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Exchange Rate Pass-Through to Inflation Via Trade Channel

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Abstract:

The rapid expansion of global trade and the volatility of currency exchange rates have a substantial impact on the stability and economic prosperity of a nation. This research is aims to observe the impact of the exchange rate pass-through (ERPT) to consumer inflation represent by consumer price index (CPI) via the trade channel that represent by the import price index (IPI), producer price index (PPI) and weighted exchange rate index represents by nominal effective exchange rate (NEER) during January 1997 to December 2021 for Indonesia's study case. Along with the variance decomposition (VD) and impulse response function (IRF) methodologies, the study used the vector error correction model (VECM) and Johansen Cointegration procedures. These techniques were used to ascertain each variable shock's effect and its associated contribution in percentage. The study's results indicate that an increase in NEER, or the appreciation of the Rupiah, resulted in a decrease in consumer price, known as CPI. Conversely, an increase in prices via the trade channels, including IPI and PPI, resulted in a further increase in consumer price or CPI. Second, IPI has the highest contribution to the consumer price shocks followed by CPI itself, IPI and NEER during the observable period. Simultaneously, there are three observable different periods of the shocks that can be categorized based on the commonalities trend. First, huge fluctuation occurs from the start in the first month until the 15th month period. Second, the shock gradually stabilizes which starts in 15th month period until 30th month period. Finally, the shock experiences an incremental change towards the long-run equilibrium which starts after the 30th month period.

Keywords: *Exchange Rate Pass-Through; Consumer Price Index; Nominal Effective Exchange Rate; Import Price Index; Producer Price Index; Indonesia.*

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1. Introduction

Inflation is a global priority for governments in ensuring economic stability, with a focus on maintaining price stability for sustainable living conditions. Stable and predictable inflation allows strategic management of savings, spending, and investment, fostering economic growth, job creation, and prosperity. The European Central Bank (2023) emphasizes the importance of avoiding excessively low or high inflation rates for optimal economic prosperity. The relationship between monetary policy, inflation rates, and a nation's currency value is crucial, as highlighted by Mishkin (2008). Understanding the Currency Rate Pass Through (ERPT) becomes essential for comprehending inflation formation, with lower ERPT in countries combining flexible exchange rates and credible inflation targets. This approach

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enables central banks to stabilize inflation by using the exchange rate as a buffer against external shocks (Ha et al., 2020).

Indonesia's inflation rate, as per World Bank data, has remained relatively stable from 2010 to 2020, consistently within single-digit figures. The consumer price index (CPI) serves as a key metric for measuring this rate. Historically, monetary authorities and central banks in Indonesia have focused on controlling domestic inflation to maintain price stability. However, Nasir et al. (2015) highlight increased challenges in preserving economic stability, managing the money supply, and promoting growth, particularly post the Global Financial Crisis of 2007–2008. Since 1999, Bank Indonesia, established as an autonomous central bank by UU Number 23/1999, has been dedicated to achieving and preserving currency stability, specifically for the Rupiah. The institution has employed inflation targeting frameworks to meet government-set objectives. Currency stability, outlined in the law's sole goal mandate, involves two key factors: stability relative to commodities and services within the inflation targeting framework and stability in relation to other nations' currencies.

Bank Indonesia (2022) outlines three key influences on the exchange rate: inflation expectations, demand pull inflation, and supply-side pressures. High and unpredictable inflation significantly affects the nation's socioeconomic situation, leading to a sustained decline in real income, particularly impacting the impoverished and diminishing overall quality of life. Volatile inflation creates ambiguity for economic decision-makers, hindering choices related to consumption, investment, and output, thereby impeding economic development. Additionally, if domestic inflation exceeds that of surrounding nations, an uncompetitive real domestic interest rate may emerge, exerting downward pressure on the Rupiah's value. To ensure citizen well-being and suitable inflation for economic growth, it is crucial to regulate the stability of the currency's value against goods and services and the Rupiah's stability against other nations' currencies.

However, the dynamics of inflation in the 21st-century open economy are increasingly influenced not only by internal domestic balances but also external balances, as globalization and liberalization have led to rising cross-border investment, trade, and fast international money movement. This global interconnectedness poses challenges for developing economies like Indonesia, with forecasts for the global economy impacting inflation rates Duc Huynh et al. (2020).

The volatility of trends, especially in currency exchange rates and trade, might potentially hinder an economy's competitiveness by constraining its capacity to repay and bear the expenses of loans denominated in foreign currencies. This would inevitably affect consumer prices over time. Data from Pham et al. (2023) further confirmed the presence of exchange rate pass-through (ERPT) for the ASEAN-5 nations (Indonesia, Malaysia, Thailand, and Singapore), connecting exchange rate shocks to significant changes in inflation. Therefore, it is essential that economists and policymakers understand how changes in currency exchange rates affect total economic activity, particularly in the context of Indonesian international business.

