International Journal of Economics, Business and Accounting Research (IJEBAR)
Peer Reviewed – International Journal
Vol-8, Issue-4, 2024 (IJEBAR)
E-ISSN: 2614-1280 P-ISSN 2622-4771
https://jurnal.stie-aas.ac.id/index.php/IJEBAR

ANALYZING FACTORS AFFECTING INDONESIA'S FOREIGN EXCHANGE RESERVES FOR THE 2012-2021 PERIOD

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Abstract: This research analyzes the effect of exchange rates, exports, and imports on Indonesia's foreign exchange reserves in the 2012-2021 period. The independent variables in this study are exchange rates, exports, and imports, while the dependent variables are Indonesia's foreign exchange reserves. The data used in this study was obtained from the official websites of the Central Statistics Agency (BPS), Bank Indonesia, and Worldbank in 2023. The data analysis method used is the Vector Error Correction Model (VECM) which is a derivative of Vector Autoregression (VAR) analysis. The data collection technique used is secondary data with quantitative research type. The results of the VECM analysis show that the exchange rate (exchange rate) has a significant effect on Indonesia's foreign exchange reserves, exports have a significant positive influence in the long run-on foreign exchange reserves, while imports have a significant effect on foreign exchange reserves. Therefore, it can be concluded that international trade has a significant influence on Indonesia's foreign exchange reserves, and exchange rates, exports, and imports are important factors affecting Indonesia's foreign exchange reserves.

Keywords: *Exchange Rate, Export, Import, Foreign Exchange Reserves*

Submitted: 2024-10-16; Revised: 2024-11-23; Accepted: 2024-12-04

1. Introduction

Indonesia's economic development is increasingly integrated with the global economy because Indonesia adheres to an open economic system whose activities are always related to international trade. This plays an important role in meeting domestic needs that cannot be fully produced by the state. In international trade activities, it is possible to transfer Natural Resources (SDA) between one country to another, both finished goods and raw goods. In an open economic system, cooperative relations between two countries are called bilateral, while cooperative relations between more than two countries are called multilateral which is transactional. International trade is motivated by countries that still need products from other countries that have abundant natural resources, resulting in export and import activities. International trade is also caused because the country is no longer able to produce goods and services due to the scarcity of human and natural resources. These two factors largely determine the increase in output over time as an important indicator in seeing how strong a country's economy is. If it is still not perfect to cover these two factors, then it is certain that the country is still in the process of economic growth. The existence of international trade also involves exchange rates (exchange rates).

Exchange rate is an agreement between countries that shows the value of the country's currency at the time of foreign transactions or payments. The relationship between exchange rates (forex) and foreign exchange reserves is that the more forex or foreign exchange owned by the government and residents of a country, the greater the country's ability to carry out international economic and financial transactions and the stronger the value of the currency.

Wrong One source of funding used by Indonesia in this economic activity is foreign exchange reserves under the responsibility of Bank Indonesia as stipulated in Law No. 3 of 2004 so that transactions are recorded in Bank Indonesia's balance of payments. Balance of payments or *Balance of Payment* (BOP) is a record of a country's international economic transactions against other countries over a period of time (generally within a period of 1 year). In the balance of payments shows the capacity/productivity of the country's population, expressed in terms of trade deficit or surplus and capital inflows and outflows.

Foreign exchange reserves are considered safe if they are sufficient for imports for at least 3 months. The more foreign exchange owned by a country, the stronger the ability to conduct economic transactions. According to Ardianti and Wayan (2018), explained that international trade activities are known as export and import activities. When a country exports, the country receives a certain amount of money in foreign currency, when a country imports, the country makes payments with a certain amount of foreign currency from foreign exchange reserves.

Table 1.
Development of Indonesia's foreign exchange reserves, exchange rates, exports, imports in 2012-2021

Year	Foreign Exchange Reserves	Exchange Rate (Rp)	Export (Million US$)	Import (Million US$)
2012	112 781	9,670	15,393.95	15,581.98
2013	99 387	12,189	16,967.80	15,455.86
2014	111 862	12,440	14,436.34	14,434.51
2015	105 931	13,795	11,917.11	12,077.30
2016	116 362	13,436	13,832.36	12,782.52
2017	130 196	13,548	14,864.55	15,104.47
2018	120 654	14,481	14,290.09	15,364.99
2019	129 183	13,901	14,428.82	14,506.78
2020	135 897	14,577	16,539.56	14,438.38
2021	144 905	14,262	22,359.55	21,318.16

Source: Bank Indonesia, 2022. Central Bureau of Statistics,2022

Foreign exchange reserves are obtained by trading on an international scale which occurs because a country needs each other in terms of the needs of goods in a country such as a country has scarcity and limitations in producing or producing a good, then the country will trade to other countries by import, and countries that have excess in an item will export these goods to countries in need. (Juniantara and Sri Budhi 2014).

Based on table 1.1 explains that the development of foreign exchange reserves, exchange rates, exports and imports. In 2012-2021, foreign exchange reserves fluctuated. The rise and fall of foreign exchange reserves from year to year due to factors that influence it such as exchange rates, exports, imports in addition to government spending in servicing foreign debt. Seen in the table above, Indonesia has the largest foreign exchange reserves in 2021 where its foreign exchange reserves are at US$ 144.

The Rupiah exchange rate is one of the factors in determining the amount of foreign exchange reserves owned. If the Rupiah exchange rate experiences instability in the exchange rate against the dollar, it will adversely affect import activities, where import activities carried out by a country must use foreign currency, namely the Dollar. Changes in supply and demand can be caused by trade in goods and services, government activities, changes in foreign exchange reserves, changes in capital flows, and changes in socio-political conditions of a country. Currency changes can occur in two ways, namely weakening and strengthening. When a country experiences currency weakening, the result is the high price of goods for domestic parties. Vice versa, if a country experiences a strengthening currency, then the price of goods becomes cheaper for domestic parties.

Exchange rate from 2012-2021 (rupiah exchange rate against US dollar) also strengthened and weakened, In 2012 amounted to Rp 9,386, in 2019 slightly strengthened the exchange rate of Rp 13,901 and weakened again until 2021 of IDR 14,262. The increase in the Rupiah exchange rate is caused by 2 factors, the first is due to *The Fed* issued a number of foreign portfolio investments from Indonesia due to the planned reduction *Quantitative Easing* (QE). QE is a program the *Fed to* print money and buy other financial assets from banks in the United States. Second, because it is caused by the value of Indonesia's trade balance experiencing a deficit, where the value of imports is greater than the value of exports. If the higher the value of a country's exchange rate, the country is not in a monetary or economic crisis and from the size of this exchange rate it can also be concluded that the exchange rate is one indicator of how strong a country's economy is.

