Estimating the shadow economy at the provincial level in Indonesia: A MIMIC model approach

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Abstract

The shadow economy encompasses economic activities that are not recorded in the Gross Domestic Product (GDP), resulting in reporting bias and diminished state revenue. This study estimates the size of the shadow economy across 34 Indonesian provinces from 2015 to 2021 using the Multiple Indicators and Multiple Causes (MIMIC) method. The results indicate that the estimated average shadow economy ranges from 4.73% to 42.64% of the provincial GRDP. Key influencing factors include tax burden, government regulations, regional autonomy, self-employed labor, and economic openness. These findings support policies aimed at reducing the shadow economy through tax efficiency, improved regulations, and enhanced welfare for micro, small, and medium enterprises (MSMEs) backed by local governments.

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1. Introduction

The shadow economy encompasses economic activities that are not included in a nation's Gross Domestic Product (GDP) calculations (F. Schneider & Enste, 2000). Its presence distorts the accuracy of a country's economic portrayal, leading to an underestimation of actual GDP figures (Safuan et al., 2021). Consequently, this raises concerns about the reliability of national economic data, ultimately weakening trust between government institutions and the public (Dell'Anno, 2007). Additionally, the shadow economy indirectly undermines the formal economy by reducing government tax revenues (M. F. Schneider & Enste, 2002). This situation expands the tax gap and may hinder the effectiveness of government policies that rely on macroeconomic indicators (Wang et al., 2006). Furthermore, the shadow economy disrupts labor market equilibrium (Habibullah et al., 2017). Businesses operating informally are not subject to labor regulations, exposing workers to precarious conditions, including unsafe environments, inconsistent wages, and a lack of job security (Eilat & Zinnes, 2002; Sibagariang et al., 2023).

The shadow economy has been extensively studied across various countries, including Indonesia (Safuan et al., 2021). Between 1981 and 2008, Indonesia's shadow economy constituted an average of 19.78% of the national GDP (Elgin et al., 2012). Tan et al. (2017) estimated that from 1997 to 2012, this figure increased to an average of 28.1%. Rothenberg (2016) further highlighted that approximately 93% of businesses in Indonesia—mainly micro, small, and medium enterprises (MSMEs)—play a significant role in the shadow economy.

A comprehensive set of strategies and policies has been suggested to address the size of the shadow economy. Policies aimed at simplifying regulatory and administrative requirements, improving tax compliance, and implementing electronic payment systems—an implication of technological advancements—have the potential to reduce the shadow economy (Kelmanson et al., 2021; Schneider, 2017). The utilization of Information and Communication Technology (ICT) facilitates the transition towards formality (Chacaltana et al., 2018). ICT enables sectoral information and business skills to be accessible to a wide range of users without significant spatial or temporal constraints (Kartiasih et al., 2023; 2023a). Additionally, information related to education, employment, and public services fosters the acceleration of informal-to-formal transitions (Garcia-Murillo & Velez-Ospina, 2017; Kartiasih et al., 2023b). The digitalization of the financial sector has significantly enhanced business activities and the overall economy (Syed et al., 2018). One notable implementation is through cashless transactions, which streamline transactions while mitigating spatial and temporal barriers (Fabris, 2019) and restricting illegal money flows such as money laundering and counterfeiting (Rogoff, 2017).

Despite various studies estimating the size of Indonesia's shadow economy, most rely on cross-country data, thereby overlooking certain country-specific determinants. Moreover, limited attention has been given to regional or provincial-level estimations in Indonesia. Thus, this study aims to estimate the size of the shadow economy in Indonesia at both national and provincial levels while identifying its influencing factors.

Generally, the shadow economy encompasses all economic activities concealed from official authorities for monetary, regulatory, and institutional reasons (Medina & Schneider, 2018). However, no single definition of the shadow economy fully captures its diverse scientific and research purposes. This study adopts the concept and definition of the shadow economy based on the analytical framework established by the Italian National Institute of Statistics (ISTAT) and published by the Organisation for Economic Co-operation and Development (OECD). This classification introduces a statistical measure known as the non-observed economy (NOE) in national accounts. The NOE consists of three key components: underground production, informal production, and illegal production (OECD, 2002).