The recent surge in trade, fueled by globalization and liberalization, highlights the increasing demand from rapidly developing Asian countries, particularly China, as a crucial trading partner for Indonesia. China's heightened demand for Indonesian resources has influenced commodity supply and demand, impacting both the Rupiah and Yuan in international transactions. Indonesia's trade relationship with China has significantly grown, with a shift from Singapore to China as the primary trade partner since 2016. China's substantial contribution to Indonesia's imports reached 39.634 million USD in 2020, contrasting with Singapore's 15.300 million USD in 2005 (Badan Pusat Statistik, 2023). Indonesia excels in exporting primary products to China while importing manufactured goods. The study underscores the importance of understanding the impact of exchange rate fluctuations on import costs, domestic prices, and the intricate relationship between domestic producer pricing, demand-driven inflation, and fluctuating exchange rates, as emphasized by Nasir et al. (2020) and Sasaki et al. (2022).

There are two sources of pressure on inflation, according to Bank Indonesia (2022): supply-side forces, which cause cost-push inflation will represent by producer price index, and demand-side forces, which cause demand-pull inflation will represent by import price index. Moreover, technological developments that ease cross-border transactions and boost trade volume will keep the global trend of greater globalization going. The transmission of shocks from the currency rate to core inflation in the consumer sector, as measured by ERPT (Exchange Rate Pass-Through), must be carefully studied. This study will concentrate on the shocks that transmit from the trade channel.

Thus, the urgency of exchange rate pass-through towards inflation studies needs to be clarified, especially in the context of Indonesia study case. Viewed from the background, the objectives of this research are to determine how the ERPT affects inflation based on currency rates, and via the trade channel, which takes producer and import prices into account, also to determine the ERPT's long-term trend equilibrium with regard to inflation based on the years' worth of exchange rates, import and producer prices, and their respective contributions to inflation.

2. Theoretical Background

Hypothesis Development

The ERPT of Exchange Rate to Inflation

A depreciation (*appreciation*) in domestic currency caused higher (*lowe*r) inflation as measured by CPI. As a result, the following hypothesis is formulated:
H1: The variable of Nominal Effective Exchange Rate has a negative impact on Consumer Price Index in Indonesia.

The ERPT of Import Prices to Inflation

In general, an increase in the Import Price Index tends to put upward pressure on inflation as measured by CPI due to cost of imported goods and raw materials, leading

to an increase in consumer prices or demand-pull inflation. As a result, the following theory is proposed:
H2: The variable of Import Price Index has a positive impact on Consumer Price Index in Indonesia.

The ERPT of Producer Prices to Inflation

When producers face higher costs for inputs such as raw materials or labour, they may choose to pass on some or all of these cost increases to consumers by raising prices thus leading to an increase in consumer prices or cost-push inflation. As a result, the following theory is proposed:
H3: The variable of Producer Price Index has a positive impact on Consumer Price Index in Indonesia.

3. Methodology

In VAR (Vector Autoregression) models consider all variables as endogenous, allowing the model to determine their values based on historical data. Each variable is expressed as a linear combination of its own past values and those of other variables. On the other hand, the Vector Error Correction Model (VECM) emphasizes deviations from long-term equilibrium connections between variables. It helps analyze both long- and short-term dynamics, especially useful for non-stationary time series data. Error correction terms in VECM address deviations from cointegrating connections, representing adjustments needed to reach long-term equilibrium. The literature review approach is used to gather theoretical references for identifying relevant situations or challenges. Data collection is tailored to suit the research needs for formulating the appropriate model.

The research employs the Vector Error Correction Model (VECM), derived from the Vector Autoregressive (VAR) model with error correction properties. It examines the relationship between various economic variables, including exchange rates, consumer inflation (NEER and CPI), and trade-related variables such as import and producer prices. Data collected is standardized to a common base year (2010=100) using Microsoft Excel and then analyzed using EViews10 statistical software. Logarithmic transformation of variables is applied to understand changes as continuous growth rates, which is particularly useful in economic and financial analysis for capturing proportional shifts and simplifying representation of multiplicative connections in a linear form.

To resolve inconsistencies between immediate and distant outcomes, Engle and Granger first advocated for the development of VECM. Statistically speaking, the VAR model provides the foundation for the VECM, or Vector Error Correction Model. Its primary use is in the examination of non-stationary data sets that show a correlation between variables. According to the guidance VECM book by Agus Tri Basuki (2017), the VECM model is characterized as a restricted VAR model due to the existence of cointegration or long-term connections. Both the Johansen and the Engel-Granger approaches may identify this cointegration when it exists. Figure 3.1 below shown the process of VECM stage need to be taken during data processing.

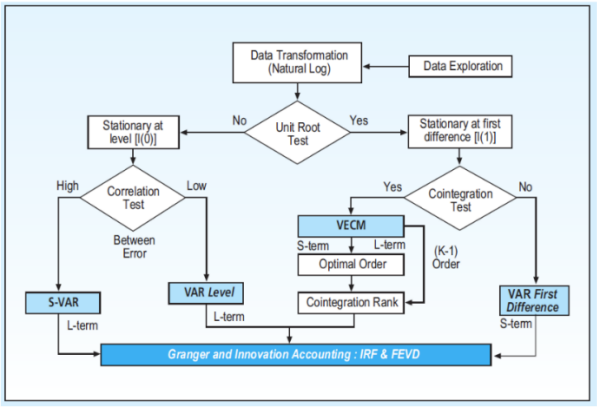


Figure 1. Stages in Conducting Vector Error Correction Model

4. Empirical Findings/Result

Granger Causality Test

The Granger causality test looks at the one-way or two-way relationships between research variables. This is done in accordance with the goal of the study, which is to ascertain and strengthen the endogeneity assumption to carry out further VECM estimation in time-series and identify the essential variables in the VECM model (Tseng, 2013). Following are the findings of the Granger causality test:

