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THE ENDOGENEITY OF OIL PRICE SHOCKS AND THEIR EFFECTS ON INDONESIA: A STRUCTURAL VECTOR AUTOREGRESSION MODEL

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ABSTRACT

The Endogeneity of Oil Price Shocks and Their Effects on Indonesia: A Structural Vector Autoregression Model. In this paper the endogeneity of oil price shocks as well as the effects of different type of the shocks on the Indonesian economy represented by its gross domestic product (GDP), consumer price index (CPI) and real effective exchange rate (REER) were investigated. A structural Vector Autoregression (SVAR) model was constructed extending Kilian (2009) model by employing several lags constraints in the model as Indonesia is a small open economy. There was evidence that oil price shocks were endogenously formed by oil-specific-demand itself, aggregate global demand and a fraction of oil stock. The exports' effect convincingly existed in the oil price shocks influencing the economy of Indonesia. In addition, there was no evidence that Indonesia enjoyed benefits from being an OPEC member.

Endogenitas shocks harga minyak dan dampaknya terhadap Indonesia: sebuah model structural vector autoregression. Artikel ini bertujuan untuk meneliti endogenitas harga minyak dan dampak dari tipe-tipe shocks yang berbeda terhadap perekonomian Indonesia yang tercermin dalam pendapatan domestik bruto (PDB), indeks harga konsumen (IHK) dan nilai tukar efektifriil (REER). Metodologi penelitian yang digunakan adalah model structural vector autoregression dengan mengembangkan model Kilian (2009). Model ini dikembangkan dengan mengaplikasikan restriksi tambahan pada lags mengingat Indonesia adalah Negara kecil yang menganut rezim perekonomian terbuka. Hasil penelitian menunjukkan bahwa harga minyak dipengaruhi oleh permintaan spesifik atas jenis minyak itu sendiri, permintaan global dan sedikit faktor produksi minyak. Efek ekspor masih mendominasi dalam pengaruh fluktuasi harga minyak terhadap perekonomian Indonesia. Sementara itu, tidak ada bukti yang menunjukkan bahwa Indonesia mendapatkan manfaat dari menjadi anggota OPEC.

1. INTRODUCTION

The price of oil is one of the core elements in driving the fluctuation of the world economy. Small open economies which have high dependence on oil may experience significantly negative impact resulting from the oil price volatility. Indonesia is one example of them. Its dependence on oil keeps rising for decades due to declining production overtime while domestic consumption goes up. That is why it is no longer a member of Organization of the Petroleum Exporting Countries (OPEC) since September 2009. The world oil price upturn may contract the Indonesian economy since most oil is imported to meet the domestic demand. Under the old fuel subsidy scheme, surging the world oil price may also raise the burden to the Indonesia's budget which was accounted for 7 per cent of the annual government budget (EIA 2014).

Many findings show that oil price shock is in connection with political conflicts in the world particularly through the shocks in oil stocks. Arab – Israeli war in 1973-1974, Iran revolution in 1978, Iraq-Iran war in 1980, Persian Gulf War, Kuwait invasion in 1990, Iraq war in 2003 are several instances that are considered as shocks to the oil supply (Alquist & Kilian 2010; Hamilton 2003). Unlike Hamilton (2003) who considers those events as exogenous shocks to the oil supply, Barsky and Kilian (2001) claims that there are substantial endogenous components of such events in driving oil price, i.e. precautionary demand or preventive actions. Other events which are associated with oil price volatility are Asian financial crises in the late 1990s, 9/11 event (Alquist & Kilian 2010), production decline by Saudi Arabia during 2005 – 2007, and strong growing demand by China (Hamilton 2009).

Many studies also have been conducted to investigate the role of oil price related to macroeconomic indicators. Hamilton (2000 cited in Abeyingshe 2001) finds that oil price surges initiate US economy contractions. Abeysinghe (2001) identifies that high oil price has positive effect on GDP growth of oil exporter countries, but it negatively affects oil importer countries. Hamilton (2003; 2011) and Cunado and Gracia (2005) find a nonlinear correlation between oil price and GDP at which oil price increase has greater effects rather than price decrease.

Most of the studies consider oil price as an exogenous shock. Kilian (2009) reveals that treating oil price as an exogenous shock is no longer appropriate as the oil price shocks correlate to its level of production and the world global demand. He separates the oil price shocks into three parts: (1) supply shocks to reflect oil production capacity, (2) aggregate demand shocks or oil demand caused by global economic conditions, and (3) oil specific demand shocks to reflect oil shocks caused by fear of future oil shortages. He then analyses impact of these distinct shocks to the US GDP and its CPI. Yoshizaki and Hamori (2013) extend Kilian's work by applying the same method on several industrialized economies and adding response of the REER to the shocks as the indirect transmission of oil price shock through trade channel.

All those works deal with developed economies. Emerging economies such as Indonesia, may response to the shocks differently. This paper extends those works in two ways. Firstly, data used is updated investigating the oil price shock affiliated with its production and the world economic activity which is indicated by index of industrial production (IIP) instead of dry cargo freight rates used in Kilian (2009). Secondly, different method in analyzing the responses of a country's macroeconomic variables is used since Indonesia is a small open economy. Kilian (2009) and Yoshizaki and Hamori (2013) perform regression of the shocks on the macroeconomic variables using single equation for each variable. In fact, the macroeconomic variables, GDP and CPI in Kilian (2009) and IIP, CPI and REER in (Yoshizaki and Hamori (2013), are correlated each other. As a consequence, the causal relationship, for example between GDP and CPI, is not captured. This paper therefore applies another VAR model in the next step by imposing lags constraints at which its GDP, CPI and REER will not affect the world oil price. However, its CPI and REER are still affected by its GDP.

This paper aims to investigate two questions. First, it explores the endogeneity of oil price shocks and second, it investigates the responses of Indonesian GDP, CPI and REER to the different type of oil price shocks. It is argued that oil price shocks are endogenously formed by oil-specific-demand itself, aggregate global demand and a fraction of oil stock. It is also contended that exports force still dominates the effects of oil price shocks to the Indonesian economy instead of oil imports dependence in recent times.