Import can be said or interpreted as a form of purchase of goods and services that we get from other countries in which there are cooperation agreements between 2 or more countries. In an import transaction we need funds used for payment instruments derived from foreign exchange reserves. The value of imports owned by Indonesia has fluctuated, seen In the last 10 years, Indonesia's import value achieved the lowest import value in 2015 of US$ 12,077 and continued to fluctuate until in 2021 it increased to the largest import value of US$ 21,318.

When Exports increase, then the domestic exchange rate increases, causing foreign exchange reserves to increase. Conversely, when imports increase, the domestic currency exchange rate falls so that foreign exchange reserves decrease (Sukirno, 2003). In addition, if the more export activity, the greater the foreign exchange earned by the country. Generally, the goods exported by Indonesia consist of two types, namely oil and natural gas (oil and gas) and other than oil and natural gas (non-oil and gas). From table 1.1 above, it can be seen that the export value also fluctuated with the achievement of the highest export value in 2021 of US$ 22,359 while the lowest export value was in 2015 of US$ 11,917.

Exports cause a country to get foreign currency and vice versa imports must be paid for using foreign currency. These transactions will be recorded by the central bank and their value shown in the balance of payments. In addition, the positive and negative influence on a country's foreign exchange reserves largely depends on how far the country's export capabilities are compared to its import capabilities.

Foreign exchange reserves in sufficient quantities are one of the guarantees of achieving monetary and macroeconomic stability of a country. The main reason countries are obliged to have foreign exchange reserves is to finance international obligations and reduce an unbalanced situation in unpredictable international payments, for example as a result of the actions of international speculators.

2. Literature Review

An open economic system is characterized by international trade activities, namely exporting and importing with other countries in the world. According to Boediono (1998), international trade is trade carried out by countries or governments with several other countries in undergoing a trade relationship with mutual agreement and provides some additional benefits known as *gains from trade*. International trade can be carried out between individuals with individuals, between individuals with the government of a country or the government of a country with the government of another country. The reason for international trade is because not all countries can meet their own country's needs for goods or services. Therefore, international trade is important and has benefits because it can meet the needs of the community.

2.1 International Trade Theory

1. Theory of Absolute Advantage

   He argued that the theory of absolute advantage is explained as a condition in which a country can produce or produce more goods or services than its competitors by spending less production costs to obtain higher profits. A country can be said to have an absolute advantage if it can produce something that other countries cannot produce.
2. Theory of comparative advantage

   This theory was put forward by a man named David Ricardo. This theory seems to overcome the weakness of the theory of absolute advantage, according to which countries that do not have an advantage According to this theory, a country that does not have an absolute advantage can still participate in international trade by specializing in the products produced in that country. In addition, comparative advantage arises when a country can produce goods or services at cheaper labor costs than other countries. A completely different fate compared to countries with absolute advantages.
3. Economic Theory of Mercantilism

   This third theory was introduced by Victor de Riquet and Marquis de Mirabeau in 1763. This theory of international trade explains the wealth of a country measured by gold and silver. This mercantilist economic theory assumes that in order to develop national economies and economic development, the volume of exports must be greater than the volume of imports. The goal is for the country's economic conditions to become stronger and become richer.
4. *Modern Theory of Heckscher* Olin or H-O

   The fourth theory of international trade was put forward by Swedish economists Eli Heckscher and Bertil Olin. This theory is also better known as the theory of relativity. According to Eli and Bertil, this theory of international trade is associated with countries whose production factors are high and production costs are generally cheap. To make it easier for countries to export products by specializing in products produced by the country efficiently and effectively. Conversely, if a country has few factors of production that are quite expensive to produce, then the country will import from other countries to fill the shortage of goods that cannot be produced by that country.
5. *David* Hume's theory

   This theory suggests a mechanism for regulating international trade without a government. David Hume stated that the government does not need to regulate international trade because the international trade balance is automatically rebalanced by the gold flow

mechanism. Hume explained, when a country experiences a balance of payments surplus, gold will enter, causing the money supply to increase. So, according to David Hume's theory, if a country experiences a trade surplus (exports > imports), then gold will enter causing the money supply to increase which means it will increase foreign exchange reserves.

2.2 Export

Export is a trade activity between countries by sending and selling goods or services abroad or by removing goods from within the country abroad by fulfilling applicable terms or conditions. Export activities include goods and services that one country sells to another, including goods, insurance, and services in a given year (Meier, 1996 and Sukirno, 2010). To export, the country must try to produce products and services that are able to compete in the international market.

Export is another country's purchase of goods made by companies in the country. The important factor that determines exports is the ability of the country to issue goods that can compete in foreign markets (Benny, 2013). When the export level decreases, foreign exchange reserves also decrease, and vice versa when the export level increases, foreign exchange reserves also increase (Sonia and Setiawina, 2016).

2.3 Import

Import is the purchase of goods and services from abroad into the country based on a cooperation agreement between two or more countries. The import process is usually the act of entering goods from other countries into the country. In general, the import of goods requires intervention from the customs of the sending or receiving country. The purpose of imports is to meet the needs of the community. These imported products are goods that cannot be produced or countries that can already be produced but cannot meet the needs of the community (Benny, 2013).

Import is the purchase and entry of goods from abroad. Large imports increase demand for foreign currency, so the domestic currency weakens. High imports will also reduce domestic production resulting in increased unemployment and reduced income thereby reducing purchasing power (Sedyaningrum and Nuzula, 2016).

2.4 Exchange rate (Exchange rate)

In carrying out international trade activities or what we often call export and import. The function of exchange between one currency with the currency of another country is very important to facilitate when making buying and selling transactions both in the form of goods and services. From this exchange there is a comparison of the value or price of two currencies and is called the exchange rate (exchange rate)

In general, the exchange rate is the price or value of one currency against another. The exchange rate is usually set by the country's central bank. The rate (exchange rate) is called a comparison of values. This means that when we exchange one currency for another. It will then be able to compare the value or price of the two currencies. In the market mechanism, the exchange rate of a currency will always experience fluctuations (the rise and fall of the value of the currency against other currencies).

