

Autoregressive Distributed Lag Modeling of the Effect Macroeconomic Variables on Export Growth (Case Study: Indonesia)

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Abstract- The purpose of this study is to analyze the short-term influence of macroeconomic variables on the growth of Indonesian exports and to find out how the growth of exports reacts to changes in the value of macroeconomic variables. The export price index, exchange rate, economic growth, inflation and the interest rate are the macroeconomic variables referred to. This research uses data from the time series 1999-2019. The use of the autoregressive distributed lag model shows that the export price index (lag -2) with a negative direction and the interest rate (lag -2) with a positive direction are the macro variables that influence export growth in the short run. In the long run, with a positive directional response to the interest rate and a negative response to the exchange rate, the interest rate and exchange rate variables are the variables that respond most to export growth.

Keywords: *export growth, macroeconomic variables, autoregressive distributed lag.*

Introduction

The economy has evolved between countries and also between trading blocks in the era of free trade, reducing or removing the costs of import duties or export duties. In general, developing countries export primary products with lower economic value; on the other hand, they import finished products from developed countries, the prices of which appear to be expensive, leading to a reduction in the trade balance between developing countries and the trading partner countries. Developing countries such as Indonesia are seeking to promote or export a much greater amount to compensate for the weakening pattern of the trade balance (Iheanacho, Eugene, 2017).

Exports are one of the economic sectors that play an important role in supporting the manufacturing sector and also as a major component of growth (export-led-development), which means that exports play a significant and important role in a nation's development process (Monineath, 2018).

An increase in national income (GDP) or economic growth will increase the buying power of people to import, however, on the other hand, an increase in national income will also increase the willingness of people to carry out the development process, whether the results are used for domestic consumption or for export to other countries (Sayef Bakari & Mohamed Mabrouki, 2017).

Two or more countries which have different currencies will be involved in the selling or export of goods abroad, so that the exchange rate of one country's currency with another will influence the value of the trade transaction. If the domestic currency decreases against the currency of its trading partner country (depreciation)

in a country that uses a floating exchange rate policy mechanism such as the one currently used in Indonesia, the price of the exported products on the foreign market will be cheap and this could increase the value of export sales, but this condition is uncertain because it will depend on the maritime value of the sales (Nicholas Tsounis & Dimitrios Serenis, 2014).

On the other hand, inflation in a country will affect the value of exports, inflation will raise the cost of production such that the price of the products sold exports tends to increase and the international demand for the goods exported decreases, thus reducing the value of exports (Araş Gör Asuman, Aras Gör Arzu, 2012).

High international demand for a country's exported goods would depend on the competitiveness of the products exported, including the price of the products exported and the quality of the products. If the fixed export price of goods can be competitive on the international market, the competitiveness of the products sold will increase so that global demand will increase, leading to an increase in the value of exports (Ravindran Ramasamy & Soroush Karimi Abar, 2015).

In general, business people who manufacture goods for both domestic and international needs, part of the capital they use comes from loans, the size of the loan will be affected by the bank interest rate, the low interest rate calculated, business people prefer to raise their loans that will be used to construct a business and will influence the price of the product that will eventually decide foreign products.

On the basis of the previous explanation, it can be stated that a country's export value would be affected by a variety of factors which are macroeconomic factors, including: export prices, economic growth, inflation, exchange rates, interest rates. The production of exports and the magnitude of macroeconomic variables are shown in the following results.

Table 1. Export growth, exchange rates, export price index, interest rates, inflation, and economic growth in Indonesia for the period 2015 s.d. 2019

Year	Export Growth (%)	Exchange Rates (\$/Rp)	Export Price Index	Interest Rates (%)	Inflation (%)	Economic growth (%)
2015	21,16018	13389,41	130,46	12,6625	6,363121	4,876322
2016	19,08899	13308,33	133,31	11,88833	3,525805	5,033069
2017	20,1773	13380,83	144,69	11,07333	3,808798	5,069786
2018	20,97222	14236,94	162,29	10,53667	3,198346	5,169706
2019	18,40752	14147,67	159,72	10,36583	3,030587	5,024714

Source : world bank data

Table 1 shows that the rupiah exchange rate against the US dollar declined or depreciated over the 5-year period, from 2015 to 2019, the interest rate decreased, inflation also decreased, and economic growth also improved or increased, but export growth decreased, which should have increased. Then, from the point of view of the export price index, the export price proxy continues to rise for the period from 2016 to 2018, but export growth shows an increase.

It is possible to recognize data occurring in Indonesia that there is a problem phenomenon that exists between macroeconomic variables and export growth, so the author wants to analyze the short- and long-term effect of macroeconomic variables on export growth.

