E-Money Transactions as Leading Macroeconomic Indicators: A Markov Switching Value Autoregressive (MSVAR) Approach

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ABSTRACT

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| **Aims:** This study aimed the combination of markov regime switching and vector autoregression (VAR) models using the number of e-money transactions as measured by leading macroeconomic indicators such as interest rates, inflation rates, stock returns and composite stock price indices.**Methodology:** This study uses a quantitative method, the first with the stationery test can explain the validity and reliability and stability of the data with Dicky-Fuller test. The second one with threshold test and the last one with markov regime switching model to describe the difference between two condition.**Results:** The results obtained from this study are the perfection of the model using the markov switching value autoregressive (MSVAR) model with the model type M (2), AR (1) with the white noise value met. Based on these results, this model is able to be a catalyst in the value of the use of electronic money against macroeconomic variables, especially the value of interest rates, inflation, stock returns and the value of the composite stock price index.**Implication:** Implication: the E-money transaction variable can analyze future macroeconomic predictions and help to make decisions about policies related to finance and control of the payment system. |

***Keywords****: Markov Regime Switching, Vector Autoregressive, Macro Economic, E-Money*

1. INTRODUCTION

Payment terms are carried out with effective methods such as using electronic devices to make it easier for each individual to make transactions at the time. Currently, it needs to be a careful consideration, that post-pandemic has become a new way to carry out transaction activities, one of which is the use of e-money. The use of e-money by the public is increasing due to a higher level of efficiency compared to transactions using ATMs or going to banking offices. People only need to ensure the nominal amount, the name of the recipient and the purpose of the transaction for the use of e-money and many people feel that it is more practical to use e-money.

Electronic money or e-money has become the current trend, and Bank Indonesia Regulation Number 18/17/PBI/2016 of 2017 explains the various types of e-money transactions and their respective functions. According to databooks (2020), almost 412.1 million people use e-money facilities for transactions. E-money transactions used in Indonesia have been used by many public or private groups. One of them is the e-money facility provided by banks in Indonesia for toll road users by issuing e-toll cards whose charging process can use e-money. The payment or financing process can also use e-money through the use of cards or cards or barcodes. Merchants in Indonesia have also been designed to use e-money so that they can support activities quickly, precisely and accurately (Bank Indonesia, 2018).

The term cashless or the useless cash as a payment instrument at every outlet or merchant in Indonesia has been developed in Indonesia to encourage Indonesians to have a culture of effective payment transactions (Hidayati et al., 2006). Interest rates and inflation are one of the indicators that have an extraordinary influence on the State, especially the Indonesian state, which has a role in maintaining financial system stability. The balance of using e-money must also be in a reasonable level, because it has a major impact on rising interest rates and the occurrence of inflation. The amount of money that is lying down is also an indicator that must be maintained considering that the amount of money in circulation is influenced by the increasing number of stock returns due to the relatively increasing stock price.

According to Lintangsari et al. (2017), interest rates and inflation that occur in a country are able to affect the value of e-money transactions. Bank Indonesia is an institution that monitors and monitors the amount of money in circulation to minimize the impact of inflation on a country by implementing several policies on the payment system, especially transactions using e-money (Abidin, 2015). One of the technologies that catalyzes investment activities in stocks or equity crowfunding is electronic money or e-money (Tayibnapis et al., 2018).

The formulation of the problem in this study includes identifying e-money transaction variables as leading macroeconomic indicators using the markov switching model and vector autoregression, predicting the future macroeconomy with e-money transaction variables and turning point positions in the macroeconomy with the measurement of e-money transaction variables. In addition, the objectives of this study include (1) Identifying e-money transaction variables as leading macroeconomic indicators using the markov switching model and vector autoregression; (2) Analyzing future macroeconomic predictions with e-money transaction variables; and (3) Analyze the prediction of turning points in the macroeconomy in the future by measuring e-money transaction variables.

In the markov chain, the main concept is a transitional state that describes a certain process in a certain state as well. The prediction of future developments can be seen in several variables that are indicators of the present, so that if you want to see the opportunities for future developments, you can see current or present events (Allo et al., 2013). The markov chain is a system of transitions in designed processes and special shape fractions of probabilistic models with stochastic processes. The transition period is a picture of the change from one state to another in the next perode. The markov chain is also a conditional event that has different measurements with the most dominant current variable indicators.

