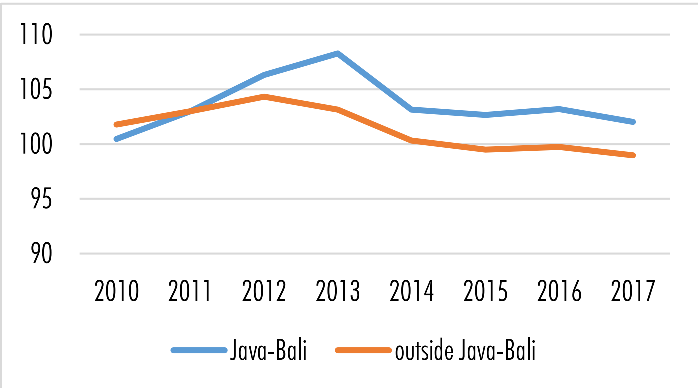

FIGURE 2. FARMER EXCHANGE RATES IN JAVA-BALI AND OUTSIDE

An essential thing to remember is that agricultural productivity plays a vital role in rural transformation (Jayne et al., 2011; UN DESA, 2021). Adequate infrastructure would increase agricultural productivity (Kamei & Sasaki, 2016; Narayanamoorthy & Hanjra, 2006). Two preconditions are required to build transformation to be more sustainable: substantial gains in agricultural productivity and the ability to expand into the non-agricultural sector (Chang et al., 2006; Haggblade et al., 2010; UN DESA, 2021). It means the higher the agriculture productivity, the higher the probability of sustainably transforming. Higher productivity will be followed by the increased purchasing power of millions of small farmers (Jayne et al., 2011). Figure 2 depicts Java-Bali's higher farmer exchange rates (*Nilai Tukar Petani* – NTP) as an indicator of farmer welfare than outside these islands. It is one factor underlying the higher marginal effect of Java-Bali in increasing the probability of transformation.

Robustness Check

This study employed a clustered standard error of observation villages to obtain a more precise standard error estimate.

TABLE 6. THE ROBUSTNESS OF STANDARD ERROR

Independent Variables	Dependent Variable Dominant Sector			
	Before robust		After robust SE	
Land access	-0.405	(0.518)	-0.405	(0.593)
Road surface:				
Earth or others	0.000	(.)	0.000	(.)
Gravel	-0.049	(0.147)	-0.049	(0.161)
Paved/concrete	0.600***	(0.142)	0.600***	(0.153)
Four-wheeler	0.441*	(0.181)	0.441*	(0.191)
Electricity	0.022***	(0.002)	0.022***	(0.002)
Flatland	0.889***	(0.078)	0.889***	(0.088)
Water or irigation	-0.373***	(0.060)	-0.373***	(0.068)
Market place	0.379***	(0.066)	0.379***	(0.074)
BTS	0.693***	(0.052)	0.693***	(0.058)
Celluler signal	0.824***	(0.072)	0.824***	(0.078)
Urban or rural area	YES		YES	
i.year	YES		YES	
i.province	YES		YES	
Observations	181,050		181,050	
Rho	0.822		0.822	
Sigma_u	3.901		3.901	

Standard errors in parentheses
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

The estimation results in Table 1 underwent the robust standard error test. Table 6 displays the comparison between estimation before and after robust. After each village was clustered, the resulting standard error was higher than before robust. In other words, the road-land access variable from and to the villages, type of road surface, road with four-wheeled vehicle access, electricity coverage, flat topography, irrigation, market presence, presence of BTS towers, and cellular signal, were undervalued. The use of robust standard error did not change the magnitude of the coefficient for each variable, but it improved their significance.

