

# Exchange Rate Pass-through to Import Prices in Indonesia

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**Submission date:** 12-Feb-2024 01:42PM (UTC+0700)

**Submission ID:** 2292633854

**File name:** Exchange\_Rate\_Pass-through\_to\_Import\_Prices\_in\_Indonesia.pdf (575.12K)

**Word count:** 4336

**Character count:** 22383



## 2 Exchange Rate Pass-through to Import Prices in Indonesia: Evidence Post Free Floating Exchange Rate

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### 4 ABSTRACT

The aim of this research was to examine the interdependence between import price, exchange rate, national income and inflation. The data analysis method used was structural vector autoregressive. The analysis was conducted on the impulse response function and forecast error variance decompositions (FEDVs) to determine the effect of exchange rate to import price and national income. The results show that the degree of exchange rate pass-through was incomplete. The exchange rate shock had positive effect on import price and had negative effect on national income. Meanwhile, the effect of inflation on import price was negative. Furthermore, FEDVs analysis show that the variations of import price were largely determined by the import price, and the exchange rate variations were largely determined by the exchange rate itself. The research results show that exchange rate, national income and inflation were gradually getting stronger and gave permanent effects.

**Keywords:** Import Price, Exchange Rate, Structural Vector Autoregressive

**JEL Classifications:** E6, F4

## 1. INTRODUCTION

28  
One of the important issues in international economy is the relationship between exchange rate movements and changes in the price of traded goods. The effect of exchange rate change on domestic price change is known as exchange rate pass-through (ERPT). When there is depreciation to the exchange rate of a domestic currency against foreign currencies, it will cause a rise in inflation as a result of the process of pass through effect. Sahminan (2002) and An (2006) state that exchange rate change is transmitted to domestic price through three channels; imported goods consumed, imported intermediate goods, and domestic goods in foreign currency prices.

From many studies on ERPT, there was no uniformity regarding the definition of pass through. Some researchers focused on the relationship between the changes in exchange rate to import price (Champa et al., 2005; Parsley, 2003), and some other researchers linked the changes in exchange rate with consumer price index (Bouakez, 2008; Beirne, 2011; Takhtamanova, 2010). From the researches, the ERPT working through consumer price index is

36  
usually less sensitive to the changes in exchange rate due to the consumer price index in it including non-tradable goods (Ghosh and Rajan, 2009).

Many studies on ERPT have been conducted, but they were mostly conducted in developed countries, such as Europe, America and Japan. The researches conducted in Europe were the researches of Bacchetta and Wincoop (2003) and Beirne and Bijterbosch (2011). Then, the researches of ERPT in America were conducted by Rowland (2004) and Vigfusson et al (2007). The analysis tools used were the ordinary least squares and the vector autoregressive (VAR). The collective evidence, in general, can be summarized as follows; first, the degree of ERPT is incomplete. The degree of ERPT for import price has a higher degree than the ERPT using consumer price. Second, in general, there is a tendency that the decrease of ERPT since the 1990s has occurred due to a decrease in the inflation rate achieved by developed countries.

However, the studies on ERPT in developing countries have not been conducted. Although there are not many of them, the research results on ERPT in developing countries tend to have the similar

characteristics to that in developed countries. The research had ever been conducted by Hakura who showed the degree of ERPT to inflation was zero for the countries of Singapore, Bahrain, and Finland. In line with the research of Hakura, Ito and Sato (2006) examined Asian countries including Thailand, Korea and Indonesia. The research results show that the degree of ERPT in Asian countries was low when measured by consumer price index, but it was higher when measured by import price.

As a country that adheres to an open economy, Indonesia's economy is strongly affected by exchange rate movements. The exchange rate movement of Rupiah can not be separated from the dynamics in the external and domestic macro economy. The financial crisis in 1997 made the government of Indonesia reconstruct the implementation of monetary policy by applying free floating in Indonesian exchange rate. Not long after wards, Indonesia adopted the inflation targeting regime in 2000.

The drastic changes in monetary policy caused the changing policy implications in Indonesia. After embracing free floating, the exchange rate volatility increased higher than before embracing free floating. At the same time, foreign currency reserves decreased and the interest rates rose. The inflation in Indonesia dropped very quickly after the application of the new monetary policy, and Indonesiawas also increasingly open to international trade.