The objective this research to help the central bank in Indonesia monitor the amount of money in circulation and minimize the impact of inflation on a country by implementing policies on the payment system and becoming a catalyst for the use of technology in every financial activity that uses e-money. by identifying e-money transaction variables as leading indicators of macroeconomics using the Markov switching model and vector autoregression and analyzing predictions of turning points in the macroeconomics in the future by measuring e-money transaction variables.

1. **LITERATURE REVIEW**
2. **Markov Switching Model**

According to Sudarsono and Sudiyatno (2016), macroeconomic factors are present in broad economic

problems, one of which is inflation. The markov chain is a stochastic system of random variables that cannot be predicted so that it is discrete.the markov switching vector autoregressive (MSVAR) model is a combination of models between the markov chain and the autoregressive vector which has the aim that all St conditions contained in the markov chain can depend on M conditions or regimes. According to Krolzig (1997), most regimes (certain conditions) in a flow are sometimes assumed in two different state conditions such as when there is no crisis and when there is a crisis.

$$y\_{t}=v\left( S\_{t}\right)+ A\_{1 }\left(S\_{t}\right) y\_{t-1}+…+ A\_{P} \left(S\_{t}\right)y\_{t-p}+ ε\_{t}$$

In this formulation has the following information; (1) 𝒚t is an indicator or changer during the period t, (2) then the indicator or other modifier as vector is 𝒚t−𝑝, (3) A𝑝 is a parameter matrix VAR(p), 𝜺t |𝑠𝑡 MVN (𝟎, Σ(st)), (4) To p is the order of the model VAR and (5) 𝒗 is constant vector.

1. **E-Money Transaction**

Electronic money (e-money) is an electronic means of payment with certain media such as servers or chips with the provisions of payment methods that have been regulated in banking laws where the value of the money used as a transaction is deposited first to the issuer. According to Azali (2016) non-cash payment instruments in Indonesia often find a greater percentage of use in digital cash or e-money compared to debit or credit cards and internet banking. In the interview process related to payment methods in Indonesia which had the result that the internet infrastructure in Indonesia was declared still unstable so that it became the main factor in the electronic payment system and its impact on e-money transactions (Robi’in et al., 2017).

1. **The Interest**

Investment decisions are a supporting factor in the economic growth of a country and also affect the amount of money circulating in society so that interest rates become an indicator in the process or economic activities in a country. Interest rates have an influence on non-cash payments both in the use of debit and credit cards (Lintangsari et al., 2017). According to Igamo and Falianty (2018), research on interest rates on e-money that has a statistically significant effect.

1. **The Inflation**

According to Tandelilin (2010), inflation is an economic condition when demand for products that subsidize product offerings, resulting in price increases. A continuous increase in the price or rate of value of money over a period of time is called inflation. Inflation affects e-money transactions, debit card transactions, and credit card transactions which are instruments of non-cash payments in Indonesia (Lintangsari et al., 2017). According to Igamo and Falianty (2018), e-money substitutes cash in Indonesia using the vector error correction model, which provides research results that the inflation rate has a significant effect on e-money.

1. **Returns**

Returns are the result of investments earned from shareholders as a profit. In a sense, return is the rate of return on shares on investments made. According to Tayibnapis et al., (2018), equity crowfunding is the implementation of a stock offering service by companies to sell shares directly to investors through an electronic system using the internet network so that e-money can increase investment in financial technology, one of which is in stocks or better known as equity crowfunding.

1. **Composite Stock Price Index**

Composite stock price index is a composite index of all types of stocks listed on the stock exchange. Index calculations represent stock price movements in the market or exchange that occur through an auction trading system. The share price is the value of a person's inclusion or ownership in a company. The more investors who want to buy or keep a stock, the higher its price. And vice versa, if more investors sell or release, it has an impact on falling stock prices (Anisma, 2012).

1. **Application of the Markov Switching Model Method in e-money Transactions**

According to Untoro et al. (2014), the use of payment system instruments as macroeconomic leding indicators using the markov switching model method. This research uses two phases, namely the recession phase and the expansion phase, which can capture well in the recession period and the expansion period. Early indications of economic movement in Indonesia such as RTGS transactions, clearing volume and ATM or debit volume where the three payment system variables are e-money transactions using payment system variables.

1. methods
2. **Research Object**

In the research on the use of e-money transactions with variables such as interest rates, inflation rates, stock returns and turning point positions in the markov regime switching model so as to be able to predict this indicator has a major impact on the electronic equivalent payment system or emoney with data from Bank Indonesia for a period of 10 years.

