Identifying Shocks on the Economic Fluctuations in Indonesia and US: The Role of Oil Price Shocks in a Structural Vector Autoregression Model

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Identifying Shocks on the Economic Fluctuations in Indonesia and US: The Role of Oil Price Shocks in a Structural Vector Autoregression Model*

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Abstract

In this paper the sources of the Indonesian economic slowdown as well as US economic fluctuations are investigated within a range of four-variable structural vector autoregression models. Identification is attained either through the combination of short-run and long-run restrictions or the more recent sign restrictions. The results show that both economies are not affected by disturbances in the same way. Indonesian economic output is lowered by falling contribution of oil price shocks, negative aggregate supply shocks and tightening monetary policy. Meanwhile, the US economy is mainly driven by aggregate supply shocks. The effect of oil price disturbance to the US itself declines over time and the monetary policy shocks no longer hurt the US economy.

Keywords: Economic fluctuations, oil price shocks, Structural Vector Autoregression

1 Introduction

During the period of the 1970s up until the 1990s the Indonesian economic growth was generally higher relative to the period of the recent 2000s (see Figure 1). The higher growth in the previous periods was associated with the enormous growth of oil sector (Hill 1996; 2000). Similar to Indonesia, the US economic growth in the current 2000s was also lower compared to the periods of the 1970s and 1990s. Peersman (2005) finds

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that the US economic slowdown in the early 2000s was partly explained by the oil price shocks. Hamilton (2000) also shows that an oil price upturn dampens the US economy. More precisely, a 3 per cent cumulative decline in the US real GDP from the late 1970s to the beginning of the 1980s and 5 per cent during global financial crisis are contributed by oil price shocks (Kilian & Vigfusson 2014). Updated studies on how oil price shocks today affect the US economic fluctuations have not been conducted since those works. Such study is even not found for Indonesia's case. This paper will be the first attempt to model the effect of oil price shocks on a small open economy like Indonesia. In particular, comparing the US as a net importer of oil with the Indonesia as a net exporter of oil can be beneficial so that the government can apply better policies to stimulate higher economic growth.

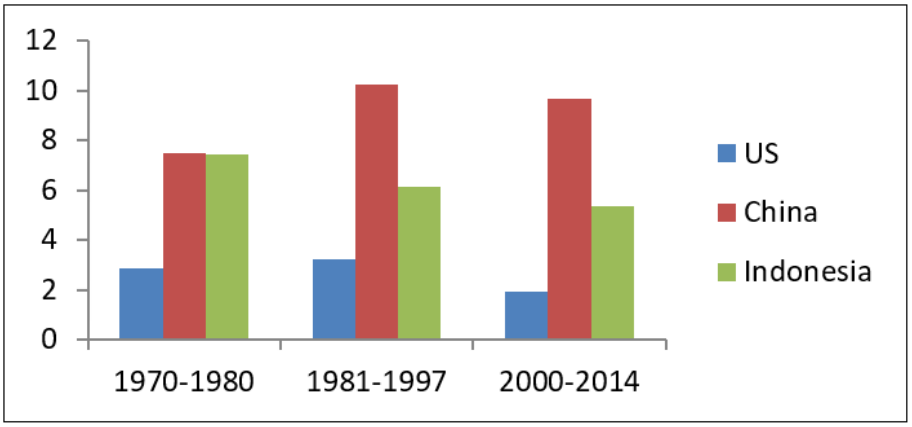

Figure 1: Average annual growth rate
Source: Indonesia Bureau of Statistics (2015); US Bureau of Economic Analysis (2015)

As presented in Figure 2, Indonesia is a net exporter of oil. In comparison, the US is still a large importer of oil although its imported volume has started to reduce since 2007. Unlike the negative effects on the oil importer countries, the shocks in the oil price lead to a positive growth on the economy of oil exporter countries (Abeysinghe 2001). Additionally, the shock impacts are nonlinear implying that the positive effects for oil exporter countries are higher compared to the negative effects for oil importer countries (Hamilton 2003; 2011; Cunado & Gracia 2005).