Underground production refers to production activities that are not directly observable due to statistical and economic reasons. Statistical reasons include unregistered production activities or underreporting due to a lack of awareness regarding statistical obligations. Economic reasons involve deliberate underreporting to evade taxes and social contributions or to circumvent legal regulations on minimum wages, working hours, occupational safety, and other labor laws. Informal production includes artisans, street vendors, agricultural laborers, domestic workers, and other small traders not recorded in official registers. It also encompasses small-scale institutional units with minimal separation between labor and capital, where employment relationships are primarily based on kinship or personal connections. Illegal production covers the manufacture of goods and services that violate legal regulations regarding sale, distribution, or possession. It also includes productive operations conducted by unauthorized entities. Although the NOE framework contributes to comprehensive national accounting, its classification does not entirely align with the shadow economy concept (Dell'Anno, 2007). Therefore, this study considers only NOE classifications that remain unobserved due to economic factors as part of the shadow economy.

Schneider & Enste (2000) argue that the growth of the shadow economy is driven by various factors, with tax burdens and government regulations being the primary contributors. Businesses and legal entities evade taxes to maximize profits and reduce labor costs, thereby shifting toward the shadow economy (Buehn & Schneider, 2013). Numerous studies have examined the relationship between tax burdens and the shadow economy across different countries, consistently finding that higher tax burdens correspond to a larger shadow economy. Government regulations significantly influence the shadow economy (Aigner et al., 1986; Johnson et al., 1998; Russo, 2018). While regulations serve as necessary mechanisms to prevent market failures, excessive regulations can escalate operational costs and drive businesses and workers toward the underground economy (Hassan, 2011). For instance, some firms prefer hiring shadow workers to bypass minimum wage requirements and work-hour restrictions (Igudia et al., 2016; F. Schneider et al., 2011). Thus, excessive government regulations correlate positively with the size of the shadow economy (Tedds & Giles, 2002).

The labor market is another critical factor directly associated with the shadow economy (Chen et al., 2020). Unemployment reflects economic recessions and labor market rigidities, and has a causal relationship with the shadow economy (Dobre et al., 2010). Individuals may engage in shadow economy activities due to a lack of formal employment opportunities, seeking financial support during periods of unemployment (Bajada & Schneider, 2009). Consequently, higher unemployment rates increase the likelihood of participation in the shadow economy (Tedds & Giles,

2002; Williams & Schneider, 2016). Furthermore, self-employment may contribute to shadow economy activities (Bordignon & Zanardi, 1997; Bosch & Maloney, 2010), as self-employed individuals receive less oversight and greater opportunities to conceal income (Williams, 2005). Thus, higher self-employment rates intensify shadow economy production (Williams & Schneider, 2016).

Globalization and economic openness can mitigate the shadow economy's size (Berdiev & Saunoris, 2018). Increased international integration compels governments to enhance institutional quality to remain competitive. Additionally, with higher trade activity in open economies, businesses and laborers can join global supply chains, increasing employment opportunities in the formal economy (Blanton et al., 2018). Feld & Schneider (2010) illustrate a positive correlation between inflation and shadow economy size in developing countries. When wages remain stagnant amid rising inflation, higher prices incentivize greater participation in the shadow economy. As individuals seek supplementary income, reduced demand for goods and services during downturns lowers inflation, which in turn, fosters increased shadow economy participation.

The relationship between the official economy and the shadow economy remains ambiguous. Schneider and Enste (2000) argue that the shadow economy diverts capital and labor from the formal sector, distorting economic policies and fostering unfair competition that hampers formal economic growth. Conversely, the shadow economy provides employment opportunities for the unemployed, supplies goods and services unavailable in the formal sector, and enhances household consumption (Mughal & Schneider, 2018).

Higher income inequality tends to increase the prevalence of the informal economy (Chong & Gradstein, 2004). Income disparity not only drives the expansion of the shadow economy but also perpetuates inequality, which ultimately exacerbates poverty in developing countries (Elijah & Uffort, 2007). Activities associated with the shadow economy serve as a coping mechanism against poverty, as the income generated from these activities contributes to meeting a portion of household financial needs (Nguyen et al., 2013). One of the consequences of the shadow economy is a decline in formal labor force participation (Schneider, 2018). Given that the total labor force consists of both formal and informal employment, an increasing number of workers shifting to the shadow economy leads to a reduced participation rate in the formal economy (Medina & Schneider, 2018).