The rest of this paper is structured as follows. Section 2 provides the description of the data. Section 3 describes the VAR model used in this paper including the identification of the structural shocks. Section 4 presents the empirical results and the conclusion of the study is in section 5.

2. DATA DESCRIPTION

Table 1 exhibits the overall data sets and their sources. The data sets consist of data for the world and the data for Indonesia. The data for the world includes index of industrial production (IIP) as a reflection of real global economic activity, world production of oil as a reflection of oil supply and data of West Texas Intermediate (WTI) spot crude oil prices. The IIP data is the weighted sum of the IIPs of all OECD countries added with six economies including Brazil, China, India, Indonesia, Russia and South Africa as used in Yoshizaki and Hamori (2013). The data for Indonesia includes its GDP, CPI and REER. All data is quarterly data at which the sample period is from 1994 quarter 1 to 2013 quarter 2. To capture the effects of the Asian financial crisis in the late 1990s, a dummy variable is added. The dummy variable is constructed by defining 1 for 1997q4 to 1999q2 and 0 for the other periods.

Table 1 Data Sources

No	Variable	Description	Source
1	World production of oil	Seasonally adjusted using census X12 and de-trended using Hodrick-Prescott Filter.	EIA
2	IIP	Seasonally adjusted using census X12 and de-trended using Hodrick-Prescott Filter.	FRED& World Bank
3	WTI crude oil price	Deflated by US CPI; in natural log form; seasonally adjusted using census X12 and de-trended using Hodrick-Prescott Filter.	FRED
4	GDP Index of Indonesia	already seasonally adjusted; de-trended using Hodrick-Prescott Filter	FRED
5	CPI of Indonesia	seasonally adjusted using census X12; de-trended using Hodrick-Prescott Filter	FRED
6	REER of Indonesia	Seasonally adjusted using census X12.	FRED

All data run in the model are in levels as recommended by Sims (1980), Dean (1982) and Enders (1995). To tackle the non-stationarity problem, Hodrick-Prescott Filter is applied to take out the trend except for REER which is already stationary. After being de-trended, unit roots tests of the data are then being performed using Augmented Dickey Fuller (ADF) and Phillips Perron tests. The results show that all data arealready stationary (see Appendix).

3. THE MODEL

In this paper, a structural VAR model is preferred to the other time series models like a simple VAR or a vector error correction model (VECM) due to the needs for restrictions in the short run. Based on the characteristics in the oil markets, oil demand shocks do not have an immediate impact on the oil production or the supply of oil (Kilian 2009; Hamilton 2003). Such restrictions for the short run dynamics can be performed in a structural VAR model.

The first step is built following Kilian (2009) and Yoshizaki & Hamori (2013) as follows:

$$\boldsymbol{A_0 z_t} = \boldsymbol{\alpha} + \sum_{i=1}^{2} \boldsymbol{A_i z_{t-i}} + \boldsymbol{\varepsilon_t}$$

Where $\boldsymbol{\varepsilon_t}$ is a vector of mutually and serially uncorrelated structural innovations and $\boldsymbol{z_t}$ includes the world oil production, IIP as index of the world economic activity and real oil price expressed in logs. Meanwhile, the reduced form errors are decomposed following $\boldsymbol{e_t = A_0^{-1}\varepsilon_t}$ recursively using Cholesky decomposition:

$$e_t \equiv \begin{pmatrix} e_t^{prod} \\ e_t^{iip} \\ e_t^{price} \end{pmatrix} = \begin{bmatrix} a_{11} & 0 & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{pmatrix} \varepsilon_t^{oil\ supply\ shock} \\ \varepsilon_t^{aggregate\ demand\ shock} \\ \varepsilon_t^{oil\ specific-demand\ shock} \end{pmatrix}$$

Kilian (2009) identifies such restrictions motivated as follows. Oil production response to the global demand is sluggish instead of immediately within the same period due to high cost of adjustment of its production. It is supported with the evidence that oil producers tend to forecast oil demand only yearly. How the global demand responds to oil price changes has similar story to the previous one. The global demand does not react instantly when there are changes in the oil price, instead there is a delay at about one period which is consistent within the sample. Finally, oil price fluctuation is driven by uncertainty of oil production shortfalls in the future. Changes in demand for industrial products for instance automobiles, may push the oil price upsurge instantaneously because of rising consumption of petrol.

After obtaining a series of identified shocks from the first step, the second step of this model is then developed as follows:

$$\boldsymbol{A_0 X_t} = \boldsymbol{\alpha} + \sum_{i=1}^{2} \boldsymbol{A_i X_{t-i}} + \boldsymbol{\mu_t}$$

where $\boldsymbol{\mu_t}$ is a vector of mutually and serially uncorrelated structural innovations and $\boldsymbol{X_t}$ contains a series of identified shocks of the world oil production, world economic activity, real oil price and Indonesian macroeconomic variables which are GDP, CPI and REER as follows:

$$\begin{pmatrix} \varepsilon_t^{\text{oil supply shock}} \\ \varepsilon_t^{\text{aggregate demand shock}} \\ \varepsilon_t^{\text{oil-specific -demand shock}} \\ \varepsilon_t^{\text{gdp}} \\ \varepsilon_t^{\text{cpi}} \\ \varepsilon_t^{\text{reer}} \end{pmatrix}$$

The recursive reduced form errors are formed by:

$$\begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} \end{bmatrix} \begin{pmatrix} \mu_t^{oil\ sup ply} \\ \mu_t^{aggregate\ demand} \\ \mu_t^{oil\ specific-demand} \\ \mu_t^{gdp} \\ \mu_t^{cpi} \\ \mu_t^{reer} \end{pmatrix}$$

The Cholesky order of this second VAR assumes that shocks in the world oil production, global demand for industrial commodities and oil price affect Indonesian economy contemporaneously. They also affect both directly and indirectly through the trade channel because most oil to meet the domestic demand is imported. The order also assumes that a shock in the GDP components has an immediate effect on the CPI. For example when there are capital inflows, GDP rises quickly and relative price of consumption drops in consequence of interest rate increase as a monetary policy adjustment. On the other hand, as capital inflows, real exchange rate appreciates before it finally affects trade balance and GDP after some time. REER therefore does not have immediate effect to GDP and CPI.

