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Exchange Rate Volatility and Export Volume: The Case of Indonesia and its Main Trading Partners

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Abstract:

This paper examines the impact of exchange rate volatility on Indonesia's export to-United States, Japan and China using both aggregate and disaggregate data.

We first estimated each pair country with export demand equations based on data from 1996 to 2014. A set of export demand equations is estimated by using Seemingly Unrelated Regression to characterized the correlation of the disturbances across equations.

In general, the estimation result shows that exchange rate volatility has negative impact on export. Estimations based on disaggregate data indicate that the impact of the exchange rate volatility on exports remains negative however it varies among industries in the countries under investigation.

Keywords: *exchange rate volatility, export, Indonesia, SUR*

JEL Classification: *F3*

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Introduction

The impact of exchange rate changes on international trade has long been the concern of economists, analysts and policymakers. Countries that have adopted the free floating exchange rate (FFE) regime with open capital accounts are likely to experience tremendous fluctuations. In the literature, the question of whether this increase in exchange rate volatility has a positive or negative effect on the volume of international trade remains unclear. Some researchers argue that an increase in exchange rate fluctuations will reduce the volume of exports. According to this view, fluctuating exchange rates are a risk to both importers and exporters. The risk adverse exporter chooses to delay or not to export goods abroad until the exchange rate returning stable. As a result, increased exchange rate volatility reduces international trade flows. Dreamer (1991) shows that the negative relationship between exchange rate volatility and trade flow is not limited to risk adverse exporter. Even in some empirical studies it is asserted that fluctuating real exchange rates have a detrimental effect on the volume of trade over time. In contrast to previous views, Frankel (1991) argued that exchange rate volatility could have positively impact on export volumes for risk-neutral companies.

The results of the analytical model development show that risk neutral companies enter the market faster or will soon leave the market when exchange rate volatility and trading volume increases. The result of the empirical model estimation shows that when the volatility increases, risk neutral companies enter the earliest markets and then exit the export market when the growth of the company's output grows slower than the growth of net cash flow and transaction advantage-exchange rate volatility

While at the theoretical level, some researchers are trying to develop hypothetical behavioral models of how firms respond when unexpected exchange rate changes occur resulting in exchange rate volatility. In empirical studies a lot of effort has gone into using different approaches and data to ascertain whether volatility of exchange rate has impacts on trading volume. Unfortunately, the results of this study provide diverse conclusions. Some are inconclusive, some are insignificant and others are contrary to expected results.

This study examines whether exchange rate volatility influences Indonesia's exports to its major trading partners, namely the United States, Japan and China, during the period 2000 to 2014. We focus on the particular industries that contribute the most to Indonesia's total exports with its trading partners namely HS15, HS27, HS38, HS40, HS44 and HS47. Identifying sub-sectors or commodities that are very sensitive to such exchange rate movements will help the monetary authorities in maintaining macroeconomic balance. Our study ties with a number of recent studies (Broda and Romalis, 2004; Clark *et al.*, 2004; Tenreyto, 2004; Byrne *et al.,* 2007; Vovchenko *et al.,* 2017; Thalassinos and Politis 2012; Thalassinos *et al.*, 2010; 2012; 2015; Suryanto and Ridwansyah, 2016; Fetai, 2015; Carstina *et al.*, 2015;

Miller and Choi, 2014; Anureev, 2017; Rupeika-Apoga and Nedovis Uraev, 2015) that have argued that exchange rate volatility have negative impact on trade. In their studies they estimated bilateral trade equations for each industry based on OLS regression or panel. However, estimating the parameter of the regression in single regression model would be biased and inefficient due to the fact that one or more of the assumptions of homoskedasticity and non-correlation of regression errors has failed. The failure of homoscedasticity in standard regression model, lead the OLS estimator being inefficient, though it is still a consistent estimator.

There are two leading approaches suggested in the literature. The first is to obtain robust of the standard error regression coefficients without assumption about the functional form of heteroskedasticity. The second approach seeks to model the heteroskedasticity and to obtain more-efficient FGLS estimates. In the panel regression model, as discussed in Baltagi (2005), fixed effect model assumes that the existence of endogeneity, that is correlation between the error and the regressor, is a central issue in econometrics. With endogeneity the OLS estimate becomes inconsistent. The use of variable IV allows obtaining results of regression parameter estimates to be consistent. Byrne *et al.* (2007) using a fixed effect model to elaborate on the two types of errors derived consistent results from cross-sectional and period effects. Their approach is to use the IV method to elaborate fitted value taking from AR (n) regression of the exchange rate volatility exchange. The fitted value resulted from the regression is used in their model specification.

