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Analyzing determinants of poverty in Central Java with Generalized Method of Moments

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***Abstract**: The purpose of this study is to examine determinants of poverty in regencies/cities in Central Java. This study examined poverty, investment, savings, and infrastructure as the research variables by focusing on the vicious cycle of poverty. The data was obtained from the Central Bureau of Statistics in Central Java. The data was analyzed using the System-Generalized Method of Moments (SYS-GMM) model using a dynamic panel data model. The results show that both investment and infrastructure negatively and significantly impact poverty. However, saving has a positive and low significant impact on poverty. It was interesting to note that the disparity in savings ownership contributes to the high poverty level. These findings contribute to the government's efforts to alleviate poverty in the regencies/cities in Central Java. Our findings also provide valuable insights into poverty dynamics in Indonesia.*

***Keywords**: poverty, vicious cycle of poverty, Central Java, Generalized Method of Moments*

Analiza determinanti siromaštva u centralnoj Javi generalizovanom metodom momenata

***Apstrakt**: Svrha ove studije je da se ispitaju determinante siromaštva u regencijama/gradovima u centralnoj Javi. Ova studija je obuhvatila ispitivanje*

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siromaštva, investicija, štednje i infrastrukture kao istraživačkih varijabli fokusirajući se na začarani krug siromaštva. Podaci su dobijeni od Centralnog zavoda za statistiku Centralne Jave. Podaci su analizirani korišćenjem System-Generalized Method of Moments (SIS-GMM) modela korišćenjem dinamičkog modela panel podataka. Rezultati pokazuju da i investicije i infrastruktura negativno i značajno utiču na siromaštvo. Međutim, štednja ima pozitivan i nizak značajan uticaj na siromaštvo. Interesantno je primetiti da disparitet u vlasništvu štednje doprinosi visokom nivou siromaštva. Ovi nalazi doprinose naporima vlade da ublaži siromaštvo u regencijama/gradovima u centralnoj Javi. Rezultati predstavljeni u radu takođe pružaju značajan uvid u dinamiku siromaštva u Indoneziji.

***Ključne reči**: siromaštvo, začarani krug siromaštva, Centralna Java, generalizovana metoda momenata.*

1. Introduction

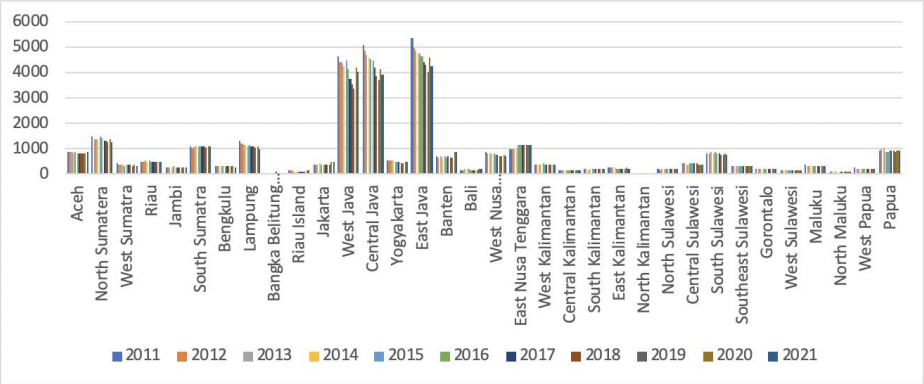
Poverty is an unrelenting concern for all countries worldwide (Zhang et al., 2023). Although poverty in low- and middle-income countries has decreased, it affects approximately 1 billion people worldwide (United Nations, 2023a). This prolonged poverty is anticipated to increase in many countries as global climate-related hazards and shocks grow (Khosla et al., 2023). According to the United Nations (2023a), progress in alleviating the poverty has increased and wide-spread, including the poverty in less developed countries, such as Africa, small countries, middle-income countries, conflict-affected countries, and post-conflict countries.

Poverty alleviation has long been a focus of economic and social research (Deng, 2023). Policymakers and economists have been interested in poverty alleviation (Yerrabati, 2022). According to the World Bank (2022a), the number of people living in poverty has decreased over the last three decades, reaching an extreme level of living on less than $2.15 per person per day. However, this trend was shifted in 2020, when the poverty rocketed due to the COVID-19 pandemic crisis. The number of extremely poor people increased by 70 million, reaching more than 700 million.

In 2019, the worldwide extreme poverty rate increased from 8.4% to 9.3%. When the Asian financial crisis hit the Indonesian economy in 1997, the number of individuals living on less than $3.2 per day (the World Bank's poverty line for lower middle-income countries) jumped from 79.8% to 90.2% in 1996. Indonesia recovered from the crisis in 1998, and many poor Indonesians were lifted from poverty (Moeis et al., 2020; Purwono et al., 2021).

The World Bank (2022b) mentioned that Indonesia has the world's fourth biggest population and the tenth largest economy regarding purchasing power parity. Indonesia has also made tremendous progress in the poverty reduction, lowering the poverty rate from more than half in 1999 to less than 10% in 2019 before the COVID-19 pandemic. The COVID-19 pandemic could limit the poverty alleviation progress from the lowest level of 9.2% in September 2019, to 9.7% in September 2021. Figure 1 depicts the trend in the number of poor people in Indonesia by province from 2011 to 2021.