The modelling framework used in this paper is a structural vector autoregression (SVAR) model. Since Sims (1980), VARs have been very popular as a tool to analyze macroeconomic data. Many studies have been conducted to investigate the factors lying behind economic fluctuations using the VAR framework, especially on a large developed economy of the US. Not only do oil price shocks have influences on the fluctuations of the GDP growth, other shocks including aggregate supply, aggregate demand and monetary policy shocks are also significant over the periods. For instance, Walsh (1993) claims that the US recessions of 1990 1991 are because of negative shocks of aggregate spending together with disruption in supply and demand for money. Likewise, using a

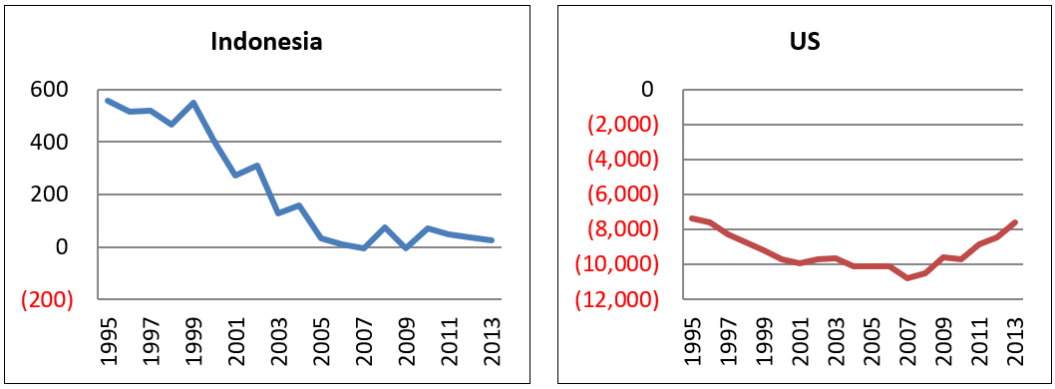

Figure 2: Daily net exports of crude oil (barrel th)
Source: OPEC (2014)

four-variable SVAR model, Peersman (2005) identifies not only oil price increase, but also negative aggregate supply shocks, negative aggregate demand shocks and restrictive monetary policy as contributors of the US economic slowdown during early millennium. For Indonesia, Siregar and Ward (2002) find that aggregate demand shocks significantly explained Indonesian output fluctuation during 1984 1999.

Unlike Siregar and Ward (2002) who identify that aggregate demand shocks have a permanent effect on the Indonesian output, Blanchard and Quah (1989) and Gali (1999) reveal that such shocks only have a temporary effect on the US output. In contrast, an aggregate supply shock has a permanent effect on the US output. Similar to the aggregate demand shock impact on the US output, a monetary policy shock is also believed that it affects the output just temporarily (Bernanke & Blinder 1992; Christiano et al. 1998). Following oil price disturbances, a tightening monetary policy is found having contribution to fluctuations of the US economy (Bernanke et al. 1997).

This paper extends the model of Peersman (2005) in several ways. First, the US dataset is extended from 90 observations (1980q1 2002q2) to 140 observations (1980q1 2014q4). Second, a similar model is estimated for an oil exporting country of Indonesia with a full set of shocks including oil price, aggregate supply, aggregate demand and monetary policy shocks. This may give valuable lessons since many episodes have happened during the last decade including the global financial crisis in 2008 2009. The oil price drop since mid-2014 may also strengthen the output growth and lower the inflation rate of the oil importing countries, but cause some losses in exports and revenues for the oil exporting countries (Baffes et al. 2015).

The key findings of this paper are as follows. The strong Indonesian economic performance during 1990s was because of the large aggregate supply shocks outweighing the other shocks. Meanwhile, the positive contribution of oil price shocks to the Indonesian output had been falling down since the Asian financial crisis in the late 1990s and they even became negative during 2013 2014. Another important finding is that the inflation

targeting framework introduced in 2005 has allowed oil price shocks to influence the Indonesian monetary policy behavior. For the US case, the effect of oil price disturbance declines over time especially compared with the period before 2002 which is when the Peersman sample period ends. The monetary policy shocks also no longer hurt the US economy.

The rest of this paper is organized as follows. Section 2 describes the model incorporating its technical aspects. The data and variables construction as well as the identification strategies are also explained. Section 3 discusses the empirical results showing the impacts of each shock to the Indonesia and US economies. This section presents impulse response analysis and some robustness check using alternative identification strategy and an alternative variable. This section also provides variance decompositions along with the historical decompositions analysis. Section 4 draws the conclusions with possible policy implications for Indonesia.

