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Estimating the effects of electronic money on the income velocity of money in Indonesia

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Abstract

This paper investigates the effects of electronic money, exchange rate, inflation, money supply, economic growth, and interest rate on the income velocity of money. We perform the Autoregressive Distributed Lag (ARDL) estimation for Indonesian data from 2009 to 2022 to examine the short-run and long-run estimations. The findings of this paper show that the income velocity of money requires 1.2 years of adjustment time to reach long-run equilibrium. We discover that electronic money and money supply have a considerable negative impact on the income velocity of money in the long term. Meanwhile, the interest rate, exchange rate, and economic growth have a significant positive effect on the income velocity of money in the long run. On the other hand, the findings indicate that in the short run, economic expansion and electronic money have a significant and positive impact on the income velocity of money. Whereas, inflation, interest rate, and money supply have a significant negative effect on the income velocity of money in the short run. Based on these findings, it is absolutely necessary for policymakers to encourage the use of electronic money to boost the income velocity of money and create a more efficient economy. A future study will likely employ cross-country data to compare the findings across samples of countries.

Keywords: Economic growth, Electronic money, Exchange rate, Income velocity of money, Inflation, Interest rate, Money supply.

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1. Introduction

The majority of people around the world regularly use money for the purpose of trade in everyday transactions as well as to repay loans. In other words, money facilitates economic transactions that subsequently increase the money supply. As a result, customers have less money to spend on goods and services, which leads to an increase in price [1]. The movement of money that occurs in transactions can be seen from the velocity of money, which shows the circulation of

money is spent on goods or services within a certain period [2, 3]. The velocity of money can be calculated by dividing the total gross domestic product (GDP) by the money supply.

A higher velocity of money indicates more money circulating through economic activities in a year, while a lower velocity of money signifies less money circulating through economic activities in a year [4, 5]. Meanwhile, because of the continuous velocity of money, an increase in the money supply will invariably result in a rise in nominal GDP. This may occur as a result of an increase in real GDP or inflation [6]. Furthermore, fluctuations in the supply of money have a predictable impact on GDP if the velocity of money fluctuates over time but in a consistent and predictable manner. Conversely, if the velocity of money changes in an unexpected way over time, the impact of changes in the supply of money on GDP becomes unpredictable [7, 8].

As a vital economic factor in establishing credible and effective monetary policies that will support overall economic stability and growth, it is necessary to study the velocity of money [9]. A steady velocity of money, or at least one that changes slowly and predictably over time, is a favorable economic state. If this happens, central banks can drive almost any desirable volume of spending simply by adjusting the money supply [10]. By having further knowledge about its influencing factors, central banks can determine various probabilities for the future velocity of money and act on that basis. Only opposite changes in the velocity of money will be able to offset changes in the supply of money [11]. Economists argue that the shift in how money is used in economic transactions as a result of developments in the banking and financial sectors is what's causing the change in velocity of money, such as an increase in digital payments, an increase in personal loans and the use of credit cards, and the availability of accounts that ease people's ability to deposit money in a bank, which is considered broad money [12].

Figure 1 reveals the changes in the velocity of money and electronic money transactions. It can be seen that as electronic money transactions increased rapidly from 2019 to 2022, the velocity of money experienced a sharp decline. This is in line with Shree, et al. [13], who state that payment instruments in the form of cards and electronic media are widely used in transactions, and thus cash payments decrease. As money is generated from nominal income, the money supply also relatively declines. If cash payments dominate economic activities where payments are made from the same nominal income, the velocity of money will decrease [14]. Similar to how increased demand for physical money increases demand for electronic money, this decreases the average amount of money that people hold and ultimately increases the velocity of money [15]. The occurring conditions are not directly proportional to those described in theory; instead of increasing along with an increase in e-money activities, the velocity of money rather decreases.