Figure 1. Number of poor people in Indonesia by province



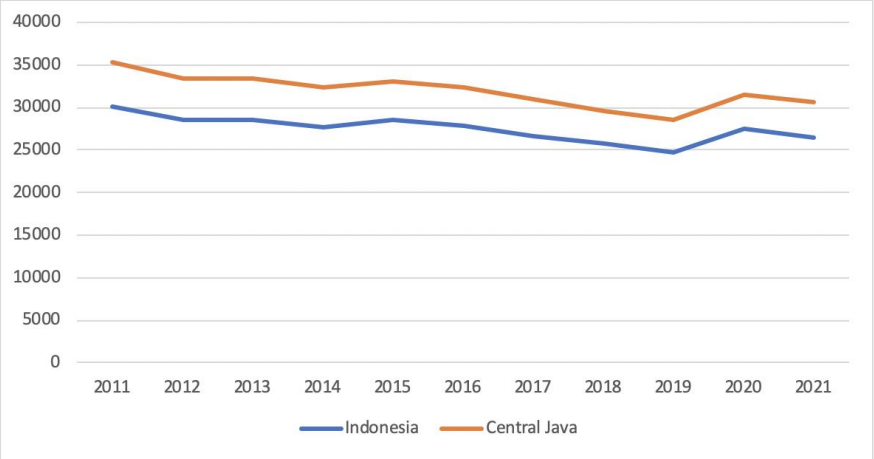
Source: Central Bureau of Statistics (2023a)

The Central Bureau of Statistics (2023b) explained that in the economic perspective, the poverty is defined as the inability to meet basic food and non-food necessities in terms of expenditure. People are categorized as poor if their monthly expenditure is less than IDR 1,048,609 per capita, which is under the poverty line (Central Bureau of Statistics, 2023c). Figure 1 shows Central Java has the second highest number of poor people after East Java. Previous studies on poverty dynamics in Indonesia have examined the phenomena using various approaches and datasets, but primarily by using the spell approach. For instance, McCulloch et al. (2007), Dartanto and Otsubo (2016); Akita and Dariwardani (2013), Dartanto and Nurkholis (2013), Dartanto et al. (2020), and Purwono et al. (2021) applied the spell approach to panel datasets from the Indonesian Family Life Survey (IFLS) and the National Socio-Economic Survey of Indonesia. Although the number of studies on poverty dynamics in Indonesia is growing, the findings remain inconclusive. This study aims to reexamine the poverty dynamics in Indonesia by using dynamic panel data models (Generalized Method of Moments).

2. Trends of change regarding poverty in Central Java in the period of 2011-2021

Despite an initial increase during the COVID-19 pandemic, the poverty rate has fallen and will remain so until 2021. Central Java still has a higher poverty rate than the national average. The trend in the number of poor people in Indonesia and Central Java from 2011 to 2021 is shown in the Figure 2 below.

Figure 2. Number of poor people in Indonesia and Central Java



Source: Central Bureau of Statistics (2023d)

The poverty in Central Java is an intriguing topic for research. Figure 2 shows that the poverty in Central Java has decreased between 2015 and 2019. However, the COVID-19 pandemic has caused an increase until 2020. Many experts from all across the world have conducted researches on variables and policies influencing the poverty. The United Nations (2023b) defined the poverty as the vicious cycle of interconnected and difficult-to-overcome element. People cannot achieve their most basic human needs due to lacking resources, competencies, and opportunities.

Apergis and Katsaiti (2018) used a panel data regression model to investigate the poverty and resources by concentrating on poverty determinants. Their findings showed that significant oil exporters, major natural gas exporters, and major coal exporters worsened the poverty. The bigger the influence on the poverty and natural gas, the less the significance of oil in the energy use. Although the significance of natural gas energy sources grew, it continued to

impact the poverty. Thus, democracy and economic freedom might play a role in the poverty alleviation.

Corruption, on the other hand, has significantly worsened the poverty. In contrast to a study by Apergis and Katsaiti (2018) which focused on the resources, Belhadj (2023) filled the research gaps in earlier researches by examining the drivers of poverty in the Middle East and North Africa (MENA) countries using a fuzzy multiple regression model. They found that the inflation rate coefficient did not affect the poverty. Meanwhile, the gross domestic product (GDP) was closely related to poverty. High GDP growth could frequently help in the poverty reduction. In addition, Belhadj (2023) also demonstrated how the poverty influenced the population growth. Depending on the circumstances of poverty, the relationship between poverty and unemployment might be negative or positive. Yerrabati (2022) investigated vulnerable employment and poverty in emerging countries using the System-Generalized Method of Moments (SYS-GMM) model. The findings showed that the vulnerable employment could lower the poverty by $1.90 per day and had no effect on the poverty at higher thresholds.

According to Appiah-Otoo et al. (2022), domestic credit and the money supply could reduce poverty. The money supply was found to have a positive effect on household consumption. Financial progress also benefited the poor. A previous study has examined the poverty reduction through the money supply. However, Asghar et al. (2022) investigated the significance of access to electricity in the poverty alleviation, and their findings suggested that the access to electricity could help reduce the poverty in both urban and rural settings. This study found that renewable energy was being generated and made available to all rural and urban inhabitants through the access to electricity to alleviate the poverty. The access to electricity in the rural and urban areas had an inverted U-shaped association with the poverty.