Since Indonesia is a small open economy, it implies that Indonesia's GDP, CPI and REER should not affect the world oil production, global demand for industrial products and also the world oil price. Therefore, constraints which will allow such postulation to happen are constructed. However, the Indonesia's GDP will still have impact on its CPI and REER. The employed constraints are shown in Table 2.

Table 2 VAR Lags Constraints

Shocks to:	Response of:					
	prod_t	iip_t	$price_t$	GDP_t	CPI_t	REER_t
Oil supply_{t-i}	b_{11}	b_{12}	b_{13}	b_{14}	b_{15}	b_{16}
Aggregate demand_{t-i}	b_{21}	b_{22}	b_{23}	b_{24}	b_{25}	b_{26}
Oil specific demand_{t-i}	b_{31}	b_{32}	b_{33}	b_{34}	b_{35}	b_{36}
GDP_{t-i}	0	0	0	b_{44}	b_{45}	b_{46}
CPI_{t-i}	0	0	0	b_{54}	b_{55}	b_{56}
REER_{t-i}	0	0	0	b_{64}	b_{65}	b_{66}

Note: i = lags (1, 2)

In both VAR models, two lags are used to preserve the degrees of freedom as the models use quarterly data. The final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SIC) and Hannan-Quinn information criterion (HQ) also indicate two lags to be used and these two VAR models have satisfied stability condition.

4. EMPIRICAL RESULTS

4.1. Endogeneity of oil price

Whilst most oil shocks before 2000s were dominantly caused by physical disruptions due to exogenous factors for example wars, OPEC quota increases and cuts, the shocks during period of 2000s were mainly driven by strong upturn in demand such as from China. There is also evidence that ballooning price of oil in the early 1990s lasted temporarily for only about two quarters (IMF 2000). It indicates that there was a surge of anxiety of oil supply disruption during those periods, rather than actual diminishing oil resources as the fact that oil shortfalls in one region are likely to initiate production escalation in different regions. Not surprisingly, the accelerated world economic expansion taking place afterwards generates positive oil shocks.

Figure 1 shows the inter-relation between the oil production, aggregate global demand and the oil-specific-demand shocks. It exhibits the impulse responses to a positive shock in each of oil supply shock, aggregate demand shock and oil-specific-demand shock. The solid lines illustrate the impulse responses based on the point estimates and the dashed lines demonstrate the confidence intervals. The size of the positive shocks are calculated as per Cholesky one-standard-deviation innovations, which are ±525 thousand barrels per day for oil supply shock, ±0.7 – 1 per cent for aggregate demand shock and ±1.2 per cent for oil-specific-demand shock.

Overall, positive oil supply shocks have positively immediate effects on the global economic activity and the oil price. Positive aggregate demand shocks have positively immediate effect too on the oil price. On the contrary, positive shocks on the oil price do not have instantaneous impact on both the global economic activity and oil stock. These findings are consistent with the postulation in Section 3.

When there is a positive shock on the oil production, the global economic activities tend to go up quickly reaching the peak response of ±0.26 per cent before going back to its steady level. The oil price peak response is higher accounted for ±1.9 per cent but it dies out more quickly compared to the global economy reaction.

A positive shock in the global economic activities yields much greater effect on the oil price increase at which its peak response is more than threefold compared to the shock in oil supply. When the global demand for industrial products goes up, oil price spike follows immediately. Oil producer countries are likely

Figure 1 Responses To Cholesky One-Standard-Deviation Structural Shocks ± 2 S.E.