Previous studies showing the impact of macroeconomic factors on exports have been observed in the short or long term.

Sayed Irshad Hussain et al. (2020) analyzed the determinants of supply in Pakistan using time series data from 1974 to 2014 using the Autoregressive Distributed Lag (ARDL) model. The study's findings concluded that production capacity has a significant effect on export goods at long-term relative prices, production costs. Relative prices, production costs and production potential display an impact on exports in the short term.

In six countries, including developing countries, Turkey, Indonesia, Brazil, Mexico, Poland and Chile, Oğus Tümtürk (2019) explores the effect of fluctuations in exchange rates on export volumes. The volatility of the exchange rate is calculated using the ARCH / GARCH formula and the Error Correction Model is used, and the results show that the volatility of the exchange rate and exports does not have a cointegration relationship between Brazil, Indonesia and Chile, whereas the cointegration relationship between Turkey, Mexico and Poland. The effect is important and has a negative direction between the exchange rate and exports in the countries of Turkey and Mexico, while it is negligible in Poland

The influence of foreign domestic investment, COP, and inflation on exports in five ASEAN countries was examined by Nanda Adhi Purusa and Nurul Istiqomah (2018) using panel data from 2000 to 2015, and the results of their research concluded that FDI and crude oil prices had an effect. Although inflation has a positive and important effect on exports, it has a negative impact on exports.

Monineath (2018) uses the ARDL approach to analyze the determinants that influence export output in Cambodia to see the short-term relationship, models from the 1993 to 2015 period, inflation, real exchange rate, official development assistance, and trade liberalization as the determining factors. The study finds that inflation has a negative export relationship, both in the short and long term, whereas the exchange rate has only a negative short-term effect on exports.

The macroeconomic impact on trade was examined by Erceg et al. (2018) using a dynamic model which concluded that the exchange rate has an effect on both net exports and the export price index on exports.

Farhana Rahman (2017) explores the complex short-term and long-term relationship of the effect of macroeconomic variables on Bangladesh's export output, with the interest rate, inflation, amount of money in circulation, and the production price index being the independent variables using monthly data from July 2011 to June. In 2016, with the Johansen test, the findings are that there is a cointegration between macroeconomic variables and exports, the results of the study suggest that in the short term there has been an impact between macroeconomic variables and exports, but there is no long-term influence.

Sugiharso Sapuan (2017) uses data from 1996 to 2014 to analyze the effect of exchange rate volatility on Indonesian exports to the United States, Japan and China, with results showing that exchange rate volatility has a negative impact on exports.

Rohit Singh Tomar and Deepika Singh Tomar (2014) analyzed macroeconomic variables and their effect on China and India's exports, concluding that both countries' exports are affected by Gross Domestic Product (GDP), FDI inflows, Exchange Rate, Per Capita Real Income and Inflation

The volatility of exchange rates and aggregate exports in two countries, namely Croatia and Cyprus, were analyzed by Dimitrios and Nicholas (2013) using quarterly series data from 1990.1 to 2012.1 and concluded

that the amount of exchange rates would have a positive effect on exports.

According to Srinivasan and Kalavani (2013), using time series data for the period 1970 to 2011, they analyzed the effect of exchange rate fluctuations on exports in India and applied the ARDL method. True exports are co-integrated with adjustments in exchange rates, gross domestic product (GDP) and international economic activity, the results show. Another finding is that long-term exchange-rate changes have a substantial positive effect, but have a negative trajectory for short-term relationships, which suggests that high exchange-rate volatility in India would reduce actual exports. GDP is important and has a positive long-term effect on India's real exports, but it does not mean that India's real exports have a positive impact.

The dynamics of exports in an economy were analyzed by Koc Yurtkur and Tay Bayramoglu (2012) with the objective of evaluating export determinants using panel data from 1994.1 to 2009.1. His research concluded that the exchange rate and the gross domestic product had a positive effect on exports, while inflation had a negative influence on the value of exports.

The effect of exchange rate fluctuations on Turkish exports was analyzed by Halil Altintas et al. (2011) using quarterly time series data from 1993.1 to 2009.4 using multivariate cointegration and error correction techniques for both long and short-term impacts. About model. The findings indicate that the long-term volatility of foreign income and currency exchange rates has a positive and statistically significant relationship with Turkish exports, whereas relative prices are negative and statistically significant.

Using time series data from 1997 to 2005, Arief Bustaman and Kankesu Jayanthakumaran (2007) analyzed the effect of exchange rate fluctuations on Indonesian exports to the USA, applying the Autoregression Distributed Lag method. And the findings indicate that exchange rate fluctuations and exports have a significant effect in the long run. This is crucial and indicates a negative path, which means that the high volume of the exchange rate will increase costs and decrease international trade in turn.