In addition to the money supply and access to electricity, Shastri et al. (2022) discovered that portfolio stock inflows helped alleviate the poverty through economic growth and trade openness. The foreign direct investment (FDI) and debt inflows had little effect on the poverty. Studies by Shastri et al. (2022) and Balasubramanian et al. (2023) complement one another by using the economic growth as a predictor. In fact, in the later decades of the twentieth century, the economic growth still has no statistically significant influence on multidimensional poverty. However, Balasubramanian et al. (2023) showed that the economic growth reduced the multidimensional poverty. This happened because the multidimensional poverty responded more strongly to the economic growth at lower starting points.

The study by Balasubramanian et al. (2023) contrasts the study by Li et al. (2021). Li et al. (2021) focused on the poverty alleviation through land transfer of rural households. By improving saving behavior, the land transfer of rural households contributes to reducing the multidimensional poverty. The motivation to save for emergencies is a land transfer mechanism that influences the rural households' multidimensional poverty. Meanwhile, Wang et al. (2022) investigated the poverty alleviation through financial infiltration. They found that the financial infiltration could accelerate the poverty alleviation in rural areas directly through increasing the use of fund through investment. This could be done indirectly by increasing the local economic growth.

While there have been global studies on poverty determinants and reduction, researchers in Indonesia have also conducted several relevant studies (Safitri et al., 2022; Nahor, 2022; Triyodani et al., 2022; Utami et al., 2022; Zuhdiyati & Kaluge, 2017). Safitri et al. (2022) explained that government subsidies and gross regional domestic product (GRDP) negatively and significantly impacted the poverty level in Banten province. On the other hand, the Human Development Index (HDI) did not affect the poverty in Banten province. In fact, the government subsidies could benefit the economy of lower-income community. However, there were still upper-class people who received it. The purchasing ability to meet the basic needs improved as the GDP increased. Meanwhile, there were an increasing number of people due to a lack of quality human resources in Banten Province.

Furthermore, Utami et al. (2022) discovered that population size had a positive and significant effect on the poverty in East Aceh. They also found that unemployment had no impact on the poverty. The greater the population, the higher the poverty rate without enough job opportunities. They also claimed that education still could not be accessed by the poor in general. Triyodani et al. (2022) revealed that the quality of human resources is needed to lower poverty. The community's productivity and quality of life will improve as human resources improve. The poverty can be alleviated by increasing the production speed of goods and services. A study by Zuhdiyati and Kaluge (2017) supported previous research, revealing that the HDI could be measured based on education, health, longevity, and income. A low level of economic growth will be ineffective in alleviating the poverty. Similarly, Nahor (2022) discovered that health negatively and significantly affected the poverty level. The poverty in North Sulawesi was found decreasing as public health improved.

Not all unemployed individuals are poor. One of the unemployed individual's family members may earn a good living. As a result, it can still cover the basic needs of the unemployed individual. Some people are unemployed but do not necessarily have a low income. They might have jobs, but in the informal sector. In Indonesia, studies on the poverty determinants and alleviation have primarily

focused on the government subsidies, GRDP (gross regional domestic product), HDI (human development index), health, education, population, unemployment rate, economic growth, etc. This present study focuses on the vicious cycle of poverty, by considering several predictors of poverty such as investment, savings, and infrastructure. Furthermore, static panel models are only used in Indonesian studies. In this study, a dynamic panel model with the Generalized Method of Moments method is employed to explain the dynamic conditions that occur in an economy.

The paper adds to the body of knowledge on poverty dynamics studies. There aren't few studies on Indonesian poverty dynamics that look into the factors contributing to poverty over time. The dynamics of poverty in Central Java regencies/cities from 2011 to 2021 are explained in this paper. It goes over how the dynamic panel data models were studied and how to estimate the factors influencing poverty dynamics. Finally, some key conclusions and recommendations for policy are provided. To sum it up, we hypothesized that investment, savings, and infrastructure significantly impact poverty levels in Central Java. The remainder of the paper is arranged as follows. Trends of change regarding poverty in Central Java in the period of 2011-2021 is presented in the second section, the development of the hypotheses and the theoretical framework are briefly covered in the third section, and the research technique is explained in the fourth section. Section five presents the results and discussions, while section six concludes with the conclusions.

3. Literature review and hypothesis development

3.1. The Vicious Cycle of Poverty Theory

The Vicious Cycle of Poverty Theory is crucial to understanding the causes of poverty. This theory highlights the constraints for developing countries in creating stable growth circumstances (Kotios et al., 2015). The poverty has no beginning or finish, and all factors causing it are interconnected. According to Pérez (2023), this theory is also known as the generational poverty, defined as the poverty experienced for generations in the poor family. The next generations will still be poor when a family is poor without external intervention. The major cause of the vicious cycle of poverty is a continuous lack of capital or wealth for generations. The high-income disparity will undoubtedly have an impact on savings. If people do not save, a decrease in their existing savings will decrease their investment. A low level of investment results in poor infrastructure, simultaneously leading to inequality and underdevelopment.

3.2. The Influence of Investment on Poverty

In this study, the investment refers to the capital investment that directly or indirectly impacts poverty alleviation (Ucal, 2014). Previous researches confirmed that increased investment inflows will result in the poverty alleviation. Agarwal and Atri (2017), Dinga (2023), Topalli et al. (2021), Ucal (2014), and Wang et al. (2022) revealed that the investment influenced the poverty. However, Shastri et al. (2022) argued that the investment had little or no effect on the poverty. Therefore, the first hypothesis that can be proposed is as follows:

H1: Investment influences the poverty.