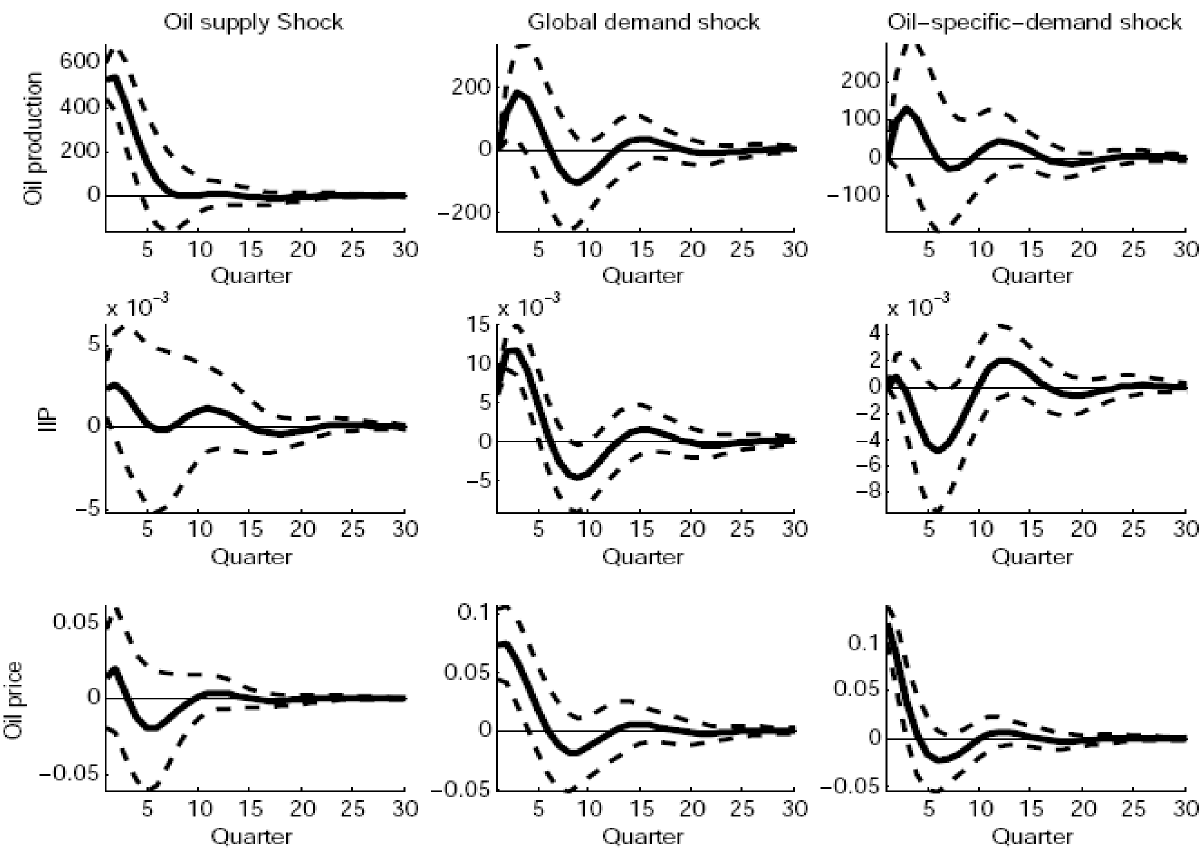
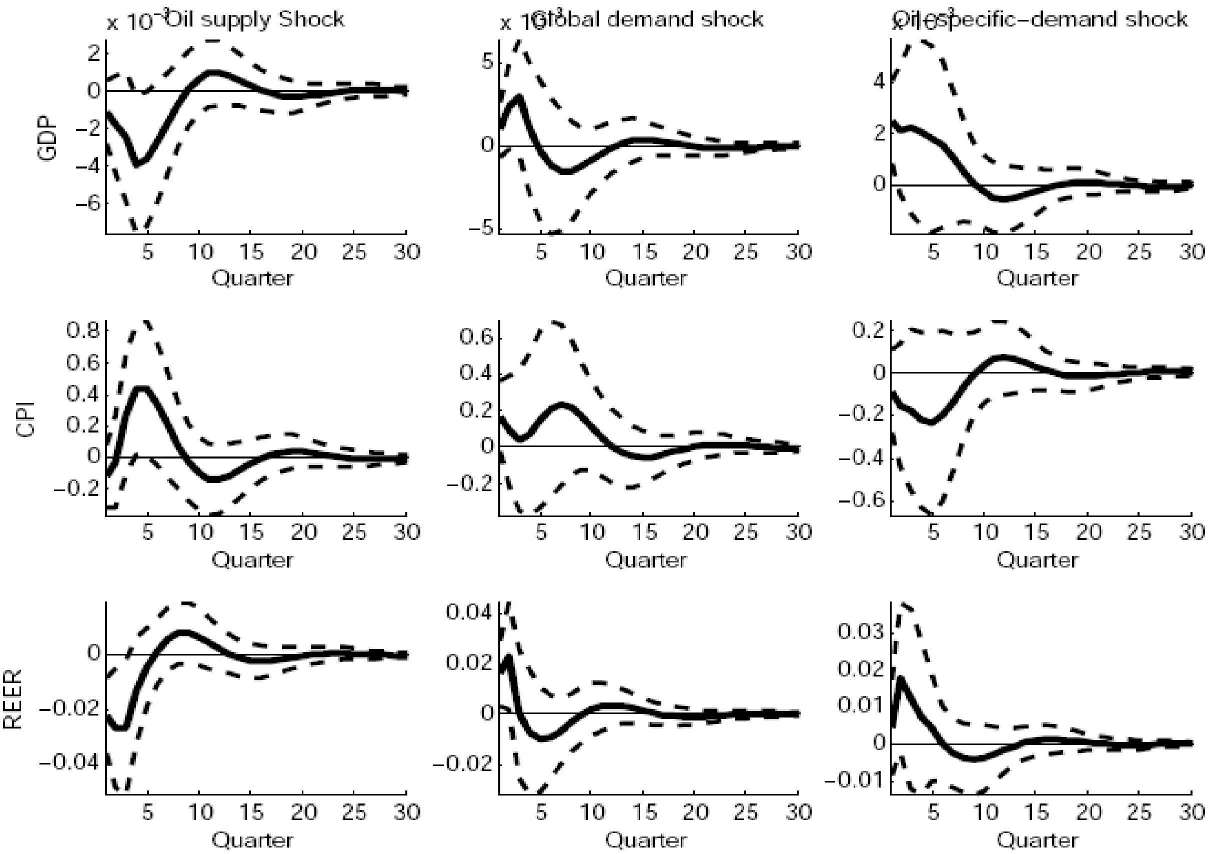


Figure 2 Responses of Indonesia Economy Indicators



to multiply their productions after at least one period. To keep the price high and stable, they reduce their production through oil cartel organizations such as OPEC. It then results in slowing down the global economic activities temporarily. Conversely, the unanticipated global demand shocks do not have statistically instant effect on the oil production. This finding indicates the exogeneity of oil supply shocks.

Table 3 Variance Decomposition

Quarter	Oil supply shock	Global demand shock	Oil-specific demand shock
	World Oil production		
1	100.00	0.00	0.00
4	87.82	8.26	3.92
8	86.00	9.97	4.03
40	83.12	12.26	4.61
	World industrial output		
Quarter	Oil supply shock	Global demand shock	Oil-specific demand shock
1	9.51	90.49	0.00
4	4.02	94.32	1.66
8	3.18	82.96	13.86
40	3.61	81.51	14.88
	Oil price		
Quarter	Oil supply shock	Global demand shock	Oil-specific demand shock
1	0.92	27.45	71.63
4	1.79	39.99	58.22
8	4.02	38.84	57.14
40	4.05	39.53	56.42

