Exchange rate volatility and exports: a panel data analysis for 5 ASEAN countries

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Abstract. The study of the effects of exchange rate volatility has still attracted the attention among economist, especially international economist. Because, if the exchange rate is unpredictable, it makes uncertainty about the profits to be gained, so this conditions may diminish the gain from international trade. In addition, some empirical literature provides various findings, where the exchange rate volatility has a positive effect on exports and can also negatively effect on exports. This paper wants to provide empirical evidence on both of these. It uses panel data involving five ASEAN countries with a period of 2000 – 2016. We also apply some analysis in panel data, such as the pooled least squares method, the fixed effect method, and the random effect method. The findings show that the exchange rate volatility has negative impact on exports. This paper suggests that each of central bank should pursue sustainable and stable exchange rate policy measures to promote greater exchange rate stability that would help to enhance the real exports of the economy.

1. Introduction
For developing countries, the exchange rate volatility has been playing an important role in trade. While this is debatable because it can hinder the flow of international trade, this opinion is believed since the exchange rate volatility is a representation of uncertainty and a representation of costs for commodity traders to avoid risk. Thus, exchange rate volatility becomes a proxy of risk and increased volatility may increase for traders who avoid risk and trade pressures [1].

Until the last decade, the study of the effects of exchange rates on international trade has attracted the attention of international economists. Where the exchange rate played an important role, especially regarding exchange rate certainty to avoid the risk of loss due to exchange rate differences. Good understanding is necessary for international trade actors [2]. Similarly, the exchange rate determination influences two important issues that are often debated namely the relevance of fiscal policy and monetary policy tries to make the exchange rate stability in reducing the variability of both import and export [3].

Based on some references, there are three things causing factors difference of estimation results. First, among the use of exchange rate measures, whether nominal or real. Many studies use real exchange rate because it can capture the movement of cost and price. Second, statistical methods of exchange rate volatility measurements are used moving averages standard deviation. The use of this
method is most widely because it can capture the movement of data. Third, the use of export and import model specifications refers to the basic model specifications of export and import equations in international trade theory.

From the above explanation, the exchange rate volatility had an important role in trading activities, because if the exchange rate becomes unpredictable, it leads to uncertainty about the profits so that this condition may diminish the benefits of international trade. This paper is expected to add the literature on the effect of exchange rate volatility on exports by taking case for five ASEAN countries.

2. Literature for exchange rate volatility and its calculations

2.1 The Relationship between Exchange Rate Volatility and Exports
The volatility of exchange rate is an unreliable exchange rate that can disrupt the activity of economy. From literature in the international trade, the price of a country's currency had played an important role in determining export and import prices, if changed, resulting in economic prosperity. Thus, the volatility of exchange rate has an important role in the flow of commercial trade [4]. In other literature, the definition of exchange rate volatility is the rate of exchange rate tendency to change. The volatility of exchange rate can lead to a high cost economy because business actors tend to cover risks by putting up high prices. So the competitiveness of domestic products becomes low due to high price pressures [5]. McKinnon and Ohno have the opinion, the excessive exchange rate volatility and recurrence of misalignment may suppress trade flows, change the direction of investment policy, and the inaccuracy of site selection for multinational corporations. Moreover, exchange rate volatility could subtract the volume of international trade because it made uncertainty of profits from international transactions [4].

Hooper and Kohlachen state the volatility of exchange rate within the framework of bilateral relations, where the source of uncertainty is the nominal exchange rate. Studies show that nothing is totally free of negative effects between the volatility of exchange rate and trading volume, but the price effect is ambiguous depending on the exporter and the importer in addressing the risk [6].

Although not explicitly stated, the international trade theory says that all economic agents are rational then they know the outcome based on their decisions. When the economy becomes more open, the output depends not only on individual decisions but also on other factors that can not be controlled by the agents. Thus, the decision-making process is not a causality of simple rational choice. Although the economic agents make a decision rationally, uncertainty condition probably cause the desired outcome to deviate. The increasing of exchange rate volatility induce uncertainty for the behavior of an impending exchange rate [7].

Taking the assumption that the utility of a firm depends on the real profit and does not measure the nominal profit. Firms are interested in taking profit not only through current contracts, but also future contracts. The contract's decision made by exchange rate observations and exchange rate volatility at the specific time. The argument assumes that uncertainty comes only from exchange rate volatility. Exchange rate uncertainty has considerable influence on export. Therefore, the determinants of real exports are real foreign revenues, real exchange rate, and the volatility of exchange rate. Exchange rate depreciation will increase the competitiveness of exported goods and will further boost exports. On the other hand, enormous volatility will increase the risk of exchange rate and reduce the stream of international trade [8].

Based on the above literature review, several studies had provided some empirical evidence. The volatility of exchange rate could have positive or negative relation to export depending on the exporters respond to exchange rate risk whether risk-averter or risk-lover. Studies conducted by several researchers indicate that exchange rate volatility has negative impacts on exports [1,5,6,7,8,9,10,11]. In other sides, some researchers found the positive relationship between exchange rate volatility and export [12,13].