Table 1. Granger Causality Test

Null Hypotesis (H0)	Prob	Test Result	Causality Relationship
LOG_NEER does not Granger Cause LOG_CPI	2.E-24	Reject H0	
LOG_CPI does not Granger Cause LOG_NEER	1.E-06	Reject H0	Bi-directional relationship of CPI & NEER
LOG_IPI does not Granger Cause LOG_CPI	1.E-11	Reject H0	
LOG_CPI does not Granger Cause LOG_IPI	8.E-05	Reject H0	Bi-directional relationship of CPI & IPI
LOG_PPI does not Granger Cause LOG_CPI	1.E-12	Reject H0	
LOG_CPI does not Granger Cause LOG_PPI	7.E-06	Reject H0	Bi-directional relationship of CPI & PPI
LOG_IPI does not Granger Cause LOG_NEER	3.E-08	Reject H0	
LOG_NEER does not Granger Cause LOG_IPI	1.E-10	Reject H0	Bi-directional relationship of NEER & IPI
LOG_PPI does not Granger Cause LOG_NEER	6.E-09	Reject H0	
LOG_NEER does not Granger Cause LOG_PPI	6.E-11	Reject H0	Bi-directional relationship of NEER & PPI
LOG_PPI does not Granger Cause LOG_IPI	0.0005	Reject H0	
LOG_IPI does not Granger Cause LOG_PPI	0.0123	Reject H0	Bi-directional relationship of IPI & PPI

Source: Appendix, processed by author in E-Views10

Based on the results of the Granger causality test above, it can be seen that the one that has a causal relationship is when the probability value is less than 5% then the null hypothesis H_0 is rejected and alternate hypothesis H_a is fail to reject, which means there is a causal relationship between variables and thus strengthen the endogeneity assumption to further carried out and justified the usage of VECM.

Johansen Co-Integration Test

The Johansen approach may be used to perform the cointegration test. We look at the probability value and compare the Trace Statistic value to the critical value at alpha 0.05 to determine if cointegrated systems are comparable. The results are shown in Table 2.

Table 2a. Johansen Cointegration Test

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0,05 Critical Value	Prob
None *	0.287093	149.3197	47.85613	0.0000
At most 1 *	0.120134	50.84424	29.79707	0.0001
At most 2	0.028836	13.60047	15.49471	0.0946

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

The cointegration test indicates that the trace statistics values of 149.3197 and 50.84424, as shown in Table 2a, are greater than the table critical values at a significance level of 0.05 (47.85613 and 29.79707, respectively). Furthermore, the probability shows 0.0000 for none and 0.0001 for at most 1 which is below alpha 5%.

This means from the result that the null hypothesis H_0 is rejected and we accept alternate hypothesis H_a. The H_0 is rejected because the value $t_{test} > t_{table}$ is at the significance level alpha 5% or probability value $< \alpha = 5\%$.

Then from the null hypothesis H_0 rejection then the Johansen Co-Integration test indicates that from 1997 to 2021 the four variables—LogCPI, LOGNEER, LogIPI, and LogPPI—show a long-term or cointegrated relationship in Indonesia. Consequently, this research will use the VECM approach in analysis instead of using VAR.

Once the cointegration or long-term link between the endogenous variables has been established, we may examine each one's historical trends. Through this study, we will be able to assess the hypotheses and ascertain if each variable has a positive or negative impact.

Table 2b. Johansen Cointegration Test (cont'd)

Normalized Cointegrating Coefficients (Long Run Result)				
Variable	**Coefficient**	**S.E**	**t-value**	**t-table**
Log_CPI	1.00			
Log_IPI	-0.088986	0.72009	0.123576	1.9682
Log_PPI	-1.770983	0.65770	**2.69269***	1.9682

Log_NEER	-2.672185	0.33734	**7.921340***	1.9682

*t-value shows significant (larger to t-table)

The Johansen cointegration test's normalized cointegrating equation is shown in table 2b above. In order to understand the long run, the normalized cointegrating equation of the Johansen model has the coefficient signs inverted. In order to capture the Indonesian viewpoint from the NEER value in the original USD terms, then the Log_IPI and Log_PPI coefficients will invert to be positive in the interpretation. However, the Log_NEER will remain as negative in interpretation.

As a result, the H_0 (null hypothesis) is rejected because the value t test > t table is at the significance alpha 5% or probability value < alpha 5% thus alternate hypothesis (H_a) : $H_1 = H_2 = H_3$—the three alternate hypotheses—are accepted.