Exchange Rate System

Foreign exchange has several systems in its use. This system is divided into three, namely:

1. Fixed exchange rate *system*. A fixed exchange rate system is a system of exchange rates that are fixed or must follow the rules issued by the central bank (government).
2. Floating exchage rate *system*. A free or floating exchange rate system is one in which market forces influence or determine exchange rates.
3. Controlled floating exchange rate system. A controlled floating exchange rate system is a foreign exchange system in which the government and market have the right to set foreign exchange rates.

2.5 Foreign Exchange Reserves

Foreign exchange reserves are *foreign* currency deposits managed and regulated by a country's central bank and monetary authority. Deposits in question are assets or assets of the central bank stored in several reserve currencies consisting of foreign currencies, namely foreign currencies that can be accepted in almost all countries, such as dollars, euros, yen and other currencies held by the central bank. The currency used to claim its obligations, namely the local currency of the country of Indonesia, which is issued and reserved by a number of banks managed by the central bank.

According to Tambunan (2001), foreign exchange reserves are foreign currencies reserved at the central bank that are used to finance development and foreign transactions such as imports, foreign debt payments, investment and other financing. Various methods are carried out in the management of Bank Indonesia, namely. buying, selling, using foreign currencies and other securities such as cash or futures.

The circulation of money in foreign exchange reserves can be seen from the amount of foreign exchange deposits in the balance of payments. Foreign exchange reserves are usually measured by the ratio of foreign exchange reserves to imports or can explain when foreign exchange reserves can cover imports in the next 3 months then foreign exchange reserves can be estimated at a safe level, but if it is lower than three months or only enough to cover two months or less is not good for the economy because it will put pressure on the balance of payments (Kamaludin, 1998).

Previous Research

The relationship between exchange rate, inflation, foreign exchange reserves, export, and import in Indonesia: A vector error correction model approach (Nadia Fitriana Dewi, Ahmad Fauzan (2023). This study analyzes Exchange Rate (ER) fluctuations from the point of view of the multivariate time series. This research proposes to determine the modeling of the ER of the Dollar (USD) toward the Rupiah (IDR) with the Vector Error Correction Model (VECM) the period January 2015 to December 2020 by forecasting the Value of Exchange Rates for the next 5 months. In this modeling used variables that are affect the ER of the Dollar (USD), Inflation, Foreign Exchange Reserves, Exports, and import. This study begins with testing the stationary data. When the data is not stationary, a differencing stage is carried out to station the data. The optimal lag is selected in the second stage. As a requirement of VECM analysis, the third step is a cointegration test to see if there is a long-term connection between variables on the exchange rate. Later, the next step is modeling for the ER using the VECM approach. Impulse Response Function (IRF) and Variance Decomposition (VD) were used to see the dynamic behavior of the VECM model. The forecast value obtained using VECM for the next 5 periods is in January 14153, February 14167, March 14181, April is 14195, and May is 14209. The Leave p-out cross-validation (LpOCV) technique is used in the cross-validation process. The Key Performance Indicators (KPI) used are Mean Absolute Error (MAE), Mean

Square Error (MSE), and Mean Absolute Percentage Error (MAPE). From the KPI results, the MAE value is 624.57, the MSE value is 762218.46, and the MAPE value is 4.11% which is in the very good category.

Measuring the effect of foreign exchange reserves on foreign direct investment in Algeria during the period 1990-2020 using the ARDL model Bourenane, Bouzid And Rezig, Kamel and Djorfi, Zakaria (2022). This paper aims to examine the impact of foreign exchange reserves on foreign direct investment in Algeria during the period 1990-2020 by applying the Auto- Regressive Distributed Lag model (ARDL). The model showed that the current variables are co-integrated. Also, the results indicate that foreign exchange reserves have a positive impact on foreign direct investment in the long term only, at a rate of 44%.

A Model of Foreign Exchange Rate Indetermination, Charles Engle (1996). These Paper about Economic agents undertake actions to protect themselves from the short-run impact of foreign exchange rate fluctuations: Nominal goods prices are set in consumers' currencies, and firms hedge foreign exchange risk. A model is presented here which shows that these features of the economy can lead to indeterminacy in the nominal exchange rate in the short run. There can be noise in the exchange rate, unrelated to any fundamentals, essentially because the short-run fluctuations do not influence any rational agent's behavior. Empirical implications of this sort of noise are explored.

Determinants Of Foreign Direct Investment Inflows: A Case of The Visegrad Countries, Bobenič Hintošová, A, Bruothová, M, Kubíková, Z., &; Ručinský, R. (2018). This study identifies the determinants of foreign direct investment inflows into Visegrad countries using the country level data from the year 1989 to the year 2016. Based on correlation and regression analyses (OLS and fixed-effect model), we have identified the level of gross wages and the share of educated labour force as the most significant determinants with positive effect on FDI inflows. On the other hand, corporate income tax rate, trade openness and expenditures on research and development have been detected as the determinants with negative impact on FDI. Our study has not brought any evidence on inflation rate, unemployment rate, GDP per capita and the innovation output, as the sum of patents and trademarks, influencing FDI inflows in the case of Visegrad countries.

Hong, T. Y., & Ali, D. H. A. (2020). The Impact of inflation towards foreign direct investment in Malaysia and Iran. This study examines th effect of inflation towards the foreign direct investment in Malaysia and Iran. The testing period for this study are ranges from year 1986 to 2016. The Augmented-Dickey Fuller (ADF) unit root test was used to test the stationary of variables, the exist of cointegration variables was tested by Johansen and Juselius test, Granger causality based on VECM framework was used to test the short run and long run relationship between variables and lastly the variance decomposition was conducted to test the variable are exogenous or endogenous. From the empirical results, it has shown the foreign direct investment has effects on gross domestic product in short run in Malaysia meanwhile in Iran there are no causality relation among the variables in short run.

3. Research Method

The method used in the analysis of this study is quantitative descriptive method. The data in this study is time series data for 2012-2021.

Data and Variables

Sources Research is carried out through literature studies. Data obtained from several official documents such as Bank Indonesia (BI), Central Statistics Agency (BPS) and other

official documents that adequately describe the effect of exchange rates, exports and imports on Indonesia's foreign exchange reserves.

Variables

Data on exchange rates, exports, imports and foreign exchange reserves from the Central Bureau of Statistics, Ministry of Finance and Bank Indonesia. The data is from 2012 - 2021.