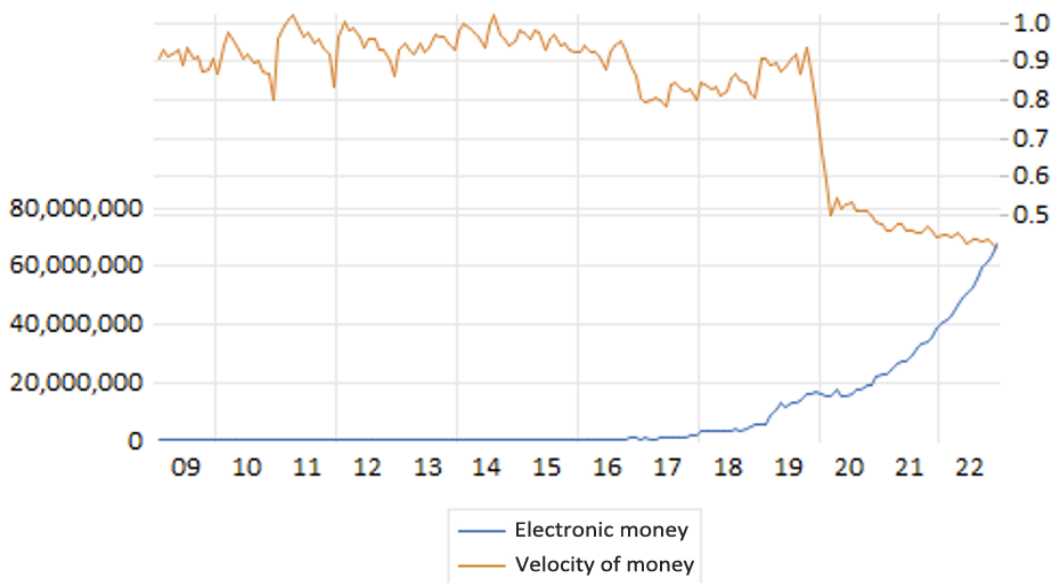


Figure 1. Velocity of money and electronic money in Indonesia in 2009-2022.

The theory of quantity of money [16] describes that the velocity of money increases along with the increase in the E-Money transactions. However, the evidence in Indonesia shows that Electronic Money transactions jumped sharply from 2019 to 2022, but the velocity of money level actually experienced a sharp decline. Tay, et al. [17] claimed that the use of payment instruments such as cards and electronic media is widely used by individuals and communities in transactions, and cash payments decrease. It is evident that money is generated from nominal income; the amount of money in circulation decreases relative to income. Likewise with observations made by Bank Indonesia, the money demand changes due to changes in electronic money. The average amount of money that the general public holds decreases as the money supply rises, which ultimately increases the circulation of money. This study exists to solve this gap.

This research differs from the existing literature on the determinants or behavior of the velocity of money. First, this paper includes electronic money transactions and macroeconomic variables that have an influence on the velocity of money. Second, we believe that the effects of Electronic Money and macroeconomic variables differ for the long and short run, and thus we applied the ARDL model to find these effects.

2. Literature Review

Several previous studies have investigated various factors that influence the velocity of money as well as the effects of different macroeconomic factors. [Yang and Zhou \[18\]](#) examined the link among money supply, money demand, and monetary policy to determine how the Chinese central bank's digital currency, electronic money, affected monetary policy. They found that electronic money will alter the money demand structure, accelerate the flow of money, make foreign exchange reserves more manageable, and make the supply of money more effective. Moreover, electronic money will, to some extent, exacerbate the fluctuations and boost the impact of the money multiplier. [Luo, et al. \[19\]](#) analyzed how each type of money changed as a result of electronic money and created a dynamics model based on the family, the commercial bank, and the national bank areas. Their findings indicate that electronic money has unequal effects on deposits and lending while having an unreasonable divergence on households.

[Roy, et al. \[20\]](#) use data from 2009 to 2019 to detect electronic and digital transactions in relation to the money velocity in Indonesia. They discover that, although the impact of digital payments as measured by credit cards appears to be negative. Debit cards, on the other hand, have a real, beneficial impact on the value and flow of money. It is interesting to note that additional empirical findings investigate the negative and minor impact of digital transactions, represented by e-money, on money velocity. This discovery has significant implications for banking efforts to integrate and use cutting-edge technologies in the financial system. Using comparative qualitative research techniques, [Zayer and Al Tweel \[21\]](#) examine how digital payment systems affect the circulation of money. Finally, the electronic payment method eliminated the need to carry money, lowering the loss.

[Nampewo and Opolot \[22\]](#) discussed how real GDP, interest rate, exchange rate, inflation expectations, and bond rate have long-term and short-term impacts on the velocity of money by applying the ARDL method in Uganda. Meanwhile, [Okafor, et al. \[23\]](#) stated economic growth, interest rate, exchange rate, inflation, and market capitalization as the indicators that affect the velocity of money. [Akinlo \[24\]](#) used the multivariate co-integration approach and error-correction model to look at how per capita income, exchange rate, interest rate, expected rate of inflation, and measures of financial developments affected the flow of money in Nigeria. The findings showed that income per capita has a long- and short-term positive and substantial impact on the velocity of narrow and wide money. With a negative connection, the exchange rate plays a key role in determining the income velocity of money. Furthermore, opportunity cost variables, namely the interest rate and the expected inflation rate, also have a negative effect on the velocity of money. In the study, the demand deposit-time deposit ratio as the first measure showed a positive link between the velocity of money and financial development, while the time deposit-currency ratio as the second measure revealed a significant negative relationship.