Methodology

As independent variables, this analysis uses macroeconomic variable data in the form of: export price index, exchange rate, economic growth, inflation rate and interest rate, while export growth is the dependent variable.

$EXP_t = (EPI, ER, Gt, INF, INT)$.

EXP = Export growth

EPI = Export price index

ER = Exchange Rates

Gt = Economic growth

INF = Inflation

INT = Interest rates

For the period 1999 to 2019, the data used is annual time series data. The World Bank, the Bank of Indonesia and the Central Statistics Agency collect data.

The first step, using the unit root test, will test the characteristics of the data. To evaluate the data to be stationary with time series data having a constant mean and variance over time, the unit root test is needed, except that the covariance value between two time periods only depends on the distance or lag of two time periods (Gujarati, 2007).

The second stage, after knowing the results of the unit root test that states that the data is not stationary at level

and the data is stationary at difference 1, then the VAR model must be established, then it must be tested by performing cointegration tests through the Johansen test to check if the data has a relationship between variables. The model used is the Vector Error Correction Model (VECM) if there is cointegration, but if there is no cointegration of endogenous variables, then the Vector Autoregressive Model (VAR) may be used as a model of difference or with Autoregressive Distributed Lag (Widarjono, 2016). In other words, if a number of variables comprise the root unit and are not co-integrated together, then the VAR model must be used to distinguish them if it is assumed that all variables can be endogenous (dependent) variables, but if all variables cannot be assumed to be endogenous variables, the ARDL model is used.

In fact, the use of the ARDL model is a direct growth of the OLS technique in the third stage (Doddy Arifianto, 2012). This ARDL model is basically a multiple regression model with an independent function that is the slackness of the Y_{t-1} dependent variable, another function correlated with the v_t disorder variable that is assumed to include problems with autocorrelation. As follows, the ARDL model to be calculated is:

$$\Delta Y_t = \alpha + \delta t + \rho Y_{t-1} + \gamma_1 \Delta Y_{t-1} + \theta X_t + \omega_1 \Delta X_t + \omega_2 \Delta X_{t-1} + \dots + e_t$$

The ARDL model can also distinguish short-term and long-term response coefficients / parameters by eliminating the error correction parameter or

$$Y_t = \alpha + \sum_{i=1}^{\rho} \beta_i Y_{t-i} + \epsilon_t$$

A short-run response parameter is called the coefficient γ_i , $i = 1, \dots, r$. When the dependent and independent variables are no longer in motion, the long-run response coefficient (e.g. λ) is obtained: the system is in a state of balance (equilibrium), i.e.

$Y_t = Y_{t-1} = \dots = Y_{t-p}$ and $X_t = X_{t-1}$ mathematically, the value of $\lambda =$

$$\frac{\sum_{i=1}^{\rho} \gamma_i}{\sum_{i=1}^{\rho} \beta_i}$$

The suggested hypothesis is that macroeconomic variables (index of export prices, exchange rate, economic development, inflation and interest rates) have an impact on the short-term growth of Indonesia 's exports. Meanwhile, we will see how Indonesia's export growth will respond to changes in macroeconomic variables (export price index, exchange rate, economic growth, inflation, and interest rates) in the long term.

Results

The test begins with the data stationarity test, which is to see whether the data is stationary or not. The data stationarity test used the unit root test using the ADF test.

Table 2. Augmented Dickey Fuller (ADF) test

No	Variables	Prob. At a level	Prob. First difference
1.	EXP	0.5298	0.0003
2.	EPI	0.1934	0.0082
3.	ER	0.9834	0.0003
4.	Gt	0.0000	-
5.	INF	0.0049	-
6.	INT	0.1865	0.0000

Sources : result of data processing

Table 2 shows that the ADF test results show that the Gt and INF variables are stationary at the level, while the variables EXP, EPI, ER and INT are not stationary at the level and are stationary at the first difference, so that the results show that the probability value of all variables is less than 5%, which means that all data variables are stationary.

The cointegration test between variables using the Johansen test is the second step after the data stationary test, since there are still several variables that are stationary in the first discrepancy.