2 The Model

2.0.1 The Model Specification

The model used is an SVAR model following Peersman (2005) as follows:

$$\boldsymbol{Y_t} = \boldsymbol{c} + \sum_{i=1}^{n} \boldsymbol{A_i Y_{t-i}} + \boldsymbol{B\varepsilon_t} \tag{1}$$

where $\boldsymbol{Y_t}$ consists of oil price (oil_t), GDP (y_t), consumer price index (p_t) and nominal interest rate (r_t). All variables are expressed in percentage log return form except for the interest rate which is in percent. $\boldsymbol{c}$ is a $(n \times 2)$ matrix containing deterministic components which are a constant and a linear trend. $\boldsymbol{A_i}$ is autoregressive coefficients of $(n \times n)$ matrix and $\boldsymbol{\varepsilon_t}$ is vector of structural disturbances. In sum, the full set of constructed endogenous variables is

$$\boldsymbol{Y_t} = \{\boldsymbol{100\Delta ln\left(oil_t\right), 100\Delta ln\left(y_t\right), 100\Delta ln\left(p_t\right),\ r_t}\ \}. \tag{2}$$

To capture the effects of the Asian financial crisis in the late 1990s, a dummy variable is added into the model specification for Indonesia, so that the equation (1) becomes:

$$\boldsymbol{Y_t} = \boldsymbol{c} + \sum_{i=1}^{n} \boldsymbol{A_i Y_{t-i}} + \boldsymbol{\kappa D_t} + \boldsymbol{B\varepsilon_t} \tag{3}$$

where where D_t is the dummy variable for the crisis period and κ is a (n×1) matrix of slope parameters. The dummy variable is constructed by defining 1 for 1997q4 to 1999q2 and 0 for the other periods.

As the data used is a quarterly data, the SVAR model is estimated using three lags.

The Likelihood Ratio (LR), Final Prediction Error (FPE) and Akaike Information Criterion (AIC) also suggest three lags to be used. LR still indicates three lags for the full data sets used in model specification for the US. All models estimated satisfy the stability condition. Under the model structure, four principal shocks identified are oil price, aggregate supply, aggregate demand (spending) and monetary policy shocks, respectively:

$$\varepsilon_t^{'} = \left[\varepsilon^{oil}, \varepsilon^{as}, \varepsilon^{ad}, \varepsilon^{m}\right]. \tag{4}$$

To analyze further due to the importance of industrial sector, GDP is replaced by industrial production on the other model specification for the Indonesian case as a robustness check. Also, to study the structural changes in the US economy over time, estimation using different periods of data is presented.

2.1 Data and sample

The four endogenous variables chosen aim to provide a full set of shocks. Oil price is used as a proxy for oil shocks. GDP and industrial production are proxies for aggregate supply shocks, while CPI is determined as a proxy for aggregate demand shocks. Finally, nominal interest rate is used as a proxy for monetary policy shocks. The data are collected from various sources (see Appendix 1). All series of variables appear in a quarterly data basis.

GDP and industrial production are already available in quarterly series, but oil price, CPI and interest rate series are available in monthly base. So, the quarterly series for these data are constructed by taking average over quarter. GDP and industrial production series are seasonally adjusted. The sample period used for Indonesia is from 1992q1 2014q4 (92 observations), while the full set of the sample period for the US is from 1980q1 2014q4 (140 observations). Estimation using sample from 1980q1 2002q2 (90 observations) as used in Peersman (2005) is also presented to analyze the structural changes in the US economy.

Unit roots tests of the raw data and constructed variables are performed using Augmented Dickey Fuller (ADF) and Phillips Perron tests in Eviews version 8. The results show that all raw data are integrated processes of order one (I (1)) at 1 per cent significance level. After constructions, all are I (0) except for the interest rate as it is still kept in its level. It is therefore still I (1). However, the interest rate can be treated as I (0) as the nominal interest rate cannot have a unit root if inflation and real interest rate are stationary (Gali 1992; Gerlach & Smets 1995; Peersman 2005). The presence of the unit roots can also be looked at through the data plots (see Appendix 2).

2.2 Identification

Without constraints or structural identification, a VAR model is less meaningful. This identification part is therefore crucial in the VAR model. After the additional structure is imposed on the model, impulse responses, variance decompositions as well as historical decompositions as information of dynamic properties are then able to be interpreted. The structure now makes the model become an SVAR model. Common identification strategies used in SVAR are short run restriction, long run restriction, combined short run and long run restriction and sign restriction (Martin et al. 2013). The first three restrictions are recognized as traditional parametric restrictions, while the latest is a non-parametric restriction since it is directly imposed onto the impulse response functions rather than on the structural parameters.

Adopting Peersman (2005) procedures, two different identification strategies are used in identifying the four shocks in this paper. First is based on traditional restriction combining short run and long run restrictions. Such strategy is also applied in Gali (1992) with a four-variable IS-LM model and Gerlach and Smets (1995) with a monetary model. As an alternative, the second strategy i.e. sign restriction where zero restrictions are released is used. Both strategies including the estimation techniques are discussed in detail respectively in the next subsections.