3.3. The Influence of Savings on Poverty

Poor communities benefit from financial development. It helps developing a micro business by allowing them to draw on their savings or borrow in the form of credit (Appiah-Otoo et al., 2022). The funds people save at the banks can be channeled into credit for the poor to help them escape the poverty. Appiah-Otoo et al. (2022), Boukhatem (2016), Burgess and Pande (2005), Odhiambo (2010) and Quartey (2005) showed that the savings affected the poverty. In other words, changes in the savings can help people escape from the poverty. Therefore, the second hypothesis that can be proposed is as follows:

H2: Savings influences the poverty.

3.4. The Influence of Infrastructure on Poverty

Infrastructure can be defined as all technical structure and facilities that serve as the foundation for the growth of productive activities, such as services, policies, and social activities (Marinho et al., 2017). Good governance drives the infrastructure quality improvement. Improving the infrastructure quality will impact the poverty alleviation (Fagbemi et al., 2022). Che et al. (2023), Fagbemi et al. (2022), Liu and Xie (2022), Marinho et al. (2017), and Seetanah et al. (2009) revealed that the infrastructure influences the poverty. In other words, changes in the infrastructure can help to reduce the poverty. Therefore, the third hypothesis that can be proposed is as follows:

H3: Infrastructure influences the poverty.

4. Research method

4.1. Data and sample

This study was done using a quantitative method. A secondary data was analyzed using a panel data model that combined time series and cross section data of 35 regencies/cities in Central Java for ten years (2011-2021). The data was obtained using a purposive sampling method in the official website of Central Bureau of Statistics in Central Java, with the following criteria: (1) The regency/city must have a complete data on the poverty, investment, savings, and infrastructure during the research period; (2) After the 1997 crisis, the economy began to stabilize and the infrastructure began to recover in 2011-2021. However, by the end of 2019, the economy had changed dramatically due to the COVID-19 pandemic, resulting in significant poverty in Central Java.

4.2. Variable Measurement

This study examined several variables: poverty, investment, savings, and infrastructure. Operational definitions and their measurement can be seen in the following Table 1.

Table 1. Operational definitions and measurements

No.	Variable	Definition	Indicator	Scale
1.	Poverty	The inability to meet basic food and non-food needs from an economic perspective, as measured by expenditure.	Poverty Gap Index (P1) (%)	Ratio
2.	Investment	The capital investment activities in various economic activities aim to obtain future profit.	Investment (million IDR)	Ratio
3.	Savings	A balancing factor in the income and expenditure balance is then transferred to the capital account as a source of income.	Savings position in Central Java province by regency/city (million IDR)	Ratio
4.	Infrastructure	The facilities, both physical and non-physical, developed by the government or individuals to meet the basic needs of the society in the economic and social scopes.	Length of provincial roads according to road surface type (Kilometers/KM)	Ratio

Source: Central Bureau of Statistics (2023e). We use the four variable as our actual data. Methodically, all variables should stationary or have no unit root. For data analysis (hypotehes testing), all variables were transformed into logarithms with first difference of [I(1)]. This action makes all variables (particularly saving and investment) stationary. Many panel data models depend on stationary underlying data to be valid. Therefore, conducting accurate unit root testing is a crucial stage in any panel data analysis (Levin et al., 2002).

4.3. Data analysis

This study employed the dynamic panel data model, analyzed in STATA software. Levin et al. (2002) explained the panel unit root test. They observed the stochastic process (y_{it}) for a panel of individual i = 1,…, N and every individual has t = 1,.., T (time series observations). Then, Levin et al. (2002) evaluated whether (y_{it}) is integrated for each individual in the panel, assuming y_{it} is developed by one of the three models below:

$$\Delta y_{it} = \delta y_{it-1} + \zeta_{it} \quad (1)$$

$$\Delta y_{it} = \alpha_{0i} + \delta y_{it-1} + \zeta_{it} \quad (2)$$

$$\Delta y_{it} = \alpha_{0i} + \alpha_{1i} t + \delta y_{it-1} + \zeta_{it} \quad (3)$$

Whereas $-2 < \delta \leq 0$ for i = 1,…, N.

The error porcess ζ_{it} was distributed independently to all individuals and follower the stationary ARMA process that was reversible for each individual.

$$\zeta_{it} = \sum_{j=1}^{\infty} \theta_{ij} \zeta_{it-j} + \varepsilon_{it} \quad (4)$$

Whereas i = 1,…, N and t = 1, . . . , T, E (ζ_{it}^4) < ∞; E (ε_{it}^2) ≥ Bε > 0; and E (ζ_{it}^2) + 2 $\sum_{j=1}^{\infty}$ E ($\zeta_{it} \zeta_{it-j}$) < B ζ < ∞.

Assumptions explained by Levin et al. (2002) involved three data generation processes. In Model 1, the panel unit root test procedure evaluated the null hypothesis H_o: δ = 0 to the alternative H_i: δ < 0. In Model 2, the y_{it} series had individual means, but did not have a time trend. In this case, the panel test procedure evaluated the null hypothesis that H_o: δ = 0 dan α_{0i} = 0, for all i, to H_i: δ < 0 and $\alpha_{0i} \in R$. Finally, in Model 3, the y_{it} series had individual means and time trend. In this case, the panel test procedure evaluated the null hypothesis that H_o: δ = 0 and α_{1i} = 0, for all i, to the alternative H_i: δ < 0 and $\alpha_{1i} \in R$.

