

The Relationship between Banking Technology and Economic Growth in Indonesia: Insights from BI-RTGS and Electronic Money Transactions

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Abstract

The role of banks as intermediary institutions have to be improved continually so that they are in line with Indonesia's economic growth which is also experiencing significant fluctuations. This study aims to analyze banking indicators, namely banking technology indicators as measured by Bank Indonesia Real Time Gross Settlement (BI-RTGS) and electronic money, banking assets, loans, exchange rates, BI interest rates (BI-rate) and the industrial sector on economic growth in Indonesia. This study uses the Vector Error Correction Model (VECM) to analyze two banking indicators, namely assets, loans, two indicators of banking technology, namely BI-RTGS, electronic money, as well as Birate (BI interest rate), exchange rates and gross domestic product in the industrial sector from 2010 to 2022. The results of data analysis using impulse response function (IRF) graphs show a positive response from economic growth to the shock of asset, loan, and electronic money. BI-rate and BI-RTGS variables show a negative response to economic growth, but affect economic growth consistently. Overall, it can be concluded that all variables are shown to have an influence on economic growth as indicated by the optimal lag obtained in the VECM model over 2 quarters. The novelty and main contribution of this study is the use of BI-RTGS and electronic money as a proxy for banking technology. Currently, little research has been done on the link between banking technology and economic growth rates.

Keywords—economic growth, BI-RTGS, e-money, VECM

JEL Classification: B22, C32, F43, G21



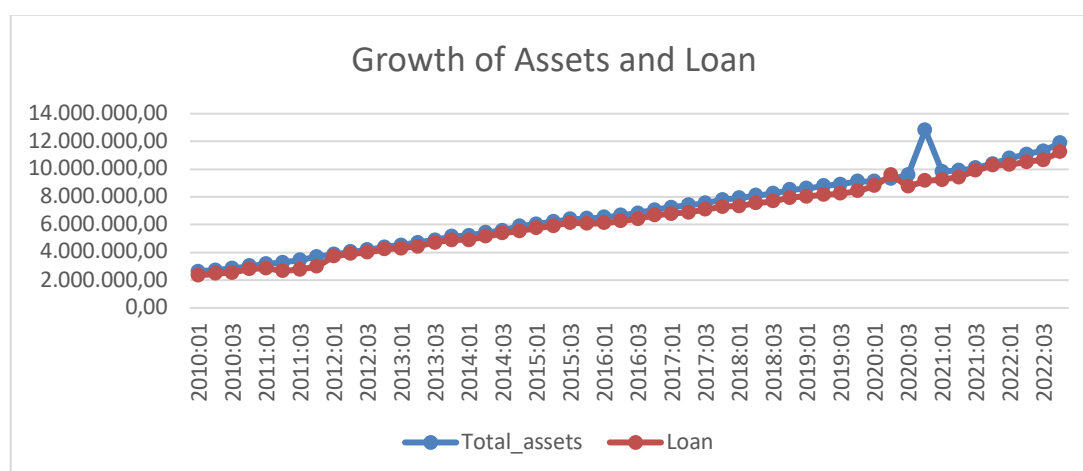
I. Introduction

As of the end of 2021, the number of Electronic Money in circulation reached 575 32 million or grew by 33.09% compared to the end of 2020. Since 2016 electronic money has continued to record very significant growth with the highest growth being in the 2017-2019 period which reached 70 years. Compared to the initial period in 2013, the amount of electronic money in circulation has grown by 1488% (ASPI-Indonesia, 2022).

Economic growth in Indonesia has experienced significant fluctuations. Based on the performance in 2022, it is found that there is a risk of global economy increasing again in 2022. This provides a challenge in terms of the efforts in accelerating the national economic recovery. Bank Indonesia strengthens synergy between the policy innovations of the Government and the Financial System Stability Committee (KSSK) which maintains the economic resilience from these global risks and continues to support the sustainability of the national economic recovery. With the economy recovering and protecting the domestic economy from the spill-over effects of global turmoil, monetary policy is being directed at maintaining stability (pro-stability), while the macroprudential policies, payment systems, money market developments, as well as economic and financial inclusion remain directed at promoting economic growth (Bank Indonesia, 2022).