Interpreting table 2b, the target variable, Log CPI, has a coefficient value of 1. Over time, Log_CPI is positively impacted by both Log_IPI and Log_PPI, which represent the trade channel variables, but only Log_PPI is statistically significant. This demonstrates the validity of the theoretical argument that an increase in the producer price index (PPI) and the import price index (IPI) will raise consumer price inflation (CPI) due to higher market final prices. The finding shows that Log_NEER has a significant and negative long-term impact on Log_CPI for NEER lends credence to the theoretical notion that consumer inflation (CPI) will decrease when the value of NEER (the Rupiah) appreciates.

The next step in VECM is to address the research question regarding the long-term trend and the contribution of ERPT to inflation via the trade channel after the effects of each hypothesis variable have been confirmed. This is done by performing in-depth estimates of the short- and long-term as well as by computing the IRF and VD.

VECM Estimation Results

The variables show co-integration or a long-term link, as indicated by the previous cointegration test. This leads to the usage of VECM analysis as the method of analysis. In addition, by doing a significance test utilizing the VECM estimate results, one may evaluate the relevance of a system variable's lag or latency, as well as the influence of that variable's lag on both itself and other system variables. After doing the optimum lag test, the lag 8 is chosen for the VECM analysis. After estimating the VECM parameters, the statistical t-value is compared to the t-table (df: 291) at 5% and 10% significance levels to perform the variable significance test. At the 5% level of significance, the critical values are +/-**1.9682** (**), while at the 10% level of significance, they are +/-**1.6501** (*). This section explains the results of the long-term and short-term VECM model estimates.

Table 3. VECM Long-Term Estimation

VECM Long-Term Estimation			
Variable	Coefficient	T-Statistic	Standard Error
LogCPI(-1)	1.000000		
LogNEER(-1)	-2.672185	**-7.92133***	0.33734
LogIPI(-1)	-0.088986	-0.12358	0.72009

LogPPI(-1)	-1.770983	**-2.69269***	0.65770
R-squared	0.686008		
Adj. R-squared	0.645689		

Source: E-Views10 processed by author (available in appendix)

The presentation of the VECM model can be seen in Table 3. From table 3 and table 4. shows an R-Squared value of 0.686008 which means the variables used can explain 68.6% of the VECM estimation model made while the remaining 31.4% are outside the research model.

The results shown in Table 3 show that the table above represents a long-term relationship between the four variables (LogCPI, LogNEER, LogIPI, LogPPI). While the second part in Table 4 is an interpretation of the short-term relationship of the four variables. In table 3, it can be seen that the LogNEER, LogIPI, and LogPPI variables affect LogCPI with estimated of coefficient value -2.672, -0.088, and -1.770 respectively which has the same number value from Johansen Normalized Cointegrating Coefficients in Table 2b thus confirming the previous Johansen Cointegration results.

It can be concluded from table 2b and 3 that in the long-term the IPI and PPI have positive impact and NEER has negative impact towards CPI. This means an increase in import price index (IPI) and producer price index (PPI) will lead to higher inflation (CPI) while the increase in NEER value (Rupiah appreciation) will lead to a decrease in consumer inflation (CPI).

In table 4 below we may get the error correction coefficient from CointEq1. The error correction coefficient gives the speed of adjustment within which the model will restore its equilibrium following any disturbances. The error correction coefficient is usually negative and between 0 and 1, indicating that the variable corrects a fraction of its deviation from the equilibrium in each period. A positive or large error correction coefficient may imply an explosive or unreasonable behaviour of the variable. The coefficient of ECT with D(LogCPI) as dependent variable are negative and statistically significant (t-stat |-2.56| > t-table 1.96) indicating that there is a convergence from short dynamics towards long run equilibrium. The adjustments coefficients were 0.03 percent towards long run equilibrium in case of disequilibrium situation.

From table 4 it also was found that in the short-term, there were two significant variables to CPI at the 5% significance level. The significant variable was the NEER in the first, second and fourth lag which negatively affected the CPI at the 5% significance level. It can be explained that an increase of one percent in NEER will decrease the CPI by 7.85% , 1.94% and 4.32% in first, second and fourth period respectively.

Table 4. VECM Short-Term Estimation

Variable	Coefficient	t-Statistic	t-table	Prob.
CointEq1	-0.003476	-2.56258**	1.9682	Significant
D(LogCPI(-1))	0.288715	4.64988**	1.9682	Significant

D(LogCPI(-7))	0.194991	3.00295**	1.9682	Significant
D(LogCPI(-8))	0.209333	3.62692**	1.9682	Significant
D(LogNEER(-1))	-0.079489	-7.85328**	1.9682	Significant
D(LogNEER(-2))	-0.022019	-1.94648*	1.6501	Significant
D(LogNEER (-4))	-0.051880	-4.32816**	1.9682	Significant
R-squared	0.686008	Adjusted R-squared		0.645689

Source: Appendix, processed results Eviews 10 by author

The second variable was inflation in the first, seventh and eighth lag which positively affected the CPI itself at the 5% significance level. It can be explained that an increase of one percent in CPI will increase itself by 4.645%, 3.01% and 3.62% in first, seventh and eighth period respectively.

