Do Rupiah Coins Have Any Value? A Cross Country Comparison and Evaluation of Rupiah Denominations

Wishnu Badrawani[1]*, John Fender[2], and Muhammad Hasan Ghozali[3]

[1, 3]Bank Indonesia Institute, Bank Indonesia, Jakarta, Indonesia 10350
[2]Department of Economics, University of Birmingham, Birmingham, United Kingdom B15 2TT

[1]w_badrawani@bi.go.id; [2]j.fender@bham.ac.uk; [3]muhammad_hasan@bi.go.id
*Corresponding author

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Abstract

Payment system innovation has grown exponentially in numerous nations, raising the prophecy of cash becoming obsolete. However, this is not the prevailing situation in Indonesia, where currency is widely used across the archipelago. In recent decades, the need for cash in circulation has risen steadily, even during the COVID-19 pandemic. In some cases, the possible economic ramifications of rejecting coins in circulation render the ongoing discussion a significant concern. Therefore, this research thoroughly examined the existence of Rupiah coins in terms of their buying power, denominational structure, and comparative analysis with other countries. The analysis of denomination structure concerning the present and future inflation rate, represented by the average of minimum wages, was conducted utilizing the D-Metric and a univariate regression. A cross-country comparative analysis was performed using a global product index, and the denomination structure of the Rupiah coin was compared to the denomination structures in several ASEAN countries and other nations. The research findings indicate that the denomination structure of Rupiah coins has been unsuitable for the current economic situation since 2013. The results are of great importance, as they support policies that improve the usefulness of Rupiah coins for economic transactions and reduce production costs.

Keywords: money demand, Rupiah coin, purchasing power, Big Mac, D-Metric

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Introduction

Cash usage continues to be substantial even during and after the COVID-19 pandemic has passed. Despite the prophecy that cash is dying and the future demand for cash is most likely affected by the rapid innovation of financial instruments and digital currency, cash is not likely to become extinct anytime soon (Fabris, 2019). Understanding the demand for cash and non-cash payments, particularly for banknotes—both high and low denominations—and coins, is critical for central banks. This necessity arises from the central bank's obligation to ensure the availability of banknotes and coins in the economy to meet the demands of individuals and businesses, as mandated by the Central Bank Act (Huang et al., 2022)

This concern is mainly focused on the circulation and proportion of banknotes in circulation, representing the role of cash for daily transactions and storing wealth. Central banks should be prepared to address fluctuations in cash demand, particularly during times of crisis when cash is considered a safe haven asset and reserved for emergency purposes. As highlighted by Fisher's quantity of demand theory (in Guttmann et al., 2021), the primary function of cash as a medium of exchange is notably amplified during financial catastrophes. Brandao-Marques and Ratnovski (2024) state that hoarding banknotes can hamper the money creation process, thereby affecting the effectiveness of monetary policy. In nations with a near-zero bond yield environment, particularly in the uncertainty, the cost of cash usage is typically reduced. Thus, firms tend to hoard cash and their liquid assets for precautionary motives, while the space of monetary policy that can be utilized to counteract future shock is limited (Alfaro et al., 2024; Sugandi & Shirai, 2019). This condition applies to cash in higher denominations, primarily banknotes, which serve as a store of value, but not to coins, which primarily function as a medium of exchange.

Coins are becoming less and less important to some people, with a minority advocating for their elimination. Nonetheless, several scholars have argued that removing coins could lead to cash rounding, which may result in higher inflation and face opposition from a segment of the community (Giles, 2015; Nguyen, 2023). Additionally, statistics reveal an increase in cash demand, driven by rising household income and inflation, which is also reflected in the demand for coins despite the rapid growth of non-cash payments in the economy.

Cash remains the primary payment instrument in numerous countries (Khiaonarong & Humphrey, 2023), especially in developing nations such as Indonesia, and is an essential component of the monetary aggregate. In Indonesia, the cash component of broad money (M2) is approximately 11%, while in narrow money (M1), it is approximately 19%. Coin accounts for approximately 1.4% of the Cash in Circulation. Coins are important in our daily transactions. However, there are instances where merchants or individuals decline their use due to low economic value (Ikhsan, 2021; Putri & Nugroho, 2023). One factor that become a concern of many scholars about the existence of the coins in the economy is their very low value, which affected their usage by individuals and merchants, as noted by (Prescott & Shy, 2023; Spector, 2019). Conversely, Chernoff (2022) indicates that a potential consequence of a

shortage of coins or small denominations in the economy is inflation, which may result from merchants or sellers rounding up the prices of goods.

Most research on money demand primarily focuses on analyzing the variables that influence money demand about recent developments, such as rapid advancements in financial technology or the COVID-19 pandemic. However, research specifically examining the demand for coin money is limited. Furthermore, it is important to note that most central banks prioritize examining and enhancing banknotes over coins; for example research by Haryono (2022) and Elkington and Guttmann (2024). Therefore, analyzing the value of coins, both in terms of their worth in commodities and in comparison to coin values in other nations, is crucial from both policy and theoretical standpoints.

Therefore, this research aims to assess the Rupiah coin's value in purchasing goods and services over time and compare the Rupiah coin's worth to those of other currencies in the region. This research endeavors to contribute to the discourse surrounding the worth of coins and their traditional role as a medium of exchange, a concept grounded in the quantity theory of money emphasized by Irving Fisher (1911), which has been a subject of debate among experts and the public for many years. Understanding the significance of Rupiah coins in relation to the home country's economy and their relative value compared to other countries is critical in this context. Another contribution of this research is the assessment of whether the current Rupiah coin denomination structure is still appropriate in light of the impact of inflation since its initial launch.

Literature Review

Over the past several decades, extensive research has been conducted worldwide to investigate the need for money. Despite the increasing prevalence of digital payment instruments, this topic continues to be of great interest. Various comprehensive approaches have been used, including theoretical and empirical studies, econometric analyses, and surveys to examine the factors influencing money demand. According to Friedman's theory of money (as cited in Bordo & Rockoff, 2013), the money held by individuals reflects the distribution of wealth between human and non-human forms, the rates of return on various assets, and various factors that influence preferences. Current research suggest that the primary determinants of money demand depend on interest rates, income, the grouping of nations under consideration, and the specific variable used in the specification, such as tax income (Çoban, 2022; Kumar, 2023).

According to Zhan et al. (2023) and (Warjiyo, 2024), the demand for money is substantially impacted by financial innovations like the introduction of digital money, digital wallets, and online payment platforms that reduce the necessity of holding physical currency. Kitamura (2022) provides a detailed analysis through case studies and monetary economic theory to evaluate the factors affecting currency denomination choices. This approach balances theoretical analysis with actual economic context and provides valuable guidance for policymakers. On the other hand, Freitas (2022) examines the influence of foreign

currencies on monetary policy and economic stability through a comprehensive analysis of economic data and trends. Shy (2023) conducts a pervasive literature review on consumer demand for cash, covering 271 papers. The review explains the features of cash payments and highlights that people tend to use cash more frequently for smaller banknote values. It also suggests that it is challenging to replace cash with other payment methods. The findings corroborate Fisher's theory of demand for money (Fisher, 1911), emphasising its function as a medium of exchange.