1. **Definition of Operational Variable**
2. **E-money Transaction**

Payment instruments that meet the elements as e-money are issued on the basis of the value of money deposited first to the issuer, the value of money is stored electronically in a medium such as a server or chip and the value of e-money managed by the issuer is not a deposit as referred to in the law governing banking. E-money transactions are taken from payment system statistics from the Bank Indonesia website.

1. **The Interest dan The Inflation**

The variables of interest rates and inflation rates in this study were taken from Bank Indonesia data and inflation data from the website of the Central Statistics Agency (BPS).

1. **Returns**

Actual returns reflect the capital gains (losses) of the calculation of stock prices and dividends. According to Jones (2007), there are two components to the actual return, namely dividend yield and capital gains. So that the total return is the result of the summation of capital gains and dividend yields. The variable return on shares of banking companies in this study was taken from data from the Indonesia Stock Exchange Investment Gallery. To calculate the capital gain (los) of a stock using the following formula.

$$CG= \frac{P\_{t}-P\_{t-1}}{P\_{t-1}}$$

When:

Pt -1 is the share price of the past period t-1

Pt is the share price of the period t

CG is the capital gain (loss)

Then for dividend yield has a formula:

$$DY= \frac{Dt}{P\_{t}-P\_{t-1}}$$

When:

Pt -1 is the share price of the past period t-1

Pt is the share price of the period t

DY is dividen yield

Then combining the two components with the capital gains and dividend yield formulas is as follows:

Total Returns = DY + CG

When:

DY is dividen yield

CG is the capital gain (loss)

1. **Composite Stock Price Index**

The variable return on shares of banking companies in this study was taken from data from the Indonesia Stock Exchange Investment Gallery STIESIA Surabaya. To calculate JCI using the following formula

$$CSPI\_{t}= \frac{NP\_{t}}{ND} x 1$$

When:

NPt represents the market value on the day 1

ND is a basic value

1. **Data Analysis Techniques**
2. **Stationarity Test**

In stationarity tests for time series data is an important prerequisite for model testing. Stationary data is data that has average values, variance and auto variance in a series of lag variations that remain wherever and whenever this data is used, in other words, stationary data in time series data is very stable to use. However, when the data is declared non-stationary, it needs to be changed again and questioned the validity and reliability and stability of the data.

1. **Threshold Test**

In markov switching mode, stochastic threshold calculations can be performed.

1. **Estimating Parameters**

When the model has made an estimate, the smoothed probability can be calculated. The following is a type of markov switching model.

**Table 1: Parameters markov regime switching**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Notation | µ | v | ∑ | At |
| MSM(M)-VAR(p) | Changed  | Unchanged  | Unchanged | Unchanged  |
| MSMH(M)-VAR(p) | Changed | Unchanged  | Changed | Unchanged  |
| MSI(M)-VAR(p) | Unchanged  | Changed  | Unchanged | Unchanged  |
| MSIH(M)-VAR(p) | Unchanged  | Changed  | Changed  | Unchanged  |
| MSIAH(M)-VAR(p) | Unchanged  | Changed  | Changed  | Changed |

1. **Determining the Transition Probability (Turning Point)**

In the Bry-Boschan method, it is necessary to identify the turning point of a business cycle in this study. Bry and Boschan (1971) is the most popular non-parametric method used to detect the turning point of an economic activity. The local maximum and minimum values of a time series can be identified by algorithmic methods. On the movement around the local minimum and maximum values on identify turning points that depend on the advantages of this algorithm. Thus, the addition of new observations rarely has an impact on previously identified turning points. In addition, the importance of the outlier for measuring turning points is synonymous with the importance of points very close to local minimum and maximum values, which often does not occur in parametric methods.

4. results and discussion

1. **Describe Statistic**

In this case, the data taken is carried out by means of a time series for 10 years from 2011 to 2021 by testing several variables that are macroeconomic indicators including interest rates, inflation rates, stock returns, composite stock price indices against the value of e-money transactions. This study has descriptive statistical results that indicate an appropriate model for testing variables such as interest rates, inflation rates, stock returns, composite stock price indices and e-money transaction values on the markov switching model and combining with the vector autoregressive (VAR) model. On descriptive statistics have the following results:

**Table 2: Statistic Test Result**

|  |  |
| --- | --- |
| Statistic | Nominal |
| Mean | 685944 |
| Max | 5886152 |
| Min | 21658 |
| Standard Deviation | 1160490 |

 **Source: Statistic Result**

From the results of table 2 data above, the value through the variable value of e-money transactions in the period January 2011 to December 2021 was obtained with an average value of using electronic money transactions of 685,944 million times in a duration of 10 years. The maximum transaction value is 5,886,152 and the minimum transaction value is 21,658. The standard deviation value is 1,160,490 which shows the value that shows the distribution of a sample in this study which has a relationship with the average value of 685,944 so that it shows that the distribution has a value close to that which indicates that the distribution is evenly distributed.