The higher the volatility of the exchange rate, it will have the effect on the changes in domestic prices in Indonesia. Based on the research of Deverux and Lane (2001), ERPT in developing countries is higher than that in developed countries. In line with this, this study examined how the ERPT in Indonesia and how the shock of the exchange rate to import prices in Indonesia.

The aims of this research was to measure the degree of exchange rate changes to domestic price in Indonesia and to measure the shock of exchange rate, national income and inflation to import price in Indonesia.

## 2. LITERATURE REVIEW

After the 1990s, the ERPT was one of the important issues in the study of international economics. ERPT is defined as the impact of exchange rate changes on domestic prices. To test ERPT, it can be denoted as follows (Knetter, 1997).

$$\pi_t = \beta_0 + \beta_1 e_t + \beta_2 x_t + \varepsilon_t \quad (1)$$

Where:  $\pi_t$  is domestic price,  $e_t$  is exchange rate, and  $x_t$  is other control variable. The research on ERPT focuses on price adjustment on exchange rate changes ( $e_t$ ) for the transactions among importing countries. Based on the equation (1), the coefficient of  $\beta_1$  indicates the coefficient of pass through.

ERPT is generally divided into two phases: In the first phase, it analyzes the changes in exchange rate to import prices and, in the second stage, it analyzes the changes in import price to consumer prices. However, in general, many studied the direct exchange rate of pass-through to consumer prices.

Sanusi (2010) examined the effect of exchange rate changes on consumer prices in Ghana by using the methods of structural VAR (SVAR). The research results showed that the pass through of exchange rate to consumer prices is incomplete and high. It indicated that the depreciation of exchange rate is an important source of inflation in Ghana. By using the variance decomposition analysis, it showed that monetary expansion is more important than exchange rate in explaining inflation. One implication of the policy was that the decreasing of inflation in Ghana should be focused on monetary policy and exchange rate stability.

Sek and Kapsalyamova (2008) examined the ERPT to domestic prices using the method of SVAR and single equation approach in four countries in Asia after the crisis of 1997. The results showed that the degree of ERPT is incomplete. The highest degree of ERPT is in import prices, the second highest is producer price index, and the lowest is consumer price index. The impact of import price shock is greater than the exchange rate shock in the domestic price movements in the four countries studied. Economic disclosure has weak effect on the degree of ERPT.

Adeyemi and Samuel (2013) examined the ERPT to consumer prices in Nigeria using the method of SVAR. The results showed that the ERPT has the great effect on inflation in Negeria. In Nigeria, it was found that exchange rate plays bigger role than the amount of money circulating in the rise in inflation.

Zorzi et al. (2007) examined the ERPT in 12 countries of emerging market in Asia, Latin America, Central Europe and Eastern Europe using the method of VAR. The results showed that ERPT degree is greater in developing countries than that in developed countries by using import and consumer prices. It was also found that there was a positive association between the degree of ERPT and inflation. Besides, the results also showed positive association between import openness and ERPT.

## 3. METHODS

### 3.1. Data

The data used in this research was the secondary data published by the Central Bureau of Statistics, the Bank of Indonesia and the International Financial Statistics. The data used was quarterly time series from the year of 1997.3 to 2013.4. The import price (LP) data is the data of import price index in Indonesia. The exchange rate data (LS) is the exchange rate against the US dollar. The national income data is the data of real gross domestic product (LY) to the base year of 2005. In analyzing the data, the data were then transformed in the form of log.

### 3.2. Data Analysis Method

In this study, the data analysis was conducted in a simultaneous way which was intended to determine the association among the variables used in the study. The method used to determine the interdependence was the method of SVAR.