2.2.1 Traditional restriction

The first identification chosen which combines short run and long run restrictions is motivated as follows. In his influential work, Sims (1980) models the US economy using recursive short run restriction with four endogenous variables including interest rate, money supply, prices and output. Extending the Sims model and Leeper et al. (2004), Kim and Roubini (2000) argue that the structural restriction does not have to be recursive. However, one limitation of the non-recursive structure is that there are difficulties to find strong instruments identifying the causality of variables (Kilian 2011).

In modelling the oil price, one example using recursive short run restriction is Kilian (2009). He disentangles the oil price shocks into three parts i.e. oil supply, global demand and oil-specific demand shocks. The latest is reflected by the oil price itself. Among those three, oil-specific demand and global demand are the most dominant shocks. This result underlines that exogenous assumption of oil price shocks may be too stringent. This assumption is released in the second identification strategy used in this paper.

Beside the strong contemporaneous assumptions, the short run restrictions either recursive or non-recursive also offer less theoretical assumptions. So, long run restriction is the next alternative identification strategy which is better justified by theory (Martin et al. 2013). One advantage of this long run restriction is that the short run dynamics remain unrestricted.

To get the best features of both short run and long run restrictions, the combination of both is used in this paper. It makes the imposed restrictions more plausible compared to single short run restriction. Under this strategy, the oil price is assumed not to be contemporaneously affected by the shocks of non-oil variables. This assumption is motivated by the fact that Indonesia is a small oil exporter and the US is an oil importer country. In the VAR literature, Sims (1992) also uses such exogenous oil price assumption. Following Bernanke and Blinder (1992), a monetary policy shock is assumed not to have immediate effect on output. Relying on the vertical long run Philips curve, aggregate demand and monetary shocks are assumed not to have long run effects on output (Blanchard & Quah 1989; Gali 1992; 1999). Shocks in the aggregate demand are also known as aggregate spending or IS shocks (Peersman 2005).

As a result of the combination of both restrictions, the system forms a just identified model. Let S is the matrix of short run restriction and F is the matrix of long run restriction. Since the model has four endogenous variables and three lags, $\mathbf{\Phi}$ which is an (4×4) inverse matrix of autoregressive parameters, is specified as

$$\Phi = \left[I_4 - \widehat{\Phi}_1 - \widehat{\Phi}_2 - \widehat{\Phi}_3 \right]^{-1} \tag{5}$$

The matrices of short run and long run restrictions are then respectively as follows:

$$\boldsymbol{S}= \begin{bmatrix} s_{11} & 0 & 0 & 0 \\ s_{21} & s_{22} & s_{23} & 0 \\ s_{31} & s_{32} & s_{33} & s_{34} \\ s_{41} & s_{42} & s_{43} & s_{44} \end{bmatrix} \boldsymbol{F}= \begin{bmatrix} f_{11} & f_{12} & f_{13} & f_{14} \\ f_{21} & f_{22} & 0 & 0 \\ f_{31} & f_{32} & f_{33} & f_{34} \\ f_{41} & f_{42} & f_{43} & f_{44} \end{bmatrix} \tag{6}$$

As $F = \Phi S$, $f_{23}$and f_{24} which are restricted to be zero in the long run, can be derived as

$$f_{23} = \Phi_{21} s_{13} + \Phi_{22} s_{23} + \Phi_{23} s_{33} + \Phi_{24} s_{43} = 0 \tag{7}$$

$$f_{24} = \Phi_{21} s_{14} + \Phi_{22} s_{24} + \Phi_{23} s_{34} + \Phi_{24} s_{44} = 0 \tag{8}$$

At which Φ_{ij} is an element of $\mathbf{\Phi}$ given in equation (5). Once all restrictions are set, the matrix S becomes

$$\boldsymbol{S}= \begin{bmatrix} s_{11} & 0 & 0 & 0 \\ s_{21} & s_{22} & s_{23} & 0 \\ s_{31} & s_{32} & s_{33} & -\frac{\Phi_{24}}{\Phi_{23}} s_{44} \\ s_{41} & s_{42} & -\frac{\Phi_{22}}{\Phi_{24}} s_{23} - \frac{\Phi_{23}}{\Phi_{24}} s_{33} & s_{44} \end{bmatrix} \tag{9}$$

Because of the non-recursive structure, ordinary least squares (OLS) method will be inconsistent as simultaneity bias will arise due to the existence of endogenous variables

in each equation (Martin et al. 2013). Therefore, maximum likelihood method is needed to estimate the parameters of the SVAR in S matrix. The parameters of the S matrix in equation (6) are estimated using maximum likelihood as follows:

$$lnL_t = -\frac{N}{2}ln(2\pi) - \frac{1}{2}ln|\Omega| - \frac{1}{2}e_t'\Omega^{-1}e_t' \tag{10}$$

where $N = 4$ is the number of endogenous variables, $\hat{e}_t$ is the estimated residuals and Ω is the variance-covariance matrix of the SVAR. The log likelihood for T observations is

$$\ln L \ = \sum_{t=1}^{T} ln\ L_t, \tag{11}$$

which is maximized with respect to the parameters in S matrix computed based on MATLAB version R2014a.