The theory underlying this research which is about the three main components of economic growth is put forward by Todaro and Smith (2015). The three components of economic growth that are of prime importance are: (1) Capital accumulation, including all new investments on land, physical equipment and human resources through improvements in health, education, and job skills; (2) Growth in population, and hence eventual growth in the labor force; (3) Technological progress-new ways of accomplishing tasks. The technological progress showed increased application of new scientific knowledge in the form of inventions and innovations with regard to both physical and human capital (Todaro & Smith, 2015).

The development of banking continues to show an increase, especially in terms of the volume of assets collected. Judging from the development of a number of banking assets, and the amount of credit disbursed, it shows rapid development in less than 20 years. To analyze the development of banking in Indonesia, the indicators used refer to the standards of the Directorate of Banking Research and Regulation of Bank Indonesia (2000) in the main banking indicators, specifically the item of total assets, and the distribution of funds. The following is an illustration of the growth of assets and bank loans in Indonesia in 2010-2022 (Figure 1).





Yunanto and Sutopo (2010), Nasrudin (2004), which uses basic concepts and models similar to Levine, Loayza and Beck (2000).

Utami (2018), states that the banking variable (credit ratio to GRDP) partially turns out to have a positive influence on the growth rate of real GRDP per capita. This means that any increase in the credit ratio to GRDP will cause an increase in the growth rate of real GRDP per capita and further confirms that the banking sectors plays a very important role in the growth. Levine (1997), states that economic activity and technological innovation undoubtedly affect the structure and quality of the banking system. Based on these studies, this research continues and extends previous research related to banking development and economic growth

Based on the results of previous research, it appears that no one has used the BI-RTGS and electronic money variables simultaneously in the research model. For this reason, this research will analyze two variables that measure banking technology on the rate of economic growth in Indonesia. The purpose of this study is to analyze the development of banking and banking technology through four indicators, namely assets, loans, e-money and BI-RTGS, and non-bank indicators, namely the industrial sector, on economic growth. The model in this study is different from previous studies. It added two dummy variables as control variables (Medyawati & Hegarini, 2011); (Medyawati & Yunanto, 2014). Previous research conducted by Medyawati, Yunanto and Hegarini (2021) on fintech as determinant of profitability is used as a reference for the selection of e-money and BI-RTGS variables as indicators of banking technology.

Similar Research Studies

Here are some similar research studies on banking and economic growth. (Levine, Loayza, & Beck, 2000), found a positive relationship between banking development and economic growth, but in this study Levine emphasized more on the influence of exogenous banking components that vary widely between countries. The results of (Kar & Pentecost, 2000) showed that the direction of the causal relationship between banking development and economic growth in Turkey is sensitive to the selection of banking indicators used as a measure of banking development. Boulila and Trabelsi (2004) found that tight controls on the financial sector in MENA countries (Middle East and South Africa) over a long period, delay the implementation of financial reforms in those countries, continuing the issues in the implementation of reforms (non-lending in particular). It further results in high information and transaction costs, which in turn will prevent resource promotion and financial deepening.

Liang (2006), state that the development of banking and rapid economic growth in China led to a wide income gap between the population locate in the coastal areas of China. Ingrid (2006) found that there is stable long-run equilibrium relationship between the development of financial sector and the real output. Using a trivariate VAR framework, Abu-Badr and Abu-Qarn (2006), it was found that there is weak support for having a long-run relationship between financial development and economic growth.

Different conditions occur in Malaysia where economic growth influences banking development over a long period of time, but a feedback relationship is not found (Ang & McKibbin, 2007). Luintel, Khan, Arestis, & Theodoridis, (2008) stated that the study conducted in 16 countries in Asia, Europe and the United States showed that for most of the sample countries, financial structure and financial development appear to be significant in explaining the level of output. The test also revealed that the panel estimates (parameters) do not match the country-specific estimates. These findings imply that financial structure and financial development are important for output levels and economic growth.

Hypothesis one: Banking, represented by assets and loans, affects economic growth.

Levine, (1997) states that economic activity and technological innovation undoubtedly affect the structure and quality of the banking system. Amaral and Quintin (2005) found that the effect of such changes in technological parameters on output is much greater when financial frictions occur. Amalia and Santoso (2022) stated that electronic money transactions have an impact on economic growth in the long run. The proxy for economic growth in the study is GDP. Using electronic money has a positive effect on GDP because it is driven by the ease of using electronic money. As a result, public consumption increases (Mashabi & Wasiaturrahma, 2021). The difference between this study and the research of Mashabi and Wasiaturrahma (2021) is the proxy for economic growth measured by GDP. However, this study uses the economic growth rate proxy to measure economic growth.