[Khan and Gill \[25\]](#) conducted a study using the Vector Autoregressive Correction (VAR) method and revealed that the interest rate, economic growth, inflation, GDP per capita, and financial developments significantly and positively influence the money velocity in Pakistan. In line with an increase in inflation, the velocity of money also increases due to changes in payment patterns and spending habits. Furthermore, financial developments tend to increase demand deposits (DD) at a lower rate than time deposits (TD), implying a decrease in the DD/TD ratio and positively affecting the velocity of money. This implies that the lower the DD/TD, the higher the velocity of money and the greater the rate of financial development.

In their study, [Faridi, et al. \[26\]](#) revealed that government revenue, GDP deflator, and total population have a negative impact on the money velocity in the South Asian countries, whereas government expenditure and worker remittances have a positive influence on the money velocity in the South Asian countries. [Nunes, et al. \[27\]](#) included interest rate, *SOPH* (the degree of financial sophistication), *NALF* (the proportion of non-agricultural labor force), and GDP per capita as variables in their study with the VECM method. The results show that all variables affect the income velocity of money. [Khanom \[28\]](#) conducted a study to find out how GDP growth, demand deposit (DD) to time deposit ratio (TD), inflation (INF), and lending interest rate (LINT) influence the velocity of money in Bangladesh. The results suggest that GDP growth negatively impacts the velocity of money in Model 1 and positively affects it in Model 2. Conversely, DD/TD has a positive influence on the velocity of money in Model 1 and a negative influence on it in Model 2. Meanwhile, LINT has a positive impact on the Velocity of Money in both Models 1 and 2, and inflation also influences the velocity of money in both Models 1 and 2.

In their study using the ECM model, [Mubin and Pambudi \[29\]](#) discovered that E-money transactions, income per capita, and interest rate have a positive influence on money velocity. [Mohamed \[30\]](#) examined the effects of GDP, M2, inflation, investment, domestic credit, government budget, and trade openness on the velocity of money using the VECM estimation. The results indicated that four of the six variables, namely GDP, M2, government budget, and trade openness, positively affect the velocity of money, whereas investment and inflation negatively affect the velocity of money. In contrast to the findings of [Mohamed \[30\]](#) and [Al-Tamimi \[31\]](#) study using the VAR (Vector Autoregressive) method explained how inflation, interest rates, and GDP per capita as independent variables affect the velocity of money favorably.

3. Data and Methodology

3.1. Data

This paper used monthly data from January 2009 to December 2022. The income velocity of money is the dependent variable, and electronic money transactions, inflation, exchange rates, interest rates, economic growth, and money supply are independent variables. The data was taken from the Indonesian Economic and Financial Statistics by Bank Indonesia and Statistics Indonesia.

3.2. Methodology

The analysis in this study referred to [Mohamed \[30\]](#) in examining the effects of electronic money on the velocity of money, with the basic model in [Equation 1](#):

$$V_t = \beta_0 + \beta_1 EM_t + \varepsilon_t \tag{1}$$

Where V is the income velocity of money and EM is electronic money.

In this study, several control variables that have a major influence on the income velocity of money were added in accordance with previous studies, thus producing Equation 2:

$$V_t = \beta_0 + \beta_1 EM_t + \beta_2 INF_t + \beta_3 ER_t + \beta_4 IR_t + \beta_5 MS_t + \beta_6 EG_t + \varepsilon_t \tag{2}$$

Where V is income velocity of money, EM is electronic money, IR is interest rate, ER is exchange rate, INF is inflation, MS is money supply, and EG is economic growth.