Variable	Variable Definition
Foreign Exchange Reserves	Foreign exchange reserves are the net position of government foreign assets and foreign exchange banks that will be held for international transactions.
Exchange rate	The relative price rate of rupiah against foreign currencies in this study is USD
Export	The value of exports of goods and services shipped abroad in millions of USD
Import	The value of imports of goods and services purchased from abroad in millions of USD units

Data Analysis Techniques

The analysis method used in this study is the *Vector Autoregression* (VAR) analysis method using the Eviews tool. Data collection technique using the time series method with a sample number of 10 years, namely from 2012 to 2021.

***Vector Error Correction Model* /VECM**

VECM is a derivative method of VAR. The assumptions that need to be met are the same as VAR, except for the problem of stationarity. Unlike VAR, VECM must be stationary at first differentiation and all variables must be equally stationary, i.e. differentiated at the first derivative. According to Nelmida (2013), VECM is a form of restricted VAR. These additional restrictions must be provided due to the existence of non-stationary but cointegrated forms of data.

Stationary Test (Unit Root Test)

Time series *economic* data are generally stochastic or have trends that are not stationary, meaning that the data has unit roots. To be able to estimate a model of data usage, the first step that must be done is data stationarity testing or known *as unit root test* (Gujarati, 2003). To test the stability or not of the VAR estimation that has been formed, a VAR stability condition check is carried out *in* the form *of nominal roots of characteristicpoly*. A VAR system is said to be stable if all *its roots* have a modulus smaller than one (Gujarati, 2003)

Optimum Lag Test

The optimum lag determination stage is useful for eliminating problems in autocorrelation in a VAR system. Determining the optimum lag is an important stage because it aims to determine the time needed by the dependent variable in responding to changes in other variables that are affected to determine the course of the next testing process.

Stability Test

The VAR model stability test can be seen at the modulus value possessed by each variable. The VAR model is said to be stable if the modulus value is at a radius of < 1, and unstable if the modulus value is > 1. If the greatest Modulus value is less than one and is at the optimal point, then the composition is already in the optimal position and the VAR model is stable.

Cointegration Test

Cointegration is a combination of linear relationships of nonstationary variables, where all variables must be integrated on the same order or degree. The cointegration test will be tested with the following equation:

$$Y = C + \beta_{1X1} + \beta_{2X2\ 3X3} + \beta + ... + \beta_{nXn} + \varepsilon$$

Where Y is the dependent variable, X is the independent variable, C is the constant, is the coefficient of the independent variable, and βis the ε residual. If there is no cointegration relationship, analysis with VECM can be performed. Testing for cointegration can be done using the Engle-Grager test or the Johansen test.

Vector *Error Correction Model* (VECM) Modeling

VECM is often referred to as the VAR model for time-series data that is not stationary and has a cointegrating relationship. If a time-series data of the VAR model is proven to have a cointegration relationship, then VECM is useful for estimating the effect of short-term behavior between variables on their long-term values. Basically, VECM is used to analyze multivariate time-series data that is not stationary. In general VAR models that are not restricted and have up to p-lags are as follows:

$$\mathbf{yt = A1Yt{-}1 + \cdots + Apyt{-}p + \varepsilon t}$$

Information:
: a vector with k variables
: matrix parameters
: vector error

Because there is a linear cointegration relationship, the VAR model will change to VECM with the general form of the VECM model using Yt−1 (first difference) as follows:

$$\alpha e_{t-1} + \beta_1 \Delta y_{t-1} + \beta_2 \Delta y_{t-2} + \cdots + \beta_p \Delta y_{t-p+1} + \varepsilon_t$$

$Dimana\ e_{t-1} = Y_{t-1} - (\varphi + \omega$Xt-1)

Information:
Δy_t : the first derived vector of the dependent variable
Δy_{t-1}: first derived vector dependent variable with 1st lag
e_{t-1} : error obtained from the regression equation between Y and X at the 1st lag and is also called ECT (*Error Correction Term*)
ε_t: residual vector
: cointegration coefficient matrixα
β: matrix coefficients of the I-th dependent variable, where i = 1, 2, ..., p

Granger Causality Test

Causality analysis or granger causality test is used to see the relationship between variables X and Y based on time series data in model estimation. By using this test, the estimation results will show possibilities,

a. The one-way causality relationship from Yt to Xt is referred to as *Unidirectional Causality from* Yt to Xt
b. The one-way causality relationship from Xt to Yt is referred to as *Unidirectional Causality from* Xt to Yt
c. Two-way causality or frequent affects (*bidirectional causality*)
a. No *causality*

***Impulse response function* (IRF)**

Impulse response describes the rate of shock of one variable against another variable in a certain span of time, so that it can be seen the length of the effect of the shock or variable on another variable until the effect disappears or returns to the equilibrium point. The trick is to give a *shock* to one of the endogenous variables. *The shock* given is usually one standard deviation from the variables (*nnnovations*).

***Decomposition Variance* (DV)**

By analyzing the results *variance decomposition* Then it can be measured the estimated error variance of a variable, which is how big the difference between before and after the shock occurs, both from the variable itself and from other variables.

4. Results and Discussion

4.1. Results

Stationary Test

Table 2. Stationary Test (Unit Root Test) Stationary Test Results (Unit Root Test)

Variable	Unit Root Test			
	Level (0) Prob	Information	*1ST Difference* Prob	Information
Foreign Exchange	0.9136	Non-stationary	0.0027	Stationary
Exchange rate	0.8529	Non-stationary	0.0015	Stationary
Export	0.8421	Non-stationary	0.0266	Stationary
Import	0.0037	Stationary	0.0000	Stationary

Source: Data processed 2023

The above results show that all data are not stationary at level level (0) but stationary at the level of the first derivative of *1st Difference*. So, it was concluded that this study used the VECM (*Vector Error Correction Model*) method.

Optimal Lag

The lag length used in this study was from 0 to 4 lags. The optimal lag length can be seen in Table 4.3 as follows:

Table 3. Lag Criteria Test

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-755.5903	NA	7.59e+33	89.36356	89.55961	89.38305
1	-733.2777	31.50004	3.88e+33	88.62091	89.60116	88.71835
2	-705.2714	26.35888*	1.42e+33	87.20840	88.97285	87.38379
3	-676.5978	13.49347	1.38e+33*	85.71739	88.26604	85.97073
4	1444.863	0.000000	NA	-161.9839*	-158.6510*	-161.6526*

Source: Data processed 2023
*) shows proper lag

Based on the Lag creiteria test used by researchers ranging from 0 to lag 4, the 4th lag is obtained as the optimal lag, this can be known from the number of stars (*). The length of the lag can be used to determine the effect of the time needed from each variable on its past variables.