The main objective of SVAR estimate is to obtain non recursive orthogonalization error term for the analysis of impulse responses, whereas the alternative recursive orthogonalization of

Cholesky requires to include sufficient restriction for identifying orthogonal error term. An endogenous variable vector with  $k$  elements is denoted by  $y$ , and the residual covariance matrix is  $\Sigma = E[e_t e_t']$ , then the model of SVAR can be written as follows:

$$Ae_t = Bu_t \quad (2)$$

Where  $e_t$  and  $u_t$  is a vector with the length of  $k$ ,  $u_t$  is the residue that can be observed (reduced form),  $u_t$  is the unobserved structural innovation.  $A$  and  $B$  are the estimated matrices of  $k \times k$ . Structural innovation was assumed to be orthogonal, the matrix covariance is identity matrix,  $E[u_t u_t'] = I$ . the assumption of orthogonal innovations included the restriction identification of  $A$  and  $B$ .

$$A \Sigma A' = B B' \quad (3)$$

In the analysis of the VAR, the steps taken are:

### 3.3. Data Generating Process (DGP)

Before going into the analysis stage of VAR model, DGP has to be previously conducted. This is important because in the model of multivariate time-series the data mostly used contains the unit root that will make the estimation become false (spurious regression) (Gujarati, 2004). The stages in DGP prior to the analysis by modeling include data stationary test, cointegration test and lag length test.

Stationarity test is conducted using Augmented Dickey-Fuller (ADF). The test using ADF is divided into three, i.e.: ADF by involving constants (C, n), ADF which involves constant and time trend (T, n), and ADF which does not involve constant and time trend (N, n).

The determination of lag length is an important thing to do in the model of VAR Structural because SVAR model (continued development of VAR model) is very sensitive to lag length (Enders, 2015).

The determination of optimal lag can be used to set the value of lag based on the test of Akaike Information Criteria (AIC) and Schwarz Information Criterion (SIC) which result in minimum value. In order to determine optimal lag, it can also be conducted by comparing the highest value of Adjusted  $R^2$  among the existing candidates (Enders, 2015).

## 4. RESULTS AND DISCUSSION

### 4.1. Data Stationarity

The important issue in the analysis of time series data is the problem of data stationarity. The procedure to test the data stationarity in this research used the ADF test.

Table 1 shows the result of data stationarity. The tests of unit root show that the ADF critical value by the level of confidence of 5% is  $-2.9036$ . Thus, the count statistics that indicates the number exceeding critical value are exchange rate, output and inflation, while the import price variable is lower than the critical value. Therefore, the null hypothesis stating that unit root is present can not be rejected or the variable of import price is not stationary.

From these results, the unit root test was continued at first difference to check if the variable integrate in the same degree. The testing of unit root in the level of first difference showed the critical value of the ADF with the level of confidence of 5% is  $-2.9041$ . The value of count statistic of the variable of import prices, exchange rates and GDP based on the ADF test has greater value than the critical value of ADF. Based on the ADF test, the test of null hypothesis stating the existence of unit root is rejected. The results show that the variables of import prices, exchange rates, GDP and inflation are stationary at the level of first difference so that the data are cointegrated in Grade 1, I(1).

Further testing was the cointegration test using Johansen test of cointegration to test the long-term relationship in the analysis using SVAR. The interplay can be seen from the cointegration occurred in the variables. When there is a cointegration among variables, the interplay runs thoroughly and the information is spread in parallel.

The steps of cointegration test in this research were started by testing the null hypothesis stating the absence of long-term relationship among the variables. The testing was conducted by comparing the value of trace statistic with the critical value at  $\alpha$  of 5%.

Table 2 shows the result of cointegration test. Based on the method of Johansen test of cointegration, it appears that the trace statistic is greater than the critical value, so it can be concluded that the variables of LP, LS, LY and INF in the long term are mutually cointegration.

The estimation of SVAR model was begun by determining the optimal lag length. The determination of the optimal lag length is important for modeling SVAR. When the determined optimal lag is too short, it does not seem to be able to explain the dynamics of the model as a whole. On the other hand, when the optimal lag is too long, it will result in an inefficient estimation due to the reduced degree of freedom (especially in the models with small samples).

Table 1: Unit root tests

Variable	Degree	ADF	Conclusion
LP	Level	-2,1468	I(1)
	First difference	-10,0601	
LS	Level	-4,7410	I(1)
	First difference	-6,3470	
LY	Level	-4,5555	I(1)
	First difference	-5,9783	
INF	Level	-3,0657	I(1)
	First Difference	-5,6800	

ADF: Augmented Dickey-Fuller

Table 2: Cointegration test

Hypothesized Number of CE (s)	Trace		0.05	
	Eigenvalue	Statistic	Critical value	P**
None*	0.387318	40.25382	24.27596	0.0002
At most 1	0.098090	8.899637	12.32090	0.1750
At most 2	0.035182	2.292226	4.129906	0.1535

The determination of the optimal lag length can use several criteria, such as the methods of AIC and Schwarz Information Criteria (SIC), Hanan-Quin Criteria (HQ), likelihood ratio and final prediction error.