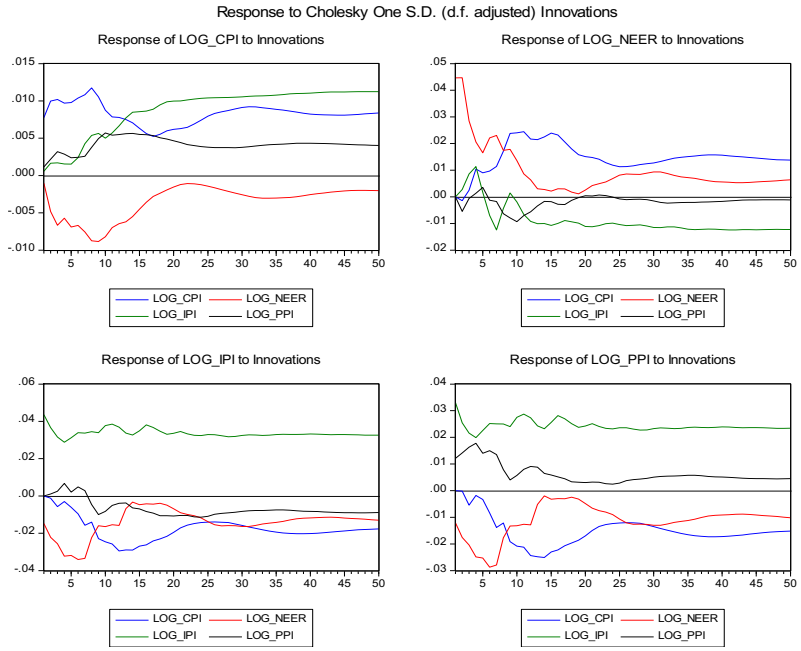
Table 4 above shows the second part of VECM estimation which shows VECM short-term table. It can be concluded that in the short term that the NEER is significant towards CPI in Indonesia with 5% significancy. Subsequently, IPI and PPI variable in the VECM test above shows it has impact although not significant towards CPI in Indonesia.

Impulse Response Function

Numerous studies have looked at the Impulse Response Function (IRF) and Variance Decomposition (VD) outputs of the VECM model in an effort to make the findings more understandable. IRF analysis must be done to determine how a shock impacts additional system variables in addition to the initial variable. One method for evaluating the effect of a shock on several variables is the Impulse Reaction Function (IRF). It assists in estimating how long the shock's effects will endure by choosing the variable that reacts to the shock with the greatest power.

The vertical axis shows the standard deviation value which measures how much response a variable will give, if there is a shock to other variables. Meanwhile the horizontal axis shows the length of the period (months) of the response given to the shock. The response given above the horizontal axis shows that shock will have a positive effect. Conversely, if the response given is below the horizontal axis, it indicates that shock will have a negative effect. Impulse response plots represent what they are named after which the response of a variable given an impulse in another variable. The following graph 2 shows four graphs of variables as the response, which are.

a. Graph 2a (top-left) shows the response of logCPI given an impulse in another variable.
b. Graph 2b (top-right) shows the response of logNEER given an impulse in another variable.
c. Graph 2c (bottom-left) shows the response of logIPI given an impulse in another variable.
d. Graph 2d (bottom-right) shows the response of logPPI given an impulse in another variable.



Graph 2. Impulse Response Graph

Graph 2 impulse-response plot illustrates the impact of a positive shock on CPI. Since the CPI initially increases by the shock's value, the shock causes a.010 standard deviation in the CPI at the one-month point. The CPI then continues to rise until it reaches the 15-month milestone, at which point it begins to decline. However, it resumes its upward trajectory and continues to do so for some time to come. The second is that a negative shock to the exchange rate's NEER (Nominal Effective Exchange Rate) causes the CPI to react swiftly—within five months. However, it then exhibits a gradual ascent that culminates in a negative shock. Thirdly, both over a 15-month period and in the long run, the Consumer Price Index (CPI) shows a rapid and persistent increase in response to a positive shock in the Import Price Index (IPI). After the first 15 months, the CPI increases somewhat more. Fourthly, the Consumer Price Index (CPI) exhibits an immediate and sustained upward tendency in response to the Producer Price Index (PPI) impulse. However, there may be some minor fluctuations along the way, but overall, the trend remains favorable over the long term. Not only that, but manufactured consumer items are the ones where the CPI has the most noticeable effect on the trade channel variable. These goods, as indicated by Import Price Index (IPI), are frequently either imported or subject to import competition. As a result, their prices exhibit a strong correlation with the exchange rate (Norman & Richards, 2010). Due to this, PPI ranks second in terms of good long-term impact, following closely behind IPI. The products in question include of home consumption items such as apparel, footwear, household appliances, furniture, and motor vehicles, which are either imported or subject to import competition.

There is a first pass-through that occurs starting from the fluctuation in exchange rate to trade channels (represent by IPI & PPI) and continue from the trade channels to consumer final price (represent by CPI) as a second pass-through. The results from

graph 2 suggest that first-stage pass-through in Indonesia is high (shown by IPI), which is not surprising since import prices largely reflect the domestic-currency cost of the good from the foreign supplier, which can be expected to vary in line with the exchange rate. However, the first-stage pass-through need not be 'full' – that is for example, a 10 per cent appreciation (*depreciation*) of the exchange rate might not lead to a 10 per cent reduction (*increase*) in import prices – if there is 'pricing to market' or 'price discrimination'. Pricing-to-market means a foreign supplier adjusts its export prices depending on the national market to which it exports. This might occur if foreign suppliers perceive that consumers in different economies are willing to pay different prices because they have different preferences or income levels (Krugman, 1986).