2. Methodology

Measuring the size of the shadow economy does not have a standardized benchmark, as it cannot be directly observed. Several reliable estimation methods have been explored and continue to evolve in their application across various studies (Lemieux, 2007). Methods for measuring the shadow economy are categorized into two types: direct and indirect methods (F. Schneider, 1998; Medina & Schneider, 2018). Direct methods include the measurement of NOE in the compilation of national accounts (Gyomai & de Ven, 2014), tax audit calculations based on survey data (Feige et al., 1994), and representative survey techniques (Feld & Larsen, 2009). Indirect methods employ various macroeconomic indicators to track changes in the size of the shadow economy over time (Medina & Schneider, 2018). Examples of these methods include the statistical discrepancy approach official and actual labor force (O'Neill, 1983), the electricity consumption approach (Johnson et al., 1997; Kaufmann & Kaliberda, 2016), the monetary transaction

approach (Langfeldt, 1982), the cash demand approach (Tanzi, 1983), and the model-based approach using the Multiple Indicator Multiple Causes (MIMIC) model (Zellner, 1970; Jöreskog & Goldberger, 1975).

The MIMIC model is a specific form of structural equation modeling (SEM) widely used in psychometric and social science research and is based on the statistical theory of unobserved variables. This model was developed in the 1970s by Zellner (1970) as well as Jöreskog and Goldberger (1975). The MIMIC model was first used to estimate the size of the shadow economy in the United States (Aigner et al., 1986).

Figure 1. General Form of the MIMIC Model
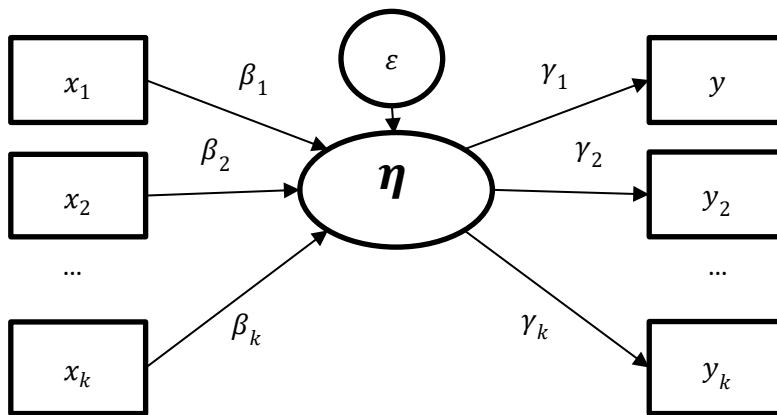
In the MIMIC model, the shadow economy acts as a latent variable whose relationship with observed variables is analyzed through a covariance matrix (Schneider & Buehn, 2018). Therefore, the unobserved variable is first linked to observed indicator variables in a factor analysis model (Elgin & Schneider, 2016). A theoretical model is initially constructed to explain the relationship between exogenous variables and the latent variable. Consequently, the MIMIC model is considered a confirmatory rather than an explanatory method (Medina & Schneider, 2018).

The confirmatory method emphasizes parameter estimation (coefficients, variances, etc.) and the goodness-of-fit of the constructed model (Chen et al., 2020). Thus, estimating the size of the shadow economy generally aims to measure the relationship between a series of observed causes and indicators of the shadow economy and to test whether the overall hypothesis aligns with the estimated results. Generally, the MIMIC model consists of two components: the measurement model and the structural model (Medina & Schneider, 2018). The general form of the MIMIC model can be expressed in Equations (1) and (2):

$$y = \gamma\eta + u \tag{1}$$

$$\eta = \beta' x + \varepsilon \tag{2}$$

Equation (1) represents the measurement model, where y=(y₁,y₂,...,yₙ)' is a set of indicator variables representing the impact of the latent variable denoted by η. $\gamma=(\gamma_1,\gamma_2,...,\gamma_n)'$ represents the variation in indicator variables after a one-unit change in the latent variable. u=(u₁,u₂,...,uₙ)' is the measurement error with a mean value of zero. In other terms, this measurement model represents the confirmatory factor analysis of the observed index y, the factor η, and the error term u.