Our approach extends Byrne et *al.* (2007) recognizing the endogeneity of the right-hand side regressor and the disturbance. We exploit this endogeneity as importance identification device that allow us to identify the relationship between export and exchange rate volatility. In this case, Zellner's (1962) seemingly unrelated regressions (SUR) approach is suitable to our model since it captures the efficiency due to the correlation of the disturbances across equations in time series or cross section data. We focus on the estimation of a set of SUR equations with panel data. We adopted Avery (1977) to consider the SUR model with error component disturbances. Admittedly, our test for the effect of exchange rate volatility on export relies on the presence of heteroskedasticity and correlated across equation for a given individual but uncorrelated across individuals in the system of linear regressions.

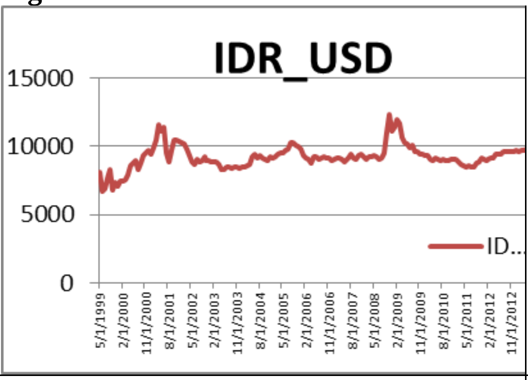
Applying our approach to three dataset over the 1996-2014, we find that exchange rate volatility have negative impact on export. Estimations based on disaggregate data indicate that the impact of the exchange rate volatility on export remains negative however it varies among industries in the countries under investigation.
The remainder of the paper is organized as follows: In Section 2 we explain a brief overview of exchange rate regime and export -Indonesia's experiences. In Section 3 we explain the methodology. Estimation results are discussed in Section 4. Section 5 concludes the article.

Exchange Rate Regime and Export-Indonesia's Experiences

Since the 1980s, Indonesia had adopted managed floating exchange rate (MFE) regime with open capital account. In this era of MFE and financial liberalization, the central bank have multiple objectives. Apart from controlling the inflation, Central Bank is also functioned as an enhancement for the economic growth, as well as increasing the work opportunity (Allegret *et al.*, 2016; Xanthopoulos, 2014).

However, when the Asian Crisis occurred in 1997-1998, Indonesian economy had experienced drastic changes in the macroeconomic environment followed with structural adjustment in its dynamic political atmosphere. The impact on its changes had thrust Bank of Indonesia to conduct adjustments from MFE to floating exchange rate and this is indicated in the Central Bank Law in 1999. The law underlines that Bank of Indonesia must be independent, single objective and well-prepared towards ITF. This single objective is in the sense that achieving and maintaining the stability of the local currency rupiah. The stability of the local currency contains two aspects, namely the stability of the currency against goods and services, as well as the stability of the currency against the currencies of other countries. In July of 2005, the Central Bank officially adopted ITF. Through the ITF policy, Bank of Indonesia was more focused on controlling or price stability (inflation) as its final target. Central Bank (*de facto*) has adopted the floating exchange rate regime. Nevertheless, it was for price stability and financial system reasons. Regularly the Central Bank can conduct an intervention in the exchange rate market indirectly by using monetary instruments that are available. The Bank of Indonesia implements exchange rate policies to reduce excessive exchange rate volatility, not to redirect the exchange rate to a certain level. As shown in Figures 1a and 1b the rupiah exchange rate against the US dollar fluctuated throughout the observation period. However, its volatility declined after Bank of Indonesia enacted its ITF policy in July 2015. On the other hand, Indonesia's total export growth rate to US, Japan and China experienced continuous fluctuation.

Figure 1a



Source: *Bloomberg*

Figure 1b

Source: *CBS*

Data and Methodology

The study uses monthly data Indonesia's exports to major trading partners, the United States, Japan and China for the period 1996-2014. The share of exports of the three main trading partners is reached almost 38% of Indonesia's total exports. Data exports as a total of each sector are breakdown into disaggregate data to a two-digit HS classification (Table 1).