Most research has been conducted on the composition of currency denominations within several central banks. Manikowski (2017) examines the structure of the Polish denomination, emphasizes the need to modify currency structures in response to economic developments such as inflationary trends and transactional needs, and recommends a reassessment of Polish currency denominations. Hendrickson and Park (2021) discover that the elimination of high-value banknotes will result in a considerable decrease in illegal trade and subsequent social costs. Kitamura (2022) conducts research on the impact of currency denominations on the economy. The research shows that using non-optimal currency denominations can result in unnecessary costs associated with cash hoarding, and the concentration of price levels around certain denominations. The research emphasizes optimal currency denominations to promote efficient circulation and reduce costs. Bartzsch et al. (2023) employ a structural time series model developed by four central banks to forecast Euro banknotes for small and high denominations. A considerable number of studies assess the suitability of current currency denominations by employing the D-Metrics model introduced by Payne and Morgan (1981); for example, research by Arshadi (2019) and Ismaiel and Al-Ahmad (2023). The D-Metric model proposes that the inflationary effect decreases the purchasing power of specific denominations of banknotes and coins. Payne and Morgan (1981) observe that the fluctuation in the purchasing power of the currency, in relation to the denomination structure, can be most accurately characterised by the average day's pay (D), which denotes the average daily wage level.

The value of money can also be assessed through its purchasing power, which is determined by its function as a universally accepted medium of exchange for goods. The comparison of economic measures across countries can be conducted through market exchange rates. However, relying solely on market exchange rates to compare economic measures across countries may not be adequate due to a multitude of factors beyond direct price comparisons influencing them. Hence, Purchasing Power Parity (PPP) is considered a more reliable method for comparing living standards across countries. PPP calculates the relative price level of commodities to account for the difference in currencies' values. PPP is regarded as a preferable method for socio-economic analysis, owing to its ability to provide accurate results across various critical development domains (Purdie & Song, 2022). PPP is also the preferred method for policy-making and poverty analysis, having been validated by Aguilar et al. (2023) and Kyei-Mensah's (2023) research.

Measuring Purchasing Power Parity (PPP) is a formidable task that demands extensive statistical effort to collect data on national average prices for a vast range of well-defined products. The process is further complicated by the challenges of gathering price comparisons

for new products within similar time intervals and comparing countries within different clusters over time (Inklaar et al., 2022). Research suggests that PPP can be better explained using a simple selection of global goods, such as the Big Mac sandwich or any other goods representing a global product, instead of relying on a more complex measurement. As a result, the employment of this global product index in doing a cross-country analysis is gaining traction among researchers (Vo & Vo, 2023). For example, Akarsu et al. (2024) use the Big Mac index approach to investigate the relationship between purchasing power and regional inequality in Turkey. Similarly, Gharehgozli et al. (2020) conduct a cross-country analysis of income distribution and inequality in 29 countries from 2000 to 2013, using a daily Big Mac Affordability (BMA). Previous research has ranked the variability of living standards and purchasing power among individuals. Subsequently, this research can assess the comparative value of a currency worldwide by using this global product index.

Numerous scholars have undertaken extensive research on the structural aspects of currency denominations and have recommended discontinuing specific denominations, focusing on the lowest one. Drawing on examples from countries such as New Zealand, Australia, the Netherlands, France, and Spain, there is an ongoing discourse regarding the potential elimination of the penny, which holds the lowest value denomination. The research conducted by Prescott and Shy (2023) indicates that discontinuing the penny would significantly alleviate the burden of exchanging cash, making transactions more efficient and less time-consuming. This research provides valuable insights into the potential advantages of discontinuing the penny and adopting more efficient currency structures. However, the removal should be accompanied by government support and education to retailers to convince people that this action would not impact the price level or round up inflation (The Isle of Man Treasury, 2023).

This suggestion is consistent with King (2006), who asserts that due to its minimal value and excessive manufacturing expenses, the penny proves to be ineffective and unfeasible. The US Mint's annual report (United States Mint, 2022) indicates that the production cost of a penny is 2.72 cents, while the cost of manufacturing a nickel is 10.41 cents, implying that the cost of creating and distributing these coins exceeded their economic worth (Nguyen, 2023). Hence, eliminating it would result in cost savings and enhance the efficiency of our monetary framework. Additionally, Spector (2019) has argued that in a world without small denominations like pennies, rounding to the nearest nickel would balance out the economy and question the usefulness of pennies. However, in a country where coins hold low value, people's negative attitude towards them should be addressed through a national initiative. In contrast, Sa'idu et al. (2022) suggest that even if higher-value currency notes are introduced, coins should be used alongside them, and their purchasing power should be raised.

This finding is supported by rounding up phenomena that potentially trigger inflaton that should be appropriately addressed by the authority, such as by adjusting the value of coins-related inflation (Nguyen, 2023), providing an alternative mean of payments for small denominations, and implementing policy through the adjustment of denomination structure (Hernandez, 2023; Udo & Agbai, 2023). Additionally, enhancing the supply chain management of coins is also necessary, as addressed by the Federal Reserve System (FRS) and

Depository Institutions (DI), to ensure the adequate supply of coins and improve coin circulation (Huang et al., 2022).

Methodology

This research aims to investigate the role of Rupiah coins in terms of their comparative worth to other currencies and their purchasing power within the country over some time. In order to gain insight into the economic significance of Rupiah coins, this research uses a cross-country comparative analysis of the monetary value of coins. Data are from various reputable institutions: Bloomberg for gold price data from 1993 to 2022, Statista for Big Mac price data, central bank and national statistic agency of selected countries for currency denomination and minimum wage information as of December 2023, and the Indonesia National Bureau of Statistics (BPS) for Indonesia's minimum wage data from 1997 to 2023.

Initially, this research evaluates the relative worth of the Rupiah coin over time by comparing it to the price of Gold, which is widely recognized as a safe haven asset. Following this, this research conducts a cross-country analysis to evaluate the comparative value of Rupiah coins about the currencies of other nations. Moreover, this research compares the highest denomination of each country's coins, using a globally available commodity like the Big Mac from McDonald's, to evaluate the relative value of the Rupiah coin against other currencies. This analysis is based on data obtained from Statista, as referenced by Dyvik (2023).

Subsequently, this research assesses the depreciation of Rupiah coins over time, and the denomination of Rupiah coins that are most suitable in light of economic variables is determined by utilizing the D-Metric model proposed by Payne and Morgan (1981). The D-Metric model posits that the purchasing power of particular denominations of banknotes and coinage diminishes because of the inflation. The model evaluates the suitability of the denomination structure by utilizing the average day's pay (D), which signifies the typical daily wage of households. Figure 1 illustrates the detailed algorithm of the denomination structure for both banknotes and coins within the D-Metric model.

Despite its intrinsic limitations, such as the absence of a theoretical framework and the limited variables evaluated in determining a currency's denomination structure (Ismaiel & Al-Ahmad, 2023), the D-Metric model's simplicity renders it suitable as a guideline for assessing the appropriate currency denomination structure. It has also been successfully applied in various countries worldwide (Arshadi, 2019; Hernandez, 2023; Manikowski, 2017).

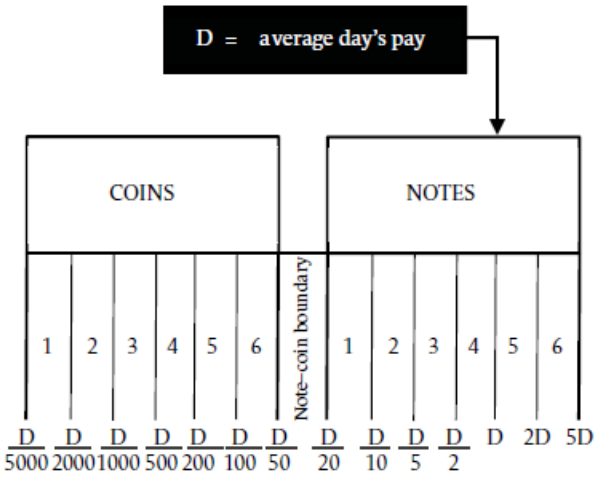


Figure 1 D-Metric Model

Source: Payne and Morgan (1981)

An autoregressive integrated moving average (ARIMA) model, a subset of the univariate model, is employed to predict the average daily wage *(D)* for the subsequent years. The ARIMA model is employed for its applicability and relevance to this research. Moreover, some scholars find that simple univariate forecasting algorithms often outperform and exhibit greater accuracy than a more complex multivariate model (Banerjee et al., 2005; Salehi et al., 2024). In these models, a time series is represented by incorporating the historical values of the series, as well as the present and previous values of a "white noise" error term. The regular ARIMA models are univariate models comprising an autoregressive polynomial, an order of integration *(d)*, and a moving average polynomial.