Hypothesis two: Banking technology as measured by BI-RTGS and electronic money affect the rate of economic growth.

Li, Park and Selover, (2017) found that three cultural factors-economic attitudes, political attitudes and attitudes towards the family-affect economic productivity growth. Kurniati (2020) found that in Indonesia, the exchange rate variable has a negative effect on economic growth. Hardi, Maipita and Firawaty (2021) showed that in the short term, the exchange rate of rupiah had a significant positive impact on economic growth. Zahro and Dewi (2019) found that Bank Indonesia interest rate had a negative effect on economic growth in Indonesia. Elfaki, Handoyo and Ibrahim (2021) indicated that industrialization, energy consumption, and financial development (measured by domestic credit) positively influence economic growth in the long run.

Hypothesis three: Exchange rate, BI-rate and industrial GDP affect the rate of economic growth

The banking technology indicator in this study is a modification of previous research by Medyawati and Hegarini (2011) and Medyawati and Yunanto (2014), which is, using BI-RTGS as measured by nominal transactions. Apart from BI-RTGS, the nominal value of e-money transactions is also a consideration because during the Covid-19 pandemic, transaction activities through mobile devices showed an increase (Walfajri & Dewi, 2021). This study develops on the previous research (Medyawati &

Hegarini, 2011; Medyawati & Yunanto, 2014) focusing in the role of the economic growth

2. Research Method

The data used in this study are secondary data taken quarterly from various sources, from the period 2010 to 2022. The data sources are Bank Indonesia (BI) and Financial Services Authority (OJK) publications in the form of Indonesia Banking Statistics, Indonesia Financial Statistics (IFS) and BPD (Central Bureau of Statistics) publications. The data includes credit data and total assets of all banks (Commercial Banks, Sharia Commercial Banks, Rural Banks and Sharia Rural Banks, Sharia Business Units), nominal BI-RTGS transactions, nominal electronic money transactions (e-money), industrial sector GDP, BI-rate, rupiah exchange rate against the US dollar, and GDP per capita rate at constant 2010 prices.

The research model is estimated using VECM, because the data is in the form of data from time series. VAR model specifications include variable selection and the number of time intervals used in the model. The estimation process can only be done under the overidentified and just-identified conditions. Judging from the t-test, VAR estimation results are often unsatisfactory. The inertia of endogeneous variables in the VAR system may not be statistically significant. In addition, the individual coefficients in the VAR model are difficult to interpret. Econometricians use impulse response analysis to track the response of endogenous variables in a VAR system due to a shock or change in the disturbance variable (e). Some important analyses that can be generated in a VAR model are impulse response, variance decomposition and causality test (Widarjono, 2007). Secondary data were tested with steps including unit root test, determination of the optimal level of inaction, cointegration test, causality test, VAR model stability test, impulse response analysis and variance decomposition. The VAR and VECM formation process is presented in Figure 1. The software used as a tool in data processing is Eviews ver. 12.

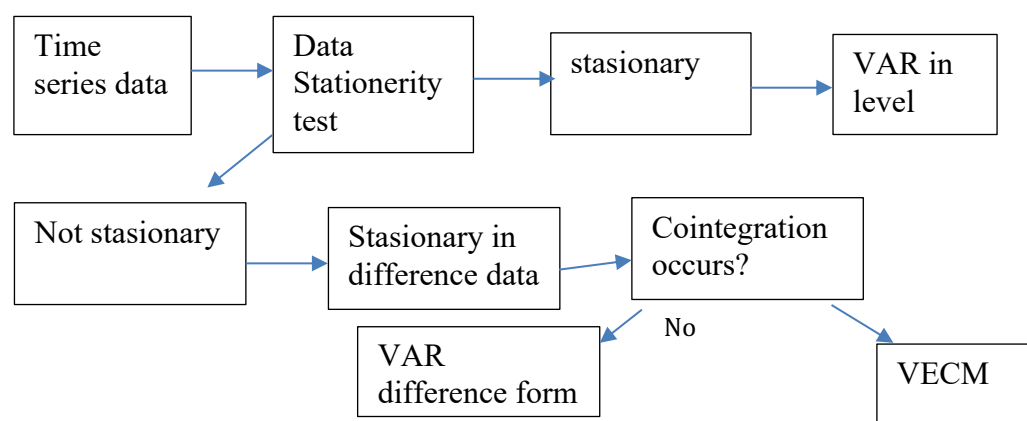


Figure 1. VAR and VECM formation process (Widarjono, 2007)