Equation (2) represents the general form of the structural model. x=(x₁,x₂,...,xₖ)' is a set of observable variables acting as causal variables for the latent variable. $\beta=(\beta_1,\beta_2,...,\beta_k)$ represents the variation in the latent variable following a one-unit change in the causal variable. The notation ε represents the stochastic disturbance in the model. After substituting the structural model into the measurement model, the MIMIC model can be viewed as a simplified form of a multivariate regression model, as shown below:

$$y = \Pi'x + z \qquad (3)$$

$$z = \gamma\varepsilon + u \qquad (4)$$

$$\theta_\varepsilon = \gamma\gamma'\,\sigma_\varepsilon^2 + \theta_u \qquad (5)$$

Here, Π is the coefficient matrix derived from γβ', and z is the disturbance vector. The covariance matrix equation for the disturbance is given in Equation (5). The rank of the Π matrix is equal to the rank of the measurement equation matrix. The covariance matrix of the disturbance is the total sum of the single-rank matrix and the diagonal matrix, which equals the rank of the measurement model equation.

Figure 2. Hypothetical MIMIC Model for the Shadow Economy in Indonesia

Source: Processed by Author
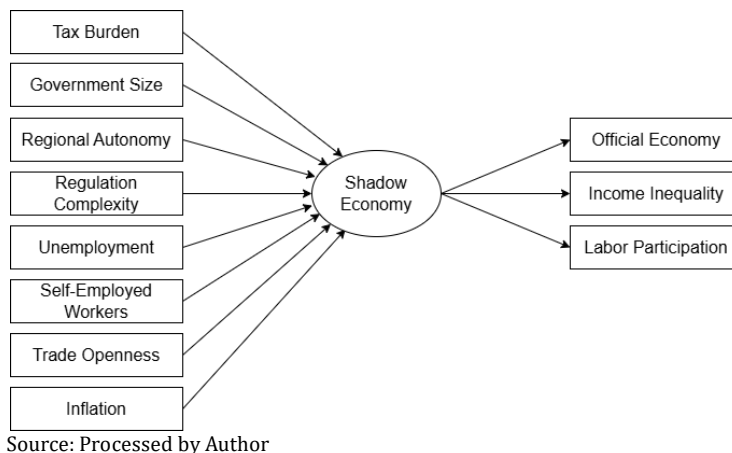
There are three stages to obtaining an estimate of the shadow economy, with the final result expressed as a percentage of the Gross Regional Domestic Product

(GRDP) in the relevant region or province. The first step involves formulating a hypothesis by analyzing various causal variables and indicators of the shadow economy as the initial design of the MIMIC model. Based on the theoretical analysis conducted, the MIMIC model of the shadow economy is developed, as shown in Figure 2.

To ensure that the MIMIC model approach aligns with the panel structure of the dataset, adjustments must be made to all variables in the model by considering the mean values of each region over the sample period. This adjustment involves transforming all variables into series with an expected mean value of zero. The adjustment aims to compute the covariance matrix and account for heterogeneity across all cross-sectional units in the MIMIC model (Dell'Anno & Mourao, 2011):

$$x^*_{jit} = (x_{jit} - \bar{x}_{ji\_}) \tag{6}$$

In Equation (6), j represents the 34 provinces in Indonesia, i represents the variables, and t represents the period (2015-2021). The next step is to run the MIMIC model, obtaining the elasticity coefficients between causal variables and latent variables through covariance information. The subsequent step is to calculate the shadow economy index based on the estimated model and calibrate the results using the estimated shadow economy size from a known year (Schneider et al., 2010). This study adopts the shadow economy size data from the most recent year available, as obtained from Medina & Schneider (2018).

$$SE_{it} = \frac{\eta_{it}}{\eta^*_{2016}} SE^*_{2016} \tag{7}$$

SE_{it} represents the size of the shadow economy in province i in year t, η_{it} is the shadow economy index value for province i in year t, η^*_{2016} is the average shadow economy index value of 34 provinces in Indonesia in 2016, and SE^*_{2016} is the overall size of Indonesia's shadow economy in 2016 based on the estimated results. The data used in estimating the size of the shadow economy consists of annual data from 34 provinces in Indonesia for the period 2015-2021.