The ARIMA *(p, d, q)* model is implemented on the entire set of wage data points, which can be expressed as follows:

$$y_t = \mu + \sum_{i=1}^{p}(\emptyset y_{t-1}) + \sum_{i=1}^{q}(\theta\, \varepsilon_{t-1}) + e_t \quad (1)$$

y_t is the differenced and stationary series of relevant variables (wage), μ is the mean value of the time series data, p is the number of autoregressive lags, $\emptyset$ is autoregressive coefficients (AR), q is the number of lags of the moving average process; θ is moving average coefficients (MA),), ε_t is the error term, e_t is the white noise error term, d is the number of differences. The behaviour of the Partial Autocorrelation Function (PACF) and the Autocorrelation Function (ACF) can be used to determine the value of the ARIMA parameters (p, d, and q) for AR and MA.

Based on the D value from the ARIMA estimations, the D-Metric method evaluates the appropriateness of Rupiah coin denominations over time, as well as the coin denomination structures of selected countries for a cross-country comparison with the current Indonesian coin denomination structure.

Results and Discussion

Rupiah Coin Purchasing Power and Cross-comparison

Declining of Purchasing Power

Since its introduction in 1993, the depreciation of the IDR 1,000 coin in Indonesia has been a strong indicator of the country's economic direction over the last three decades. The main factor responsible for this decrease in value is inflation, a prevalent economic occurrence characterized by the gradual decline of a currency's purchasing power. Consequently, a IDR 1,000 coin could no longer purchase an item that demanded a substantial amount of currency to acquire in the early 1990s. Therefore, an item purchased in the early 1990s could no longer be purchased with a current IDR 1,000 coin. A decline in value is not merely a theoretical concept. It is a practical reality that affects the daily lives of individuals. The economic consequences of inflation are demonstrated by the decreasing utility of lower-denomination currency, such as the IDR 1,000 coin, in daily transactions. The diminishing purchasing power of this highest-value coin is also apparent when contrasted with the price of gold. According to Chiang (2024), gold is often considered an insurance or safe haven asset against inflation due to its scarcity and long-lasting nature, particularly in the United States, the United Kingdom, China, and Indonesia.

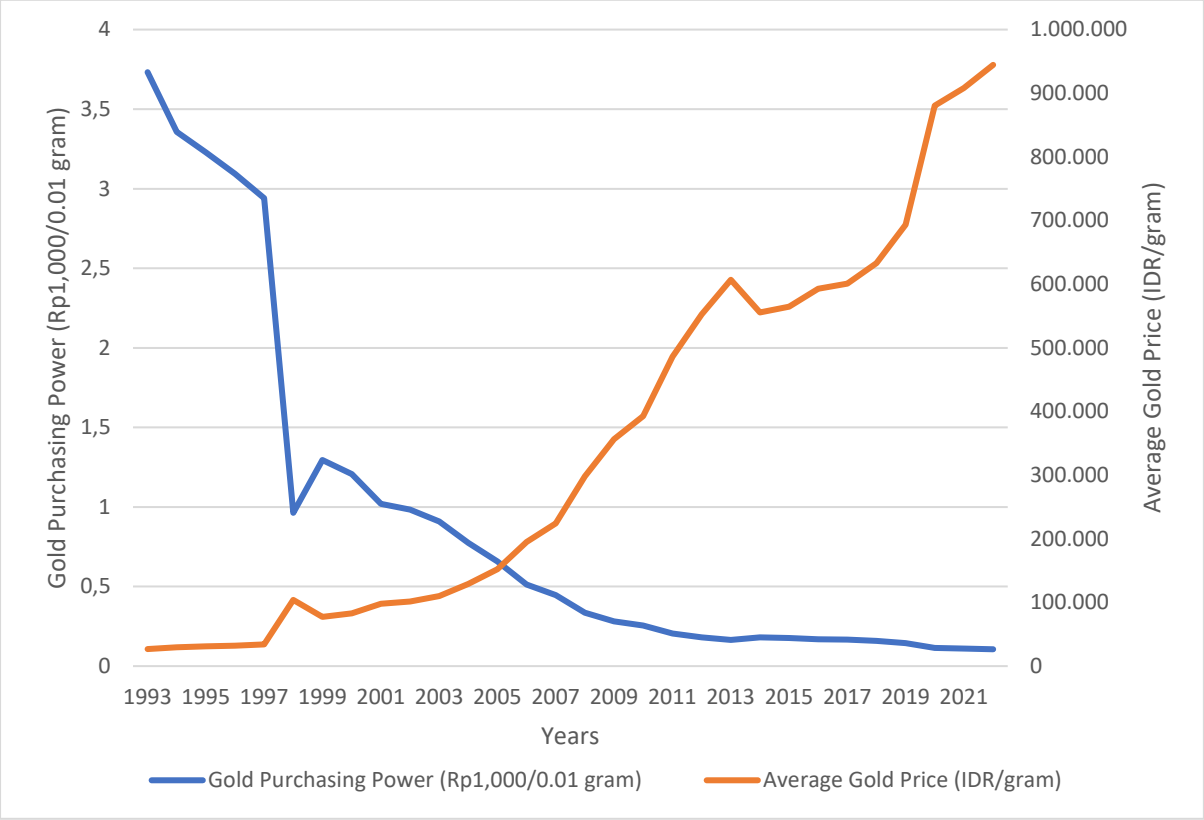


Figure 2 Purchasing Power of IDR 1,000 in terms of gold (IDR 1,000/price of 0.01 grams of gold)

Source: Bloomberg, Author's Calculation

Figure 2 indicates that throughout the observed period, the value of the coin denomination has consistently decreased. In contrast, the price of gold has steadily increased over the years. Compared to its value in 1993, the IDR 1,000 coin has experienced a significant decline in purchasing power. In the early 1990s, IDR 1,000 are sufficient for transactions involving minimal quantities of gold, such as small gold jewelry, using 20-30 coins. However, these coins now lack the purchasing power to acquire even a fragment of gold due to their depreciating value. As of 2022, its ability to buy 0.01 grams of gold has decreased by 95.96%. One consideration is whether our coin is the only one with such a low value on a global or regional scale.

This phenomenon is commonly observed whereby fiat money, such as the Rupiah, tends to depreciate relative to the value of assets like gold. The eventual depreciation of coins in Indonesia illustrates how fiat money may gradually lose value relative to a more stable intrinsic asset, such as gold. This situation reflects broader global economic trends, wherein currencies often experience a decline in their purchasing power due to inflation.

Cross-country Comparison

This research conducts a comparative study of coins between different countries to compare the Indonesian Rupiah with other currencies and highlight its distinctive characteristics in the context of the country's monetary and economic system. This research focuses on neighboring countries in Southeast Asia. Vietnam currently has the coin with the highest nominal value in circulation, 5,000 Dong, which was first issued in 2003. Indonesia follows with the second-highest denomination, the 1,000 Rupiah coin, introduced in 1993. Most developed countries typically have their highest denominations of coins in circulation within the single to double-digit range. Exceptions exist in Japan, which introduced the 500-yen coin in 1982, and South Korea, which similarly introduced the 500 KRW coin in that same year. Table 1 illustrates that most countries have a range of coin denominations, typically five to six denominations. Then, Appendix A reports more details on coin denominations in various countries.