In addition, this study tested the results of the graph and obtained the value of the graph as shown below:



**Figure 1: e-money Transaction value**

In this chart, it is assessed every year from January 2011 to January 2021 with an increase in the number of transactions from year to year. From 2011 to 2014, the value of e-money transactions remained stable below the value of 1,000,000 million in transactions. In 2015 it experienced a significant increase and began to penetrate up until the beginning of 2018 and was seen in 2020 to 2021 experienced a peak increase, namely at 6,000,000 transactions which indicated environmental conditions that at that time occurred a pandemic.

In the table and graph that is explained above, it shows that the use of transactions using e-money for 10 years has increased significantly to reach 6,000,000 due to the pandemic.

1. **Stationerity Test with graphs ACF and PACF**

Test stationerity with graphs of autocorrelation function (ACF) and partial autocorrelation function (PACF). In the econometric model, it is the most important thing when calculating data in timeseries with some provisions that the data is in a stable condition so that there is no need to test reliability and validity. In the ACF graph, the study is used to determine the level of the data stationer in a time series manner how the existing lags are able to drop exponentially, while the PACF graph is usually used to determine the data class in a time series.



**Figure 2: Autocorrelation Function (ACF)**

In the next test, namely with ACF and PACF graphs which indicate that the data is stationer. When data is categorized on non-stationary data when ACF and PACF are slowly decreasing and out of significant limits throughout the lag of the results of this study. The ACF describes the correlation between values at different times (time lag) while the PACF describes a function used to indicate the influence of time lag. Because the ACF graph is shown relatively sharply decreased, this data is categorized as a stationer. Data independence indicates the model has no lag on residual PACF beyond the boundary line. The second pattern of the graph that enters the autocorrelation classification shows a dying down pattern.

1. **Stationerity Test with Uji Dicky Fuller**

The next test to strengthen the ACF and PACF tests is the Dicky Fuller test. Here's the stationer test with the Dickey Fuller test:

**Table 3: Dickey Fuller Test**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Tipe | Rho | Pr < Rho | Tau | Pr < Tau | F | Pr > F |
| Zero Mean | 9.4812 | 0.999 | 5.52 | 0.999 |  |  |
| Single Mean | 9.6104 | 0.999 | 4.76 | 0.999 | 15.11 | 0.0010 |
| Trend | 8.4963 | 0.999 | 3.03 | 0.999 | 11.44 | 0.0010 |

**Source: Statistic Result**

From table 3 above the Dickey Fuller test results, the P-vales value of the single mean shows the number < 0.05, which is the resulting value of 0.0010 < 0.05. For trend values on the P-value indicate a value of 0.0010 < 0.05. These results show that the fuller dickey test is declared a stationer.

1. **Markov Regime Switching Model Test**

The next test in this study is with the next test is by modeling markove regime switching. When testing with this model, the modeling was divided into 2 regimes, namely before BI regulations and after BI regulations. This model is collaborated with the autoregressive model so that the model formed becomes a markov switching value autoregressive (MSVAR). Here are the results of the markov modeling regime:

When Bank Indonesia regulation No. 18/17/PBI/2016 and before Bank Indonesia regulation No. 18/17/PBI/2016 was inaugurated, we began to analyze the indicators that became variables with the markov regime switching model and positioned the two conditions into 2 regimes. The AR order used is AR (1), AR (2), and AR (3). The order is used because the data on the declared stationary data forms an uptrend pattern and there is no seasonal pattern. So the biggest opportunity of the AR order formed is carried out through three levels of the model, namely AR (1), AR (2), AR (3). Here are the results of modeling with the order AR (1), AR (2), AR (3).

Based on the three models in table 3 that are most suitable, namely the M (2), AR (1) models, all variables in the model are almost significant all at the level of significant 5% namely the value of all variables in regime 1 which is 0.000<0.05 and the value in regime 2 is 0.049<0.005 and there is only one significant variable at the level of significant 10% namely P11-C with a value of 0.070<0.10 and P21-C with a value of 0.000<010.