Table 1. Data and Data Sources Used in the Study

Variable	Operational Definition	Unit	Source
TAX	Percentage of regional taxes and levies to total regional revenue realization	%	Directorate General of Taxes (DJPK)
GOV	Percentage of government consumption expenditure to GRDP	%	BPS
LREG	Percentage of workers with government employee status to total workers	%	BPS
FISCAL	Fiscal capacity ratio (ratio of regional original income (PAD) to total regional expenditure)	-	Ministry of Finance

Variable	Operational Definition	Unit	Source
UNEMP	Percentage of unemployment in the labor force	%	BPS
SELF	Percentage of workers with self-employed status to total workers	%	BPS
OPEN	Percentage of total exports and imports to GRDP	%	BPS
INF	Annual inflation using the GDP deflator method	-	BPS
GDRP	Constant GRDP of each province (2010=100)	Trillions of Rupiah	BPS
INEQ	Ratio of urban household income to rural household income	-	BPS
LFR	Percentage of the total workforce to the total population	%	BPS
SE	Value of Shadow Economy activity to total GDP	%	Medina, Schneider (2018)
ELEC	Percentage of population with access to electricity	%	World Bank
MOB	Number of mobile phone service subscribers providing access to voice communication per 100 people	-	World Bank
TELE	Number of landline telephone, landline, and public telephone service subscribers per 100 people	-	World Bank

Source: Processed by Author

3. Result and Discussion

The estimation results of the shadow economy magnitude using the MIMIC model approach are presented in Table 2. This study reports five estimation models, where Model 1 serves as the baseline model containing all theoretical determinants of the shadow economy. Model 1 includes all theoretical causal variables from the MIMIC model design in estimating the magnitude of the shadow economy in Indonesia. Based on Model 1, the tax burden variable significantly influences the shadow economy size in Indonesia. The positive sign indicates a strong indication that government-imposed tax policies contribute to increased shadow economy activities. Higher tax rates also encourage individuals to continue working in the shadow economy sector.

Government regulations, proxied in this study by the percentage of government employees relative to total workers, significantly influence the shadow economy. Government regulations play a vital role in preventing fraudulent financial activities. A well-structured and effective regulatory system can prevent Indonesian citizens from engaging in shadow economy activities, such as using brokers or other illegal services in administrative processes. The local government autonomy system also significantly influences the shadow economy in Indonesia. The negative sign suggests that the implementation of fiscal autonomy is effectively applied by each provincial government.

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**Table 2.** MIMIC Model Estimation Results

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
Causal Variables					
TAX	5.044***	5.307***	5.25***	5.239***	5.304***
GOV	-0.762	-0.468	-0.85	-	-
LREG	-1.691***	-1.425***	-1.455***	-1.382***	-1.385***
FISCAL	-25.275***	-25.074***	-24.806***	-24.839***	-25.1***
UNEMP	-7.025***	-	-5.093*	-5.075*	-
SELF	-0.733***	-0.538**	-	-	-0.542**
OPEN	-51.176***	-46.268***	-49.898*	-48.282***	- 45.407***
INF	-0.84	-	-	-	-
Indicators					
GDRP	-1	-1	-1	-1	-1
INEQ	0.000	0.007***	0.007***	0.007***	0.000***
LFR	0.004	1.929***	1.927***	1.925***	0.006**
Fit Indices					
RMSEA	0.128	0.124	0.133	0.112	0.104
CFI	0.678	0.741	0.713	0.809	0.833
SRMR	0.06	0.066	0.059	0.053	0.062

Source: Processed by Author

Regarding labor market factors, self-employed workers or entrepreneurs negatively impact the shadow economy in Indonesia. Although entrepreneurship enjoys more regulatory flexibility, micro, small, and medium enterprises (MSMEs), which dominate entrepreneurial activities, contribute to job creation.

The prevalence of MSMEs across various societal levels fosters legal economic activities. Additionally, increasing awareness among entrepreneurs to register their Businesses with the relevant MSME or cooperative agencies also contribute to the significant effect of self-employment on the shadow economy.