Table 1. *Harmonisation Codes and its explanations*

Codes	Description
HS 15	animal or vegetable oil/fats and their cleavage products; prepared edible fats; animal or vegetable
HS 27	Mineral fuels, mineral oils and product of the distillation
HS 38	Miscellaneous chemical product
HS40	rubber and articles there of
HS 44	wood and article of wood; wood charcoal
HS 47	pulp of wood or other fibrous cellulosic, recovered (waste scrap) paper

Export data sourced from the Bureau of Statistics. Monthly Industrial Production Index data and daily data for the exchange rate are from Bloomberg. Monthly volatility data are calculated from the daily exchange rate for the period 1996 -2014.

Model specification

We specify the model of export demand function in log linear specification as follows:

$$LX_{ijt}^{k} = \beta_0 + \beta_1 LIP_t^k + \beta_2 LREER_t + \beta_3 LTOT_t + \beta_4 LV_t + \varepsilon_{it} \qquad (1)$$

Where

LX_{it}^{k} is the volume of industry- i exports of good and services (in domestic currencies deflated unit value of exports) from county j to k, LIP_t^k is Industrial Production Index for country *k*, *k*=USA, Japan, and China, $REER_t$ is Real Effective of Exchange Rate (as measure of one countries' competitiveness that may reflect country's exchange rate policy, $LTOT_t$ is term of trade (a price index measured as export prices is divided by import prices period t), LV_t is exchange rate volatility proxy for period t, all variables measured in natural logarithm. β_1 and $\beta_2 > 0$ and $\beta_3 < 0$, β_4 is uncertain.

Econometric Implementation

Our model attempt to relate the export in each industry-i as the dependent variable depends on the same regressors which are LIP_t^k , LIP_t^k , $LTOT_t$ and LV_t. In econometric literature, see Baltagi (2005), estimating the parameter of the regression would be biased and inefficient due to the correlation of the disturbances across equations. Verbon (1980), applies the SUR procedure with one-way error components to a set of four demand equations. He extends the above error component specification to allow for heteroskedasticity in the individual effects modeled as a simple function of *p* time-invariant variables.

In the panel regression model, as discussed in Baltagi (2005), Fixed Effect assumes the existence of endogeneity that is correlated with the error and the regressor. This is a central issue in econometrics. Endogeneity in OLS estimates creates inconsistence. The use of variable IV allows obtaining results of regression parameter estimates to be consistent. Bryne *et al.* (2007) using a Fixed Effect model to elaborate on the two types of error derived from cross-sectional and period effects. Their approach is to use the IV method to elaborate fitted value taking from AR (n) regression volatility in exchange rates are then fitted value included in the model to be estimated. Breusch and Pagan (1979) argued that LM test is used in the case of heteroschedasticity.

In our study, we follow their approach to set of the export demand equations using data from several sources i.e. Central Bureau of Statistics, Central Bank of Indonesia and Bloomberg. The data cover six industries (based on HS classification), over monthly observations covering the period of 1980- 2013. Our data consist of four sets of variables, namely Indonesia's export to United States, Japan and China, bilateral exchange rates, industrial production's index, real effective exchange rate, term of trade data and exchange rate volatility. A variety of different methods for measuring exchange rate volatility have been developed by researchers. The widely used approaches are based on the difference between spot and forward rate (Thursby and Thursby, 1985). In this approach, exchange rate volatility is calculated from the average percentage change in the spot rate at period t. Our study follows their approach to measuring the volatility of the bilateral exchange rate between rupiah currency against the US Dollar, Yen, and Renimbi.

Estimation Results

Our estimation approach is based on the following determinants of exports.

$$\boldsymbol{LnX_{ijt}^{Ind\_US} = f(\,LIP_{ijt}^{US},\ LREER_{ijt}, LTOT_{ijt}^{Ind_{US}}, LV_{ijt})} \tag{2}$$

Where,

LX_{it}^{Ind-US} is the volume of sector- i exports of good and services (in Dollar currencies deflated unit value of exports) from Indonesia to US, LIP_t^{US} is

Industrial Production Index for US, $REER_t$ is Real Effective of Exchange Rate (as measure of one countries' competitiveness that may reflect country's exchange rate policy, $LTOT_t$ is term of trade (a price index measured as export prices is divided by import prices), LV_t is exchange rate volatility proxy , all variables measured in natural logarithm.

The application of SUR considered in this study involves eight dependent variables that are the logarithm of aggregate export (total) Indonesia to USA (Lxtotal), logarithm of export total of commodity in HS15, HS27, HS58, HS40, HS40, HS47 classification, and logarithn of the Lxtotal minus total of the six industries.