The dynamic panel data model used the System-Generalized Method of Moments (SYS-GMM). Arellano and Bover (1995) explained that the SYS-GMM or a general system for correcting the weaknesses of FD-GMM. The SYS-GMM estimated the data loss in low time series elements to minimize the data loss. This method of parameter estimation combined differences and levels. Meanwhile, compared to other GMM approaches, the SYS-GMM had the largest proportion (Arellano & Bond, 1991; Arellano & Bover, 1995; Tinungki, 2019; Tinungki et al., 2022). The general form of dynamic panel data regression is as follows:

$$Y_{it} = \alpha_{it} + \delta Y_{it-1} + \delta Y_{it-2} + \beta` X_{it} + u_{it} \quad (5)$$

Whereas,

$$u_{it} = \mu_i + v_{it} \quad (6)$$

Note:

Y_{it} : Response from individual unit i for time t

δ : Coefficient vector of Y_{it-1}

Y_{it-1} : Observation of exogenous variables in the first lag of Y_{it}

Y_{it-2} : Observation of exogenous variables in the second lag of Y_{it}

$\beta`$ ($\beta_1, \beta_2, \cdots, \beta_n$) : Vector of slope coefficients of size 1 × n (n = exogeneous variable)

X_{it} : Observation of exogenous variables from individual i for time t

α_{it} : Intercept coefficient of each individu i for time t

u_{it} : Residuals in individual i for time t

A two-step estimator model was used for the SYS-GMM estimation. To obtain robust parameters, the model specification testing must be performed to ensure that the estimates formed were consistent and impartial. The consistency test by Arellano-Bond (1991) confirmed no relationship between ε_{it} and ε_{it-2}. As a result, the panel data regression model is constructed as follows:

$$POV_{it} = \beta_0 + \gamma_1 POV_{it-1} + \gamma_1 POV_{it-2} + \beta_1 INV_{it} + \beta_2 SAV_{it} + \beta_3 INFRA_{it} + \varepsilon_{it} \quad (7)$$

POV_{it} refers to the state of poverty in individual i at time t. $\gamma_1 POV_{it-1}$ is poverty with a period of lag 1 for individual i at time t. $\gamma_2 POV_{it-2}$ is poverty with a period of lag 2 for individual i at time t. INV_{it} represents the investment in individual i at time t. SAV_{it} describes the savings of individual i at time t. $INFRA_{it}$ denotes the infrastructure for individual i at time t. β_0 represents a constant parameter. $\beta_{1,\cdots,3}$ indicates the coefficient of influence of exogenous variables on endogenous variables. ε_{it} shows the residual regression error for individual i at time t.

5. Empirical results and findings

Empirical results of this study included various key aspects, such as descriptive statistics, variable correlation, unit root test, static panel test, and dynamic panel test. The following Table 2 provides a summary of the descriptive statistics.

Table 2. Descriptive statistics

No.	Regency/City	Pov (%)	Inv (Mio IDR)	Sav (Mio IDR)	Inf (KM)
1	Cilacap Regency	2.008	1,994,179	5,451,730	308.546
2	Banyumas Regency	2.885	2,858,251	6,158,771	179.943
3	Purbalingga Regency	2.977	798,485	2,073,136	383.777
4	Banjarnegara Regency	2.911	708,412	1,970,366	240.767
5	Kebumen Regency	3.276	988,215	3,274,775	198.761
6	Purworejo Regency	1.966	1,000,951	2,427,784	226.893
7	Wonosobo Regency	3.643	562,169	1,712,108	273.863
8	Magelang Regency	1.675	1,188,273	2,396,484	284.334
9	Boyolali Regency	1.830	793,186	2,530,008	168.780
10	Klaten Regency	2.225	1,650,316	4,427,467	172.373
11	Sukoharjo Regency	1.112	1,461,943	3,506,797	154.294
12	Wonogiri Regency	1.727	631,728	2,323,308	336.324
13	Karanganyar Regency	1.880	1,159,027	2,747,536	248.757
14	Sragen Regency	2.401	864,562	3,052,501	69.140
15	Grobogan Regency	1.952	786,340	2,767,804	336.693
16	Blora Regency	1.929	689,035	2,303,057	326.287
17	Rembang Regency	2.936	604,926	1,595,249	260.780
18	Pati Regency	1.683	1,204,534	4,581,745	241.843
19	Kudus Regency	0.971	7,279,848	5,197,569	155.363
20	Jepara Regency	0.936	830,628	2,885,544	565.348
21	Demak Regency	2.242	551,915	1,868,476	36.722
22	Semarang Regency	1.213	2,885,294	3,661,447	204.401
23	Temanggung Regency	1.505	1,189,359	2,499,931	157.992
24	Kendal Regency	1.791	754,077	2,653,493	212.591
25	Batang Regency	1.567	346,622	1,459,871	156.659
26	Pekalongan Regency	1.701	804,715	2,112,151	179.310
27	Pemalang Regency	2.962	544,780	2,449,986	218.535
28	Tegal Regency	1.270	879,831	2,760,906	202.268
29	Brebes Regency	3.272	639,161	2,887,222	254.564
30	Magelang City	1.218	2,115,100	3,090,818	310.030
31	Surakarta City	1.607	13,400,000	13,400,000	133.303
32	Salatiga City	0.841	1,560,725	2,643,901	127.574
33	Semarang City	0.630	31,600,000	25,400,000	439.347
34	Pekalongan City	1.073	1,466,312	3,101,692	48.066
35	Tegal City	1.251	1,335,209	2,771,584	334.745

Note: N: 630; n: 21; T: 30; Pov: poverty; Inv: investment; Sav: savings; Inf: infrastructure.