Stability Test

Table 4. Stability Test

Root	Modulus
0.996137	0.996137
`-0.306230 - 0.715070i	0.777883
-0.306230 + 0.715070i	0.777883
0.509677	0.509677
0.022821 - 0.455570i	0.456142
0.022821 + 0.455570i	0.456142
-0.227596	0.227596
0.176987	0.176987

Source: Data processed 2023

Based on stability test results. The VAR model is said to be stable if the modulus value is at a radius of < 1, and unstable if the modulus value is > 1. If the greatest modulus value is less than 1 and is at the optimal point, then the composition is already in the optimal position and the VAR model is stable. Based on the stability test results in Table 3.5, it is known that the model is stable and passed the stability test. This can be seen from the modulus value which is still below one.

Cointegration Test

The cointegration test aims to be able to find out whether there will be balance or not in the long run, namely there is a stable relationship and similarity in movement between the variables in this study. Based on the cointegration test with stationary data at the first derivative level (*1st difference)* for all research variables, the following results were obtained:

Table 5. Cointegration Test

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistics	0.05 Critical Value	Prob.**
None*	0.905862	86.22450	47.85613	0.0000
At most 1 *	0.685318	43.69055	29.79707	0.0007
At most 2 *	0.587125	22.87909	15.49471	0.0032
At most 3 *	0.320535	6.956099	3.841466	0.0083

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistics	0.05 Critical Value	Prob.**
None*	0.905862	42.53395	27.58434	0.0003
At most 1*	0.685318	21.81146	20.13162	0.0454
At most 2 *	0.587125	15.92299	14.26460	0.0271
At most 3 *	0.320535	6.956099	3.841466	0.0083

Source: Data processed 2023

Based on the results of the Johansen cointegration test in Table 4.2 showing the results of the cointegration test, it can be seen that *the statistical trace* value and *maximum eigenvalue* at r = 0 have a value greater than *the critical value* with a significant level of 5%. It is stated that no cointegration is rejected and the alternative hypothesis stating that there is cointegration is accepted.

Based on the results of the analysis above, we can know that among the four variables in this study, there is a cointegration relationship at a significant level of 5%. So, the next step in VAR modeling is to do a VECM estimate.

Vector *Error Correction Model* (VECM) estimation

VECM estimation is performed after stationary and/or cointegration tests are performed.

Table 6. Estimate VECM

Cointegrating Eq:	CointEq1			
Y(-1)	1.000000			
X1(-1)	-24.08037			
	(3.51813)			
	[-6.84466]			
X2(-1)	0.522204			
	(0.23361)			
	[2.23537]			
X3(-1)	-0.168673			
	(0.02587)			
	[-6.51887]			
C	144587.8			
Error Correction:	D(Y)	D(X1)	D(X2)	D(X3)
CointEq1	0.443667	-0.035900	-0.056944	22.70137
	(0.23798)	(0.01946)	(0.57528)	(5.34392)
	[188431]	[-1.84516]	[-0.09898]	[4.24807]
D(Y(-1))	-1.242936	-0.166280	0.947533	-43.18617
	(0.70846)	(0.05792)	(1.71262)	(15.9088)
	[-1.75441]	[-2.87080]	[2.15326]	[-2.71460]
D(Y(-2))	0.664721	-0.039546	0.485124	0.385356
	(0.49309)	(0.04031)	(1.19198)	(11.0725)
	[1.34808]	[-0.98097]	[0.40699]	[0.03480]
D(X1(-1))	-7.497196	0.623542	-10.25808	-63.57695
	(4.06885)	(0.33265)	(9.83594)	(91.3678)
	[-1.84258]	[1.87445]	[-1.04292]	[-0.69584]
D(X1(-2))	5.187050	-0.445257	-9.652039	-18.03814
	(3.65358)	(0.2987)	(8.83206)	(2.0426)
	[1.41972]	[-1.49064]	[-1.09284]	[-0.21986]
D(X2(-1))	-0.215179	-0.005938	-0.362103	2.628149
	(0.19675)	(0.01609)	(0.47561)	(4.41802)

	[-1.09369]	[-0.36916]	[-0.76134]	[0.59487]
D(X2(-2))	-0.095959	0.028677	-0.233886	-15.28866
	(0.17656)	(0.01443)	(0.42681)	(3.96475)
	[-0.54349]	[1.98663]	[-0.54798]	[-3.85615]
D(X3(-1))	0.046303	-0.004287	-0.018247	1.695096
	(0.02894)	(0.00237)	(0.06997)	(0.64992)
	[1.59982]	[-1.81159]	[-0.26080]	[2.60816]
D(X3(-2))	0.005644	-0.001468	-0.018394	0.746854
	(0.01477)	(0.00121)	(0.03569)	(0.33158)
	[0.38225]	[-1.21576]	[-0.51531]	[2.25243]
C	11219.18	-566.1605	9022.685	323046.7
	(5821.10)	(475.910)	(14071.8)	(130715)
	[1.92733]	[-1.18964]	[0.64119]	[2.47138]
R-squared	0.588817	0.658447	0.554818	0.923411
Adj. R-squared	0.177635	0.316895	0.109635	0.846823

Source: Processed Data, 2023

Based on the estimation results in Table 4.5, it is known that the table at the top is a long-term relationship between the four variables (foreign exchange reserves, exchange rates, exports and imports). While at the bottom of the table is an interpretation of the short-term relationship of the four variables.

The following decision-making criteria are based on statistical tests t.

- If the statistical value t |*tstatistik*| < |*tkritis*|, then it has no significant effect
- If the statistical value t |*tstatistik*| > |*tkritis*|, hence the significant effect

- In the long run the exchange rate variable, export and import have a significant effect on the variable foreign exchange reserves, with the statistical value t respectively |-6.84466| |2.23537| and |-6.51887| which are greater than the critical value t |2.14479|.
- In the short term, changes in foreign exchange reserves 1 quarter ago significantly affect the exchange rate variable in the current quarter with a statistical value t |2.87080| > critical value t |2.14479|. If foreign exchange reserves during the previous 1 quarter increase by 1 rupiah, it will cause the current exchange rate change to decrease by 0.166280 rupiah.
- In the short term, changes in foreign exchange reserves 1 quarter ago do not significantly affect the export variable in the current quarter with a statistical value t |2.15326| > critical value t |2.14479|. If foreign exchange reserves during the previous 1 quarter increase by 1 rupiah, it will cause the current export change to decrease by 0.947533 rupiah.
- In the short term, changes in foreign exchange reserves 1 quarter ago significantly affect the import variable in the current quarter with a statistical value t |-2.71460| > critical value t |2.14479|. If foreign exchange reserves in the past 1 quarter increase by 1 rupiah, it will cause changes in imports at this time to decrease by -43.18617 rupiah.