3. Result and Discussion

The identification of equations in this study was carried out by using the formula: $Kk \geq m-1$ (Gujarati, 2003), which makes the conditions obtained more indetifiable. In this study, the amount of information obtained exceeds the desired number of estimated parameters. The first stage is the unit root test to ensure that the model that can be used is VECM. The results of the data from the stationarity test show that all variables in this study are not stationary at the level. This indicates that the data can be analyzed using the VECM model. The complete unit root test results are presented in Table 1 below.

Table 1. Level Data Stationarity Test Results

Variable	ADF t-Statistik	Mc Kinnon		Description
		Critical Value 5%	Prob.	
Assets	-0,014318	-2,922449	0,7838	Not stasionary
Loan	0.636566	-2,948404	0,9894	Not stasionary
E-money	1.987714	-2,935001	0,8389	Not stasionary
BI-RTGS	-1.585024	-2,919952	0,9887	Not stasionary
Birate	-2.265996	-2.919952	0,9887	Not stasionary
Exchange rate	-3.565430	-2.919952	0,9887	Not stasionary
PDB industry	-2.425841	-2.919952	0,9887	Not stasionary
Economic-Growth	-2.565189	-2.919952	0,9887	Not stasionary

The next step is the differentiation process, which is a process of finding the difference between the data from one period to another in a sequential manner. The resulting data is called first-level differential data (first difference) (Widarjono, 2007). The cointegration test results indicate the existence of a long-term relationship between the variables studied. These results also determine the form of VAR that will be estimated later, namely VECM. The cointegration test results are presented in Table 2 below.

Table 2. Cointegration test results

No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.821186	2.772.361	1.595.297	0.0000
At most 1 *	0.721373	1.963.298	1.256.154	0.0000
At most 2 *	0.591443	1.362.695	9.575.366	0.0000
At most 3 *	0.470327	9.419.872	6.981.889	0.0002
At most 4 *	0.435258	6.433.039	4.785.613	0.0007
At most 5 *	0.343345	3.747.521	2.979.707	0.0054
At most 6 *	0.231251	1.770.720	1.549.471	0.0228
At most 7 *	0.107526	5.346.640	3.841.465	0.0208

Trace test indicates 8 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

The results in Table 2. Show the existence of cointegration in the variables studied, that is, the variables of total bank assets, total loans, exchange rate, BI-rate, BI-RTGS, industrial GDP and economic growth rate, indicating a long-term relationship. The next test is the causality test, namely the Granger causality test at Lag 1 (Table 3).

Table 3. Lag 1 Granger causality test results

Null Hypothesis	Obs	F-statistic	Prob.
DPINJAMAN does not Granger cause DLAJU	50	0.00060	0.9806
DLAJU does not Granger cause DPINJAMAN		774.311	0.0077
DASBANK does not Granger cause DPINJAMAN	50	0.00944	0.9230
DPINJAMAN does not Granger cause DASBANK		200.235	5.E-05
DASBANK does not Granger cause DLAJU	50	668.187	0.0129
DLAJU does not Granger cause DASBANK		0.59500	0.4444
DELEK1 does not Granger cause DRTGS	49	527.474	0.0262
DRTGS does not Granger cause DELEK1		0.15713	0.6936

The results show that the rate of economic growth influences loans at $\alpha = 5\%$ at lag 1. Likewise the rate of economic growth influences bank loans at lag 2 (see Table 4). The complete results of the Granger causality test at lag 2 can be seen in Table 4.

Table 4. Lag 2 Granger causality test results

Null Hypothesis	Obs	F-statistic	Prob.
DLAJU does not Granger cause DPINJAMAN	50	374.728	0.0314
DPINJAMAN does not Granger cause DLAJU		161.240	0.2110
DPINJAMAN does not Granger cause DASBANK	49	369.263	4.E-10
DASBANK does not Granger cause DPINJAMAN		107.682	0.3495
DLAJU does not Granger cause DASBANK	49	481.417	8.E-12
DASBANK does not Granger cause DLAJU		378.557	0.0304
DELEK1 does not Granger cause DRTGS	48	289.425	0.0662
DRTGS does not Granger cause DELEK1		114.834	0.0001

In lag 2, there is a two-way causality, that is, the electronic money transactions influence BI-RTGS transactions, and vice versa, that is, BI-RTGS transactions influence electronic money transactions. From these results it is suspected that Indonesian people have started to make more use of these two payment methods to complete their transactions. The increase in volume in the use of electronic money through mobile banking, especially for e-commerce transactions, was triggered by the Covid 19 pandemic, which restricted people from leaving home to do their shopping (Walfajri & Dewi, 2021).