Policy Implication

These estimation results unveiled a signal of transformation of the village agricultural sector influenced by the accessibility and quality of villages' infrastructure (Asher & Novosad, 2020; UN DESA, 2021). These findings can be linked to the government's policy on village development through village funds (Undang-Undang (UU) Nomor 6 Tahun 2014 Tentang Desa, 2014). President of Indonesia, Joko Widodo, has stated that rural infrastructure has become a foundation of development for Indonesia. Since 2015, the Government of

Indonesia has disbursed IDR 257 trillion of village funds, comprising IDR 20.7 trillion in 2015, IDR 47 trillion in 2016, IDR 60 trillion in 2017, IDR 60 trillion in 2018, and IDR 70 trillion in 2019. During those periods, the village funds were prioritized for infrastructure development, with the total development output increasing significantly (Arham & Hatu, 2020; The World Bank, 2019). According to the Minister of Finance, implementing the village funds has benefited the community, especially in the infrastructure sector (www.kemenkeu.go.id).

Following the findings in this study, the priority of village development through improvement in villages' infrastructure tended to affect rural economic transformation, as discovered by previous studies (Asher & Novosad, 2020; Bakht, 2000; Davis et al., 2017; Gibson & Olivia, 2010; Rammelt & Leung, 2017; UN DESA, 2021). However, the effect of villages' infrastructure differed between Java-Bali and outside these islands (Faoziyah & Salim, 2020; Gibson & Olivia, 2010; Sari & Yudhistira, 2021). Therefore, specific strategies are highly required to optimize village infrastructure development to induce village economy through agricultural sector development and a non-agriculture sector that may be interrelated (Abate et al., 2020; Faoziyah & Salim, 2020; UN DESA, 2021).

The quality of road-related infrastructure and its accessibility in Java-Bali, in the case of road land access and road access to four-wheeled vehicles throughout the year, were adequate, thus, no longer necessitating to be a priority. However, road surface improvement in paved or concrete was necessary. The increased paved or concrete road surface in Java-Bali acquired a higher marginal effect than outside these islands. Moreover, due to the size and possible shorter evolution of rural economic transformation, facilitating to an extent by a better level of agricultural productivity, villages in Java-Bali are likely to experience faster growth in the non-agricultural sector (UN DESA, 2021).

For villages outside Java-Bali, road-related infrastructure development should focus on improving road quality, thereby increasing the number of villages with paved or concrete roads, and ensuring the road accessibility of four-wheeled vehicles throughout the year. This improvement is highly required for inclusive and equitable development (Abate et al., 2020; Calderon & Serven, 2010). The government should prioritize low-quality and rural road infrastructure investment strategy (Fan & Chan-Kang, 2005). Meanwhile, road access through the villages should no longer be a priority due to the topography outside Java-Bali, consisting of many coastlines (Faoziyah & Salim, 2020).

Subsequently, market, irrigation, BTS towers, and cellular signal quality are crucial both within Java-Bali and outside. However, the provision of such infrastructure must consider both resources and the level of government delivering it. Relatively affordable infrastructure, such as the construction of village dams, small-scale electricity, and village markets, could be funded by village funds. However, more extensive infrastructure, such as reservoirs or lakes, large-scale markets, and large-scale electricity, as well as those beyond capacity, such as the provision of BTS towers, and cellular networks, could be coordinated with government agencies, state-owned enterprises, and the private sector to provide it.

Moreover, due to the Covid-19 pandemic over the last two years (Djalante et al., 2020; Ing & Basri, 2022; Malahayati et al., 2021; Nugroho et al., 2022; Rozaki et al., 2021), the government has shifted the main priority to handle the pandemic (Peraturan Menteri Keuangan Republik Indonesia Nomor 17/PMK.07/2021 Tentang Pengelolaan Transfer Ke Daerah Dalam Rangka Mendukung Penanganan Pandemi Corona Virus Disease (Covid-19) Dan Dampaknya, 2021; Muhyiddin & Nugroho, 2021; Nugroho et al., 2022; Olivia et al., 2020). The respondents also confirmed that rural infrastructure development appeared to stall in 2020-2022. As pandemic conditions subside and the economy recovers (Ing & Basri, 2022), the need for infrastructure development in rural areas should continue.