2.2 The measurement of exchange rate volatility
Some researchers suggest that the measurement of exchange rate volatility using the moving average standard deviation (MASD). Firstly, this measurement introduced by Kenen and Rodick in 1986 [13]. It was followed by several researchers afterward. The measurement as follows:
\[ V_t = \left( \frac{1}{m} \sum_{i=1}^{m} (e_{t-i} - e_{t-2})^2 \right)^{1/2} \]  

From the equation, we can determine \( e \) is the log of exchange rates and \( m \) is the degree of moving average. The variable \( e_{t-1} \) is represented as a log value of the exchange rate of the one previous period. While the variable \( e_{t-2} \) is represented as a log value of the exchange rate of the two previous periods. The degree of moving average used in this study is 4 quarter period — the advantage of using this measurement because it can capture the high frequency of exchange rate movements in addition to knowing the pattern of smoothing of the data itself. Some authors have used this to smooth the movement of data.

3. Data, model specification, and panel data approach

3.1 Data

The data sources in this paper came from the Asian Development Bank Statistics. The data period covers from year of 2000 until 2016, it covers from 5 countries in South East Asia Region. They consist of Indonesia, Thailand, Singapore, Malaysia, and the Philippines. The data variable consists of real gross domestic product, real exchange rate, export, and relative price.

3.2 Model Specification

The model applied in this study, where exports are influenced by national income at a constant price, the volatility of the real exchange rate, and relative price. The model of export equation was originally developed by Hooper and Kohlagen [8]. Then the model of export equation was applied and developed by some researchers [7,11,13]. The model can be written as follows:

\[ \log(\text{EXPORT})_{it} = \beta_0 + \beta_1 \log(\text{GDPC})_{it} + \beta_2 \text{REPRICE}_{it} + \beta_3 \text{VOLEXRATE}_{it} + u_{it} \]  

The expected direction on the equation (2) is if the export volume increases then it is expected to increase the real pdp or \( \beta_1 > 0 \). The rising of domestic price ratio will cause the domestic goods to become less competitive so that the export tends to decrease then \( \beta_2 < 0 \). Based on the literature, the increasing of exchange rate volatility support the increase or decrease on exports, it depend on the willingness of exporters respond to risk factors from exchange rate, some literature states that the prediction of \( \beta_3 \) coefficient could be positive or negative. Then, the variable description of the model as follows:

| Variable   | Description                                                                                                                                 |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| EXPORT     | Dependent variable, this variable in the log form. It’s defined by the sales of goods and services produced by a country to another country. The export variable uses the real measured by multiplying the export value at the relative price. |
| GDPC       | Independent variable, this variable in the log form. It’s defined by the total value of the final goods and services produced country during a certain year. The GDP variable uses the real value as measured with the 2010 base year. |
| REPRICE    | The ratio of domestic prices to foreign prices. This ratio is calculated from the comparison the domestic consumer price index to the foreign consumer price index using the 2010 base year. |
| VOLEXRATE  | This variable is exchange rate volatility, which is calculated using the moving average standard deviation approach. Exchange rate is defined as the price of a currency compared to other currencies. The exchange rate in this study uses the real exchange rate as measured by multiplying the nominal exchange rate with the relative price. |

3.3 Panel data approach

The panel data regression model analysis has three approaches, consisting of the least squares approximation (known as pooled least square approach), fixed effect approach, and random effect
approach. In data panel, we use the repeated cross-sections over time [14,15]. Specifically, the three approaches can be described as follows:

**Pooled least square**, $y_{it} = \alpha + \beta_1 x_{it} + \varepsilon_{it}$, defined as the method by which each cross section has the behavior shown with the same intercept and slope parameters. This technique is similar to regression with time series or cross section data, but for panel data, the two data are combined then treated as a whole which is then estimated by Ordinary Least Squares. In this case, “country” represents the entities or panels (i) and “year” represents the time variable (t).

**Fixed effect**, $y_{it} = \alpha + \beta_1 x_{it} + \delta_i D_{it} + \varepsilon_{it}$, this approach allows for different values of different parameters between cross-section units or between times. The general form is to enter the dummy variable into the regression equation. In this case, “country” represents the entities or panels (i) and “year” represents the time variable (t). The variable D represents binary (dummies) that we have n-1 entities included in the model.

**Random effect**, $y_{it} = \alpha + \beta_1 x_{it} + \varepsilon_{it}$ where $\varepsilon_{it} = u_i + v_t + w_{it}$, for every $u_i \sim N(0, \delta_u^2)$ are cross section error components; $v_t \sim N(0, \delta_v^2)$ are time series error components; and $w_{it} \sim N(0, \delta_{w}^2)$ combination error components. This approach assumes that different parameters between regions and between times are included in the error. In this case, “country” represents the entities or panels (i) and “year” represents the time variable (t).

In the panel data analysis approach, we need to select the estimation method, some step to select the methods as follows:
- Choosing between pooled least squares vs fixed effect model
- Choosing between fixed effect model vs random effect model

Formally, we can test the best model between fixed effect model (FEM) or pooled least squares (PLS), where the PLS model is a restricted model where it applies the same intercept to all individuals besides the FEM is an unrestricted model.