2.2.2 Sign restriction

The zero contemporaneous restrictions imposed in the traditional strategy are found too stringent, for instance the exogenous assumption of oil price. Kilian (2009) argues that this assumption is inappropriate since the oil price shock is closely connected to its precautionary demand or market concerns about oil supply and its global demand. Also, assumption of no contemporaneous impact of monetary policy on output is not consistent with most general equilibrium models (Canova & Pina 1999). Similarly, long run restriction can also be misleading. Permanent impacts of nominal and money shocks on output are accepted based on some growth models, such as OLG model (Gali 1992).

So, to check the robustness of the results using traditional identification strategy, sign restrictions are used as an alternative. Instead of imposing parametric restrictions, this latter strategy imposes more explicit restrictions directly onto impulse response functions.

This identification strategy which is also known as a non-parametric restriction is a representation of generalization approach of the previous traditional restrictions (Martin et al. 2013). In the previous methods, the ordering of variables is chosen with the purpose of obtaining impulse responses consistent with the theory. In this sign restriction approach, models with signs consistent are directly selected, so that the zero restrictions imposed in traditional approach are no longer needed. To study the economic fluctuations, this strategy is used by Peersman (2005), Ruffer et al. (2007) and Sanchez (2007). Meanwhile, Faust (1998), Canova and de Nicolo (2002), Uhlig (2005), Scholl and Uhlig (2008) and Rafiq and Mallick (2008) use this strategy to study a monetary shock. Kilian and Murphy (2009; 2012) also use this strategy to study the oil market dynamics. Even though this sign restriction method solves the structural identification problem, the model identification problem is still unresolved (Fry & Pagan 2011).

The sign conditions applied in this paper are based on theoretical framework and the

characteristics of each economy of Indonesia and the US. For example, an oil price shock is expected to have positive effect on the Indonesian output, but negative effect on the US output. This is because Indonesia is a net exporter of oil while the US is a net oil importer referring to Figure 2 in Section 1.

Other sign conditions following Peersman (2005) are as follows. First, after an expansion of the economy, it is expected that output will increase and prices and nominal interest rates will decrease. It is because when supply of goods escalates, prices in the goods market tend to fall, so that interest rates are likely to be lower. Second, following a positive demand shock, responses of all variables are expected to be non-negative. These are consistent with IS curve shift. On the contrary, after a tightening of monetary policy, it is expected that there will be a negative response of oil price, output and prices. All sign conditions are imposed as $\leq$ or $\geq$ implying that zero responses are allowed. Additionally, since an oil price shock can be considered as a supply shock, there is no restriction imposed on oil price response due to an aggregate supply shock. The response will be determined by the data. As a consequence, the responses of output, prices and interest rates due to either oil price shock or aggregate supply shock will be the same. So, to separate between the two shocks, it is assumed that the shock with the greatest impact on oil price is the oil price shock. All the sign conditions are summarized in Table 1 and 2.

Shocks	oil price	output	CPI	r
Aggregate demand	≥ 0	≥ 0	≥ 0	≥ 0
Monetary policy	≤ 0	≤ 0	≤ 0	≥ 0
Aggregate supply	?	≥ 0	≤ 0	≤ 0
Oil price	≥ 0	≥ 0	≤ 0	≤ 0

Table 1: Sign restriction for Indonesia

Shocks	oil price	output	CPI	r
Aggregate demand	≥ 0	≥ 0	≥ 0	≥ 0
Monetary policy	≤ 0	≤ 0	≤ 0	≥ 0
Aggregate supply	?	≥ 0	≤ 0	≤ 0
Oil price	≥ 0	≤ 0	≥ 0	≤ 0

Table 2: Sign restriction for the US

Technically, the B matrices in equations (1) and (3) are estimated to generate new set of uncorrelated shocks by incorporating Givens rotation matrix Q. Since the shocks ε_t are orthogonal, variance covariance matrices in equations (1) and (3) are $\Omega = \mathrm{BB}'$. Infinite number of appropriate decompositions of Ω can be found by setting up $\Omega = BQQ'B'$ where B is the Cholesky decomposition of Ω.