Table 3. Lag Length Criteria Results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3.994.533	NA	3.70e+62	1.667.722	167.0841*	1.668.901
1	-3.906.266	1.434.342	1.40e+62	1.657.611	1.685.679	1.668.218
2	-3.807.117	128.0675*	4.02e+61*	164.2965*	1.695.983	166.3001*

Based on the results from the output of AR Roots tabel with a range of modulus values 0.188020 – 0.818580. The Lag Length Criteria could be seen in Table 3, the maximum lag is two (2). In the next process, the results of the lag length criteria (indicated in asterisks), the candidate interval by LR. FPE and AIC is 2. The selection criteria used in this study is based on the smallest AIC value. The optimal lag obtained is 2 (2 quaterly month)

The next step in the analysis is the use of the two properties of VAR namely impulse response function and variance decomposition. The impulse response function of the model confirms the estimated dynamic response of all variables with a shock of one standard deviation of the variables in the system. The following is the response of growth to the shock of variable industrial sectors, total assets, loan, electronic money, exchange rate, BI-rate and the BI-RTGS.

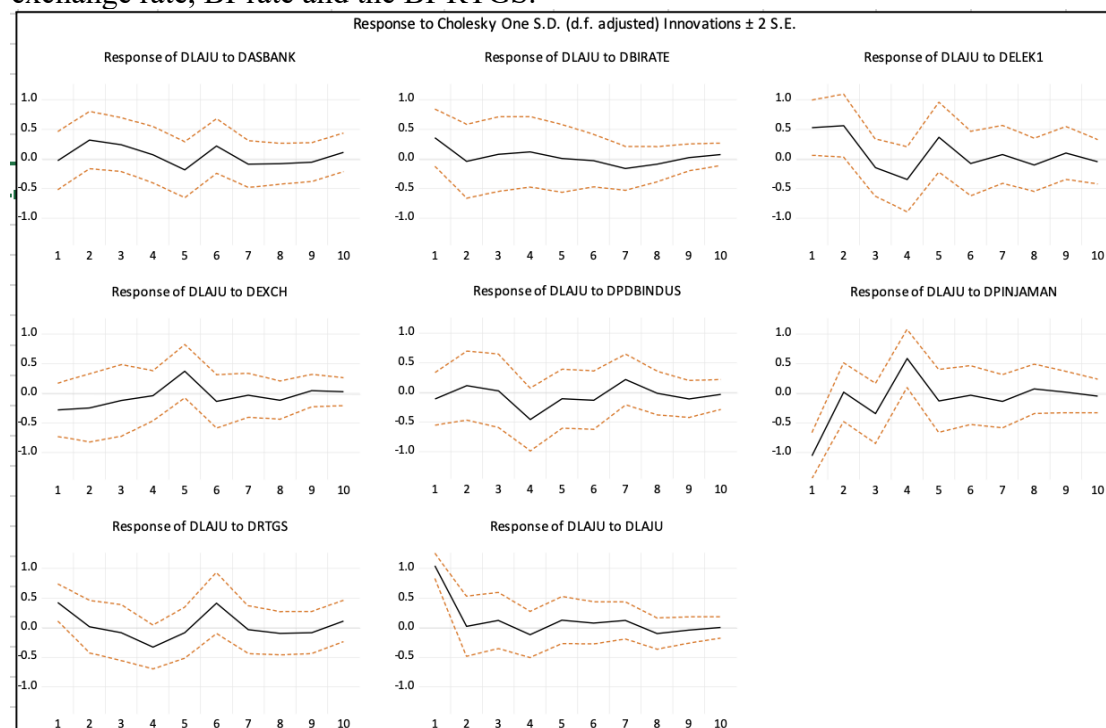


Figure 2. Shock of variable assets, BI-rate, electronic money, exchange rate, GDP of industrial sector, loan and BI-RTGS to economic growth



Based on Figure 2 above, it can be concluded that the shock of variable loan, assets, exchange rate, industrial sector, electronic money is getting a positive response from economic growth in the first month, This means that all eight variables affect economic growth, and that all hypotheses in this study are accepted.