CONCLUSION

Conclusion

This study revealed that the accessibility and quality of road infrastructure increased the probability of village agricultural sector transformation. Paved or concrete roads and roads with year-round four-wheeled vehicle access significantly increased the likelihood of village agricultural sector transformation. Other independent variables, encompassing electricity coverage, flatland topography, trade facilities of markets or groceries, ICT infrastructure of BTS towers, and the quality of the cellular network, significantly enhanced the opportunity for transformation. Meanwhile, the availability of water or irrigation significantly affected the probability of surviving in the agricultural sector.

As an infrastructure gap existed in Java-Bali and outside these islands, the study discovered a slightly different effect of infrastructure development on the probability of transformation in the two regions. In Java-Bali, the improvement of village road quality to paved or concrete surfaces significantly influenced the transformation probability and even obtained a higher marginal effect than the areas outside these islands. However, land access to and from the villages and road access to four-wheeled vehicles throughout the year did not significantly affect the agricultural sector transformation for villages in Java-Bali due to their adequate infrastructure.

For villages outside Java-Bali, road surface and access to four-wheeled vehicles significantly increased the probability of shifting to the non-agricultural sector (Rozaki, 2020). However, the marginal effect of increasing paved or concrete road surface on transformation acceleration was lower than in Java-Bali. Meanwhile, road-land access to and from the villages in the two regions did not significantly influence the probability of shifting to the non-agricultural sector.

Other types of infrastructure, covering the electricity coverage, marketplace or groceries, availability of BTS towers, and quality of the cellular network, both within and outside Java-Bali, increased the probability of village agricultural sector transformation significantly. In contrast, the availability of water or irrigation in both regions significantly affected survival in the agricultural sector.

Recommendation

Following this research, the effect of developing transportation accessibility could accelerate economic transformation. The policymakers (in this case, under the authority of the Ministry of Rural Development of Disadvantaged Regions and Transmigration) should continue prioritizing the development of transportation infrastructure. However, it is necessary to differentiate the treatment between Java-Bali and outside these islands. In the case of road land access and road access to four-wheeled vehicles throughout the year, Java-Bali should no longer be a priority due to their adequate transportation. Unfortunately, it was not the case outside Java-Bali. Nevertheless, the priority of increasing paved or concrete roads could be continued for areas within and outside Jave-Bali. Furthermore, improved paved or concrete roads in Java-Bali possessed a higher marginal effect than outside these islands.

Other infrastructure developments should also be considered, including village electricity coverage services, irrigation, economic infrastructure, and ITC infrastructure. The village government should improve these types of infrastructure following their authority and budget. Affordable infrastructure, such as small-scale electricity resources, small dams, agricultural irrigation, and market development, could be built independently by the village government. Moreover, infrastructure development exceeding the capacity of the village government, such as large or massive electricity supply, large-scale reservoirs, and ICT infrastructure requiring a large budget or high technology, should be carried out in collaboration with other government agencies, state-owned enterprises, or the private sector.

Limitation of study

This study utilized PODES data with a long enough time range, reaching three to four years (three times in 10 years). PODES has been considered relevant considering the period of data and the choice of the outcome of interest. Agricultural sector transformation is a relative evolution and thus viewed not as an annual event. Nonetheless, there is a limitation regarding the set of variables and indicators used in this study. The characteristics of the PODES data provide general information on the dominant sector in the villages and only refer to a simple question directed to the village heads. Exact measures, such as the number of villagers with the main work activities in specific sectors, are unavailable. Therefore, the measurement is limited to the village status or rural development and not to the more specific measures of sectoral welfare improvement.

Acknowledgment: The authors are grateful to all respondents interviewed; colleagues at the Faculty of Economics and Business for the advice and support; M. H. Yudhistira, Ph.D. and Nurkholis, M.SE. for the constructive comments on the earlier draft of this manuscript. Ahmad Saifullah Kamaludin is supported by the targeted scholarship from the Indonesian Endowment Fund for Education (LPDP).

Authors contributions: ASK was contribute on conceptualization, data curation, data analysis, writing - original draft, writing - review & editing. RMQ was contribute on conceptualization, data analysis, writing - review & editing.