Table 1 demonstrates that the IDR 1,000 coin is a fairly large denomination compared to the largest denominations of coins in circulation in other ASEAN countries such as Singapore, Malaysia, and Thailand. These countries have SGD 1 (equivalent to 0.75 USD), RM 1 (equivalent to 0.21 USD), and THB 10 (equivalent to 0.28 USD), respectively. Some nations with three-digit zeros coins include Colombia, with a denomination of COP 1000, which is comparable to USD 0.25, and Vietnam, with a denomination of VND 5000, which is equivalent to USD 0.20. Another comparison may be made with nations that have two-digit zeros. The Central African Republic has a currency of XAF 500, which is comparable to USD 0.827, and Cambodia has a currency of KHR 500, which is equivalent to USD 0.12. The coins of all countries under observation exhibit higher value when compared to the Indonesian coin IDR 1,000, which is equivalent to USD 0.064.

Table 1 Coin Currency Denomination in Selected Countries

Countries	Code	1	2	3	4	5	6	7	8
United States	USD	1	0.5	0.25	0.1	0.05	0.01	-	-
United Kingdom	GBP	1	0.5	0.2	0.1	0.05	0.02	0.01	-
Germany	EUR	2	1	0.5	0.2	0.1	0.05	0.02	0.01
Colombia	COP	1,000	500	200	100	50	20	10	5
South Africa	ZAR	5	2	1	0.5	0.2	0.1	-	-
Central African Rep.	XAF	500	100	50	25	10	5	1	-
Australia	AUD	1	0.5	0.2	0.1	0.05	-	-	-
Japan	JPY	500	100	50	10	5	1	-	-
South Korea	KRW	500	100	50	10	0	0	-	-
China	CNY	1	0.5	0.1	-	-	-	-	-
Philippines	PHP	20	10	5	1	0.3	0.1	0.05	0.01
Thailand	THB	10	5	2	1	0.5	0.25	-	-
Vietnam	VND	5,000	2,000	1,000	500	200	-	-	-
Malaysia	MYR	1	0.5	0.2	0.1	0.05	-	-	-
Cambodia	KHR	500	200	100	50	-	-	-	-
Singapore	SGD	1	0.5	0.2	0.1	0.05	-	-	-
Indonesia	IDR	1,000	500	200	100	50	-	-	-

Source: The Central Bank of Each Country

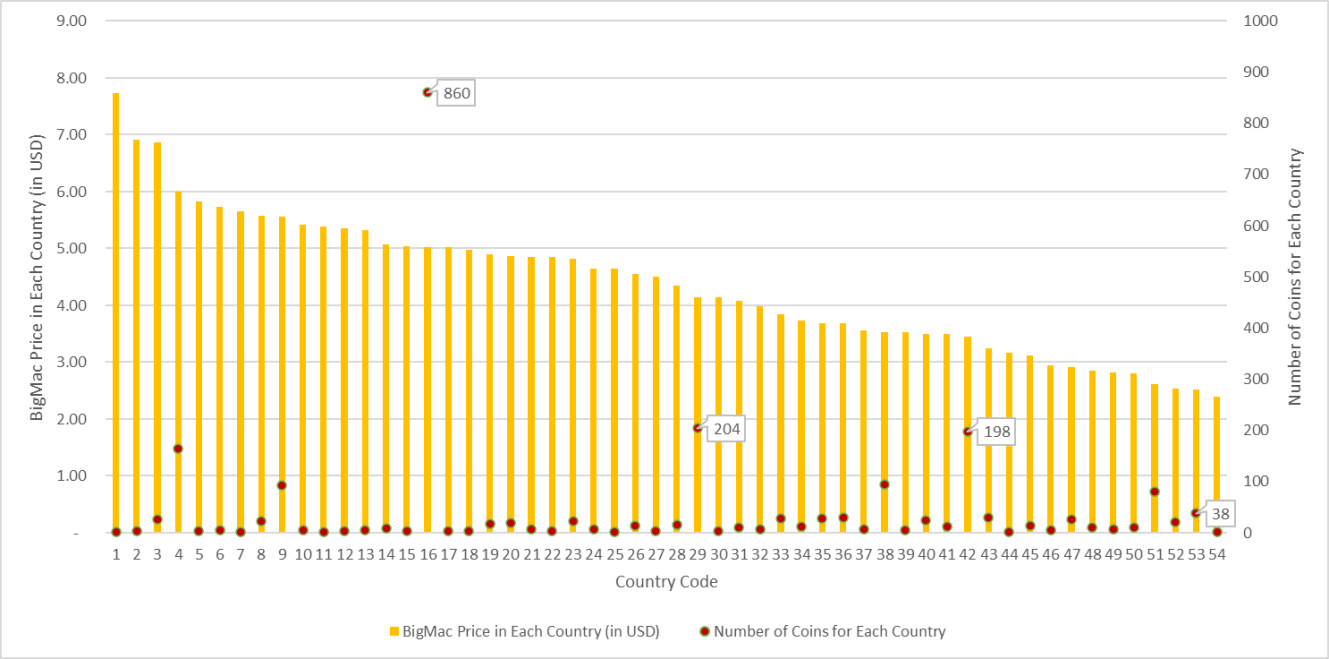
Despite variations in behavior across countries and the distinct characteristics of each payment instrument that may influence adoption levels (Chang et al., 2023), this cross-country analysis illustrates the standing of Rupiah coins in relation to other nations, regionally and globally. In a nutshell, the coin denomination and value comparison may clearly illustrate the distinctiveness of Indonesia's monetary and economic policies compared to other nations in a straightforward manner.

The comparison of nominal denominations may provide a more precise visualization of the high nominal value of Rupiah coins, which possess three-digit zeros, to those of other nations. However, this does not necessarily represent the actual value of the coins from each country. A purchasing power analysis can be conducted to evaluate the value of currency in the selected nations for specific goods or services.

Purchasing Power Comparison

Gaining a comprehensive understanding of Indonesia's economic condition within the global context, specifically concerning the stability of its currency's purchasing power, holds considerable significance. Several factors, including inflation, the state of the real economy and financial stability, the dynamics of international trade, and government exchange rate policy, determine a country's currency value. A comparative analysis is conducted to assess the monetary value of Rupiah coins relative to the coin currency of other nations. This objective can be achieved by examining the purchasing power of the Rupiah relative to globally recognized products, such as Coca-Cola and McDonald's.

Although the Big Mac Index (BMI) does not perfectly reflect CPI inflation due to its representation of the relative price of all goods and services in the consumer basket, the BMI remains a useful tool for examining purchasing power parity as an alternative non-traded good (Wee & Lee, 2022). This research conducts a comparative analysis of Rupiah coin purchasing power relative to other nations' coins using a Big Mac price index. This analysis is based on the Global pricing of a Big Mac as of July 2023, utilizing data obtained by Dyvik (2023). The denomination of the Rupiah coin used for comparison is IDR 1000, compared to the highest coin denomination of other countries. Figure 3 illustrates the coins necessary to purchase a Big Mac in the local currency of different countries, as derived from the Big Mac Index for July 2023.