We must decide between fixed effect or random effect. In this case, we run a Hausman test where the null hypothesis is the random effect and the alternative hypothesis is fixed effect. This test determines the unique errors are correlated with the regressors, while the null hypothesis are not.

### 4. Results and discussion

Based on table 2, it shows that the appropriate panel data analysis approach in this study is fixed effect model. From the first step, the test procedure related to pooled least squares model and fixed effect model, it gives the conclusion that we reject the null hypothesis or we do not reject the alternative hypothesis, in other words the model chosen is the fixed effect model. The second step, the test of Hausman gives the conclusion that rejects the null hypothesis or not rejects the alternative hypothesis, in other words, the selected model is fixed effect model.

From the output, we can prove that the volatility of exchange rate is negatively and significantly correlated with exports for the pooled least square model, whereas in the fixed effect model found that the volatility of exchange rate is still negative but not significant. The random effects model gives the finding that the volatility of exchange rate is positive but not significant. These findings support a previous study, it argues that the volatility of exchange rate have a negative effect on exports. Some previous researchers produced the same findings [1,5,6,7,8,9,10,11].

This findings support the argument that if the volatility of exchange rate is higher, it represents the cost from the side of risk-averse traders and it also decrease the foreign trade, so it made the unpredictable condition that cause by the volatility of exchange rates. In addition, the other impact for traders that their profit becomes diminishing and uncertain then the benefits of international trade will be decline in the long run.

We can also argue that if the volatility of exchange rate is higher, it represents the higher uncertainty of exchange rate fluctuations so that production costs to overcome uncertainty are increasing. This increase in volatility can increase the price of imported raw materials which many industry actors do besides they have expectations of profit from exports to be uncertain. This condition forces exporters to face high uncertainties especially in the case of expecting profits. For industry players are facing a surge in imported raw materials, the resulting product becomes more expensive so
that the product becomes uncompetitive for export. To avoid losses, the exporter reduces the demand for imports or in other words reduces exports, thus indirectly reducing the production rate. One of the efforts made by exporters to reduce losses is usually by diverting their original export sales to the domestic market.

Table 2. Regression results

| Dependent | Pooled Least Squares | Fixed Effect | Random Effect |
|-----------|----------------------|--------------|---------------|
|           | Coef. | Std. Error | Sig. | Coef. | Std. Error | Sig. | Coef. | Std. Error | Sig. |
| LOG(GDPC) | 0.197 | 0.034       | ***  | 0.750 | 0.071       | ***  | 0.675 | 0.070       | ***  |
| REPRICE   | -0.005 | 0.002      | **   | 0.002 | 0.001       | **   | 0.001 | 0.001       |
| VOLEXRATE | -7.403 | 3.411      | **   | 0.073 | 0.990       |     | 0.250 | 1.174       |
| C         | 10.152 | 0.335      | ***  | 3.075 | 0.731       | ***  | 3.867 | 0.838       | ***  |
| R-squared | 0.317 |            |      | 0.929 |            |      | 0.672 |            |
| Adjusted R- squared | 0.292 |            |      | 0.922 |            |      | 0.660 |            |
| F – Stat  | 12.545 |           |      | 143.755 |         |      | 55.282 |            |
| Prob F - Stat | 0.000 |            |      | 0.000 |            |      | 0.000 |            |
| N         | 85     |            |      | 85    |            |      | 85    |            |
| Cross Section F | 199.963 |         |      | Cross-section random |         |      | 12.243 |            |
| Prob      | 0.000 |            |      | Prob | 0.007       |      |

***: sig. $\alpha = 1\%$; **: sig. $\alpha = 5\%$; * sig. $\alpha = 10\%$

The relative price has a negative and significant sign for the pooled least square model and fixed effect model. This finding indicates that the final goods produced by the five countries are still less competitive and thus tend to lower exports. This, however, does not apply to some countries that are subject to studies such as Singapore. Besides, it is likely that most of the export components are still raw materials or not finished goods then the implication that if the product is produced by a country, it usually has no value-added.

For real gross domestic gross have a positive and significant sign for pooled, fixed effects, or random effects. The positive relationship shows that the higher gross domestic gross domestic product will increase the export of a country. As seen in the identity equation, the higher the export is a positive representation of the trade balance of a country, in other words there is an indication that exports are higher than imports so as to encourage gross domestic product. In addition, there is a conjecture that the five countries that are the object of study have a positive trade balance or higher export of imports. Besides, a positive relationship between gross domestic product and exports can also be interpreted as an increase in national income and prosperity of a country. This has an impact on the increase in people's purchasing power in a country.

5. Conclusions
From our results, we want to give the empirical findings on the relationship between the exchange rate volatility and exports. Previous literature says that the findings have the mixed evidence. This study founds that the volatility of exchange rate has negative impact on exports. The study recommends that the Reserve Bank for each country should have monitored consistently the volatility of exchange rate and try to keep at moderate level. This means that the central bank must have several policies in order
to create a stable and sustainable exchange rate that encourages an increase in real exports and the economy in a country.

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