Conflict of interest: The authors declare no conflict of interest

REFERENCES

Abate, G. T., Dereje, M., Hirvonen, K., & Minten, B. (2020). Geography of Public Service Delivery in Rural Ethiopia. *World Development*, *136*, 105133. https://doi.org/10.1016/j.worlddev.2020.105133

Adam, C., Bevan, D., & Gollin, D. (2018). Rural–Urban Linkages, Public Investment and Transport Costs: The Case of Tanzania. *World Development*, *109*, 497–510. https://doi.org/10.1016/j.worlddev.2016.08.013

Afifah, T., Nuryetty, M. T., Cahyorini, Musadad, D. A., Schlotheuber, A., Bergen, N., & Johnston, R. (2018). Subnational Regional Inequality in Access to Improved Drinking Water and Sanitation in Indonesia: Results from the 2015 Indonesian National Socioeconomic Survey (SUSENAS). *Global Health Action*, *11*(sup1), 31–40. https://doi.org/10.1080/16549716.2018.1496972

Arham, M. A., & Hatu, R. (2020). Does Village Fund Transfer Address the Issue of Inequality and Poverty? A Lesson from Indonesia. *Journal of Asian Finance, Economics and Business*, *7*(10), 433–442. https://doi.org/10.13106/jafeb.2020.vol7.no10.433

Arifin, B., Wicaksono, E., Tenrini, R. H., Wardhana, I. W., Setiawan, H., Damayanty, S. A., Solikin, A., Suhendra, M., Saputra, A. H., Ariutama, G. A., Djunedi, P., Rahman, A. B., & Handoko, R. (2020). Village Fund, Village-Owned-Enterprises, and Employment: Evidence from Indonesia. *Journal of Rural Studies*, *79*, 382–394. https://doi.org/10.1016/j.jrurstud.2020.08.052

Asher, S., & Novosad, P. (2020). Rural Roads and Local Economic Development. *American Economic Review*, *110*(3), 797–823. https://doi.org/10.1257/aer.20180268

Asian Development Bank. (2012). The Saemaul Undong Movement in the Republic of Korea: Sharing Knowledge on Community-Driven Development. In *Agricultural History Studies* (Vol. 5, Issue 2).

Bachewe, F. N., Berhane, G., Minten, B., & Taffesse, A. S. (2018). Agricultural Transformation in Africa? Assessing the Evidence in Ethiopia. *World Development*, *105*, 286–298. https://doi.org/10.1016/j.worlddev.2017.05.041

Bakht, Z. (2000). Poverty Impact of Rural Roads and Markets Improvement & Maintenance Project of Bangladesh. In *World Bank South Asia Poverty Monitoring and Evaluation Workshop*.

Barrios, E. B. (2008). Infrastructure and Rural Development: Household Perceptions on Rural Development. *Progress in Planning*, *70*(1), 1–44. https://doi.org/10.1016/j.progress.2008.04.001

Belton, B., & Filipski, M. (2019). Rural Transformation in Central Myanmar: By How Much, and for Whom? *Journal of Rural Studies*, *67*, 166–176. https://doi.org/10.1016/j.jrurstud.2019.02.012

Berdegué, J. A., Rosada, T., & Bebbington, A. J. (2013). The Rural Transformation. In *Evolving Concepts of Development through the Experience of Developing Countries* (pp. 1–44).

Calderon, C., & Serven, L. (2010). Infrastructure and Economic Development in Sub-Saharan Africa. *Journal of African Economies*, *19*(Supplement 1), i13–i87. https://doi.org/10.1093/jae/ejp022

Chalil, T. M. (2020). The Efficieny of Village Government Spending in Indonesia: a Meta-Frontier Analysis. *Journal of Indonesian Economy and Business*, *35*(1), 1–16. https://doi.org/10.22146/jieb.44660

Chang, J. J., Chen, B.-L., & Hsu, M. (2006). Agricultural Productivity and Economic Growth: Role of Tax Revenues and Infrastructures. *Southern Economic Journal*, *72*(4), 891–914. https://doi.org/10.2307/20111859