Based on the testing of optimal lag length in Table 3, it appears that based on the criteria of AIC and HQ, the optimal lag length is 4.

### 4.2. Impulse Response

The analysis of impulse response functions International Financial Reporting Standards (IFRS) is the core of the analysis of SVAR model. The estimation to IFR was conducted to examine the impact of shocks on the variable of innovation and the other variables. The estimation using the assumptions of each innovation variable is not correlated with one another so that the searches for the effect of a shock may be direct.

The IFR shows how the variables used in future study respond to the exchange rate shock. The IRFs analysis in this section tracked the impact of exchange rate shocks (LS) on the variables of import price (LP) and national income (LY). The IFRS analysis was conducted to innovation by increasing the value of exchange rate variable of one standard deviation at the beginning of the period resulting in quarterly changes over a period of ten quarters or 2½ years. The selection of ten quarter was expected to be relatively precise to observe the changes in the variables of price (LP) and national income (LY) to the shock innovation of exchange rate.

The figure of impulse response shows the response of a variable due to the shock of the other variables for some periods after the shock. When the images of impulse response show the movement which is getting closer to balance (convergence) or returns to the previous equilibrium, it means that the response of a variable due to the shock does not leave permanent effect on the variables.

Figure 1 shows that the observation of the effects of responses received by import prices due to the shock of exchange rate over ten quarters. At the beginning of the period, the price response due to the shock of exchange rate was very small. Then, the price response increased until the second quarter. However, after the second quarter, the price response to exchange rate change was relatively constant, but do not indicate the nature of convergence. It shows that the shock of exchange rate to exchange rate is relatively permanent.

Figure 2 shows the output response import prices to output. At the beginning of the period, the import price response to output was very small. After passing through the second quarter, it slightly increased. However, the response of import price to output had a tendency not to be convergent until the tenth quarter.

Based on the observations from the figure of impulse response, the variables of import prices and output show that the equilibrium is not convergent, and it indicates that the adjustment process takes a long time.

The response of import price variable to inflation shock can be seen in Figure 3. At the beginning of the period, the price response due to the exchange rate shock was very small. Furthermore, the price response decreased until the fourth quarter. After that, import price slightly increased. However, the general tendency until the tenth quarter, the response of import price to the shock of inflation variable decreased.

### 4.3. Variance Decomposition

IFR aimed to explore the impact of a variable response caused by the shock of other variables assumed that the variables of innovation were not mutually correlated. In fact, the innovation variables were correlated so that the shock impacts could not actually be seen individually to a variable.