The ARDL estimation is applied as the econometric methodology, making it easy to examine both the short-term and long-term income velocity of money in Equation 3.

$$y_t = \alpha_0 + \alpha_1 + \sum_{j=1}^p \beta_j y_{t-j} + \sum_{k=0}^q \gamma_k x_{t-k} + \varepsilon_t \tag{3}$$

With conditional error-correction described by the following formula in Equation 4:

$$\Delta y_t = \alpha_0 + \alpha_1 t - \varphi(y_{t-1} - \theta x_t) + \sum_{j=1}^{p-1} \psi_j y_{t-1} + \sum_{j=0}^{q-1} \omega' \Delta x_{t-n} + \varepsilon_t \tag{4}$$

Where $\varphi = 1 - \sum_{k=1}^p \gamma_k$ describes the adjustment speed and $\theta = \frac{\sum_{k=0}^q \beta_k}{\varphi}$ denotes the long-run coefficients. Thus, Equation 5 is:

$$\Delta V_t = \alpha_0 + \alpha_1 \Delta EM_t + \beta_1 EM_{t-1} + \alpha_2 \Delta INF_t + \beta_2 INF_{t-1} + \alpha_3 \Delta ER_t + \beta_3 ER_{t-1} + \alpha_4 \Delta IR_t + \beta_4 IR_{t-1} + \alpha_5 \Delta MS_t + \beta_5 MS_{t-1} + \alpha_6 \Delta EG_t + \beta_4 EG_{t-1} + \varepsilon_t \tag{5}$$

4. Results and Discussions

4.1. Empirical Results

4.1.1. Optimal Lag Test

The results of model selection using Akaike Information Criterion values indicate that the ARDL (2, 1, 1, 0, 1, 1, and 2) model is the best model with the smallest AIC value. Figure 2 reveals the optimal lag selection for ARDL estimation.

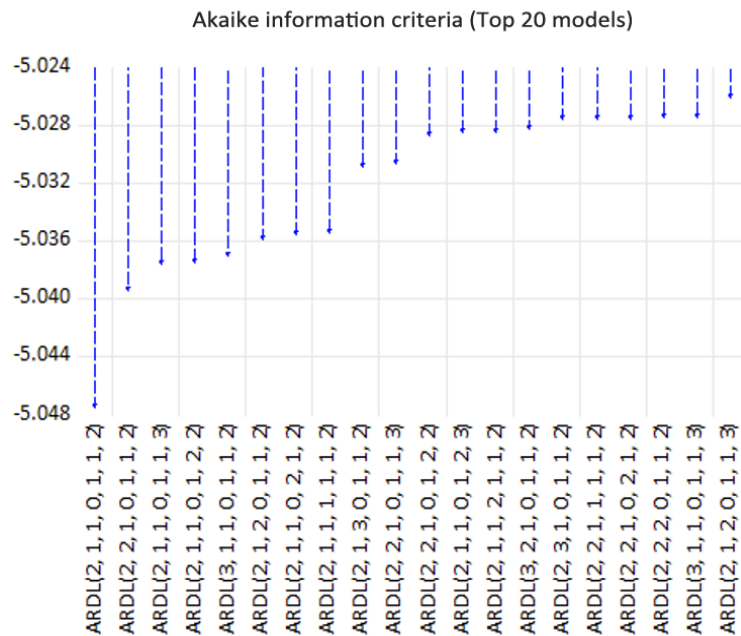


Figure 2. Result of optimal lag selection.

Table 1. Result of bound test.

Statistics test	Value	K
F-statistics	3.9485	6

4.1.2. Bound Test

As seen in Table 1, the F-statistics (3.9485) in this model are greater than the critical values in the upper bound at the 1% (4.43), 5% (3.61), and 10% (3.23) levels. As a result, it is possible to conclude that the model has a short-term to long-term balance.

Table 2.

Estimation of autoregressive distributed lag.

Variable	Income velocity of money
Long-run coefficients	
Electronic money	-0.0001*** (0.0000)
Inflation	0.0073 (0.0632)
Exchange rate	0.0002*** (0.0000)
Interest rate	0.0763*** (0.0262)
Money supply	-0.0371** (0.0019)
Economic growth	0.0965*** (0.0353)
Short-run coefficients	
Error corrections	-0.0535*** (0.0099)
Δ Velocity of money (-1)	0.4209*** (0.0742)
Δ Electronic money	0.0001*** (0.000)
Δ Inflation	-0.0063** (0.0027)
Δ Interest rate	-0.0132* (0.0069)
Δ Money supply	-0.0071*** (0.0004)
Δ Economic growth	0.0308*** (0.0084)
Δ Economic growth (-1)	-0.0199*** (0.0081)
R^2	0.7362

Note: *, **, and *** indicate 10%, 5%, and 1% levels of significance.