Note: 1. Switzerland; 2. Norway; 3. Uruguay; 4. Argentina; 5. Europe Area; 6. Sweden; 7. Denmark; 8. United States; 9. Sri Lanka; 10. Costa Rica; 11. Britain; 12. Canada; 13. Mexico; 14. Saudi Arabia; 15. New Zealand; 16. Lebanon; 17. Australia; 18. Poland; 19. United Arab Emirates; 20. Colombia; 21. Singapore; 22. Czech Republic; 23. Brazil; 24. Chile; 25. Israel; 26. Kuwait; 27. Bahrain; 28. Nicaragua; 29. Honduras; 30. Peru; 31. South Korea; 32. Hungary; 33. Qatar; 34. Thailand; 35. Oman; 36. Guatemala; 37. Moldova; 38. Turkey; 39. Jordan; 40. China; 41. Azerbaijan; 42. Pakistan; 43. Romania; 44. Japan; 45. Vietnam; 46. Hong Kong; 47. Malaysia; 48. Ukraine; 49. Philippines; 50. South Africa; 51. Egypt; 52. India; 53. Indonesia; 54. Taiwan.

Figure 3 Big Mac Index and Amount of Coins Required, By Country

Source: Dyvik (2023) and Author's Calculation

According to Figure 3, the price of a Big Mac in Indonesia is comparatively lower than several other nations, including those within the ASEAN area. Nevertheless, the number of coins required to purchase a Big Mac in Indonesia is disproportionately high compared to other countries when the local currency of each country is taken into account based on its highest denomination. The substantial variation in the number of coins needed to purchase a Big Mac indicates the disparity in the purchasing power of Rupiah coins globally, with

Indonesia being one of the countries with the lowest coin values in the global economy. Consequently, Rupiah coins possess a considerably lower value than other countries, including those within the ASEAN regions.

The minimum number of coins to purchase a Big Mac in Indonesia is 38, which is significantly higher compared to the Philippines and Vietnam, where only 8 and 15 coins are needed for the same purchase. The value of Indonesia's coins was among the lowest in the global context. However, it was not as low as Lebanon, Honduras, and Pakistan, which required 860 coins, 204 coins, and 198 coins to purchase a single Big Mac. It is important to note that the cost of a Big Mac in Uruguay is USD 6.86, more than double the cost in Indonesia, which is only USD 2.52. However, individuals in Uruguay only require six coins to purchase a Big Mac. This finding suggests that while the inflation rate in Indonesia, as indicated by the Big Mac index, is relatively low, the buying power of IDR coins is considerably lower. Therefore, it is necessary to conduct a more thorough evaluation, especially concerning the suitability of the Rupiah coin denomination structure.

Rupiah Denominations and Economic Growth (D-Metrics)

The analyzes of the appropriateness of Rupiah coins and their denomination structure rely on the D-Metric model (Payne & Morgan, 1981). The research cover the period of 1997–2023 using data from the Indonesian Statistics Bureau (BPS, 2023). In obtaining the results for the whole country, the wages of each province are then calculated into the national average.

Forecasting the Wages

In the initial phase of conducting the D-Metric analysis, the wage (D) for the subsequent years until 2030 is forecasted using an autoregressive integrated moving average (ARIMA) model. The ARIMA forecasting model is identified by observing the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) plots between data points in time series and previous series values measured for different lag lengths. According to the stationarity test result, the data on Indonesian wages are not stationary at the level and first difference. However, it is stationary at the second difference (see Appendix B.1). Based on the ACF and the PACF graph, the appropriate ARIMA model should be ARIMA with the values for each parameter (p, d, q) are 3, 2, and 0.

All the data on minimum wage in Indonesia are included in the ARIMA estimation covering a period from 1997 to 2022 with a forecast period of 7 years. Figure 4 shows the forecasting results of Indonesia's minimum wage from the ARIMA model.

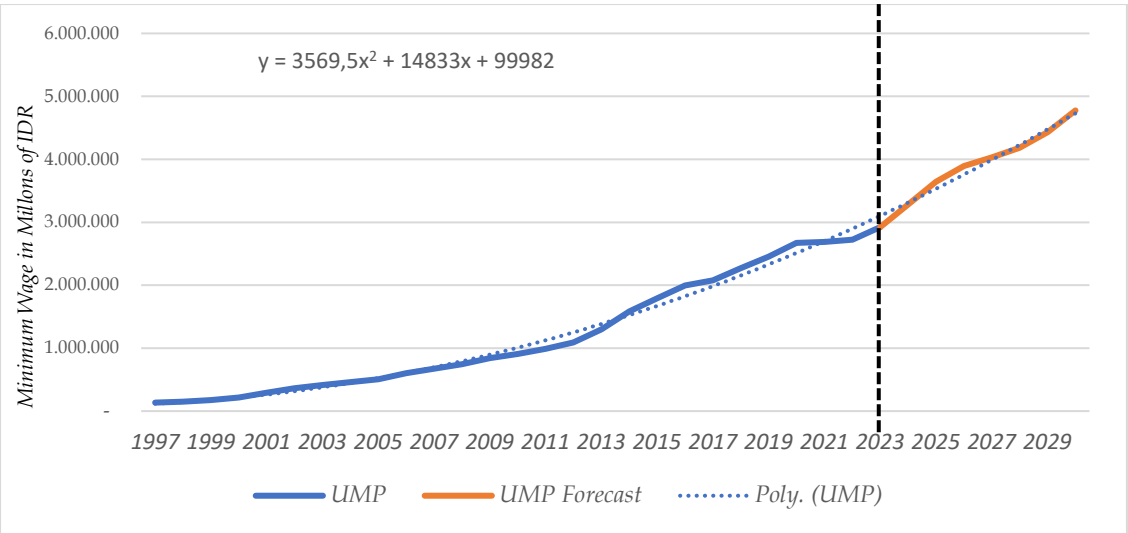


Figure 4 Forecasted Average Monthly Pay

Source Author's Calculation

Figure 4 depicts Indonesian workers' minimum wage from 1997 to 2023 and its forecast until 2030, showing a consistent upward trajectory. According to Schaefer and Singleton (2022) and Schmillen et al. (2023), this phenomenon can be explained by the fact that minimum wages are often adjusted based on various economic factors, such as economic growth, inflation rate, cost of living, worker productivity, and labor market conditions which shows a trend of economic development in the last decade. Government policies that are aimed at improving worker welfare and reducing the unemployment rate and poverty may also be implemented through an increase in the minimum wage (Medrano-Adán & Salas-Fumás, 2023).

Analysing the Rupiah Coin Denomination Structure

Subsequently, the Rupiah coin denomination structure is analyzed using the D-Metric model. To achieve the appropriate value, the data in this D-Metric model use the assumption of the number of working days in one month, as many as 22 days. The minimum monthly wage is obtained based on data from the Indonesia Central Bureau of Statistics (BPS), and the autoregressive integrated moving average (ARIMA) forecast. The D-value is calculated by dividing the Rupiah's net monthly wages by the number of working days in a month. Table 2 shows the D values determined from minimum wage, considering the number of days.