The parameters of the SUR model are estimated by using the sureg command in Stata. We estimate the correlation matrix for fitted residual that is used to form a test of the independence of the error of the eight equations. In the case of US, for dependent variable lxtotal, lx4, lx7, we have R-square = 0.79, 0.77, and 0.73, respectively. All test joint significance of all regressors in the equations are significant except for lx2 (for USA), (see Tabel 2a, coloum 1). Table 2a, column 2 and 3 presents similar to the US however this is a case for Japan and China. For dependent variable lxtotal , lx2, lx4, lx7 we have R-square = 0.80, 0.74, 0.83 and 0.75 respectively. All Test joint significance of all regressors in the equations are significant.

The result in Table 2b, presents the estimated coefficient of the model. As we can see in this Table, most volatility variables are statistically significant at 5% significaance level. The volatility variables generally have a negative impact on export. The final result shows the correlation matrix for the fitted value of residuals. The error in these seven equations are calculated by using the Breusch-Pagan Lagrange multiplier test for independence. The calculation of Chi^2 with 28 degrees of freedom yields 358.163 with Probability = 0.0000. This indicates statistically significant correlation among the error in these seven equations as expected due to the seven industrial outputs that may have similar underlying determinant.

Table 2a. *Seemingly Unrelated Regression Results*

	Indonesia-USA	Indonesia-Japan	Indonesia-China
LX Total			
lip	0.0284**	0,0111	0,3168***
tot	0,0144***	0,0219***	0,0305***
lreer	0,0244	0,3911***	0,2104
lvol	-21,388***	-24,2848***	-600703***
cons	17,708***	16,3004***	10,7197***
LX_1			
lip	0,3191	0,2361**	0,5965***
tot	-0,0494*	-0,04124**	0,0609***
lreer	0,7801	1,1809**	0,5661*

lvol	-45,193***	-50,2920***	-88,8122***
cons	5,6853*	1,7112	2,3878**
LX_2			
lip	-0,0081	-0,0001	0,2853**
tot	0,0505*	0,0259***	0,0369***
lreer	-0,2482	0,4124***	1,1062***
lvol	-8,752	-26,5619***	-63,4619***
cons	17,279***	15,2490***	5,2612***
LX_3			
lip	-0,0569	0,0131	0,6690***
tot	0,0000	0,0045	0,0165
lreer	-0,3010	0,5436***	-1,5186***
lvol	-52,321***	-13,5022***	-91,3268***
cons	9,777***	10,8136***	9,1577***
LX_4			
lip	0,1640***	-0,0032	0,9305***
tot	0,0190***	0,0682***	0,0555***
lreer	0,9089***	1,2464***	0,9841***
lvol	-36,146***	-64,7988***	-100,5827***
cons	9,5091***	3,6919**	-2,6787**
LX_5			
lip	0,0857***	0,0228	0,2254**
tot	-0,0141***	-0,0220***	-0,0328***
lreer	0,1547*	0,8951***	-0,0855
lvol	15,8355***	16,5752***	-2,7692
cons	18,3413***	16,2890***	16,4471***
LX_6			
lip	-0,4799	-0,0255	-0,0272
tot	0,1204	0,0636***	0,0483***
lreer	-3,0110*	0,8749*	-0,2938
lvol	112,1183***	-38,3713***	-54,222***
cons	32,9328***	6,2567***	11,6530***
LX_7			
lip	0,0101	0,0258*	0,3682***
tot	0,0158***	0,0234***	0,0340***
Lreer	- 0,0129**	e0,1555**	-0,3461**
Lvol	-21,150***	-25,3315***	-59,4851***
cons	18,187***	16,2499***	12,0167***

****,**,*denotes rejection of the null hypothesis at 1%,5%, and 10% level of significance.*

Conclusion

This paper examines the impact of exchange rate volatility on Indonesia's export to- United States, Japan and China using both aggregate and disaggregate data (Appendix). We first estimated each pair of countries' export demand equations based on data from 1996 to 2014. A set of export demand equations is estimated by using Seemingly Unrelated Regression to characterized the correlation of the disturbances across equations. In general, the estimation result shows that the exchange rate volatility has negative impact on exports. Estimations based on disaggregate data indicates that the impact of the exchange rate volatility on exports remains negative, however it varies among industries in the countries under investigation.