As shown in graph 2, the data on second-stage pass-through for imported or susceptible to import competition items demonstrates that the exchange rate has a far less impact on retail pricing at the end than it does on import prices at the port. That means the second-stage pass-through (represented by CPI) is considerably smaller than first-stage pass-through (represented by IPI & PPI). The practice of currency hedging by retailers and wholesalers might be one reason for this disparity. Reason number one for these phenomena is that transportation costs, labor inputs, rental fees, and distributor and merchant profit margins make up a significant portion of the pricing of imported items. Based on these results, it seems that home expenditures make up around half of the final retail price of products. Products and services produced inside the nation are mostly unaffected by fluctuations in import costs and the currency rate, according to a 2011 report from the Reserve Bank of Australia.

From impulse response graph 2b, 2c and 2d given the impulse from other variable, we can find a commonalities with graph 2a which is the trend is observable and can be categorized into three shocks period. The first period starts from the first month period until the 15 months period where the shocks reach their peak across the four graphs and due to its high fluctuation trend then we may refer this period as fluctuation period. The second period starts from the 15-month period where the shocks start to stabilize and decline in trend until the fluctuation is greatly diminished by the 30-month period. We may refer to the second period as the stabilization period due to the finally stabilizing and diminished fluctuation. The third period starts with the 30-month period where there was no huge fluctuation to be found and stabilizing in the long run log horizon. We may refer to the third period as equilibrium period.

Variance Decomposition (VD)

Variance decomposition (VD) is a component of the VECM study that supports the findings of the earlier analysis. Variable decomposition (VD) may be used to express the proportion of the variable's influence on changes in other variables as well as its own across several future periods. The factors that are most likely to have an impact on a certain variable will be identified as a result.

The findings of a Variance Decomposition (VD) analysis of the LogCPI variable are shown in Table 5. They indicate that the LogIPI variable is anticipated to have the

most impact on CPI over the next 50 months, or around 4 years. by the beginning of this time, LogIPI is expected to contribute 0.5% to CPI, and by the end of the observed period, 45.2%. The CPI itself has the second-highest contribution to the CPI, with 95.6% at the beginning of the period and 36.5% at the conclusion of the observed period. From 2.1% of the Consumer Price Index (CPI) at the beginning of the observation period to 9.3% at its end, the Producer Price Index (PPI) increased. NEER contributed the least to the CPI during a 50-month period, ranging from 1.7% to 8.7%.

Table 5. Variance Decomposition of Inflation

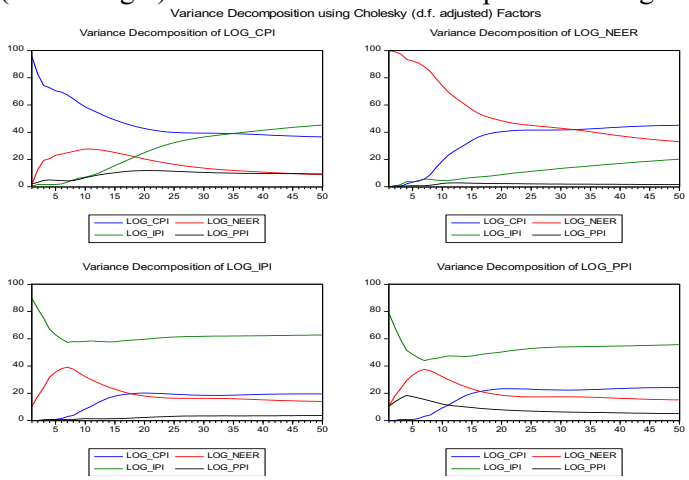
Period	S.E.	LogCPI	LogNEER	LogIPI	LogPPI
1	0.007943	95.66699	1.708863	0.515561	2.108588
2	0.013915	82.67550	12.58728	1.560965	3.176253
3	0.018843	74.33609	19.37956	1.663111	4.621239
4	0.022189	72.70800	20.61413	1.681008	4.996861
5	0.025372	70.47365	23.16780	1.650165	4.708386
6	0.028425	69.49244	23.99325	2.030239	4.484072
7	0.031738	67.37107	24.93585	3.433152	4.259928
8	0.035567	64.54659	25.90675	5.025417	4.521248
9	0.038869	61.39456	26.87175	6.323527	5.410165
10	0.041384	58.64170	27.64082	7.042710	6.674776
11	0.043417	56.55947	27.70032	8.121620	7.618598
12	0.045408	54.65253	27.33950	9.578443	8.429526
13	0.047410	52.64356	26.78668	11.43898	9.130772
14	0.049315	50.71140	26.00322	13.53579	9.749582
15	0.050953	49.04847	25.14464	15.50049	10.30640
16	0.052394	47.53745	24.24809	17.37826	10.83620
17	0.053741	46.13658	23.32100	19.25041	11.29201
18	0.055136	44.84092	22.34157	21.24281	11.57471
19	0.056579	43.70706	21.33195	23.22163	11.73936
20	0.057991	42.74004	20.37539	25.06380	11.82077
21	0.059361	41.91435	19.48774	26.76211	11.83580
22	0.060716	41.19800	18.65877	28.36236	11.78087
23	0.062101	40.61635	17.86753	29.83567	11.68045
24	0.063524	40.18018	17.11339	31.16977	11.53665
25	0.064985	39.89063	16.40120	32.34359	11.36458
26	0.066466	39.70094	15.73928	33.37906	11.18071
27	0.067949	39.56502	15.13642	34.29733	11.00123
28	0.069432	39.46814	14.58968	35.11599	10.82619
29	0.070923	39.40880	14.09215	35.84631	10.65274
30	0.072424	39.37752	13.63983	36.49557	10.48708
31	0.073928	39.34518	13.23257	37.08597	10.33627
32	0.075417	39.29219	12.86849	37.63113	10.20819
33	0.076879	39.21194	12.54022	38.14571	10.10212
34	0.078307	39.10929	12.23810	38.63791	10.01470
35	0.079706	38.98655	11.95538	39.11846	9.939612
36	0.081084	38.84325	11.68817	39.59326	9.875324