Table 3. Johansen test

Sample (adjusted): 2000 2019				
Included observations: 20 after adjustments				
Trend assumption: Linear deterministic trend				
Series: ER EXP INT EPI				
Lags interval (in first differences): 1 to 1				
Unrestricted <u>Cointegration Rank Test (Trace)</u>				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.639840	41.07956	47.85613	0.1862
Trace test indicates no <u>cointegration</u> at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Sources : result of data processing

Based on the test results from Table 3 of the Johansen test. The chance value is greater than 0.05 at 0.1862. This shows that H_a , which states that cointegration is rejected or embraces H_0 between variables, indicates that there is no cointegration between variables, so ARDL or VAR can be used by the model that will be used to approximate parameter specifications. In this case, on the basis that the current value of the dependent variable (Y_t) is not only determined by the current value of the independent variable (X_t), but also by the value of the

dependent variable and past independent variables, the author has chosen the ARDL model, such that a trend occurs. In nature, complex.

Apart from being influenced by the current independent variables (X_t), the current export variable as a dependent variable may also be influenced by the value of exports in the past, provided that export production now depends on export earnings obtained in previous years, and that other export variables in the current year might be influenced by export rates, economic growth, etc.

The data normality test was performed before estimating the ARDL model with the following results:

Table 4. Normality test

	ER	INFL	INT	GT	EPI	EXP
Jarque-Bera	2.180130	1.158538	5.566782	189.1028	2.192730	0.884694
Probability	0.336195	0.560308	0.061828	0.000000	0.334083	0.642527

Sources : result of data processing

On the basis of the table, the normality test shows that the exchange rate, inflation, interest rates, export price index and export growth variables display normal data, but economic growth is not normal, but this variable is still used by the authors since only one variable is not normally distributed, and other than that, they still want to see if economic growth has an impact on export growth.

In addition, the classical assumption test is performed since the data used is time series data, multicollinear tests, heteroscedastic tests, and autocorrelation tests, with the following results:

1. Multicollinear test to see whether independent variables have a linear relationship

Tabel 5. Multicollinearity test

VAR. INDEP.	R ²	TOL = 1 - R ²	VIP = 1/TOL
ER	0,6278	0,3722	2,686727566
INT	0,8548	0,1452	6,887052342
INFL	0,5572	0,4428	2,258355917
Gt	0,6552	0,3448	2,900232019
EPI	0,3163	0,6837	1,462629808

Sources : result of data processing

Based on Table 5, it can be shown that the VIP value is less than 10, suggesting that multicollinearity has been prevented by the data or that there is no linear relationship between the independent variables.

2. Heteroscedastic test to see if the residue of a regression equation differs over a certain data set whether there are symptoms

Table 6. Heteroskedastis test

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	4.026884	Prob. F(5,15)	0.0162
Obs*R-squared	12.03443	Prob. Chi-Square(5)	0.0343
Scaled explained SS	3.470536	Prob. Chi-Square(5)	0.6279

Sources : result of data processing

Table 6 shows that more than 5% of the probability value means that the data is heteroscedastic-free. The final step is to estimate the impact of the variable export price index, the exchange rate, economic development, inflation and the interest rate in the dynamic ARDL model. With the findings as illustrated in Table 7.

Table 7. ARDL estimation results

Dependent Variable: EXP				
Method: Least Squares				
Sample (adjusted): 2001 2019				
Included observations: 19 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	7.619020	2.947247	2.585131	0.0362
EXP(-2)	-0.226526	0.294824	-0.768342	0.4674
EPI	0.000506	0.000402	1.258050	0.2487
EPI(-2)	-0.001060	0.000389	-2.723876	0.0296
ER	-0.416485	0.247400	-1.683445	0.1362
ER(-2)	-0.143091	0.158880	-0.900627	0.3977
GT	-0.257512	0.321307	-0.801452	0.4492
GT(-2)	0.117002	0.089708	1.304251	0.2334
INFL	0.116744	0.066814	1.747293	0.1241
INFL(-2)	0.028080	0.044072	0.637123	0.5443
INT	-0.030056	0.361718	-0.083093	0.9361
INT(-2)	0.629363	0.197525	3.186242	0.0154
R-squared	0.981574	Mean dependent var		3.256543
Adjusted R-squared	0.952619	S.D. dependent var		0.210373
S.E. of regression	0.045792	Akaike info criterion		-3.064782
Sum squared resid	0.014678	Schwarz criterion		-2.468294
Log likelihood	41.11543	Hannan-Quinn criter.		-2.963833
F-statistic	33.90017	Durbin-Watson stat		2.103850
Prob(F-statistic)	0.000053			

Sources : result of data processing

Based on the results of the ARDL estimate in Table 7, the dynamic regression model specification indicates that the variables influencing export growth in the short term are:

1. For the previous two years, the export price index with a response coefficient of -0.001 suggests that a one-unit rise in the export price index will decrease export growth by 0.001 units.
2. An interest rate with a response coefficient of 0.6293 for the previous two years implies that an

improvement in the interest rate of one unit would improvement export growth by 0.6293 units.