The loan variable shock shows a positive response to the economic growth rate in the first and second quarters. In the third quarters, a negative response can be seen from the downward trend, but it goes up in the fourth quarter.

This fluctuating condition can be interpreted as the banks being cautious when lending money to the public. These results are in line with the results from Levine, Loayza and Beck (2000), Inggrid (2006), Kar and Pentecost (2000), Liang (2006), Medyawati and Yunanto studies (2014). According to the study from Nasrudin (2004), the loan negatively affects economic growth.

The electronic money variable responded positively to the economic growth rate in the first and second quarters. This shows that people are enthusiastic about using electronic money as a tool for transactions (Walfajri & Dewi, 2021). These results are in line with the results from Rahayu, Rahmatia, Hamrullah, and Junior (2023) that e-money showed a significant positive effect on the demand for the use of E-Money in one of the major cities in Indonesia. However, the negative response is seen in the third and fourth quarters, as indicated by the decreasing trend during that period. Otherwise, different conditions are as follows. The study's findings suggest that going cashless won't have a direct impact on economic development in the near future. This conclusion might be explained by the fact that cashless payments take time to have an influence on economic growth since they require equitable infrastructure development, digital ecosystems, and public financial literacy (Christianti, 2024).

The BI-rate variable shock to economic growth showed a negative response in the first and second quarters. These results are in line with the results from Zahro and Dewi (2019). But in the third and fourth quarters there is a moderately positive response as shown by the upward trend (see Fig. 2). Almost the same condition also occurs with BI-RTGS. The BI-RTGS variable shock in the first and second quarters showed a negative response as shown in Figure 2.

A slightly different condition occurred in terms of economic growth, with the response from the exchange rate variable. It can be seen that the growth increased slightly in the first and second quarters and it continued to rise in the third to fifth quarter. These results are in line with the research study by Akibode, Fapetu, Olabisi and Ojo (2019). That is, in the long run, the economic growth was affected by exchange rate, government expenditure and interest rate. To be precise, the exchange rate had a negative effect on the growth of the Nigerian economy in the long run.

The industrial GDP variable shock showed a positive response to the economic growth rate in the first and second quarters. However, in the third and fourth quarters, it showed a drastic decline (see Fig. 2). This can be explained by the fact that economic conditions tended to slow down in the last few years due to a reduction in exports (Bank Indonesia, 2022).

The next step is the analysis of variance decomposition. This is to illustrate the relative importance of each variable in the VAR system based on the shock experienced. Table 4 illustrates the percentage contribution of predicted economic



growth variable changes in terms of variable assets, loans, electronic money BI-RTGS, BI-rate and the industrial sector of economic growth.

Table 4. Variance Decomposition Result

per	SE	Dasbank	Dbirate	Delek1	Dexch	Dpdbindus	Dpinjam	Drtgs	Dlaju
1	1.69404	0.03006	4.44530	9.63311	2.72067	0.41090	3.86292	6.26814	3.78626
2	1.83662	3.00340	3.84393	1.75734	4.14123	0.74533	3.29912	5.35765	3.23437
3	1.90059	4.39648	3.76155	1.70034	4.28291	0.71428	3.40304	5.20182	3.06090
4	2.10464	3.69907	3.38195	1.65772	3.53615	5.31860	3.55379	6.68743	2.52616
5	2.18828	4.12330	3.12927	1.81340	6.19586	5.15869	3.32211	6.32978	2.37092
6	2.24933	4.83464	2.97821	1.72905	6.234.660	5.22143	3.14698	9.40038	2.25711
7	2.27676	4.87215	3.40302	1.69916	6.109.292	6.02131	3.10819	9.19945	2.23202
8	2.29011	4.94158	3.51744	1.69861	6.293.949	5.95422	3.08081	9.26195	2.22395
9	2.29897	4.96636	3.50297	1.70590	6.289.068	6.14459	3.05967	9.33011	2.21114
10	2.30685	5.16356	3.58651	1.69855	6.257.940	6.12388	3.04247	9.49957	2.19589

Table 4 provides information that economic growth can be explained or influenced by economic growth itself by 3.78%. Almost all variables showed a decreasing percentage in the second quarter, with regards to the BI-rate, electronic money, loans and BI-RTGS variables.