Granger Causality Test

We can see the results of this causality test from the probability value. The decision criterion used is that$_{H0}$ is rejected if the probability value is less than 5 percent (0.05%).

Granger causality is carried out to be able to test the causality relationship between two variables over a long period of time. If H_0 is rejected, then the variable has a causality

relationship. The lag length used is according to the lag test that has been done before, namely lag 4 for the variables Foreign Exchange Reserves, Exchange Rates, Exports, Imports. Here are the results of the Granger Causality Test.

Table 7. Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
D(X1) does not Granger Cause D(Y)	19	0.55743	0.0439
D(Y) does not Granger Cause D(X1)		1.27705	0.3094
D(X2) does not Granger Cause D(Y)	19	0.15253	0.0301
D(Y) does not Granger Cause D(X2)		2.57750	0.1114
D(X3) does not Granger Cause D(Y)	19	1.37324	0.0026
D(Y) does not Granger Cause D(X3)		6.37075	0.0108
D(X2) does not Granger Cause D(X1)	19	0.80223	0.4679
D(X1) does not Granger Cause D(X2)		5.12868	0.0213
D(X3) does not Granger Cause D(X1)	19	1.71481	0.2157
D(X1) does not Granger Cause D(X3)		3.06001	0.0790
D(X3) does not Granger Cause D(X2)	19	0.37898	0.6914
D(X2) does not Granger Cause D(X3)		7.70999	0.0055

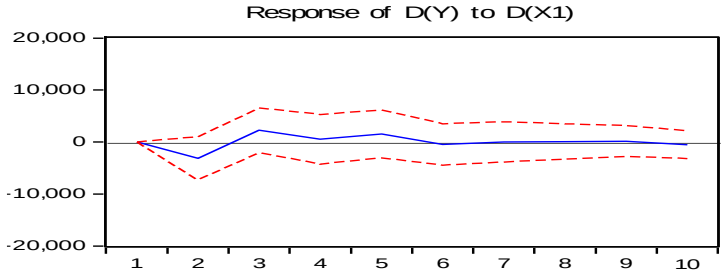
Source: Source: Data processed 2023

From the results of the causality test above, we can know that those who have a causality relationship are those who have a probability value smaller than 5% so that the value of H_0 will be rejected which means that one variable will affect other variables.
So that the results of the overall analysis of the granger causality test resulted in the conclusion that all research variables projected as theoretically significant independent variables have an influence on foreign exchange reserves. Thus, it can be concluded that all independent variables, namely exports, imports and exchange rates (exchange rates), have a significant causality relationship with foreign exchange reserves.

Impulse *Response Function Analysis*

Impulse response function *analysis* is one of the important analyses in the VECM model. *Impulse Response* Analysis tracks the response of endogenous variables in the VECM system due to shocks *or changes in the disturbance variables so that it can be used to see the dynamic behavior of the VECM model by observing* the shocks *given to the variables tested thoroughly.*

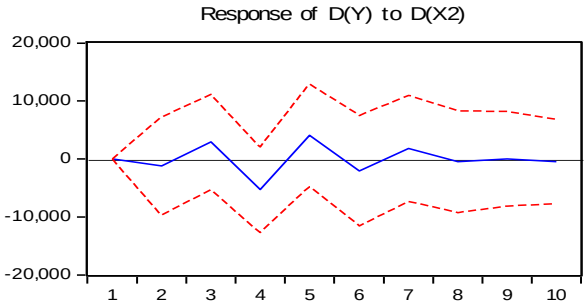
Figure 1. *Impulse Response* of Foreign Exchange Reserves to Exchange Rate Shocks



Source: Data processed 2023

Based on the results of IRF analysis in Graph 4.1 above, it shows the response of foreign exchange reserves to exchange rate shocks. In the first *period of shock*, there was a response that caused foreign exchange reserves to fluctuate where in the 1st period foreign exchange reserves showed a declining value until the 2nd period, but the response of foreign exchange reserves in the 3rd period had an increasing trend until the 4th lag had a downward trend in unison, but rose again in the 5th lag period, continued from the 6th lag period to the 10th lag period in a stable trend or was at a point Balance. The shock here means that the rupiah exchange rate depreciates, if the value of the rupiah currency depreciates then the price of Indonesian domestic products becomes relatively cheaper so that this encourages exports. Indonesia's negative trade conditions make exports depressed while imports continue to increase, making the rupiah currency continue to depreciate. This is indicated to be the cause of the depreciation of the rupiah value.

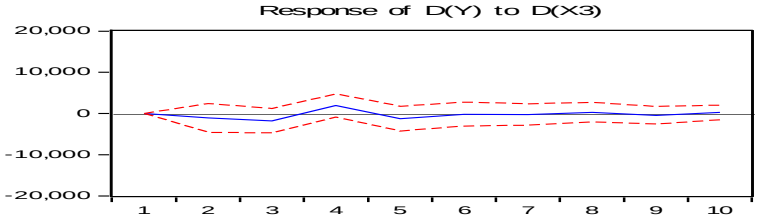
Figure 2. Foreign Exchange Impulse Response to Export Shocks



Source: Data processed 2023

Based on the results of IRF analysis in Graph 4.2 above, it shows the response of foreign exchange reserves to very large export shocks. Based on the graph above, we can see that if there is a shock of 1 standard deviation in the Export growth variable, it will cause significant fluctuations in the Foreign Exchange Reserves variable. The shock to the Export variable was responded by a decrease and increase in the Foreign Exchange Reserve variable in the 1st to 7th lag period. Then entering the next period has a very small influence, which is very close to the point of convergence (equilibrium) occurs starting in the 8th period to the 10th period. The shock here means that the influence of exports on foreign exchange reserves is so great because when export activities occur, it will directly increase foreign exchange reserves. The results of this *impulse response* analysis are in accordance with research (Batubara &; Saskara, 2015) where exports have a more positive influence in the long run-on Indonesia's foreign exchange reserves

Figure 3. *Impulse Response* of Foreign Exchange Reserves to Import Shocks



Source: Data processed 2023

Based on the results of IRF analysis in Graph 4.3 above, it shows the response of foreign exchange reserves to import shocks. In the first period of *shock*, there was a response that

caused foreign exchange reserves to fluctuate where in the 1st period foreign exchange reserves showed a decreased value until the 3rd lag period, but the response of foreign exchange reserves in the 4th lag period increased until entering the 5th lag period again decreased slightly until entering the 6th lag period had a very small effect, namely increasing until it was very close to the equilibrium point until in the period of the 10th lag. The shock here means that the value of imports has increased, if imports are too large it will result in a reduction in existing foreign exchange reserves and allow a deficit in the existing trade balance.