Table 2 D-Value Calculation

	1997	2007	2021	2022	2023	2030f
Working days	22	22	22	22	22	22
Net monthly wages (IDR)	135,000	672,480	2,687,724	2,725,505	2,923,309	4,776,626
D-Value	6,136	30,567	122,169	123,887	132,878	217,119

Source: Author Calculation

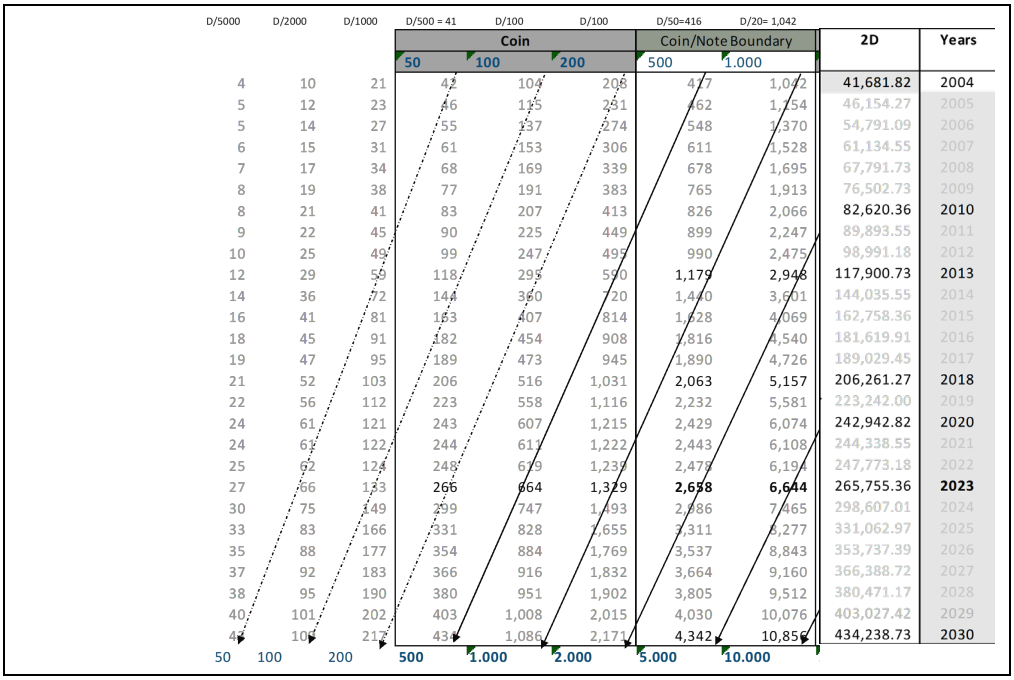
Note:

f: forecasted data

Table 2 displays the trend of daily minimum wage for Indonesian workers, which will be the primary factor in analyzing the denomination of Rupiah coins using the D-Metric model. Once the D value is acquired, this research examines the attributes of the D-Metric to get a more comprehensive understanding of the denominations of the Rupiah. The D-Metric analyzes three currency types: coins, banknotes, and the boundary between coins and banknotes. The coin characteristics are explained from D/5000 to D/100, while the coin-note boundary is determined using D/50 and D/20. The banknote characteristics are calculated within the range of D/10 to 5D. Figure 5 shows the result of a detailed assessment of the D-Metric Model for coins in Indonesia.

The comparison of the D-Metric Model among selected countries is reported in Appendix C. Based on the D-Metric analysis, the highest coin denomination is positioned at the boundary of a note and a coin, which are D/50 and D/20. The summary of the D-Metric model analysis for the denomination structure of coins in Indonesia is shown in Figure 5 below. Each row presents the D value derived from the D-Metric method for 2004 to 2030, while each column corresponds to the various denominations of coins or banknotes. The suggested denomination for the designated observation period falls within the D-value class (each region defined by two diagonal lines).

According to Figure 5, the D-Metric analysis indicates that the suggested possible highest denomination of the Rupiah coin in 2023 is IDR 5,000, positioned between D/20 and D/50, with values of 6664 and 2658, respectively. The IDR 5,000 denomination is advised may be made in the form of coins or notes. In response to the increase in the daily wage of labor, the D-Metric evaluates how frequently different denominations are used in day-to-day transactions and how efficiently they serve the demands of both consumers and merchants. As a result, the overall structure of the coin denomination needs to be adjusted in response to the inflation rate and the increase in the minimum wage of labor. The following denominations are suggested: IDR 2,000 (between D/50 and D/100, with a value of 2,658 and 1,329), IDR 1,000 (between D/200 and D/500, with a value of 1,329 and 664), IDR 500 (between D/500 and D/1000, with a value of 664 and 266), and IDR 200 (between D/1000 and D/2000, with a value of 266 and 133).



D/5000	D/2000	D/1000	50	100	200	500	1.000	2D	Years
4	10	21	42	104	208	417	1,042	41,681.82	2004
5	12	23	46	115	231	462	1,154	46,154.27	2005
5	14	27	55	137	274	548	1,370	54,791.09	2006
6	15	31	61	153	306	611	1,528	61,134.55	2007
7	17	34	68	169	339	678	1,695	67,791.73	2008
8	19	38	77	191	383	765	1,913	76,502.73	2009
8	21	41	83	207	413	826	2,066	82,620.36	2010
9	22	45	90	225	449	899	2,247	89,893.55	2011
10	25	49	99	247	495	990	2,475	98,991.18	2012
12	29	59	118	295	590	1,179	2,948	117,900.73	2013
14	36	72	144	360	720	1,440	3,601	144,035.55	2014
16	41	81	163	407	814	1,628	4,069	162,758.36	2015
18	45	91	182	454	908	1,816	4,540	181,619.91	2016
19	47	95	189	473	945	1,890	4,726	189,029.45	2017
21	52	103	206	516	1,031	2,063	5,157	206,261.27	2018
22	56	112	223	558	1,116	2,232	5,581	223,242.00	2019
24	61	121	243	607	1,215	2,429	6,074	242,942.82	2020
24	61	122	244	611	1,222	2,443	6,108	244,338.55	2021
25	62	124	248	619	1,238	2,478	6,194	247,773.18	2022
27	66	133	266	664	1,329	**2,658**	**6,644**	265,755.36	**2023**
30	75	149	299	747	1,493	2,986	7,465	298,607.01	2024
33	83	166	331	828	1,655	3,311	8,277	331,062.97	2025
35	88	177	354	884	1,769	3,537	8,843	353,737.39	2026
37	92	183	366	916	1,832	3,664	9,160	366,388.72	2027
38	95	190	380	951	1,902	3,805	9,512	380,471.17	2028
40	101	202	403	1,008	2,015	4,030	10,076	403,027.42	2029
4	10	21	43	1,086	2,171	4,342	10,856	434,238.73	2030

Figure 5 D-Metric Model of Denomination Structure Coins in Indonesia (IDR)

Source: Author's Calculation

The D-Metric analysis indicate that the model effectively addresses the impact of inflation, which reduces the purchasing power of current Rupiah coins. It suggested the necessity for a higher denomination of IDR 2,000 and the potential issuance of a IDR 5,000 coin, which could remain suitable until 2030. However, a more thorough evaluation of a new coin denomination structure is required. The implications of coins being valued below their suggested nominal can be observed in the diminished purchasing power, rendering transactions increasingly impractical for both merchants and consumers. This situation may ultimately lead to the rejection of such coins in the purchase of everyday goods and services.

Cross-Country Comparison of Coin Denominations Structure

This research has conducted a comparative analysis of currency denomination structures across various countries. This analysis focuses on the value of Rupiah coins in relation to other countries, including developed and Asian nations, and neighbouring countries such as Vietnam, Cambodia, and Singapore. The US dollar is often used as a benchmark because it is the global currency with the highest Gross Domestic Product (GDP). Additionally, Taiwan is noted for having one of the lowest Big Mac prices, as reported by Dyvik (2023). Table 3 shows the outcomes of comparing the value of coins among the surveyed countries.