4.1.3. ARDL Estimation

The regression results in Table 2 suggest that electronic money and money supply have a significant negative influence on the income velocity of money in the long run. Conversely, interest rates, exchange rates, and economic growth have a significant positive effect on the velocity of money's income. Meanwhile, inflation positively affects the income velocity of money, but not significantly.

4.1.4. Stability Test

The CUSUM and CUSUMQ tests were done to examine long-term stability along with short-term adjustments. If the CUSUM and CUSUMQ plots are at a critical value of 5% or do not exceed the upper and lower limits, then the estimation is considered stable. In this study, the model used was relatively stable based on the output of the CUSUM Test, but showed instability in the CUSUMQ Test. The output of the CUSUM and CUSUMQ tests can be viewed in Figures 3 and 4, respectively. As shown in Figure 4, the CUSUM graph is significant at the 5% confidence level, indicating a stable parameter.

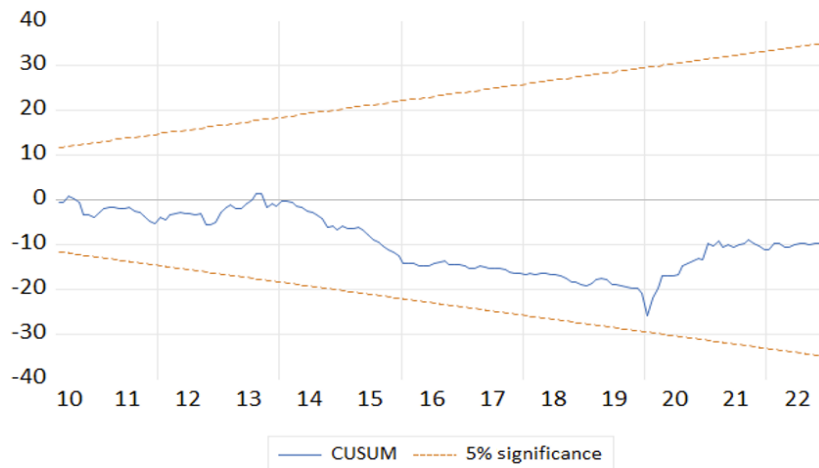


Figure 3.
CUSUM test.

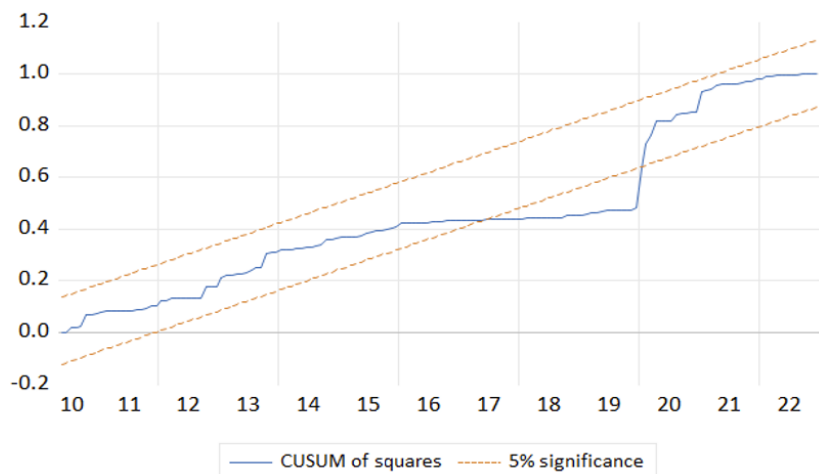


Figure 4.
CUSUM square test.

4.2. Discussions

The long- and short-term effects of electronic money on the income velocity of money can be measured using the ARDL model. Electronic money has a positive and significant influence on the income velocity of money in the short term. This means that an increase in electronic money transactions increases the income velocity of money in the short run. In contrast, electronic money reveals a significant negative influence on the income velocity of money in the long term, implying that a long-term decline in the income velocity of money is a response to an increase in e-money transactions. Meanwhile, in the short-term and long-term ARDL estimation models, the e-money current period has a significant and positive effect on the income velocity of money.

Thus, electronic money has a different effect on the income velocity of money in Indonesia in the long- and short-run. This is in line with the previous studies by Yang and Zhou [18], Zayer and Al Tweel [21], and Mubin and Pambudi [29], which found that electronic money has a positive and significant influence on the income velocity of money both in the long- and short-run. In this regard, Fisher [16] has stated that if there is a change in the means of payment for economic transactions, the income velocity of money will also change. Likewise, the increased usage of electronic money as a payment mechanism at this time will also improve the velocity of money. Additionally, Bank Indonesia, the Republic of Indonesia's central bank, takes into account e-money, which reduces the average amount of money that people hold and eventually increases the velocity of money.