To determine the minimum optimal lag in the VAR model judging from the Akaike Info Criterion (AIC) value on the M (2) model, AR (1) is 26.61. Models M (2), AR (1) have the following formulations of regime 1 and regime 2:

**Regime 1**

Yt = 1289954 + 1,13 Yt-1

**Regime 2**

Yt = 194909,6 + 1,13 Yt-1

The process of white noise is a process between sequential random variables that does not occur a correlation and and is distributed in a particular model. On model M (2), AR (1) is declared white noise has been met. In the M (2) model, AR (1) has met both regime 1 and regime, this indicates that the use of e-money transaction value as an indicator of macroeconomic measurement in each regime can be identified by the markov regime switching model.

**Table 4: Markov Switching Value Autoregressive (MSVAR) Result**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Model | Variable  | Coefficient  | Z-stat | P-Value | AIC | Nominal Distribution Residual | White Noise |
| M(2), AR(1) | C Regime 1 | 1289954 | 9,45 | 0,000 | 26,61 | Unfulfilled | Fulfilled |
| C Regime 2 | 194909,6 | 1,97 | 0,049 |
| AR (1) | 1,13 | 79,29 | 0,000 |
| Log (Sigma) | 11,76 | 176,8 | 0,000 |
| P11-C | 1,89 | 1,81 | 0,070 |
| P 21-C | -4,76 | -4,61 | 0,000 |
| M(2), AR(1) | C Regime 1 | 1336616 | 7,72 | 0,000 | 26,61 | Unfulfilled | Fulfilled |
| C Regime 2 | 171402,2 | 1,12 | 0,260 |
| AR (1) | 1,45 | 15,73 | 0,000 |
| Log (Sigma) | 11,7 | 174,52 | 0,000 |
| P11-C | 1,89 | 1,8 | 0,070 |
| P 21-C | -4,77 | -4,58 | 0,000 |
| M(2), AR(1) | C Regime 1 | -704642 | -3,52 | 0,000 | 26,61 | Unfulfilled | Fulfilled |
| C Regime 2 | 71465,83 | 0,37 | 0,710 |
| AR (1) | 1,15 | 11,97 | 0,000 |
| Log (Sigma) | 11,73 | 172,61 | 0,000 |
| P11-C | 0,68 | 0,79 | 0,430 |
| P 21-C | -4,03 | -5,45 | 0,000 |

**Source: Statistic Result**

**Discussion**

This study examines the relationship between indicators that are proxied to macroeconomic variables including interest rates, inflation, the composite stock price index and stock returns in analyzing the transaction value using electronic money using the markov switching value autoregressive (MSVAR) model. This study emphasizes the identification of variables to measure the value of e-money transactions in Indonesia so that they can become leading indicators on macroeconomic variables. It is also used to predict economic conditions in Indonesia in the future when using electronic money transactions. Using the MS-VAR model shows that the M(2), AR(1) models have met the predetermined conditions. The duration of the lead is measured using the month parameter to be able to describe the condition continuously so that it can describe the condition of each specific time duration. From the M (2) model, AR (1) results in a regime change from a pre-Bank Indonesia regulation to a post-Bank Indonesia regulation of 9.45%, while the probability of regime change from a post-Bank Indonesia position to a pre-Bank Indonesia regulation is around 1.97%. The MSVAR method can predict times of crisis and expansion. So that according to the explanation above, the transaction value of e-money can be used as a leading indicator of macroeconomic variables. In addition, it is able to predict the economic cycle at some point if there is a change in the value of the conditions for the use of electronic money.

From the above results, it is identified that the e-money transaction variable has a role as a leading macroeconomic indicator using the markov switching model and vector autoregression. The results are also able to provide an overview that the e-money transaction variable is able to analyze future macroeconomic predictions and determine turning points.

4. Conclusion

This study has ACF and PACF graph values that indicate that the data is stationary and can be continued to the next test. The study also had a Dickey Fuller value shown on the P-vales value of the single mean expressed stationer. This study has the perfection of the model using the markov switching value autoregressive (MSVAR) model with the model type M (2), AR (1) with white noise values met. Based on these results, this model is able to be a catalyst in the value of using electronic money against macroeconomic variables, especially the value of interest rates, inflation, stock returns and the value of the composite stock price index. The variable of e-money transaction becomes a measurement indicator on macroeconomic variables with the markov model of regime switching and vector autoregression in each existing regime. In addition, e-money transactions can also be used as variable indicators to measure several other macroeconomic variables in the future.

**Disclaimer (Artificial intelligence)**

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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