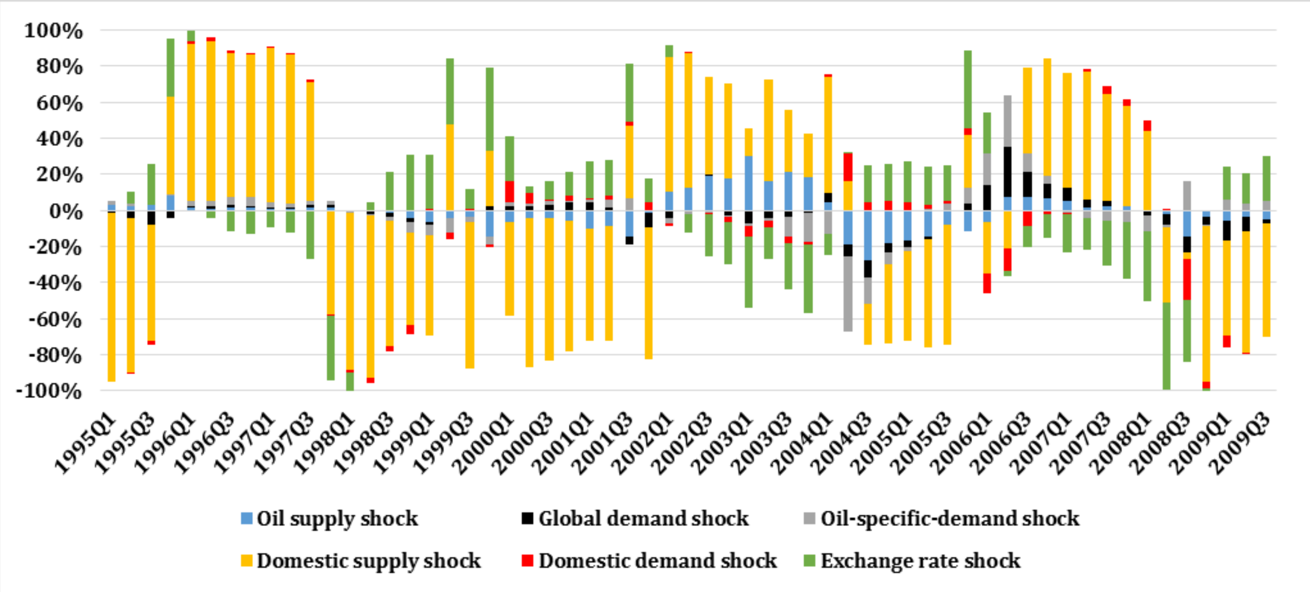
When oil price shoots up, the global economy does not instantaneously slow down, but there is a delay of one or two periods. This is consistent with the findings in Kilian (2009). Again, oil producer countries try to escalate their production in the next periods due to higher prices instead of promptly significant changes.

In other words, the oil price volatility is largely determined by its demand both global demand and oil-specific demand. Unanticipated global demand shocks and oil-specific-demand shocks have a greater effect to the oil price volatility compared to unanticipated oil supply shocks. It can also be seen from Table 3 that oil price is endogenous relative to the oil supply and the world's industrial output at all horizons. Meanwhile, the degree of exogeneity of oil supply is higher than the aggregate demand's in determining the oil price. Global demand shock has an influence on the oil supply in the long run only accounted for about 12 per cent, but it has significant impact for the world's industrial output and oil price for both in the short run and long run.

4.2. The responses of Indonesian economy

Indonesia had greatly depended on oil sector since the 1970s oil boom to early 2000s and it was a net oil exporter in the world during these periods since its oil supply exceeded its consumption. Figure 2 illustrates how Indonesia's economy as an oil exporter country reacts to global oil markets. The figure generally shows the responses of the level of Indonesia's real GDP, CPI

Figure 3 Historical Decomposition of Indonesia's GDP 1995Q1-2009Q3



and REER to each of three oil shock types which are the oil price shocks caused by the world oil production, by global demand for industrial products and also by the oil-specific-demand shocks.Instantaneously significant effects on the Indonesia's GDP shown in the figure demonstrate that these results are consistent with the presumptions in the model.

An oil supply shock initiates a statistically significant reduction in the GDP lasting for about eight quarters and then dies out afterwards. At the same time, the effects on the REER decline last longer for about 12 quarters before going back to its steady level and CPI falls in the first period then moves up with diminishing trend from second quarter ahead. Oil supply shocks affect GDP negatively because of the constraints in supply-side compliance to OPEC quotas. Hill (2000) finds that there has been only tiny variation in the volume of oil production of Indonesia since the beginning of 1970s. With the same level of production over time, Indonesia cannot achieve optimal gains from exports which eventually adversely affect its GDP. Having joined OPEC in 1962, Indonesia does not have significant influence within this organization (Barnes 1995). Moreover, he reveals that Indonesia has adhered to a range of production ceilings and quotas granted by OPEC for years as Indonesia is not a big-scale oil producing country.

Unlike the oil supply shock, unanticipated oil price shocks caused by global demand raise GDP in about four quarters then it declines below its level thereafter before coming back to its steady level after 12 quarters. Conversely, CPI goes down slightly in the first period, while REER goes up then depreciates from the second quarter.

Shocks in oil price caused by specific-demand produce statistically positive effects in which GDP significantly escalates in four horizons before slowing down towards its initial level. Surprisingly, this kind of shocks nearly does not have statistically significant impact on REER. There are only slightly positive changes on REER in three quarters and CPI also gain only a minor shift.

Why effect on GDP of an oil price shock initiated by specific-demand is greater than oil shock caused by an aggregate demand indicates that exports effect still dominates Indonesian economy. Such effect also depends on the macroeconomic policies performed. For the Indonesian case here, its policies regarding the oil price can be summarized as follows.