Figure 3. Average Shadow Economy Size Across 34 Provinces in Indonesia 2015-2022 (% of GRDP)
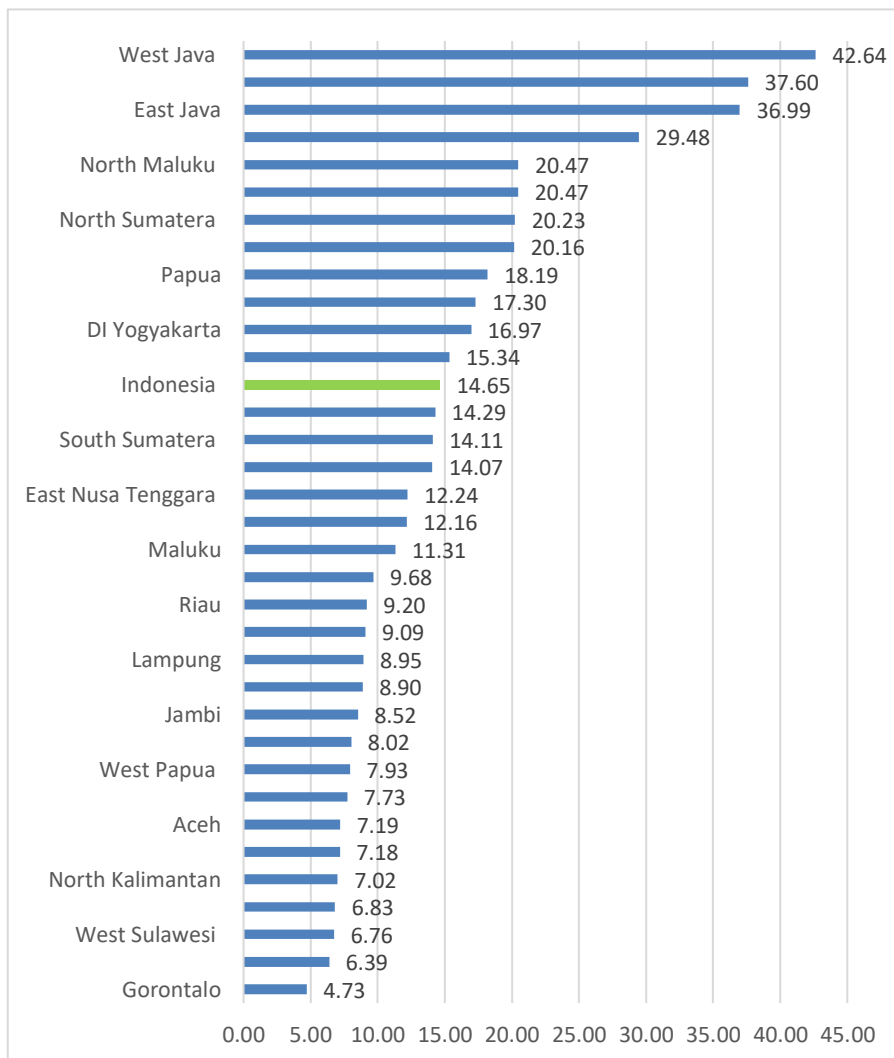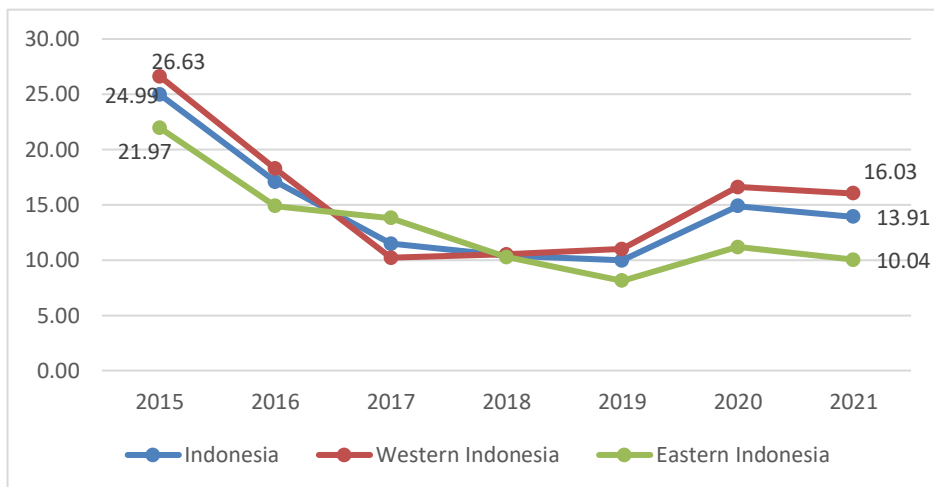

Source: Processed by Author

In selecting the best model, multiple criteria regarding the overall structural model fit are considered. Based on the fit indices of the MIMIC estimation model, Model 5 is chosen as the best model for estimating the shadow economy size at the provincial level in Indonesia due to its lowest RMSEA value and highest CFI value among the proposed models.