Table 3 Findings of the Currency Denomination Structure Analysis in Several ASEAN Countries, US, and Taiwan

D value and Coin	Indonesia		Vietnam		Singapore		Thailand		Malaysia		Cambodia		United States		Taiwan	
	D / Coin Denomination															
	132,887	Rupiah	212,727	Dong	284	S$	353	Baht	68	Ringgit	37218	Riel	58	$	1200	NT$
	B	I	B	I	B	I	B	I	B	I	B	I	B	I	B	I
Coins																
		-		-								-		0.01		-
D/5,000	27		43		0.06		0.07		0.01		7.44		0.01		0.24	
1st Coin		50		-		0.05				-		-		0.05		0.5
D/2,000	66		106		0.14		0.18		0.03		18.61		0.03		0.6	
2nd Coin		100		200		0.1		0.25		0.05		-		0.05		1
D/1,000	133		212,73		0.28		0.35		0.07		37.22		0.06		1.2	
3rd Coin		200		500		0.2		0.5		0.1		50		0.1		-
D/500	266		425,45		0.57		0.71		0.14		74.44		0.12		2.4	
4th Coin		500		1,000		0.5		1		0.2		100		0.25		5
D/200	664		1,063.64		1.42		1.77		0.34		186.09		0.29		6	
5th Coin		1,000		2,000		1		2		0.5		200		0.5		10
D/100	1,329		2,127.27		2.84		3.53		0.68		372.18		0.58		12	
6th Coin		NA		5,000		NA		5		1		500		1		20
Note-coin boundary																
D/50	2,658		4,255		5.68		7.06		1.36		744.36		1.16		24	
Coin Note		NA		5000		NA		10		NA		NA		NA		50
D/20	6,644		10,636		14		17.65		3.4		1,861		2.9		60	

Source: Author's Calculation, the Central Bank and National Statistic Agency in Each Country.

Note:
B: Bound
I: Items

Based on the data in Table 3, the coin denominations of countries in Southeast Asia, the United States, and Taiwan mostly follow the D-Metric structure. However, it should be noted that Indonesia and Singapore deviate from this alignment. According to D-Metric, the highest denomination coins in the United States, Malaysia, and Cambodia fall within the recommended range of appropriate coin denomination structure. In the United States, the highest denomination coin is the US$ 1 coin, falling within the recommended range of 58 cents to US$ 1.16. The largest denomination coins in Cambodia and Malaysia are the 500 Riel coin and the 1 Ringgit coin, which lie between the D/200 and D/100 ranges. It is worth mentioning that Vietnam, Thailand, and Taiwan have effectively positioned their highest denomination coins within particular ranges of D/50 to D/20 range, the note-coin boundary border, to limit the expected impact of future inflation. The highest denomination coins in these countries are 500 Dong, 10 Baht, and NTD 50. From the denomination structure point of view, the highest Rupiah coin, IDR 1000, introduced in 1993, was already forward-looking and considered the future economic condition that will make it suitable for the next 20 years until 2013. However, Indonesia's highest denomination coin is IDR 1,000, which falls below the D-Metric range of D/100 (1.329), which ideally should be the second-highest coin. The denomination structure of Indonesian coins is comparable to that of Singapore Dollar coins, both below the suggested value, as indicated by D-Metric analysis.

This research aligns with the examination by Manikowski (2017). However, based on the D-Metric model analysis, countries with developed economies do not necessarily have a better denomination structure that corresponds effectively with increases in their household incomes. Regarding the Rupiah coin denomination, this research suggests further comprehensive examination to analyze the overall Rupiah denomination structure of banknotes and coins. The Rupiah coin denomination exhibits a remarkably low value, similar to the situation observed with the Canadian and USA pennies. The purchasing power of these pennies has progressively diminished. Consequently, individuals often accumulate low-value coins instead of using them for transactions (Nguyen, 2023).

An analysis of the nominal value of Rupiah coins for goods and services reveals a distinct trend that underscores the diminishing value of these coins within the economy, warranting the attention of the central bank. Moreover, through cross-country comparisons, such as those illustrated by the Big Mac index, this research discerns the standing of Indonesian coins in relation to others regionally and globally. It concludes that the purchasing power of the Rupiah is relatively low.

Although the value of money in relation to inflation is primarily influenced by monetary policy, it is essential to assess the structure of Rupiah coin denominations to ensure that their purchasing power within the economy and their function as a medium of exchange remain intact. This evaluation helps prevent hoarding behaviours and mitigate the potential rise in minting costs associated with the deficit of coins in circulation.

Conclusion

This research examines the declining importance of coins in the economy, particularly in the context of Indonesia. Moreover, this research offers a thorough examination of the value of Rupiah coins. The diminishing value of Rupiah coins over time affects their purchasing power within the country and in comparison, to other countries. This diminishing values is resulting in Rupiah coins being among the lowest valued currencies globally, necessitating 38 coins to purchase a Big Mac.

Despite employing a relatively simple D-Metric and an ARIMA model in its analyses, this research demonstrates strong results and offers valuable insights for policy recommendations. The findings indicate that the current denomination structure of Indonesian coins is inadequate for the existing economy, given the depreciating value of Rupiah coins domestically and in comparison to other countries, regionally and globally. From the perspective of denomination structure, the highest Rupiah coin, IDR 1,000, introduced in 1993, was designed with foresight, anticipating economic conditions that would render it suitable for the subsequent 20 years, up to 2013. However, its value must be adjusted to align with the current economic conditions while anticipating future economic trends, with a recommended range between 2.658 (D/50) and 6.644 (D/20).

This research suggests several policy recommendations. The central bank must conduct a comprehensive assessment of the existing denomination structure of Rupiah coins to restore their function as a means of payment in the economy. Furthermore, it is advisable for the central bank to undertake further research on the overall denomination structure of the Rupiah, encompassing both banknotes and coins, while assessing the denomination structure of coins. This initiative would improve the efficiency of cash usage in economic transactions and potentially enhance the efficiency of cash usage in economic transactions.

This research has limitation, particularly due to the simplicity of the D-Metric model in assessing the suitability of the currency denomination structure and the narrow focus on Rupiah coins. Therefore, it is suggested to improve the examination of banknotes and coins through a more rigorous methodology that incorporates additional macroeconomic factors, including financial innovation and the behavioural aspects of individuals and merchants. The analysis should also incorporate the behavioural aspects of merchants and consumers, such as the principles of least effort (PLE) and the principle of least cost (PLC). Anticipating the potential risk of introducing too high denominations is also essential, as it may influence the shadow economy in the country.

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About The Authors

Wishnu Badrawani is a senior researcher at Bank Indonesia Institute, Bank Indonesia, Indonesia. He obtained his PhD in Economics from the Department of Economics at the University of Birmingham and his master's degree from the University of Queensland. He focuses his research on the economics of payment systems and the digital economy, policy impact analysis, central banking, and the application of interpretable machine learning.

John Fender has been teaching at the University of Birmingham since 1992 and was a Professor of Macroeconomics between 1998 and 2021. Since February 2021, he has been an Emeritus Professor. He is an active researcher and supervises postgraduate students.

Muhammad Hasan Ghozali is an Junior Analyst at Bank Indonesia Institute and obtained his Master of Business Administration from Bandung Institute of Technology in 2021.