$$Q = \Pi_{m,n} Q_{m,n}(\theta) \tag{12}$$

with $Q_{m,n}(\theta)$ as six bivariate rotation matrices since there are four endogenous variables within the model. $Q_{1,2}$, for instance, has the form:

$$Q_{1,2}=\begin{bmatrix} \cos(\theta) & -\sin(\theta) & 0 & 0 \\ \sin(\theta) & \cos(\theta) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{13}$$

The Q matrix is then formed by:

$$Q=Q_{1,2}\times Q_{1,3}\times Q_{1,4}\times Q_{2,3}\times Q_{2,4}\times Q_{3,4} \tag{14}$$

where this Q matrix is an orthonormal matrix with the properties $QQ' = Q'Q = I_n$. $\theta = \theta_1, \dots , \theta_6$ and rows m and n are rotated by the angle θ_i. Each θ_i is drawn from a uniform distribution $[0, \pi]$. Finally, impulse response functions are computed. If they satisfy the sign conditions, they are retained, but if not, another Q matrix is drawn. To correct the problems of identification for the shocks magnitude, a normalization of the structural equations is needed (Ouliaris et al. 2015). This step is used in this paper following Peersman (2005).

3 Empirical results/discussion

3.1 Dynamic inter relationships: Impulse responses based on traditional restriction

The responses of each variable due to structural shocks based on traditional short run and long run restrictions are displayed in Figure 3 (Indonesia) and Figure 4 (US). The impulse responses of oil price, output and price are accumulated to look into the effects on levels of these variables. While the impulse responses of interest rate are not accumulated since this variable is already in level. All of impulse responses are reported for 40 quarters or 10 years.

Oil price shocks

The responses of all four variables due to an unanticipated oil price shock are shown in the first columns of Figure 3 and Figure 4. This shock is signified by a positive shock to oil price. Following this shock, there are permanent effects on the output and price levels, but only a short-lived effect on the interest rates. The magnitudes of the oil price shock are very close in both countries accounted for over 12 per cent. It shows that both countries are price takers in the oil market. However, given that Indonesia is a net exporter of oil, this shock affects Indonesian GDP positively. As the economy expands, prices in the goods market fall. Interest rate rises in short term as a consequence of