Davis, B., Di Giuseppe, S., & Zezza, A. (2017). Are African Households (not) Leaving Agriculture? Patterns of Households' Income Sources in Rural Sub-Saharan Africa. *Food Policy*, *67*, 153–174. https://doi.org/10.1016/j.foodpol.2016.09.018

Deininger, K., Jin, S., Xia, F., & Huang, J. (2014). Moving off the Farm: Land Institutions to Facilitate Structural Transformation and Agricultural Productivity Growth in China. *World Development*, *59*, 505–520. https://doi.org/10.1016/j.worlddev.2013.10.009

Djalante, R., Lassa, J., Setiamarga, D., Sudjatma, A., Indrawan, M., Haryanto, B., Mahfud, C., Sinapoy, M. S., Djalante, S., Rafliana, I., Gunawan, L. A., Surtiari, G. A. K., & Warsilah, H. (2020). Review and Analysis of Current Responses to COVID-19 in Indonesia: Period of January to March 2020. *Progress in Disaster Science*, *6*, 100091. https://doi.org/10.1016/j.pdisas.2020.100091

Do, M. H., & Park, S. C. (2018). New Rural Development and Hierarchical Governance in Vietnam: Impacts of Government Support on Rural Households' Income Using a Hierarchical Linear Modelling. *Agris On-Line Papers in Economics and Informatics*, *10*(4), 3–15. https://doi.org/10.7160/aol.2018.100401

Fan, S., & Chan-Kang, C. (2005). Road Development, Economic Growth, and Poverty Reduction in China. In *International Food Policy Research Institute Washington, DC*.

Fan, S., & Zhang, X. (2004). Infrastructure and Regional Economic Development in Rural China. *China Economic Review*, *15*(2), 203–214. https://doi.org/10.1016/j.chieco.2004.03.001

Faoziyah, U., & Salim, W. (2020). Seeking Prosperity Through Village Proliferation: An Evidence of the Implementation of Village Funds (Dana Desa) in Indonesia. *Journal of Regional and City Planning*, *31*(2), 97–121. https://doi.org/10.5614/jpwk.2020.31.2.1

Gafarso, H. N., & Tufa, M. E. (2019). Effect of Universal Rural Road Access Program (URRAP) on Rural Households' Sociocultural Features: The Case of Jimma and Bunno Bedele Zones, South Western Ethiopia. *Üniversitepark Bülten*, *8*(1), 44–62. https://doi.org/10.22521/unibulletin.2019.81.4

Gibson, J., & Olivia, S. (2010). The Effect of Infrastructure Access and Quality on Non-Farm Enterprises in Rural Indonesia. *World Development*, *38*(5), 717–726. https://doi.org/10.1016/j.worlddev.2009.11.010

Haggblade, S., Hazell, P., & Reardon, T. (2010). The Rural Non-farm Economy: Prospects for Growth and Poverty Reduction. *World Development*, *38*(10), 1429–1441. https://doi.org/10.1016/j.worlddev.2009.06.008

Hwang, J., Park, J., & Lee, S. (2018). The Impact of the Comprehensive Rural Village Development Program on Rural Sustainability in Korea. *Sustainability*, *10*(7). https://doi.org/10.3390/su10072436

Imai, K. S., Gaiha, R., & Garbero, A. (2017). Poverty Reduction during the Rural–Urban Transformation: Rural Development is Still more Important than Urbanisation. *Journal of Policy Modeling*, *39*(6), 963–982. https://doi.org/10.1016/j.jpolmod.2017.10.002

Ing, L. Y., & Basri, M. C. (2022). *COVID-19 in Indonesia: Impacts on the Economy and Ways to Recovery (1st ed.)*. Routledge. https://doi.org/10.4324/9781003243670

Jayne, T. S., Haggblade, S., Minot, N., & Rashid, S. (2011). *Agricultural Commercialization , Rural Transformation and Poverty Reduction : What have We Learned about How to Achieve This?*

Kamei, K., & Sasaki, H. (2016). Agricultural Productivity, Infrastructures and the Optimal Timing of Opening Trade. *The Manchester School*, *84*(5), 621–641. https://doi.org/10.1111/manc.12125