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Appendix A. Denominations of Coins by Countries (list of nations in the Big Mac Index)

Country	*	1	2	3	4	5	6	7	8	9
Argentina	ARS	10	5	2	1	-	-	-	-	-
Australia	AUD	2	1	0.5	0.2	0.1	0.05	-	-	-
Azerbaijan	AZN	0.5	0.2	0.1	0.05	0.03	0.01	-	-	-
Bahrain	BHD	0.5	0.1	0.05	0.025	0.01	0.005	-	-	-
Brazil	BRL	1	0.5	0.25	0.1	0.05	-	-	-	-
United Kingdom	GBP	2	1	0.5	0.2	0.1	0.05	0.02	0.01	-
Canada	CAD	2	1	0.5	0.25	0.1	0.05	0.01	-	-
Cambodia	KHR	500	200	100	50	-	-	-	-	-
Chile	CLP	500	100	50	10	5	1	-	-	-
China	CNY	1	0.5	0.1	-	-	-	-	-	-
Central African Rep.	XAF	500	100	50	25	10	5	1	-	-
Colombia	COP	1000	500	200	100	50	20	10	5	-
Costa Rica	CRC	500	100	50	25	10	5	1	-	-
Croatia	HRK	5	2	1	0.5	0.2	0.1	0.05	-	-
Czech Republic	CZK	50	20	10	5	2	1	-	-	-
Egypt	EGP	1	0.5	0.25	-	-	-	-	-	-
Euro area	EUR	2	1	0.5	0.2	0.1	0.05	0.02	0.01	-
Germany	EUR	2	1	0.5	0.2	0.1	0.05	0.02	0.01	-
Guatemala	GTQ	1	0.5	0.25	0.1	0.5	0.01	-	-	-
Honduras	HNL	0.5	0.2	0.1	0.05	-	-	-	-	-
Hong Kong	HKD	10	5	2	1	0.5	0.2	0.1	-	-
Hungary	HUF	200	100	50	20	10	5	-	-	-
India	INR	10	5	2	1	-	-	-	-	-
Indonesia	IDR	1000	500	200	100	50	-	-	-	-
Israel	ILS	10	5	2	1	0.5	0.1	-	-	-
Japan	JPY	500	100	50	10	5	1	-	-	-
Jordan	JOD	1	0.5	0.25	0.1	0.05	0.01	-	-	-
Kuwait	KWD	0.1	0.05	0.02	0.01	0.005	-	-	-	-
Lebanon	LBP	500	250	-	-	-	-	-	-	-
Malaysia	MYR	1	0.5	0.2	0.1	0.05	-	-	-	-
Mexico	MXN	20	10	5	2	1	0.5	-	-	-
Moldova	MDL	10	5	2	1	0.5	0.25	0.1	0.05	-
New Zealand	NZD	2	1	0.5	0.2	0.1	-	-	-	-
Nicaragua	NIO	10	5	1	0.5	0.25	0.1	0.5	-	-
Norway	NOK	20	10	5	1	-	-	-	-	-
Oman	OMR	0.5	0.1	0.05	0.025	0.01	0.05	-	-	-
Pakistan	PKR	10	5	2	1	-	-	-	-	-
Peru	PEN	5	2	1	0.5	0.2	0.1	-	-	-
Philippines	PHP	20	10	5	1	0.3	0.1	0.05	0.01	-
Poland	PLN	5	2	1	0.5	0.2	0.1	0.5	0.2	-
Qatar	QAR	0.5	0.25	-	-	-	-	-	-	-
Romania	RON	1	0.5	0.1	0.05	0.01	-	-	-	-
Saudi Arabia	SAR	2	1	0.5	0.25	0.1	0.5	0.01	-	-
Singapore	SGD	1	0.5	0.2	0.1	0.05	0	-	-	-
South Africa	ZAR	5	2	1	0.5	0.2	0.1	-	-	-
South Korea	KRW	500	100	50	10	-	-	-	-	-
Sri Lanka	LKR	10	5	2	1	0.5	0.25	0.1	-	-
Sweden	SEK	10	5	2	1	-	-	-	-	-
Switzerland	CHF	5	2	1	0.5	0.2	0.1	0.05	-	-
Taiwan	TWD	50	20	10	5	1	-	-	-	-
Thailand	THB	10	5	2	1	0.5	0.25	-	-	-
Turkey	TRY	1	0.5	-	-	-	-	-	-	-
United Arab Emirates	AED	1	0.5	0.25	-	-	-	-	-	-
United States	USD	1	0.5	0.25	0.1	0.05	0.01	-	-	-
Uruguay	UYU	10	5	2	1	-	-	-	-	-
Venezuela	VES	1	0.5	0.25	-	-	-	-	-	-
Vietnam	VND	5000	2000	1000	500	200	-	-	-	-

Appendix B.1 Unit Root Test

Augmented Dickey-Fuller Unit Root Test on D(UMP,2)

Null Hypothesis: D(UMP,2) has a unit root
Exogenous: None
Lag Length: 2 (Automatic - based on SIC, maxlag=6)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.606274	0.0000
Test critical values:	1% level	-2.674290	
	5% level	-1.957204	
	10% level	-1.608175	

Appendix B.2 ACF-PACF Correlogram of Indonesia Monthly Minimum Wage

Correlogram of D(UMP,2)

Date: 11/17/23 Time: 11:05
Sample: 1997 2030
Included observations: 25

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.144	-0.144	0.5853	0.444
		2	-0.195	-0.221	1.7061	0.426
		3	-0.348	-0.444	5.4134	0.144
		4	0.157	-0.082	6.2008	0.185
		5	0.201	0.046	7.5642	0.182
		6	-0.042	-0.131	7.6269	0.267
		7	-0.061	0.019	7.7674	0.354
		8	-0.265	-0.270	10.552	0.228
		9	0.051	-0.220	10.659	0.300
		10	0.106	-0.118	11.160	0.345
		11	0.002	-0.325	11.161	0.430
		12	0.048	-0.097	11.282	0.505

Appendix C.1. D-Metric analysis of Selected Country

	Vietnam		**Indonesia**		**Thailand**		**Malaysia**		**US**		**Cambodia**	
	D =											
	212,727	Dong	132,887	Rupiah	353	Baht	68	Ringgit	58	$	37,218	Riel
	B	I	B	I	B	I	B	I	B	I	B	I
						coins						
		-		-		-		-	-	0.01		-
D/5000	43		27		0.07		0				7.44	
1st Coin		-		50		-		-	-	0.05		-
D/2000	106		66		0.18		0				18.61	
2nd Coin		-		100		0.25		0.05	0.25	0.05		-
D/1000	212.73		133		0.35		0.1				37.22	
3rd Coin		200		200		0.5		0.1	0.5	0.1		50
D/500	425.45		266		0.71		0.1				74.44	
4th Coin		500		500		1		0.2	1	0.25		100
D/200	1,063.64		664		1.77		0.3				186.09	
5th Coin		1000		1000		2		0.5	2	0.5		200
D/100	2,127.27		1,329		3.53		0.7				372.18	
6th Coin		2000		**NA**		5		1	5	1		500
						note-coin boundary						
D/50	4,255		2,658		7.06		1.4		1.16		744.36	
Coin Note		5000		**NA**		10		NA		NA		NA
D/20	10,636		6,644		17.65		3.4		2.9		1,861	

Appendix C.2. D-Metric analysis of Selected Country (continue)

	Taiwan		Philippines		United Kingdom		Japan		South Korea	
					D =					
	1,200	NT$	506	Peso	147	Pounds	13	Yen	171,343	Won
	B	I	B	I	B	I	B	I	B	I
					coins					
		-		0.01		0.02		-		-
D/5000	0.24		0.1012		0.0232		2.6022		34	
1st Coin		0.25		0.05		0.05		-		10
D/2000	0.6		0.253		0.058		6.5055		86	
2nd Coin		0.5		0.1		0.1		1		50
D/1000	1.2		0.506		0.116		13.011		171	
3rd Coin		1		0.3		0.2		5		100
D/500	2.4		1.012		0.232		26.022		343	
4th Coin		5		1		0.5		10		500
D/200	6		2.53		0.58		65.055		857	
5th Coin		10		5		1		50		NA
D/100	12		5.06		1.16		130.11		1,713	
6th Coin		20		10		2		100		NA
					note-coin boundary					
D/50	24		10.12		2.32		260.22		3,427	
Coin Note		50		20		NA		500		NA
D/20	60		25.3		5.8		650.55		8,567	