Table 2 shows that Banyumas regency has the highest average poverty rate of 3.643. Meanwhile, Semarang city has the lowest average poverty rate of 0.630. Semarang city donates the greatest average investment of 31.600,000. Meanwhile, Batang regency contributes the least amount of investment of 346,622. Further, Semarang city contributes to the most average savings of 25,400,000. Semarang city also has the lowest average savings of 1,459,871. In addition, Jepara regency has the longest average infrastructure (road) of 565,348. Whereas Demak regency has the shortest average infrastructure (road) of 36,722. This study also presents the correlations between research

variables. The correlation coefficient referred to a coefficient that could measure the relationship between two variables, which can be seen in Table 3 below:

Table 3. Correlation Matrix

Variable	Pov	Inv	Sav	Inf
Pov	1.000			
Inv	-0.313**	1.000		
Sav	-0.322**	0.960**	1.000	
Inf	-0.214**	0.095	0.157**	1.000

*Note: **significant at $\alpha = 0.05$.*

Table 3 shows that the investment and poverty have a negative and significant correlation of -0.313. The savings and poverty have a negative and significant correlation of -0.3218. In addition, the infrastructure and poverty have a negative and significant correlation of -0.214. In contrast, the infrastructure and savings have a positive and significant correlation of 0.157. Meanwhile, the savings and investment have a positive and significant correlation of 0.960. However, the infrastructure and investment are not significantly correlated. The following Table 4 displays the results of the unit root test.

Table 4. Results of Unit Root Test

Variable		I(0)	I(1)	p-value	
I(0)	I(1)	Adjusted t	Adjusted t	I(0)	I(1)
Pov	Δlogpov	-10.865	-7.5875	0.0000	0.0000
Inv	ΔlogInv	8.9515	-3.4005	1.0000	0.0003
Sav	ΔlogSav	-3.5555	-12.8016	0.0002	0.0000
Inf	ΔlogInf	-15.9045	-12.971	0.0000	0.0000

Table 4 shows that at the degree of integration level of [I(0)], the investment data is not stationary (has unit roots) because the p-value is 1.000 > 0.05. Therefore, the data was transformed into logarithms with first difference of [I(1)]. To maintain the data consistency and uniformity, the poverty, saving and infrastructure data were also converted into logarithms with first differences of [I(1)]. The model can be seen in the following Model 8:

$$\Delta logPOV_{it} = \beta_0 + \gamma_1 \Delta logPOV_{it-1} + \gamma_1 \Delta logPOV_{it-2} + \beta_1 \Delta logINV_{it} + \beta_2 \Delta logSAV_{it} + \beta_3 \Delta logINFRA_{it} + \varepsilon_{it} \quad (8)$$

Model 8 is a reference for testing static panel data analysis (POLS, FEM, REM, and FEM). The results of the static data panel analysis can be seen in Table 5 below.

Table 5. Results of static panel data analysis

Statistics	Dependent Variable: ΔlogPov			
	POLS	FEM	REM	LSDV
ΔlogInv	-0.0644 (-0.98)	-0.0667 (-0.96)	-0.0644 (-0.98)	-0.0372 (-0.44)
ΔlogSav	-0.1897 (-1.13)	-0.1978 (-1.08)	-0.1897 (-1.13)	-0.128 (-0.65)
ΔlogInf	-0.0459 (-4.69)***	-0.046 (-4.46)***	-0.0459 (-4.69)***	-0.0134 (-1.13)
Hausman (Prob > chi2)			0.9981	
Average VIF	2.04			
R^2	0.0851			0.2832
Adj. R^2	0.0772			0.1744

*Note: ***significant at α = 0.001.*

Table 5 shows the estimated coefficients from the four models (POLS, FEM, REM, and FEM). The POLS, FEM, and REM coefficients are quite similar. It is possible that the cross samples were not significantly different. Country and time dummies coefficients are included in the LSDV analysis. Furthermore, the results of the multicollinearity test show no multicollinearity, because the average VIF is less than 10. A static to dynamic model transformation was performed and the results can be seen in the Table 6.

Table 6: Transformation from Static to Dynamic Model

Statistics	Dependent Variable: ΔlogPov			
	POLS	FEM	REM	LSDV
L1.ΔlogPov	-0.467131 (-7.96)***	-0.510329 (-8.14)***	-0.467131 (-7.96)***	-0.583119 (-9.12)***
L2.ΔlogPov	-0.225959 (-3.65)***	-0.2685208 (-4.03)***	-0.225959 (-3.65)***	-0.3117871 (-4.77)***
ΔlogInv	-0.103084 (-1.56)	-0.127875 (-1.83)*	-0.103084 (-1.56)	-0.059417 (-0.72)
ΔlogSav	0.121583 (-0.51)	0.2229615 (-0.87)	0.1215831 (-0.51)	-0.165456 (-0.63)
ΔlogInf	-0.057076 (-6.12)***	-0.057673 (-5.89)***	-0.057076 (-6.12)***	-0.016673 (-0.12)
Hausman (Prob > chi2)			0.9981	
Average VIF	1.13			
R^2	0.2694			0.491
Adj. R^2	0.2561			0.3905