Analysis of Variance Decomposition

After the impulse response test, the VECM model also provides *an analysis of Forecast Error Decomposition of* Variance or often referred to as *Variance Decomposition*. This analysis provides a different method of describing the dynamic system of VECM compared to previous analyses. Basically, *impulse response function* and *variance decomposition* analysis are often used as good analytical tools in explaining the relationship between economic variables. If the correlation between economic variables has a small value, it means that it is too important (Hadi et al., 2020). Previous analyses were used to track the impact of shocks from endogenous variables on other variables in the system. While the analysis of *variance decomposition* describes the relative importance of each variable in the VECM system due to *shock*. The following is a table showing the results of *Variance Decomposition analysis.*

Table 8. *Variance Decomposition*

Variance Decomposition of D(Y):

Period	S.E.	D(Y)	D(X1)	D(X2)	D(X3)
1	10465.25	100.0000	0.000000	0.000000	0.000000
2	11245.35	90.16164	7.700719	1.180288	0.957352
3	12136.49	80.09426	10.02444	6.888750	2.992552
4	13398.79	65.75970	8.380326	21.29731	4.562658
5	14282.72	59.85132	8.529502	26.80754	4.811637
6	14443.80	58.56927	8.456445	28.25586	4.718422
7	14587.61	57.83842	8.290633	29.21094	4.660012
8	14599.48	57.74560	8.279746	29.28086	4.693790
9	14623.18	57.77999	8.263713	29.18612	4.770182
10	14647.17	57.64399	8.384026	29.18965	4.782336

Source: Data processed 2023

Based on the results *of variance decomposition*, it can be seen that the exchange rate variable (exchange rate) is able to explain the fluctuating movement of foreign exchange reserve variables, had experienced an increase in the 2nd period which reached 7%, the exchange rate variable then continued to increase in the 3rd period to 10% until the 4th period decreased to 8% until the end of the 4-10th period experienced fluctuations but remained stable in the range of 8% ratio in explaining the movement variable foreign exchange reserves.

The contribution of the influence of export variables on foreign exchange reserve variables experienced very good changes in each period, always increasing and the ability of export variables explained the variable of foreign exchange reserves from the initial period to the 6th period of 28%, until the end of the period 7-10 experienced fluctuations but remained stable in the range of 29 ratios. Export ability explains the variable of foreign exchange reserves is

getting bigger, but in the first period it cannot be explained by the ratio of exports itself (Li &; Law, 2020).

Similar to the import variable, the import variable also in the first period could not explain the movement of foreign exchange reserves, the contribution of the influence of import variables on the variable of foreign exchange reserves continued to increase from the first period to the end of the period reaching 4%. The ability of the import variable explains that the variable of foreign exchange reserves fluctuated from the 4th period to the 10th period but remained stable in the range of the 4% ratio.

4.2. Analysis Discussion

After the stationary test, it shows variable data on foreign exchange reserves, exchange rates, exports and stationary imports at the *first different* level. Then the optimum lag length is lag 4. The cointegration test shows the results of all cointegrated variables therefore indicating a long-term and short-term relationship. The results of the causality test provide results that there are only 5 one-way causality relationships on exchange rate variables, exports and imports to foreign exchange reserves, exchange rate variables to export variables and import variables to exchange rate variables. Therefore, the appropriate model used in this study is the VECM model with the aim of estimating the relationship in the long and short term in a time series.

Exchange Rate Effect on Indonesia's Foreign Exchange Reserves

After a stationary test, it was found that the variable data of foreign exchange reserves, exchange rates, exports, and imports were stationary at the first difference level. The optimum lag obtained is lag 4. The cointegration test shows that all variables are cointegrated, indicating both long-term and short-term relationships. The results of the causality test show that there are only 5 one-way causality relationships on exchange rate variables, exports, and imports on foreign exchange reserves, exchange rate variables on export variables, and import variables on exchange rate variables. Therefore, the appropriate model used in this study is the Vector Error Correction Model (VECM) model with the aim of estimating the relationship in the long and short term in a time series. Based on the results of research from variance decomposition, it is known that the ability of exchange rates to affect foreign exchange reserves fluctuates until the 10th period. This shows that the exchange rate (exchange rate) affects the size of foreign exchange reserves.

The test results on VECM estimates in the short and long term show that the exchange rate has a significant and negative effect on foreign exchange reserves. This can be seen from the exchange rate value that has a negative Coefficient. A negative exchange rate parameter coefficient indicates that if the exchange rate (rupiah exchange rate) decreases (depreciates), then foreign exchange reserves also decrease. If there is a weakening of the rupiah exchange rate (depreciation), the country needs more foreign exchange in order to carry out international transactions. A depreciating exchange rate (rupiah exchange rate) will have a negative impact on the trade balance. This is due to the high import content in export-oriented industries so that the depreciation of the rupiah exchange rate reduces the ability to produce and export products to the global market. The acquisition of this study is in accordance with the theory, that if the exchange rate of a country's currency depreciates, it is certain that a country's foreign exchange reserves will decrease. This is because the country will find it difficult to intervene in changes in exchange rates. Meanwhile, if the country's currency strengthens, then the country's foreign exchange reserves increase because it will be difficult to be depressed due to negative

sentiment. If the position of a country's foreign exchange reserves continues to thin and deplete, there will be a rush or attack of the desire to buy foreign exchange to increase which causes foreign exchange prices to increase and ultimately the exchange rate decreases (depreciation). Meanwhile, Indonesia's foreign exchange reserves are large and able to purchase sufficient foreign exchange if needed to stabilize the exchange rate.

The Effect of Exports on Indonesia's Foreign Exchange Reserves

Based on results from *variance decomposition* revealed that the ability of exports to affect foreign exchange reserves is very large which increases every period, indicating that export variables contribute greatly to Indonesia's foreign exchange reserves.