Period	S.E.	LogCPI	LogNEER	LogIPI	LogPPI
37	0.082438	38.67830	11.43447	40.06495	9.822276
38	0.083760	38.49603	11.19161	40.53203	9.780319
39	0.085045	38.30379	10.95679	40.99318	9.746242
40	0.086300	38.10785	10.72824	41.44806	9.715853
41	0.087534	37.91183	10.50520	41.89681	9.686158
42	0.088750	37.71885	10.28795	42.33742	9.655779
43	0.089949	37.53289	10.07695	42.76556	9.624595
44	0.091128	37.35697	9.872751	43.17804	9.592242
45	0.092290	37.19303	9.675553	43.57326	9.558152
46	0.093439	37.04209	9.485452	43.95086	9.521599
47	0.094580	36.90530	9.302604	44.30941	9.482688
48	0.095712	36.78316	9.127252	44.64770	9.441891
49	0.096836	36.67512	8.959621	44.96534	9.399917
50	0.097951	36.57954	8.799822	45.26330	9.357330

Source: Appendix, processed by author on E-Views10

The VD result confirms what the IRF found: pass-through is usually low on an aggregate basis, but it's much higher for the price of manufactured goods, especially those that are imported regularly (as shown by the IPI). It was found that import prices were particularly vulnerable to changes in currency exchange rates. The findings of the VD contribution research show that changes in exchange rates have little effect on the inflation of total consumer prices. Changes in exchange rates do not immediately impact the price of goods, although certain products have a greater pass-through than others. This is because the retail price of these commodities is heavily influenced by domestic factors (Reserve Bank of Australia, 2011). To illustrate the dynamics of the Variance Decomposition contribution changes over time, graph 3 is presented in the following order.

a. Graph 3a (top-left) shows the variance decomposition of logCPI
b. Graph 3b (top-right) shows variance decomposition of logNEER
c. Graph 3c (bottom-left) shows the variance decomposition of logIPI
d. Graph 3d (bottom-right) shows the variance decomposition of logPPI



Graph 3. Variance Decomposition Graph

Graph 3 shows the dynamic of the Variance Decomposition of CPI contribution percentage changes overtime which complements the result of the IRF graph 2a as the response of logCPI given an impulse in another variable. The first finding on graph 3, the rapid trend declines of CPI to itself in IRF in graph 2 contributes to 50% loss in contribution within 15 months period in graph 3a, but the decrease afterwards gradually decreasing and not as huge as before account to less than 10% of the contribution until the 30 months period and incremental decrease in the long run log horizon. Second finding on graph 3, the import prices represent by IPI apparently only comes in second place after the domestically produced good's price represents by PPI in the first 15 months period, but afterwards the contribution percentage between the two toward inflation is switch out with IPI rapidly increasing by two-fold growth percentage by the end of the 30 months period and still steadily increasing in the long run log horizon. On other hand PPI contributions start to greatly diminishes post 15 months period after switched out by IPI and keep decreasing in the long-run log horizon which also meet by NEER in its peak growth in 15 months period and start stagnating afterwards with slightly incremental contribution increase in the long-run horizon.

Furthermore, from variance decompositions graph 3b, 3c and 3d, we can find a commonality with graph 3a which also has the same trend with impulse response graph 2 that the observable trend can be categorized into three distinguished shocks period. The first period starts from the first month period until the 15 months period where the shocks reach their peak across the four graphs and due to its high fluctuation trend, we may refer this period as fluctuation period. The second period starts from the 15-month period where the shocks start to stabilize and decline in trend until the fluctuation is greatly diminished by the 30-month period, we may refer to the second period as the stabilization period due to the finally stabilizing fluctuation. The third period starts with the 30 months period where there was no huge fluctuation to be found and stabilizing in the long run log horizon. We may refer to the third period as equilibrium period. Thus, the results in both IRF and VD complement each other's explanation and results

Discussion

The research aims to observe the impact of the exchange rate pass-through (ERPT) to consumer inflation represent by consumer price index (CPI) via the trade channel that represent by the import price index (IPI), producer price index (PPI) and weighted exchange rate index represents by nominal effective exchange rate (NEER) during January 1997 to December 2021 for Indonesia's study case. The research confirms the theoretical argument that increases in the producer price index (PPI) and import price index (IPI) lead to a higher CPI due to increases in final market prices. Conversely, appreciation of the nominal effective exchange rate (NEER) tends to lower the CPI, in line with the existing literature.