*Note: *significant at α = 0.1, ***significant at α = 0.01.*

Table 6 shows that the main difference between the static panel and the static to dynamic model transformation is the value of the first Lag (L1.ΔlogPov) and second Lag (L2.ΔlogPov). In general, the R^2 of cross-sectional data is lower than the time series data. The R^2 value is not quite high due to the cross-sectional heterogeneity in the panel data (Gujarati & Poter, 2020; PeiZhi & Ramzan, 2020). To overcome this weakness, it was necessary to test using the GMM approach. This study employed the SYS-GMM to control for endogeneity. The results are summarized in Table 7 below:

Table 7. Results of the Generalized Method of Moments

Statistics	Dependent Variable: ΔlogPov
	SYS-GMM
L1.ΔlogPov	-0.4606956 (-7.52)***
L2.ΔlogPov	-0.1964168 (-3.01)**
ΔlogInv	-0.21795752 (-3.48)**
ΔlogSav	0.46187079 (1.75)*
ΔlogInf	-0.06461964 (-4.76)***
AB test AR(1)	-4.5953 [0.0000]
AB test AR(2)	0.56342 [0.5731]

*Note: *significant at α = 0.1, **significant at α = 0.05, *** significant at α = 0.01. Generally, a 10% confidence level is not considered statistically significant. At some conditions, we can argue it may be significant (because of the small sample size, because of the low representativeness of the sample). There is no standard to determine the cut-off of the p-value. It depends on not only the sample size but also the disciplines. For example, 5% or 1% is recommended in medical sciences to avoid Type I error. In economic research, 10% is very common because potential Type I error will not lead to serious problems. Notably, 5% is commonly used by researchers as a cutoff p-value to determine the significance level. In this case, it will be reasonable to relax the significance level from 5% to 10%. Therefore, a cut-off p-value of 10 % will be used to interpret the results in the present study, which is a widely adopted criterion in economic studies (Shi et al., 2022). Therefore, we may say that there is a positive and low significant effect from the impact of saving on poverty in Central Java.*

Table 7 shows the first order serial correlation test [AR(1)], indicating the existence of first order serial correlation (0.0000 < 0.05). Meanwhile, the second order serial correlation test [AR(2)] shows that there is no second order serial correlation (0.5731 > 0.05). This indicates that the specification test for parameter consistency has been met. The SYS-GMM test results show that the L1.ΔlogPov instrument negatively and significantly affects ΔlogPov. Meanwhile, the L2.ΔlogPov instrument has a negative and significant effect on ΔlogPov. The test results for the three hypotheses show that ΔlogInv has a

negative and significant effect on ΔlogPov. Likewise, ΔlogInf has a negative and significant effect on ΔlogPov. Interestingly, ΔlogSav has a positive and low significant effect on ΔlogPov.

First, the results of testing the first hypothesis (H1) demonstrate that the investment negatively and significantly influences poverty. This finding is consistent with those of Agarwal and Atri (2017), Dinga (2023), Topalli et al. (2021), Ucal (2014), and Wang et al. (2022), who discovered that the financial infiltration could directly accelerate the poverty alleviation in the rural areas by increasing the use of fund through investment. This finding supported the vicious cycle of poverty theory. When the investment grew, capital turnover improved, and the market became more perfect. Then, the productivity would increase, leading to an increase in earnings and a reduction in the poverty. Central Java province had developed special economic zones, integrated industrial regions, and other industrial sectors to attract potential investors, both domestic and foreign investors. Central Java province would be able to eliminate the poverty with a large number of investors, simultaneously creating more job opportunities and increasing labor absorption.

Second, the results of testing the second hypothesis (H2) show that the savings have a positive and low significant effect on the poverty. This finding contradicts the ones by Appiah-Otoo et al. (2022), Boukhatem (2016), Burgess and Pande (2005), Odhiambo (2010) and Quartey (2005) that the savings reduced the poverty. This finding also supports the vicious cycle of poverty theory. In Central Java, the composition of savings continued to dominate (64.82% of third-party funds). In the first quarter of 2019, the composition of household third-party funds was still dominated by the savings (64.82%), deposits (32.34%), and current accounts (2.84%). The significant share of household savings in total third-party funds at the bank demonstrated the households' preference for high liquidity. This exposed the banks to liquidity problems if large quantities of consumer funds were withdrawn at any time. Further investigation reveals that approximately 0.02% of major depositors (with savings exceeding IDR 1M) controls 16.61% of total third-party funds. This suggested that Central Java banking was still heavily reliant on wealthy individual deposits (Bank Indonesia, 2019). The performance of the wholesale retail trade business sector, which was strongly influenced by the COVID-19 pandemic, slowed and declined in line with the decreasing economic conditions in Central Java. The closing of shopping malls in Central Java had exacerbated the trade sector performance.

Furthermore, the transportation sector was also not growing as quickly as it should. The COVID-19 pandemic had also impacted the government administration, defense, and social security sectors. Due to the COVID-19 pandemic, there were community activities restrictions. The performance of the transportation sector, both on land and at sea, had deteriorated. The poverty

line continued to rise, both nationally and in Central Java province, along with the inflation. The sales had also fallen due to the community activities restrictions, even though the households still had savings for purchasing the daily needs. The rise in the value of the poverty line in Central Java was mostly due to an increase in the poverty line in the urban areas. Based on the categorization of poverty groups into urban and rural areas, the urban poverty line in Central Java increased by 7.82% (yoy) from IDR 387,646 per capita/month in the reporting period to IDR 359,526 per capita/month earlier. Meanwhile, the rural poverty line climbed by 5.85% (yoy), from IDR 355,306 per capita/month (Central Bureau of Statistics, 2022).