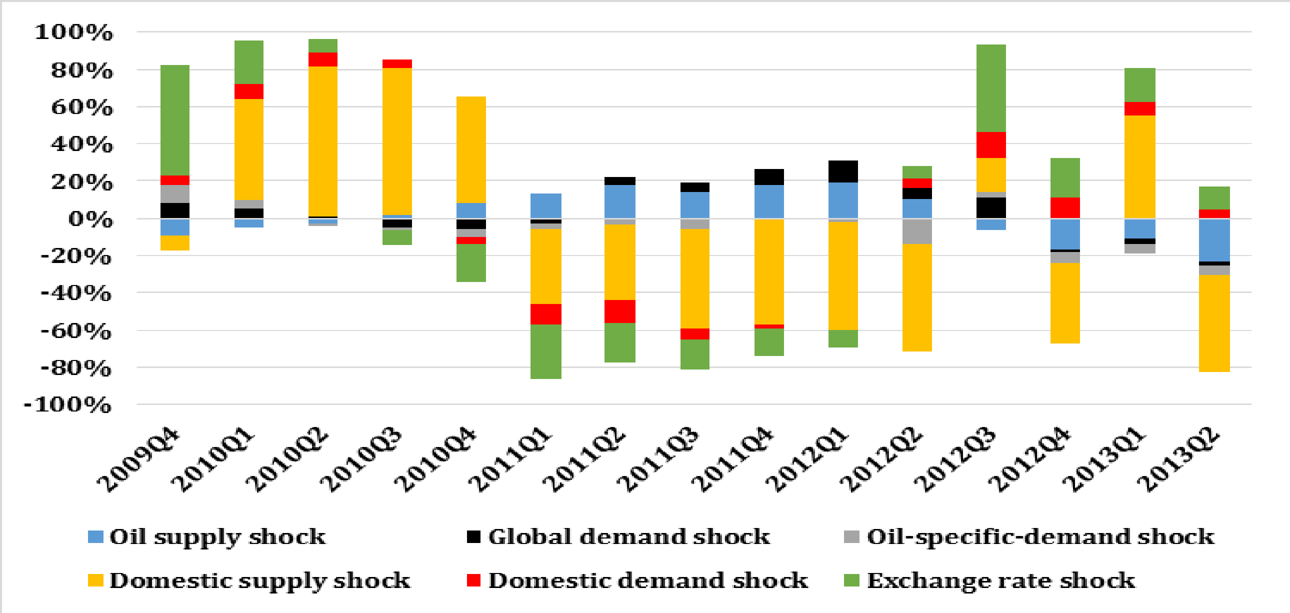
As an oil exporting country, Indonesia gain income shifts from the oil importing countries. During the oil boom in 1970s, Indonesia earned remarkable revenues and even in 1980s when the oil prices sharply declined, Indonesia still collected considerable revenues. The key policy implemented during those periods was that the government recycled the oil revenues into state enterprises sector. Another important policy carried out was the introduction of tariffs and non-tariff barriers relate to trade policies. These policies were then resulted in successful adjustments in driving manufacturing sectors which had made essential contribution to the economy through exports from 1990s.

4.3. Contribution to the Indonesia's GDP

This subsection is to study the impact of the shocks before and after Indonesia was withdrawn from OPEC in September 2009. Figure 3 depicts the contribution of each shock to the Indonesia's GDP in each period before 2009Q4 and Figure 4 illustrates the contribution of each shock after Indonesia was no longer an OPEC member.

The GDP was still mainly determined by domestic supply shocks along the period when Indonesia was still an OPEC member (see Figure 4). However, there was evidence that oil supply shocks and oil-specific-demand shocks played some role to the Indonesian GDP, for example between 2002Q1 and 2007Q1. There

Figure 4 Historical Decomposition of Indonesia's GDP 2009Q4-2013Q2



were positive oil supply shocks between 2002Q1 and 2004Q1, but they became negative thereafter. Negative oil-specific-demand shocks appeared getting larger from 2003Q3 to 2004Q3. This were because of spiking crude oil price during the period.

During the global financial crisis in 2008-2009, the pressures on the Indonesian economy originated mainly from negative domestic supply shocks and negative exchange rate shocks. There was only a small proportion of the pressures coming from negative oil supply shocks.

After Indonesia was removed from the OPEC membership in 2009Q3, the contribution of oil supply shock and oil-specific-demand shock to the Indonesian GDP remained unchanged. There were positive oil supply shocks between 2010Q4 and 2012Q2 then they became negative afterwards. In other words, there was no difference for Indonesia before and after becoming a member of OPEC or there was no evidence that Indonesia enjoyed benefits from being an OPEC member. So, the rejoining Indonesia into OPEC recently is questioned. In addition, after the Asian financial crisis in the late 1990s, the effect of exchange rate shock and global demand shock on the Indonesian GDP got stronger. This is due to the free floating regime in exchange rate applied by Indonesia

5. CONCLUSIONS

The main results can be summed up as follows. First, oil price shocks are endogenously formed by oil-specific-demand itself, aggregate global demand and a little of oil stock. A shock in the global demand has greater effects in determining the oil price compared to a shock in the oil production. Second, exports effect still dominates the oil price shocks impact on the Indonesian economy instead of oil imports dependence lately. The Indonesian economic variables respond in different ways depending on the type of the oil price shocks. To some extent, its GDP is influenced by all the three different types of unanticipated oil price shocks. It responds negatively due to the oil supply shocks but positively due to global demand and oil-specific-demand shocks. CPI and REER are only statistically significantly influenced by unanticipated oil supply shocks and aggregate demand shocks. Additionally, there is no evidence that Indonesia enjoys benefits from being an OPEC member.

As a consideration for the policy makers, Indonesia needs new investments in oil refineries to boost up the oil production. Not only will a positive oil supply shock stimulate a GDP growth, but it will also raise the government revenue from oil sector. Moreover, it can contribute to price stability especially in the energy sector. One limitation of this paper is that the strong assumptions imposed using the Cholesky identification strategy. Applying different strategies such as sign restrictions to check the robustness of the results is a worth topic to investigate in the future.