The results are in line with previous research on exchange rate pass-through (ERPT) and economic openness in Indonesia and other Asian countries. In particular, our findings supported the previous ERPT and economic openness research for Indonesia and asian economies by Kurnia & Sugiyanto (2023) which concluded that "*trade*

openness with a floating exchange rate system increases consumer prices". In Kurnia & Sugiyanto (2023) research mentioned the usage of *TS* variable that represent ERPT model from trade openness as a ratio of trade (export plus import) to the GDP while on other hand in our finding above we use the variable of import price index and producer price index to represent ERPT via trade channel in Indonesia.

In the long run, this study finds that IPI and PPI have a positive impact on CPI, indicating that rising import and producer prices contribute to higher inflation. In contrast, NEER has a negative impact on CPI, indicating that Rupiah appreciation leads to lower consumer inflation. These findings corroborate previous studies of Malisa & Karsinah (2019), Alhabib (2019), and Sesarika (2017) for the Indonesian case study, and further strengthen the understanding of inflation dynamics in Indonesia.

Moreover, the short-term analysis shows that NEER significantly affects the CPI in Indonesia, consistent with previous studies by Malisa & Karsinah (2019), Alhabib (2019), and Sesarika (2017). However, although IPI and PPI also affect CPI in the short-run, their impact is not statistically significant, which is in line with the results of previous studies by Malisa & Karsinah (2019) and Alhabib (2019). This underscores the importance of considering both long-run and short-run effects when analyzing the dynamics of inflation and economic variables.

Furthermore, the impact of exchange rate fluctuations on retail prices is significantly lower than the impact on import prices at the port. The difference in pass-through rates between the first stage variables (IPI and PPI) and the second stage (CPI) indicates the existence of currency hedging practices by retailers and wholesalers. In addition, the large share of price components such as transportation costs, labour input, rental costs, and profit margins on imported goods indicates that domestic factors play an important role in determining retail prices.

The findings also suggest three distinct periods in the pass-through dynamics: fluctuation, stabilisation, and equilibrium. These periods reflect the evolving nature of shocks and their impact on inflation over time. Understanding these temporal patterns can help in designing more targeted and effective policy responses to reduce inflationary pressures.

Furthermore, the variance decomposition analysis underscores the dominant role of import price index (IPI) in influencing CPI over a 50-month period. This finding underscores the importance of monitoring and managing import prices to mitigate inflationary pressures. Additionally, while changes in exchange rates have relatively little immediate effect on consumer prices, certain products exhibit greater pass-through than others, highlighting the need for nuanced policy interventions.

The response of CPI given impulses from NEER, IPI, PPI and itself in figure 2a is consistent with the findings of Bada et al. (2016) that CPI reacts negatively to exchange rate shocks, in this case in the first of four quarters of the year and shows an

upward trend thereafter. This is because a higher exchange rate represented by the NEER means an appreciation in the Rupiah leading to lower consumer inflation (CPI). Not only that, the consumer goods produced are the ones where CPI has the most pronounced effect on the trade channel variables. These goods, as indicated by the Import Price Index (IHI), are often imported or subject to import competition. As a result, the prices of such goods show a strong correlation with the exchange rate (Norman & Richards, 2010). Because of this, the PPI is ranked second in terms of favorable long-term impact, after the IHI. The products in question include household consumption goods such as clothing, footwear, household appliances, furniture, and motor vehicles, which are imported or subject to import competition.

These findings contribute to a deeper understanding of inflation dynamics in Indonesia, particularly regarding the role of exchange rate and trade-related variables. The research underscores the importance of considering both long-run and short-run effects, as well as the complex interactions between various economic factors in shaping inflation trends. These insights have implications for policymakers and businesses looking to navigate the economic landscape in Indonesia and other emerging economies.

5. Conclusions

Based on the results and discussion presented, it can be concluded that there is a two-way relationship between the CPI (Consumer Price Index), NEER (Effective Exchange Rate), IPI (Industrial Production Index), and PPI (Producer Price Index) variables, which confirms the assumption of endogeneity and the use of the VECM (Vector Error Correction Model) method. In the long run, an increase in the NEER exchange rate or appreciation of the Rupiah has a negative impact on the CPI, while the IPI and PPI have a positive impact on the CPI. Consumer goods that are imported or compete with imported goods have a stronger impact in the trade channel on the CPI. IPI is the largest contributor to consumer inflation, followed by CPI itself, PPI, and NEER. There are three observation periods that can be categorized based on the trend of shocks to the CPI. The IPI has the largest impact on the CPI, partly because prices of imported commodities have a sizable cost element.

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