Lastly, the results of testing the third hypothesis (H3) show that the infrastructure (long road) negatively and significantly affects poverty. This finding is in line with Che et al. (2023), Fagbemi et al. (2022), Liu and Xie (2022), Marinho et al. (2017), and Seetanah et al. (2009) who found that the infrastructure had a detrimental impact on the poverty. In other words, the infrastructure changes could help to reduce the poverty. The long road infrastructure development was such a key component of poverty alleviation. If the road was well-built, it would make travel more comfortable and save time. The comprehensive improvement and building of toll roads in Central Java attempted to improve traffic flow, increase the efficiency of products and services distribution, and assist the growth of economic activities more smoothly. The toll road revenue would boost the government's revenue, which would be channeled in the form of subsidies (Ministry of Public Works, 2009).

The primary indicators of poverty also include low productivity, a poor quality of life, poor social governance, excessive use of natural resources that is not environmentally sound, limited land and capital ownership, urban development that is biased, disparities in opportunities amongst members of society, and differences in human resources and economic sectors. In Central Java province, poverty is one of the issues facing the cities and regencies. Central Java is a province sandwiched between West Java and East Java, two larger provinces on the Java island. Geographically, the area of Central Java is recorded at 3,254,412 hectares or around 25.04% of the area of Java Island and 1.70% of the area of Indonesia. Central Java province with the central government in Semarang City, is administratively divided into 35 regencies/cities consisting of 29 regencies and 6 cities with 573 sub-districts covering 7,809 villages and 769 sub-districts. The province of Central Java's poverty issue has been prioritized and is considered a strategic issue. The fact that many impoverished people are still in Central Java province poses an annual challenge. Consequently, poverty is a shared duty, with the government bearing a particular share of the blame because it supports efforts to improve

people's lives and must act quickly to find a solution to lower the number of people living in poverty.

Many different approaches have been used in the fight against poverty. This is accomplished directly by giving out stimulus aid money as startup capital for profitable ventures and social services. Examples of indirect assistance include facilities and infrastructure that promote socioeconomic activities and community empowerment. The government of Central Java began implementing free school programs and scholarships for low-income children in education. In addition to these initiatives, projects to provide affordable housing, inexpensive power connections, etc., are used to reduce poverty.

6. Conclusions

This study explores the determinants of poverty in Central Java, employing the System-Generalized Method of Moments (SYS-GMM) model with data from the Central Bureau of Statistics. It notably finds that investment, savings, and infrastructure significantly impact poverty levels, and emphasizes the role of disparities in savings ownership. This research aims to inform government efforts in poverty alleviation in Central Java. This study's results conclude that investment and infrastructure have a negative and significant effect on the poverty in Central Java regencies/cities. Meanwhile, the savings have a positive and low significant effect on the poverty in Central Java regencies/cities. The poverty determinants were related to the vicious cycle of poverty theory. One of the determinants of high poverty levels was the disparity in savings ownership in financial institutions. If people did not save, a reduction in their savings would result in a reduction in the investment. Reduced investment resulted in the poor infrastructure. Inequality and underdevelopment happened as a result of poor infrastructure. It continued to move in a cycle, with no beginning or end. People would only save if their salary was high. When they saved more, they had more money to invest. If the capital turnover ran smoothly and the investment increased, the proper infrastructure would be well-built or repaired, and poverty would decrease.

The investment, savings, and infrastructure were all key variables that could generate and alleviate poverty. To alleviate the poverty, government policies in Central Java regencies/cities should prioritize comfortable infrastructure for investment activities, enhancing the convenience of investing with the principles of being fast, easy, and corruption-free. The government in Central Java regencies/cities must additionally multiply the funding for training and skill upgrading programs for the employees who lost their jobs during the crisis (for example, the COVID-19 pandemic). In addition, the government in Central Java regencies/cities could consider measures to reduce the savings ownership disparity in the financial institutions. The government must then focus on

repairing damaged roads. Therefore, road access could be used and supported public manufacturing, distribution, and consuming operations.

Along with introducing policies like asset allocation in retirement savings, the government should implement policies that redistribute assets, direct investment toward essential public infrastructure, and offer long-term social security. Programs to reduce poverty should be established that are spatially diversified based on the type and degree of poverty, as there is a significant difference in poverty levels between urban and rural areas as well as between regions. To reduce poverty, connectivity is also important. Poverty can likely be reduced more quickly if development is accelerated or transportation infrastructure is improved. People are more likely to be non-poor if they live one kilometer closer to a bus stop or terminal than in the village. Since it speeds up the flow of products and services, lowers transportation costs, and increases people's mobility, connectivity may help reduce poverty.

Along with its advantages, this research has a number of limitations. This study estimated the short-term effect of poverty determinants in Central Java regencies/cities. As a result, future researches are suggested to evaluate the long-term effect in the SYS-GMM using a non-linear combination formula. The lag variable of the dependent variable is an additional feature provided by the dynamic panel estimation. This variable is used to examine the adjustment dynamic (convergence coefficient).

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