Nevertheless, variables that show a percentage increase when compared to the first quarter are total bank assets, exchange rate and industrial GDP. In the first quarter, the shock from the electronic money variable immediately provided positive response to economic growth, with quite a significant percentage of 9.63%. This percentage is the largest within all quarters in the table. However, in contrast, in the second quarter there was quite a drastic decline, being only 1.75%. The effect of electronic money on GDP is positively related because it is drive by the ease of using electronic money, thus increasing public spending. This boosts country's economy (Mashabi & Wasiaturrahma, 2021) and it has a long term effect (Tee & Ong, 2016). On the contrary, another condition that occurs is that, overall economic conditions tend to slow down as indicated by a decrease in the export performance in Indonesia. However, domestic demand is still strong. Therefore, the Indonesia economy is still supported (Bank of Indonesia, 2022)

The percentace contribution of the loan variable contributing to the economic growth rate is relatively stable ranging from 3.04% to 3.86%. The positive response of economic growth rate to the loan variable in the first quarter with the largest percentage of 3.86% indicates that the banking sector clearly affects economic growth (Utami, 2018). The same condition is also experienced by the country of Ghana. The study found that, in contrast to domestic deposits, the quantity of credit extended to the



private sector by domestic sources had a positively significant relationship with economic growth (Abebrese, Pickson, & Diabah, 2017).

Different conditions occur in the variable-total assets of the bank. In the first quarter, the response to the shock of the assets variable was positive, but only with a relatively small percentage of 0.03%. Second largest percentage can be seen in the assets variable, i.e. 3.0%, 4.14% of exchange rate, and GDP industrial i.e. 0.74%. As of the fourth quarterly month, the percentage contribution to GDP industrial slightly increased and continued to increase until the seventh quarter.

Next is the percentage of the exchange rate variable. It increased from the first quarter to the third quarter. In the fourth quarter the percentage decreased slightly but in the fifth to tenth quarters it was consistently in the range of 6.2%. These results are in line with the research study by Akinbode et.al (2019) that in the long run the exchange rate affects economic growth.

The percentage contribution of the BI-rate variable to the economic growth rate showed a decline in the first and second quarters. Furthermore, the percentage contribution is relatively stable until the fifth quarter. Nevertheless, the percentage declined in the sixth quarter but then stabilized from the seventh to the tenth quarter.

In general, the role of BI-RTGS variable in this study is still consistent with the previous research by Medyawati and Muhammad Yunanto (2014). The contribution percentage of BI-RTGS variable regarding economic growth is relatively large at the tenth quarter (9.4%). However, when referring to the previous research, in terms of the optimal lag obtained in the previous study is the same, the lag length is only 2 (two) quarterly months compare to the previous VAR models which is 8 months (Medyawati, & Hermana, 2010).

The BI-RTGS system provides many benefits in addition to increasing the certainty of settlement finality for each payment transaction. This minimizes settlement risk. The BI-RTGS system is also a practical, fast, efficient, safe and reliable means of inter-bank fund transfer. In addition, the BI-RTGS system which is equipped with a centralized checking account mechanism, is a reliable means to increase the effectiveness of fund management for both participants, monetary and banking authorities. For the authority, information on the management of banking funds supports information related to carrying out monetary operations and early warning systems for bank supervision (Bank Indonesia, 2023).

4. Conclusion

Based on our results, it can be concluded that all variables affect economic growth consistently. An interesting finding of this study is the existence of a two way relationship in the short term, that is, between electronic money and BI-RTGS variables. This is possible because both are electronic-based payment instruments that are used equally by the Indonesian people. Another finding is that the shock from the electronic money variable in the first quarter received a positive response from the economic growth rate and showed a sizeable percentage, the largest throughout the

estimation over ten quarters. This result shows that electronic money is widely chosen by Indonesians for transactions (Walfajri & Dewi, 2021).

However, the limitation of this study is that dummy variables have not been used to distinguish the research timing whether it occurred before the Covid 19 pandemic or after. The implication of this research is that electronic money can be used as a tool to encourage economic growth because it is clear that electronic money has a positive effect on economic growth.

Conflict of interest: "The authors declare no conflict of interest"

Contribution: The authors contributed equally to this work.

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