Karaca-Mandic, P., Norton, E. C., & Dowd, B. (2012). Interaction Terms in Nonlinear Models. *Health Services Research*, *47*(1 pt 1), 255–274. https://doi.org/10.1111/j.1475-6773.2011.01314.x

Khandker, S. R., Bakht, Z., & Koolwal, G. B. (2009). The Poverty Impact of Rural Roads: Evidence from Bangladesh. *Economic Development and Cultural Change*, *57*(4), 685–722. https://doi.org/10.1086/598765

Kruseman, G., Mottaleb, K. A., Tesfaye, K., Bairagi, S., Robertson, R., Mandiaye, D., Frija, A., Gbegbelegbe, S., Alene, A., & Prager, S. (2020). Rural Transformation and the Future of Cereal-Based Agri-Food Systems. *Global Food Security*, *26*, 100441. https://doi.org/10.1016/j.gfs.2020.100441

Lokshin, M., & Yemtsov, R. (2005). Has Rural Infrastructure Rehabilitation in Georgia Helped the Poor? *The World Bank Economic Review*, *19*(2), 311–333. https://doi.org/10.1093/wber/lhi007

Majumdar, K. (2020). Rural Transformation in India: Deagrarianization and the Transition from a Farming to Non-farming Economy. *Journal of Developing Societies*, *36*(2), 182–205. https://doi.org/10.1177/0169796X20912631

Malahayati, M., Masui, T., & Anggraeni, L. (2021). An Assessment of the Short-term Impact of COVID-19 on Economics and the Environment: A Case Study of Indonesia. *EconomiA*, *22*(3), 291–313. https://doi.org/10.1016/j.econ.2021.12.003

Menteri Keuangan Republik Indonesia. (2021). *Peraturan Menteri Keuangan Republik Indonesia Nomor 17/Pmk.07/2021 Tentang Pengelolaan Transfer Ke Daerah Dalam Rangka Mendukung Penanganan Pandemi Corona Virus Disease (Covid-19) Dan Dampak Nya*.

Mok, M. S., Sohn, S. Y., & Ju, Y. H. (2010). Random Effects Logistic Regression Model for Anomaly Detection. *Expert Systems with Applications*, *37*(10), 7162–7166. https://doi.org/10.1016/j.eswa.2010.04.017

Muhyiddin, M., & Nugroho, H. (2021). A Year of Covid-19: A Long Road to Recovery and Acceleration of Indonesia's Development. *Jurnal Perencanaan Pembangunan: The Indonesian Journal of Development Planning*, *5*(1), 1–19. https://doi.org/10.36574/jpp.v5i1.181

Nakamura, S., Bundervoet, T., & Nuru, M. (2020). Rural Roads, Poverty, and Resilience: Evidence from Ethiopia. *The Journal of Development Studies*, *56*(10), 1838–1855. https://doi.org/10.1080/00220388.2020.1736282

Narayanamoorthy, A., & Hanjra, M. A. (2006). Rural Infrastructure and Agricultural Output Linkages: A Study of 256 Indian Districts. *Indian Journal of Agricultural Economics*, *61*(3), 444–459.

Nguyen, T. A., Gillen, J., & Rigg, J. (2020). Economic Transition without Agrarian Transformation: the Pivotal Place of Smallholder Rice Farming in Vietnam's Modernisation. *Journal of Rural Studies*, *74*, 86–95. https://doi.org/10.1016/j.jrurstud.2019.12.008

Nugroho, A., Fajri, Iqbal, R. M., Fadhiela, K., Apriyani, D., Ginting, L. N., & Nurdin, S. (2022). Impacts of Village Fund on Post Disaster Economic Recovery in Rural Aceh Indonesia. *International Journal of Disaster Risk Reduction*, 70, 102768. https://doi.org/10.1016/j.ijdrr.2021.102768