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Appendix

Table 1. Seemingly Unrelated Regression Results

Indonesia - China

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
lxtotal	216	4	.3413917	0.8617	1346.18	0.0000
lx1	216	4	.7925724	0.7239	566.45	0.0000
lx2	216	4	.5193706	0.7843	785.23	0.0000
lx3	216	4	.8700564	0.6612	421.46	0.0000
lx4	216	4	.8588976	0.7612	688.34	0.0000
lx5	216	4	.426405	0.1541	39.36	0.0000
lx6	216	4	.8364102	0.4043	146.59	0.0000
lx7	216	4	.3869027	0.8084	911.21	0.0000

Indonesia-USA

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
LxtotalUS	216	4	.1484602	0.7879	802.31	0.0000
lx1US	216	4	2.010025	0.1866	49.56	0.0000
lx2us	216	4	1.671823	0.0196	4.32	0.3645
lx3us	216	4	.76645	0.4846	203.08	0.0000
lx4us	216	4	.3182812	0.7770	752.59	0.0000
lx5us	216	4	.2219548	0.4866	204.70	0.0000
lx6us	216	4	4.634792	0.2013	54.45	0.0000
lx7us	216	4	.1638465	0.7310	587.05	0.0000

Indonesia-Japan

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
lxtotalj	216	4	.1810999	0.7978	852.51	0.0000
lx1j	216	4	1.276284	0.3683	125.94	0.0000
lx2j	216	4	.234047	0.7350	599.03	0.0000
lx3j	216	4	.3078215	0.4031	145.85	0.0000
lx4j	216	4	.4472663	0.8269	1031.97	0.0000
lx5j	216	4	.2500489	0.4378	168.24	0.0000
lx6j	216	4	1.291694	0.1765	46.30	0.0000
lx7j	216	4	.2037336	0.7447	629.97	0.0000

Indonesia-China

Correlation matrix of residuals:

	lxtotal	lx1	lx2	lx3	lx4	lx5	lx6	lx7
lxtotal	1.0000							
lx1	0.6156	1.0000						
lx2	0.7563	0.2893	1.0000					
lx3	0.4823	0.2089	0.2538	1.0000				
lx4	0.6303	0.4695	0.3297	0.4040	1.0000			
lx5	0.2084	0.0229	0.0314	0.2151	-0.0551	1.0000		
lx6	0.4060	0.2539	0.1556	0.2461	0.0769	0.0950	1.0000	
lx7	0.8193	0.5613	0.4138	0.5398	0.6306	0.3181	0.2989	1.0000

Breusch-Pagan test of independence: chi2(28) = 1020.698, Pr = 0.0000

Indonesia-Japan

Correlation matrix of residuals:

	lxtotalj	lx1j	lx2j	lx3j	lx4j	lx5j	lx6j
lxtotalj	1.0000						
lx1j	0.1813	1.0000					
lx2j	0.9136	0.1137	1.0000				
lx3j	0.3080	0.0986	0.2559	1.0000			
lx4j	0.6773	0.1035	0.6031	0.4132	1.0000		
lx5j	0.0357	0.1203	0.0098	0.0132	-0.3378	1.0000	
lx6j	0.1077	-0.0421	0.1119	0.0139	0.1405	0.0195	1.0000
lx7j	0.7936	0.1996	0.4993	0.2724	0.6034	-0.1128	0.0605

	lx7j
lx7j	1.0000

Breusch-Pagan test of independence: chi2(28) = 778.543, Pr = 0.0000

Breusch-Pagan test of independence: chi2(28) = 358.163, Pr = 0.0000

Indonesia - USA

Correlation matrix of residuals:

	LxtotalUS	lx1US	lx2us	lx3us	lx4us	lx5us
LxtotalUS	1.0000					
lx1US	0.1162	1.0000				
lx2us	-0.0875	0.0141	1.0000			
lx3us	0.2340	0.1364	-0.0646	1.0000		
lx4us	0.4943	0.1879	-0.1287	0.2669	1.0000	
lx5us	0.2146	0.0873	0.0142	0.0132	0.0244	1.0000
lx6us	0.1058	0.0354	0.0114	-0.1399	0.0008	0.2042
lx7us	0.9369	-0.0031	-0.1989	0.1755	0.2919	0.1540

	lx6us	lx7us
lx6us	1.0000	
lx7us	0.0795	1.0000

Breusch-Pagan test of independence: chi2(28) = 358.163, Pr = 0.0000