From test results on VECM estimation diketahui export berpengaruh signfikan and positive terhadap cadangan devisa dalam jangka pendek maupun jangka panjang. This can be seen from nilai export memiliki nilai *Coefficient* Yang positif dimana may be explained as follows: every transaction of selling domestic products to foreign parties, will bring benefits obtained domestically. Sales transactions of domestic products to exported foreign parties must use foreign currency transactions. In managing foreign exchange reserves, Bank Indonesia can conduct various foreign exchange transactions and can receive loans. The amount of foreign exchange reserves is influenced by exports and imports. Indonesia's trade activities are not only exporting oil and gas products, but also non-oil and gas, such as industry, agriculture, plantations and many others. One of the products that contributes a lot to the country's foreign exchange is plantation products, especially rubber plantations.

Export activities of a country will certainly get the amount of money in the form of foreign exchange or can be said to be foreign exchange, this is one of the country's income. Export is a trade activity between two countries that usually provides a stimulus to increase domestic demand which gives rise to large industrial factories, in order to provide a boost in the dynamics of foreign trade growth that later a developing country can compete with more developed countries. (Tri Wibowo and Hidayat Amir, 2005: 1). In export activities, Indonesia will be able to increase trade flows in the form of goods, money and capital between countries, where economic relations between countries will be intertwined. Due to the growth and development of the International Economy will indirectly affect the demand and supply of foreign currencies to conduct international trade transactions. Foreign Exchange from Oil and Gas Exports is one of the factors that affect the increase in foreign exchange reserves which include increasing factors. The increasing oil and gas exports sold abroad, resulting in an increase in foreign exchange reserves. Indonesia has many natural resources which include the oil and gas sector, the government and we participate in efforts to protect and make the best use of natural resources. Indonesia as a developing country has an open economic policy, one of which is the export promotion policy, because in addition to generating foreign exchange, it also trains and increases the competitiveness or productivity of domestic economic actors. Export Is one of the sources of foreign exchange.

Result This research is in accordance with the theory put forward by David Hume which says if a country has a trade balance surplus (exports > imports), there will be an inflow of gold which causes the money supply to increase, which means it will increase foreign exchange reserves. Meanwhile, according to the theory of mercantilism, to develop the national economy and economic development, the amount of exports must be greater than the amount of imports. If exports are greater than imports, it will increase foreign exchange reserves. The results of this study are also in line with research conducted by Sianturi (2011) and Benny (2013) which showed that exports have a positive effect on Indonesia's foreign exchange reserves. If

Indonesia often exports goods to other countries, Indonesia will earn foreign exchange from importing countries, so the more goods exported, the more foreign exchange will be obtained. With the increasing value of exports, it shows that the country is increasingly receiving income from outside countries, or commonly called receiving foreign exchange or foreign exchange which is one of the sources of state income.

The Effect of Imports on Indonesia's Foreign Exchange Reserves

Based on results from *variance decomposition* Revealed that the ability of imports to affect foreign exchange reserves increased by 4% in the 4th to 10th period, fluctuating but remained in the range of the 4% ratio, meaning that import variables would affect the size of foreign exchange reserves.

Negative influence means that the higher the imports, the lower Indonesia's foreign exchange reserves. This is because if a country imports, then the country will pay for imports with foreign exchange, so that the country's foreign exchange reserves will be depleted or reduced. According to Adam Smith's theory of absolute advantage, if a country is more efficient and has an absolute advantage than other countries in producing other commodities, then both countries can benefit by specializing in producing a commodity. A country's wealth is achieved from export surpluses. That is, with international trade between countries (exports > imports), a country can enjoy benefits by increasing or increasing foreign exchange reserves. So, it can be concluded that imports affect foreign exchange reserves. In making imports, the Indonesian government will finance these imports with Indonesia's foreign exchange reserves. Where if the amount of imports increases, the value of foreign exchange reserves will decrease. Based on the estimated results, this is in accordance with the theory that states that the higher the value of imports, it will reduce the inventory of foreign exchange reserves.

Effects of Exchange Rates, Exports, Imports on Indonesia's Foreign Exchange Reserves

Based on the analysis of research results, it is known that exchange rates, exports, imports and imports have a significant effect on foreign exchange reserves.

5. Conclusion

Based on the results of estimates and analyses that have been carried out with a derivative approach from VAR, namely VECM (*Vector Error Correction Model) and the* discussion that has been described in chapter IV with dependent variables of exchange rates, exors, imports and independent variables of Foreign Exchange Reserves in the 2012-2021 period, the author can draw several conclusions, namely:

- The exchange rate has a significant and negative effect on Indonesia's Foreign Exchange Reserves. Because if the Exchange Rate (Rupiah Exchange Rate) strengthens against the US dollar, then foreign exchange reserves will simultaneously increase as well.
- In this study, exports have a significant positive influence in the long run on National Foreign Exchange Reserves. This is reinforced by export procedures, if Indonesia often exports goods to other countries, Indonesia earns foreign exchange from importing countries. Thus the increase in the value of exports, shows that the country is increasingly developed and receives a lot of income from foreign countries or referred to as foreign exchange which is one of the sources of state income.
- Imports have a significant and negative influence in the long and short term on the National Foreign Exchange Reserves. In importing, the Indonesian government will finance these

imports with Indonesian foreign exchange reserves, where if the amount of imports increases, the value of foreign exchange reserves will decrease.
- Exchange rates (Exchange Rates), exports, imports both have a significant influence on Indonesia's Foreign Exchange Reserves.

Suggestion
- The government must pay attention to export growth in order to further increase economic capacity. And the Government must convince the world that Indonesia's exports can be better and increase, in order to increase the amount of foreign exchange through a policy of increasing exports in the country. Export-related policies should be improved so that domestic industries can export to international markets.
- Bank Indonesia as the controller of monetary policy and the government as the controller of fiscal policy together in order to always control and maintain the stability of the Indonesian economy, especially macroeconomic variables such as exchange rates, exports, inflation rates, and external debt, which are usually vulnerable to external influences. Every policy taken must all favor the welfare of the people as the top priority.
- Maintaining effective exchange rate stability and volatility by reducing consumption of goods and replacing it with consumption of local goods so that exchange rate stability can be created and can attract foreign investors to enter and invest in Indonesia, because exchange rate stability will have an impact on the certainty of the rate of return on incoming investment.
- In this era of free trade, the government should provide policies that can restrain the small rate of imports and also protect domestic goods in order to compete in the domestic and foreign markets.

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