In the meantime, other factors, such as exchange rates, economic growth and inflation, have little impact on growth in exports. The stationary requirements have been met by Autoregressive Coefficient (EXP (-2)) since it has an absolute value below 1, which is 0.226555.

Because of the EPI, ER, Gt, INF, and INT variable values, the long-run response parameter to economic growth can be determined as follows:

Table 8. Long-term Response Parameters

No.	Var. Independen coefficient	Long Run Parameter
1.	EPI	-0,00045
2.	ER	-0,4562
3.	Gt	-0,1145
4.	INF	0,1181
5.	INT	0,4886

Sources : result of data processing

Based on Table 8, the equilibrium conditions indicate that:

1. A 1 % rise in export prices (EPI) would reduce the growth of exports by 0.00045% or vice versa
2. A 1% exchange rate (ER) rise would decrease export growth by 0.4562% or vice versa
3. A 1% rise in economic growth (Gt) would decrease the growth of exports by 0.1145%, or vice versa
4. A 1% rise in inflation (INF) would increase the growth of exports by 0.181% or vice versa.
5. An interest rate (INT) rise of 1 percent would rise export growth by 0.4886 percent or vice versa.

Discussion

The implications of the results indicate that, in the short term, export growth in the current year is substantially affected by the export price index of the previous two years and is in a negative direction, so the current export price growth will actually decrease when the export price rises in the previous two years, and vice versa, when the export price increases. This is understandable because the size of the demand for exported goods from abroad will depend on the competitiveness of these goods and one of the competitiveness is the price of goods that must be able to compete with the price of comparable products from other countries, two years ago, the decline will cause export growth now (this year), It seems that, in view of the prices offered in previous years , business people who export their goods abroad must always minimize the cost of production so that the export price offered will compete in the foreign market and will also impact the demand for export products in subsequent years.

Another consequence is that the interest rate of the previous two years has a major effect on current export growth in the short term and has a positive trajectory, which implies that when the interest rate has risen in the previous two years, current export growth will rise, and vice versa, when the interest rate has decreased in the

previous two years, export growth is now still down, export growth will also decrease.

The impact of the interest rate on export growth is of great concern on the basis of the long-term findings, showing that an increase in the interest rate of 1 percent would increase export growth by 0.49 percent or when the interest rate is lowered by 1 percent, export growth will also decrease with a decrease of 0.0. Forty-nine percent. It can be said that when the interest rate is lowered by the Central Bank, it turns out that Indonesia's export businesses will not immediately raise their loans to banks in order to increase their export demand.

Another long-term concern is the effect of the exchange rate on export growth, which indicates that when the exchange rate rises by 1 percent, export growth will decrease by 0.46 percent, indicating that if the rupiah is appreciated against the US dollar, the export growth of Indonesia will decrease, this is natural considering when the rupiah improves, the price of Indonesian expo will decrease. On the other hand, if the exchange rate falls by 1 percent, export growth will increase by 0.46 percent, which means that if the rupiah depreciates, the export growth of Indonesia will increase as the weakening of the rupiah against the US dollar makes the prices of export goods comparatively cheaper to increase international demand for products. Exports from Indonesia.

Based on the data processing findings that show that: 1) the export price index has a major and negative effect on export growth in the short term, this is in line with the research results conducted by Farhana Rahman (2017), which shows that export prices have an impact on exports in Bangladesh, as well as the research results by Sayed Irshad Hussen, who reported that export prices h 2) The interest rate has an effect on export growth, but in a different direction, in line with the results of Farhana Rahman's (2017) study.

Long-term findings indicate that the export price index has a negative effect on export growth, in line with the results of Halil Altintas, Rahmi Cetin and Bulent Oz (2011), which conclude from their research results that export prices have a negative export direction and are statistically significant in Turkey. The exchange rate and has a negative direction is the effect of another important variable on export growth, this result is in line with research conducted by Oguş Tümtürk (2019) in Turkey and Chile, the effect is significant and has a negative direction between the exchange rate and exports. Similarly, Sugiharso Sapuan (2017)'s research findings indicate that uncertainty in the exchange rate has a negative effect on exports.

Conclusion

The following findings were obtained on the basis of data processing results:

1. In the short term, the export price index, as a proxy for export prices and the interest rate, is the macroeconomic variable that affects export growth. Export growth in the current year is negatively affected by the export price of the preceding two years, driven by the interest rate of the preceding two years and in a positive direction.
2. In the long run, with a positive directional response to the interest rate and a negative response to the exchange rate, the interest rate and exchange rate variables are the variables which have the greatest response to export growth.

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