Long-run estimates show that inflation has no influence on the income velocity of money. This means that changes in inflation are not immediately responded to by the income velocity of money in the long-run. However, in short-term estimations, inflation has a significant negative effect on the income velocity of money. These results are different from those of previous studies by Al-Tamimi [31], Luo, et al. [19], Roy, et al. [20], and Khanom [28], which found that the relationship between velocity of money and inflation is positive. Depending on how it affects money balances and income growth more generally, inflation's influence on the velocity of money can be either positive or negative. However, a high velocity of money may create inflation, while a low velocity of money can induce deflation, making the velocity of money a critical limit on the value of money and economic growth.

The exchange rate has a positive influence on the income velocity of money in the long-term. This means that depreciation in the exchange rate increases the income velocity of money in the long-run. There is evidence that the exchange rate has a significant impact on the velocity of money. In the study by Yang and Zhou [18], Roy, et al. [20], and Akinlo [24],

this variable has a negative sign on the short-run model. Contrarily, studies by Nampewo and Opolot [22] obtained the same result: a positive effect of the exchange rate on the velocity of money.

In the long run, interest rates have a significant positive effect on money's income velocity. Therefore, a higher interest rate has an impact on a longer-term increase in the income velocity of money. Conversely, in the short-term estimation, the influence of the interest rate on the income velocity of money is negative, meaning that a higher interest rate produces a lower income velocity of money in the short run. This finding is in accordance with the results of previous studies by Mohamed [30], Mubin and Pambudi [29], and Okafor, et al. [23], which found that the interest rate has a positive effect on the income velocity of money. Besides affecting the velocity of money, the interest rate is also one of the variables that can influence the demand for money. Higher interest rates lead to lower cash holdings by individuals because of the high opportunity cost of holding money, which motivates people to deposit their money in banks. An increase in interest rates also causes a decline in asset prices, so individuals prefer buying assets to holding money. This condition will result in a decrease in the demand for money and consequently increase the velocity of money. This is in line with the result of the Baumol Tobin analysis, which predicts that when interest rates rise, less money will be available for transactions and more money will move more quickly.

We discover that the money supply has a negative and considerable impact on the income velocity of money throughout the long- and short-terms. This means that in the short-run and long-run, when the money supply expands, the income velocity of money decreases. Thus, the money supply partially has short-run and long-run effects on the income velocity of money. In a study by Roy, et al. [20], the money supply was seen to have a partial or simultaneous significant influence on the income velocity of money. This shows that public interest in using cash remains high compared to E-Money. The more money circulating through economic transactions, the slower the velocity of money.

Our findings suggest that long-term economic expansion has a positive and substantial influence on money income velocity. This suggests that an increase in economic growth will enhance the long-run income velocity of money. Furthermore, in the short-term, the economic growth variable in lag 1 has a significant positive effect on the income velocity of money. This means that in the short-run, the higher the economic growth in the previous month, the higher the income velocity of money. However, lag 2 economic growth has a significant negative impact on the income velocity of money.

Thus, economic growth partially has long- and short-run effects on the income velocity of money in Indonesia. In the study by Khanom [28], economic growth was found to have a negative impact on the income velocity of money in Model 1 and a positive effect in Model 2. Income velocity shows how quickly or frequently people use their income as a means of payment for economic transactions. When economic growth increases gradually, the velocity of money is trending downward.

5. Conclusion

The study examined the effects of electronic money on income velocity of money in Indonesia and found that electronic money and money supply have a significant negative effect on income velocity of money, while exchange rate, interest rate, and economic growth have a significant positive effect on it in the long run. On the other hand, electronic money and economic growth positively affect the income velocity of money, whereas inflation, interest rates, money supply, and lag 1 economic growth negatively affect it in the short run. This implies that policymakers need to keep e-money transactions on the rise in order to reduce the income velocity of money.

The findings provide policy insights for Indonesia in that the development of electronic money transactions has been growing and needs to be improved for electronic money infrastructure so that people who have more confidence in electronic money will be able to speed up transactions. The sample countries are one of the study's most notable drawbacks; currently, we use single-country data. For future research, consider using cross-country data and comparing the results among countries.

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