For further examination, Figure 3 illustrates the average shadow economy size across 34 provinces from 2015 to 2021. The shadow economy varies considerably among provinces, ranging from 4.73% to 42.64% of the provincial GDP. The four provinces with the largest shadow economy proportions are West Java (42.64%), DKI Jakarta (37.6%), East Java (36.99%), and Central Java (29.48%). Geographically, all four provinces are situated on the island of Java. Moreover, these provinces share a common characteristic of having a higher proportion of tax revenue relative to regional income compared to other provinces, consistently ranging between 45-60% throughout the 2015-2021 period. The provinces with the smallest shadow economy sizes are Gorontalo (4.73%), Bangka Belitung Islands (6.39%), and West Sulawesi (6.76%). These three provinces share the common characteristic of having a lower tax burden compared to other provinces, with tax burdens below 0.8% of GDRP.

This study aligns with findings from Schneider & Enste (2000) and Medina & Schneider (2018), which suggest that high tax burdens and complex regulations contribute to the growth of the informal economy (shadow economy). Provinces with high local taxes may have incentives to enhance tax compliance, but they may also unintentionally drive growth in the informal sector if taxpayers feel excessively burdened. High local taxes can contribute to the shadow economy if individuals and small businesses prefer to operate informally to evade taxes and stringent regulations.

Figure 4. Temporal Trends in Average Shadow Economy Size Across 34 Provinces (2015-2021)

Source: Processed by Author

The temporal trend of the shadow economy across Indonesia's 34 provinces is depicted in Figure 4. The analysis divides the regions into two geographical groups: western Indonesia (Sumatra, Java, Bali, and Kalimantan) and eastern Indonesia (Nusa Tenggara, Sulawesi, Maluku, and Papua). A fluctuation occurred in 2020, affecting both western and eastern Indonesia. Initially, the national shadow economy trend declined until 2017, followed by stagnation, then a surge in 2020 and 2021, likely due to the COVID-19 pandemic.

This aligns with Berdiev et al. (2020), who suggested that increasing epidemic intensity tends to escalate shadow economy activities. The pandemic also impacted entrepreneurship. In Indonesia, MSME activities dominate entrepreneurship. The pandemic hindered outdoor business operations, leading many entrepreneurs to shut down their businesses. This is evident from the decline in the share of entrepreneurs in total employment, from 35.897% in 2020 to 21.633% in 2021. Since entrepreneurship negatively and significantly influences Indonesia's shadow economy, the average shadow economy size surged across all provinces in 2020 and 2021.

4. Conclusion

By examining the factors and indicators influencing the shadow economy in Indonesia through the MIMIC model, this study identifies that the tax burden, government regulations, regional autonomy, self-employment, and economic openness significantly affect the shadow economy in Indonesian provinces between 2015 and 2021. Among these factors, the tax burden stands out as the most significant contributor to the expansion of the shadow economy across provinces.

This study provides several key policy implications to mitigate shadow economy growth. First, a more adaptive local tax reform is necessary. Given the strong link between local taxation and the shadow economy, regional governments should implement more flexible tax structures with incentives to encourage small businesses to transition into the formal sector. Simplifying licensing procedures and reducing tax compliance costs can also help curb informal economic activities. Second, strengthening oversight of the informal sector and advancing economic digitalization. Provinces with a high shadow economy should enhance the use of digital data to detect unrecorded economic activities, such as through electronic tax systems and integration with digital financial transactions.

A digital incentive-based approach, such as lower tax rates for micro, small, and medium enterprises (MSMEs) that adopt electronic payment systems, can help attract businesses to the formal sector. Third, implementing targeted policies for provinces with a high shadow economy. Given that provinces such as West Java, DKI Jakarta, East Java, and Central Java exhibit high levels of shadow economy activity and a significant share of tax revenue relative to locally generated income, policies should be tailored to the economic characteristics of each region. For instance, in West Java and East Java, where small-scale manufacturing industries and informal trade are prevalent, policies should focus on integrating informal businesses into the formal industrial ecosystem through mentoring programs and incentives. Meanwhile, in DKI Jakarta, economic digitalization and improved transaction transparency could be more effective in reducing the shadow economy.

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