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APPENDIX

Unit root test of variable for oil production

Null Hypothesis: PROD_HP has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.856865	0.0037
Test critical values:	1% level	-3.519050	
	5% level	-2.900137	
	10% level	-2.587409	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(PROD_HP)
Method: Least Squares
Date: 12/24/15 Time: 05:48
Sample (adjusted): 1994Q3 2013Q2
Included observations: 76 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PROD_HP(-1)	-0.263643	0.068357	-3.856865	0.0002
D(PROD_HP(-1))	0.356400	0.110301	3.231148	0.0019
C	8.449587	62.37896	0.135456	0.8926

R-squared	0.210307	Mean dependent var	7.971571
Adjusted R-squared	0.188672	S.D. dependent var	603.7234
S.E. of regression	543.7962	Akaike info criterion	15.47370
Sum squared resid	21587148	Schwarz criterion	15.56570
Log likelihood	-585.0006	Hannan-Quinn criter.	15.51047
F-statistic	9.720522	Durbin-Watson stat	2.049433
Prob(F-statistic)	0.000181		

Null Hypothesis: PROD_HP has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.350298	0.0159
Test critical values:	1% level	-3.517847	
	5% level	-2.899619	
	10% level	-2.587134	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	321096.6
HAC corrected variance (Bartlett kernel)	471822.4

Phillips-Perron Test Equation
Dependent Variable: D(PROD_HP)
Method: Least Squares
Date: 12/24/15 Time: 05:55
Sample (adjusted): 1994Q2 2013Q2
Included observations: 77 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PROD_HP(-1)	-0.194639	0.068585	-2.837924	0.0058
C	4.437762	65.43218	0.067822	0.9461

R-squared	0.096971	Mean dependent var	5.251180
Adjusted R-squared	0.084931	S.D. dependent var	600.2132
S.E. of regression	574.1595	Akaike info criterion	15.56932
Sum squared resid	24724438	Schwarz criterion	15.63020
Log likelihood	-597.4189	Hannan-Quinn criter.	15.59367
F-statistic	8.053811	Durbin-Watson stat	1.419332
Prob(F-statistic)	0.005838		

Unit root test of variable for IIP

Null Hypothesis: IIP_HP has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.968128	0.0000
Test critical values:	1% level	-3.519050	
	5% level	-2.900137	
	10% level	-2.587409	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(IIP_HP)
Method: Least Squares
Date: 12/24/15 Time: 05:58
Sample (adjusted): 1994Q3 2013Q2
Included observations: 76 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IIP_HP(-1)	-0.231309	0.038757	-5.968128	0.0000
D(IIP_HP(-1))	0.763014	0.075535	10.10150	0.0000
C	2.52E-05	0.000895	0.028156	0.9776

R-squared	0.610333	Mean dependent var	0.000104
Adjusted R-squared	0.599658	S.D. dependent var	0.012329
S.E. of regression	0.007801	Akaike info criterion	-6.830567
Sum squared resid	0.004442	Schwarz criterion	-6.738565
Log likelihood	262.5616	Hannan-Quinn criter.	-6.793799
F-statistic	57.16982	Durbin-Watson stat	1.809347
Prob(F-statistic)	0.000000		

Null Hypothesis: IIP_HP has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.186699	0.0246
Test critical values:	1% level	-3.517847	
	5% level	-2.899619	
	10% level	-2.587134	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.000138
HAC corrected variance (Bartlett kernel)	0.000280

Phillips-Perron Test Equation
Dependent Variable: D(IIP_HP)
Method: Least Squares
Date: 12/24/15 Time: 05:58
Sample (adjusted): 1994Q2 2013Q2
Included observations: 77 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IIP_HP(-1)	-0.132100	0.057244	-2.307677	0.0238
C	0.000157	0.001359	0.115747	0.9082

R-squared	0.066298	Mean dependent var	0.000165
Adjusted R-squared	0.053848	S.D. dependent var	0.012259
S.E. of regression	0.011924	Akaike info criterion	-5.994833
Sum squared resid	0.010664	Schwarz criterion	-5.933955
Log likelihood	232.8011	Hannan-Quinn criter.	-5.970482
F-statistic	5.325372	Durbin-Watson stat	0.671484
Prob(F-statistic)	0.023777		

Unit root test of variable for WTI crude oil price

Null Hypothesis: PRICE_HP has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.761594	0.0000
Test critical values:	1% level	-3.519050	
	5% level	-2.900137	
	10% level	-2.587409	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(PRICE_HP)
Method: Least Squares
Date: 12/24/15 Time: 06:01
Sample (adjusted): 1994Q3 2013Q2
Included observations: 76 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PRICE_HP(-1)	-0.560580	0.097296	-5.761594	0.0000
D(PRICE_HP(-1))	0.385491	0.108523	3.552156	0.0007
C	0.026547	0.951901	0.027888	0.9778

R-squared	0.319859	Mean dependent var	-0.016883
Adjusted R-squared	0.301225	S.D. dependent var	9.926788
S.E. of regression	8.298077	Akaike info criterion	7.108598
Sum squared resid	5026.640	Schwarz criterion	7.200601
Log likelihood	-267.1267	Hannan-Quinn criter.	7.145367
F-statistic	17.16534	Durbin-Watson stat	2.021852
Prob(F-statistic)	0.000001		

Null Hypothesis: PRICE_HP has a unit root
Exogenous: Constant
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.055975	0.0020
Test critical values:	1% level	-3.517847	
	5% level	-2.899619	
	10% level	-2.587134	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	76.64324
HAC corrected variance (Bartlett kernel)	59.26248

Phillips-Perron Test Equation
Dependent Variable: D(PRICE_HP)
Method: Least Squares
Date: 12/24/15 Time: 06:03
Sample (adjusted): 1994Q2 2013Q2
Included observations: 77 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PRICE_HP(-1)	-0.405072	0.092779	-4.365996	0.0000
C	0.026407	1.010896	0.026122	0.9792

R-squared	0.202653	Mean dependent var	0.026220
Adjusted R-squared	0.192022	S.D. dependent var	9.868515
S.E. of regression	8.870573	Akaike info criterion	7.228987
Sum squared resid	5901.530	Schwarz criterion	7.289865

Log likelihood	-276.3160	Hannan-Quinn criter.	7.253337
F-statistic	19.06192	Durbin-Watson stat	1.540061
Prob(F-statistic)	0.000040		

Unit root test of variable for GDP of Indonesia

Null Hypothesis: Y_HP has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.385966	0.0145
Test critical values:	1% level	-3.519050	
	5% level	-2.900137	
	10% level	-2.587409	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(Y_HP)
Method: Least Squares
Date: 12/24/15 Time: 06:04
Sample (adjusted): 1994Q3 2013Q2
Included observations: 76 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Y_HP(-1)	-0.194430	0.057422	-3.385966	0.0011
D(Y_HP(-1))	0.361614	0.107321	3.369467	0.0012
C	0.000241	0.001118	0.215458	0.8300