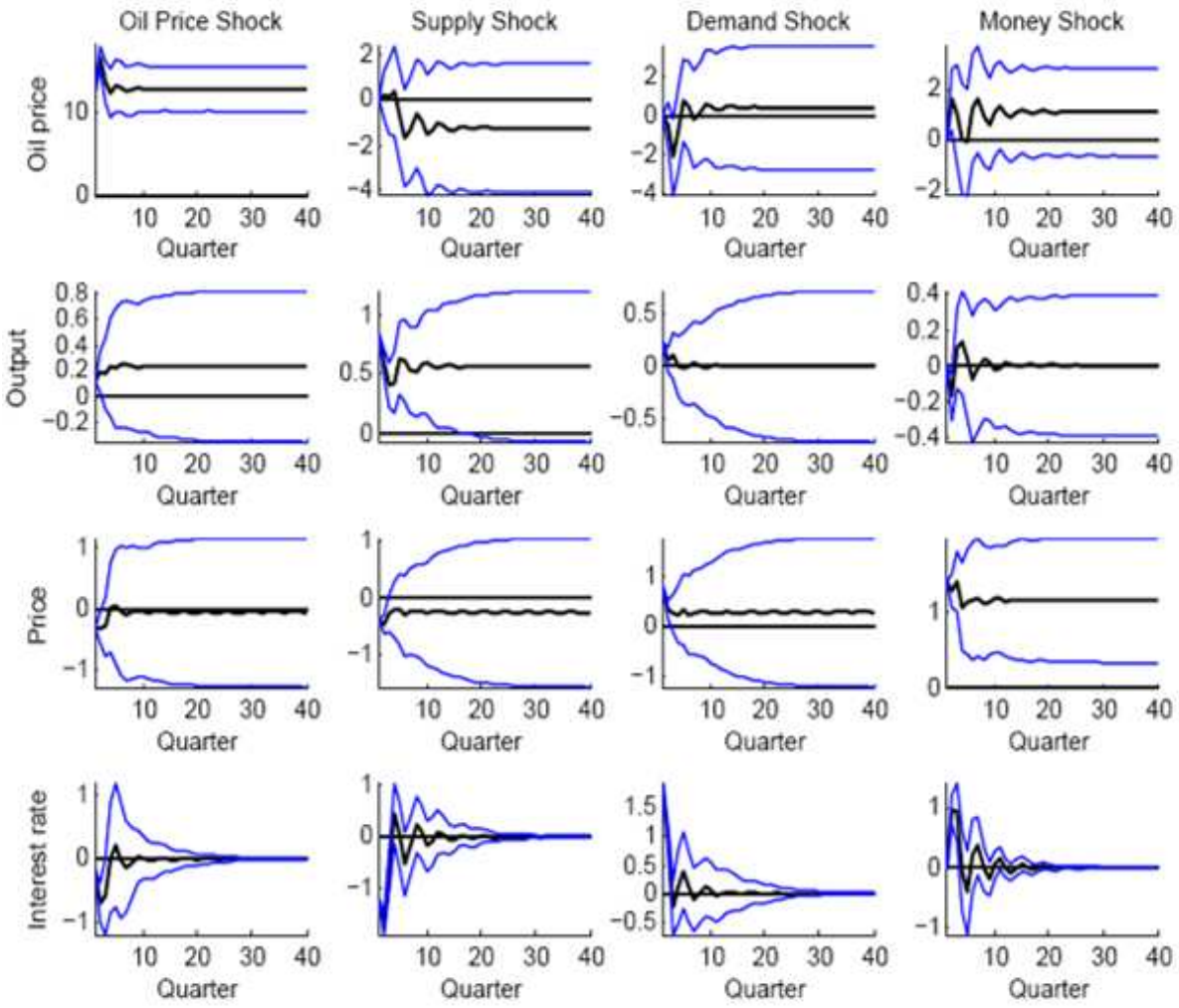

Figure 3: Impulse responses for Indonesia based on traditional restriction ± one standard deviation

inflationary reduction. Unlike Indonesia, US GDP is permanently hurt by the oil price shock as the US is a large importer of oil. Its response is still positive up to three quarters but it suddenly sinks afterwards. There is evidence that the effect of oil price shock to the US economy is recently not as huge as in the past. This issue is discussed further in Section 3.2. (iii). Following the contraction of the US economy, prices in the goods market shoot up and a temporary increase in interest rate follows to compensate the inflationary tensions.

Aggregate supply shocks

The responses due to an unanticipated aggregate supply shock are displayed in the second columns of Figure 3 and Figure 4. Aside from the insignificant effect on oil price in both Indonesia and the US, this shock is indicated by permanent effects on output and prices as well as temporary effect on interest rates. The effect of aggregate supply shock on the prices of goods market is found somewhat stronger in Indonesia than in US. As a result, the decline in the interest rate lasts longer in Indonesia than in the US, for at