Figure 1: Response of import prices to exchange rates

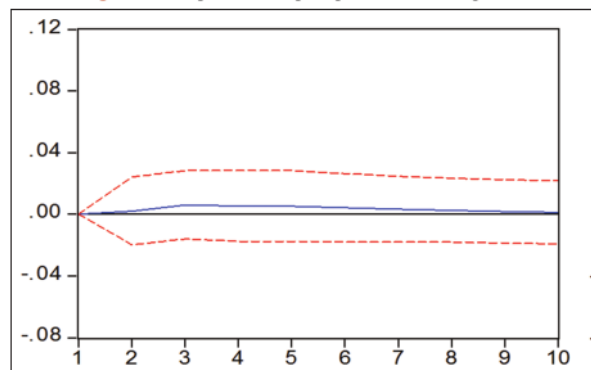


Figure 2: Response import price to output

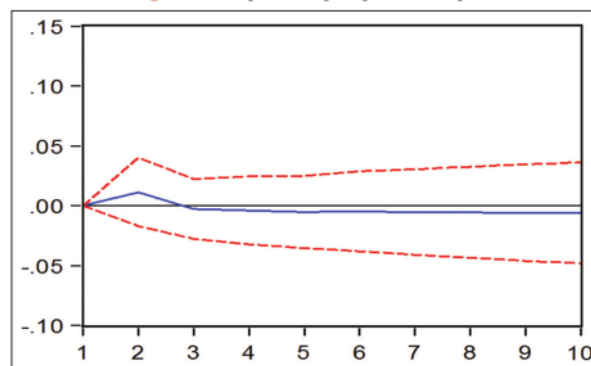


Table 3: Lag length

Lag	LogL	LR	FPE	AIC	SC	HQ
0	122,5465	NA	4,51e-06	-3,795128	-3,693074	-3,754990
1	260,5780	258,5352	7,51e-08	-7,891366	-7,483150*	-7,730813
2	274,5841	24,89972	6,42e-08	-8,050290	-7,335911	-7,769321
3	282,6874	13,63414	6,64e-08	-8,021823	-7,001283	-7,620440
4	302,2081	30,98524*	4,80e-08*	-8,355814*	-7,029111	-7,834015*

FPE: Final prediction error, LR: Likelihood ratio, AIC: Akaike information criteria, HQ: Hanan-Quin Criteria. \*Significant at 5%

Variance decomposition is to separate the effect of each innovation variable individually to the response received by a variable including innovation to the variable itself. This analysis is useful for estimating the contribution of the variance percentage of a variable in SVAR system due to the shocks.

Based on the analysis, it indicates that, in the first period, the contribution of exchange rate shocks to import prices was not noticeable at all. However, after the third quarter, it showed a significant contribution by 19%. In the third quarter, the contribution of exchange rate shock continued to increase until the sixth quarter reaching 33%. After the sixth quarter, it declined gradually. Furthermore, the contribution of output to price ratio is very small, only <1% (Table 4).

For the decomposition variance of exchange rate, the exchange rate response in the first period was almost entirely (97.25%) due to exchange rate shocks, and the rest was explained by the variable of price ratio. From the second to tenth quarter, this pattern did not change because the response rate was 79.16% due to the exchange rate shocks and 19.04% due to the import prices.

The other findings are the variance decomposition for national income. The ability of exchange rate significantly influenced national income at the beginning of the period (94.09%) compared to price ratio (1.36%) or output level (4.53%). The same pattern did not change until the tenth quarter. The ability of exchange rate significantly affected national income by 87.06%.

### 5. CONCLUSION

This study analyzed the effects of exchange rate on import prices in Indonesia using SVAR analysis, and the data used were the quarterly data from 1997.3 to 2014.3. This study used three shocks,

Figure 3: Response of LP to INF

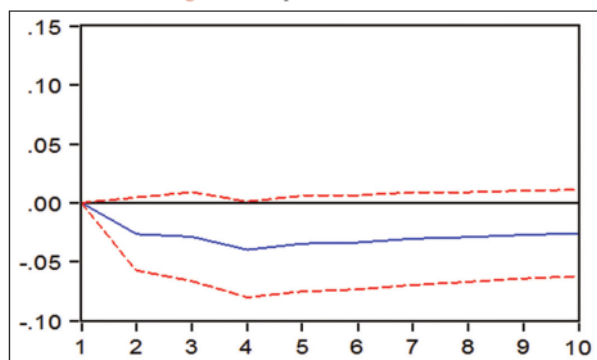


Table 4: Variance decomposition

Periode	Variance decomposition of LP			
	LP	LS	LY	LINF
1	100	0	0	0
2	94.9845	0.1249	0.7426	4.1478
6	85.7504	0.2641	0.5011	13.4842
8	84.25210	0.4412	0.5396	14.7670
10	83.3873	0.5213	0.6074	15.4838

i.e.: The shocks of exchange rate, national income, and inflation. Then, the data analysis used impulse response and forecast error variance decompositions (FEDVs).

Based on the analysis of impulse response (IRFS), it indicates that the exchange rate shock to the import prices examined show positive effect. Meanwhile, the effect of the exchange rate shock on the national income is positive and higher than the exchange rate shocks to the import prices. The exchange rate shock to the national income was higher in the first quarter, and then it fell from the second quarter to the next. Both the responses of import prices and national income equally showed the response away from the balance point (divergence). This means that the response accumulation of the variables of real prices and national income was gradually getting stronger and gave permanent effects (persistent).

Furthermore, the analysis of FEVDs found that the exchange rate had a more powerful effect on the national income compared with the import prices. This fact shows that the variability of the exchange rate was smaller than the variability value of the national income.

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