R-squared	0.200953	Mean dependent var	0.000361
Adjusted R-squared	0.179061	S.D. dependent var	0.010748
S.E. of regression	0.009739	Akaike info criterion	-6.386779
Sum squared resid	0.006923	Schwarz criterion	-6.294776
Log likelihood	245.6976	Hannan-Quinn criter.	-6.350010
F-statistic	9.179388	Durbin-Watson stat	2.073172
Prob(F-statistic)	0.000278		

Null Hypothesis: Y_HP has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.034418	0.0361
Test critical values:	1% level	-3.517847	
	5% level	-2.899619	
	10% level	-2.587134	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.000104
HAC corrected variance (Bartlett kernel)	0.000156

Phillips-Perron Test Equation
Dependent Variable: D(Y_HP)
Method: Least Squares
Date: 12/24/15 Time: 06:05
Sample (adjusted): 1994Q2 2013Q2
Included observations: 77 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Y_HP(-1)	-0.152058	0.058342	-2.606293	0.0110
C	0.000467	0.001179	0.396268	0.6930

R-squared	0.083048	Mean dependent var	0.000483
Adjusted R-squared	0.070822	S.D. dependent var	0.010730
S.E. of regression	0.010343	Akaike info criterion	-6.279329
Sum squared resid	0.008024	Schwarz criterion	-6.218451
Log likelihood	243.7542	Hannan-Quinn criter.	-6.254978
F-statistic	6.792762	Durbin-Watson stat	1.358440
Prob(F-statistic)	0.011035		

Unit root test of variable for CPI of Indonesia

Null Hypothesis: CPI_HP has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.983320	0.0001
Test critical values:	1% level	-3.520307	
	5% level	-2.900670	
	10% level	-2.587691	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(CPI_HP)
Method: Least Squares
Date: 12/24/15 Time: 06:06
Sample (adjusted): 1994Q4 2013Q2
Included observations: 75 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPI_HP(-1)	-0.291144	0.058424	-4.983320	0.0000
D(CPI_HP(-1))	0.395935	0.102384	3.867138	0.0002
D(CPI_HP(-2))	0.320039	0.112668	2.840541	0.0059
C	-0.014031	0.120105	-0.116821	0.9073

R-squared	0.369855	Mean dependent var	-0.018128
Adjusted R-squared	0.343229	S.D. dependent var	1.282038
S.E. of regression	1.038982	Akaike info criterion	2.966219
Sum squared resid	76.64338	Schwarz criterion	3.089818

Log likelihood	-107.2332	Hannan-Quinn criter.	3.015571
F-statistic	13.89080	Durbin-Watson stat	1.981973
Prob(F-statistic)	0.000000		

Null Hypothesis: CPI_HP has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.302596	0.0181
Test critical values:	1% level	-3.517847	
	5% level	-2.899619	
	10% level	-2.587134	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	1.453607
HAC corrected variance (Bartlett kernel)	2.641944

Phillips-Perron Test Equation
Dependent Variable: D(CPI_HP)
Method: Least Squares
Date: 12/24/15 Time: 06:06
Sample (adjusted): 1994Q2 2013Q2
Included observations: 77 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPI_HP(-1)	-0.154977	0.059538	-2.602973	0.0111
C	-0.030788	0.139218	-0.221148	0.8256

R-squared	0.082855	Mean dependent var	-0.029346
Adjusted R-squared	0.070626	S.D. dependent var	1.267194
S.E. of regression	1.221626	Akaike info criterion	3.263873
Sum squared resid	111.9277	Schwarz criterion	3.324751
Log likelihood	-123.6591	Hannan-Quinn criter.	3.288224
F-statistic	6.775468	Durbin-Watson stat	1.170383
Prob(F-statistic)	0.011133		

Unit root test of variable for REER of Indonesia

Null Hypothesis: REER_HP has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.268193	0.0000
Test critical values:	1% level	-3.520307	
	5% level	-2.900670	
	10% level	-2.587691	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(REER_HP)
Method: Least Squares
Date: 12/24/15 Time: 06:08
Sample (adjusted): 1994Q4 2013Q2
Included observations: 75 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
REER_HP(-1)	-0.421177	0.079947	-5.268193	0.0000
D(REER_HP(-1))	0.370986	0.104371	3.554498	0.0007
D(REER_HP(-2))	0.294832	0.113221	2.604043	0.0112
C	0.001019	0.007270	0.140163	0.8889

R-squared	0.319127	Mean dependent var	0.000566
Adjusted R-squared	0.290358	S.D. dependent var	0.074725
S.E. of regression	0.062948	Akaike info criterion	-2.641144
Sum squared resid	0.281338	Schwarz criterion	-2.517545
Log likelihood	103.0429	Hannan-Quinn criter.	-2.591792
F-statistic	11.09263	Durbin-Watson stat	2.004032
Prob(F-statistic)	0.000005		

Null Hypothesis: REER_HP has a unit root
Exogenous: Constant
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.148551	0.0271
Test critical values:	1% level	-3.517847	
	5% level	-2.899619	
	10% level	-2.587134	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.004744
HAC corrected variance (Bartlett kernel)	0.004744

Phillips-Perron Test Equation
Dependent Variable: D(REER_HP)
Method: Least Squares
Date: 12/24/15 Time: 06:09
Sample (adjusted): 1994Q2 2013Q2
Included observations: 77 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
REER_HP(-1)	-0.232728	0.073916	-3.148551	0.0024
C	0.000335	0.007953	0.042120	0.9665

R-squared	0.116747	Mean dependent var	0.000268
Adjusted R-squared	0.104970	S.D. dependent var	0.073766
S.E. of regression	0.069787	Akaike info criterion	-2.461098

Sum squared resid	0.365270	Schwarz criterion	-2.400220
Log likelihood	96.75226	Hannan-Quinn criter.	-2.436747
F-statistic	9.913374	Durbin-Watson stat	1.400206
Prob(F-statistic)	0.002356		

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