Olivia, S., Gibson, J., & Nasrudin, R. (2020). Indonesia in the Time of Covid-19. *Bulletin of Indonesian Economic Studies*, *56*(2), 143–174. https://doi.org/10.1080/00074918.2020.1798581

Pemerintah Republik Indonesia. (2014). Undang-undang Nomor 6 Tahun 2014 tentang Desa (Issue 1). Retrieved from https://peraturan.bpk.go.id/Home/Details/38582/uu-no-6-tahun-2014

Rammelt, C. F., & Leung, M. W. H. (2017). Tracing the Causal Loops Through Local Perceptions of Rural Road Impacts in Ethiopia. *World Development*, *95*, 1–14. https://doi.org/10.1016/j.worlddev.2017.02.024

Renkow, M., Hallstrom, D. G., & Karanja, D. D. (2004). Rural Infrastructure, Transactions Costs and Market Participation in Kenya. *Journal of Development Economics*, *73*(1), 349–367. https://doi.org/10.1016/j.jdeveco.2003.02.003

Rozaki, Z. (2020). Decrease of Agricultural Land and Industry Growth in Special Region of Yogyakarta. *IOP Conference Series: Earth and Environmental Science*, *458*, 012033. https://doi.org/10.1088/1755-1315/458/1/012033

Rozaki, Z., Wijaya, O., Rahmawati, N., & Rahayu, L. (2021). Farmers' Disaster Mitigation Strategies in Indonesia. *Reviews in Agricultural Science*, *9*, 178–194. https://doi.org/10.7831/ras.9.0_178

Sari, Y., & Yudhistira, M. H. (2021). Bad Light, Bad Road, or Bad Luck? The Associations of Road Lighting and Road Surface Quality on Road Crash Severities in Indonesia. *Case Studies on Transport Policy*, 9(3), 1407–1417. https://doi.org/10.1016/j.cstp.2021.07.014

Shamdasani, Y. (2021). Rural Road Infrastructure & Agricultural Production: Evidence from India. *Journal of Development Economics*, *152*, 102686. https://doi.org/10.1016/j.jdeveco.2021.102686

Suprayitno, B., & Pradiptyo, R. (2017). Fiscal Decentralization and Corruption: The Facts in Regional Autonomy in Indonesia. *Journal of Advanced Research in Law and Economics*, *8*(5), 1467–1483. https://doi.org/10.14505/jarle.v8.5(27).09

Syafingi, H. M., Dewi, D. A. S., Suharso, Heniyatun, Sulistyaningsih, P., & Rahmawati, U. (2020). Village Fund Optimization Strategy for Rural Community Welfare in Indonesia. *Journal of Critical Reviews*, *7*(7), 580–583. https://doi.org/10.31838/jcr.07.07.103

The World Bank. (2019). *Indonesia TA on Village Transfer: Policy Note on Redefining Village Expenditure Classification -Towards a Better Tracking of Village Spending*. http://documents.worldbank.org/curated/en/935921564028030541/Indonesia-TA-on-Village-Transfer-Policy-Note-on-Redefining-Village-Expenditure-Classification-Towards-a-Better-Tracking-of-Village-Spending

Timmer, C. P. (2009). A World without Agriculture: The Structural Transformation in Historical Perspective. In *The Henry Wendt Lectures Series*. http://www.aei.org/wp-content/uploads/2014/06/-a-world-without-agriculture-the-structural-transformation-in-historical-perspective_145442400043.pdf

Timmer, C. P. (2015). Managing Structural Transformation : A Political Economy Approach. In *WIDER Annual Lecture* (Vol. 18). Retrieved from https://www.wider.unu.edu/sites/default/files/AL18-2014.pdf

United Nations Department of Economics and Social Affairs (UN DESA). (2021). World Social Reports 2021: Reconsidering Rural Development Strategies. In *World Social Report*. United Nations.

Wong, H. L., Luo, R., Zhang, L., & Rozelle, S. (2013). Providing Quality Infrastructure in Rural Villages: The case of Rural Roads in China. *Journal of Development Economics*, *103*, 262–274. https://doi.org/10.1016/j.jdeveco.2013.03.002