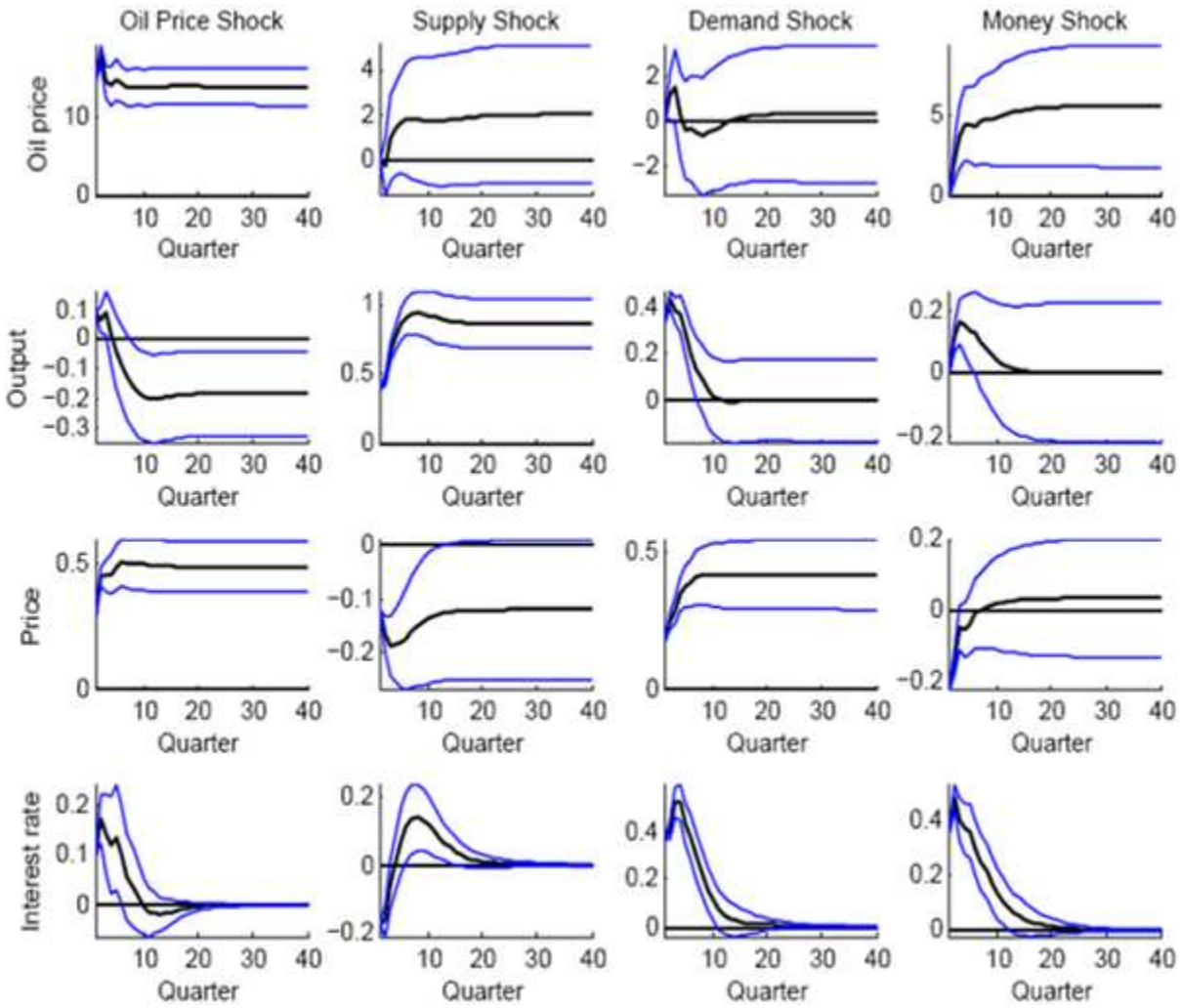

Figure 4: Impulse responses for the US based on traditional restriction ± one standard deviation

least up to 8 quarters and 4 quarters, respectively.

Aggregate demand shocks

The third columns of Figure 3 and Figure 4 display impulse responses of each variable as a result of an aggregate demand shock represented by permanent increase in price. The effect on oil price due to this shock is not significant in both countries. In contrast, this aggregate demand shock is noteworthy in influencing the economy of both countries to expand in the short run. In the long run, the output growth returns to the base line because the neutrality of nominal shocks holds. The effect on output is somehow a lot stronger in US than in Indonesia. It lives for 10 quarters in the US but only 2 quarters in Indonesia.

Money shocks

An unanticipated money shock is characterized by an increase in the interest rate as depicted in the last columns of Figure 3 and Figure 4. The magnitude itself is twice

larger in Indonesia than in the US. It is accounted for 100 basis points in Indonesia and 50 basis points in the US. The output of both countries reacts in a different way after this shock. The Indonesian economy contracts for just two quarters before the effects become insignificant. Unlike Indonesia, after a tightening of monetary policy the US economy still expands for at least three quarters before the effects fade away. Since the interest rate in the US is now almost zero per cent, a tightening monetary policy no longer hurts the economy. There is only a temporary decrease in inflation for three quarters before the effect dissipates. Nevertheless, there is evidence of *price puzzle* for Indonesia. This finding is discussed further in Section 3.2. (ii). In addition, the money shocks do not have significant impacts on the oil price in Indonesia, but the impacts are significant in the US.

3.2 Sensitivity analysis

The robustness of the previous results is discussed in this section by applying sign restriction as an alternative identification strategy. Zero restrictions in the traditional identification are released. Instead, restrictions are imposed directly into the impulse response function. The results are discussed in Section (i) which presents the median impulse responses with their 5^{th} and 95^{th} percentiles. Section (ii) evaluates the resulted responses of the Indonesian economy emphasizing the role of industrial sector. Also, the structural changes in the US economy are analyzed further in Section (iii) by comparing impulse responses using different time periods within the model.

3.2.1 Impulse responses based on sign restriction

Oil price shocks

The median responses together with their 5^{th} and 95^{th} percentiles give very similar results to the previous results based on traditional restrictions. After an unanticipated oil price shock, there are permanent effects on the output and price levels, but only a short-lived effect on the interest rates. As before, the Indonesian economy is positively affected but the US economy is negatively affected. These are depicted in the first columns of Figure 5 and Figure 6.

Aggregate supply shocks

Similar to the previous results based on traditional restrictions, the aggregate supply shock is characterized by permanent effects on higher output, lower prices and temporary lower interest rates (second columns of Figure 5 and Figure 6). However, the response of oil price due to aggregate supply shocks is different using this sign restriction, especially for the US. Given that the 5^{th} percentile of the impulse response is below zero, it can be considered that the aggregate supply shock in Indonesia is insignificant to influence oil

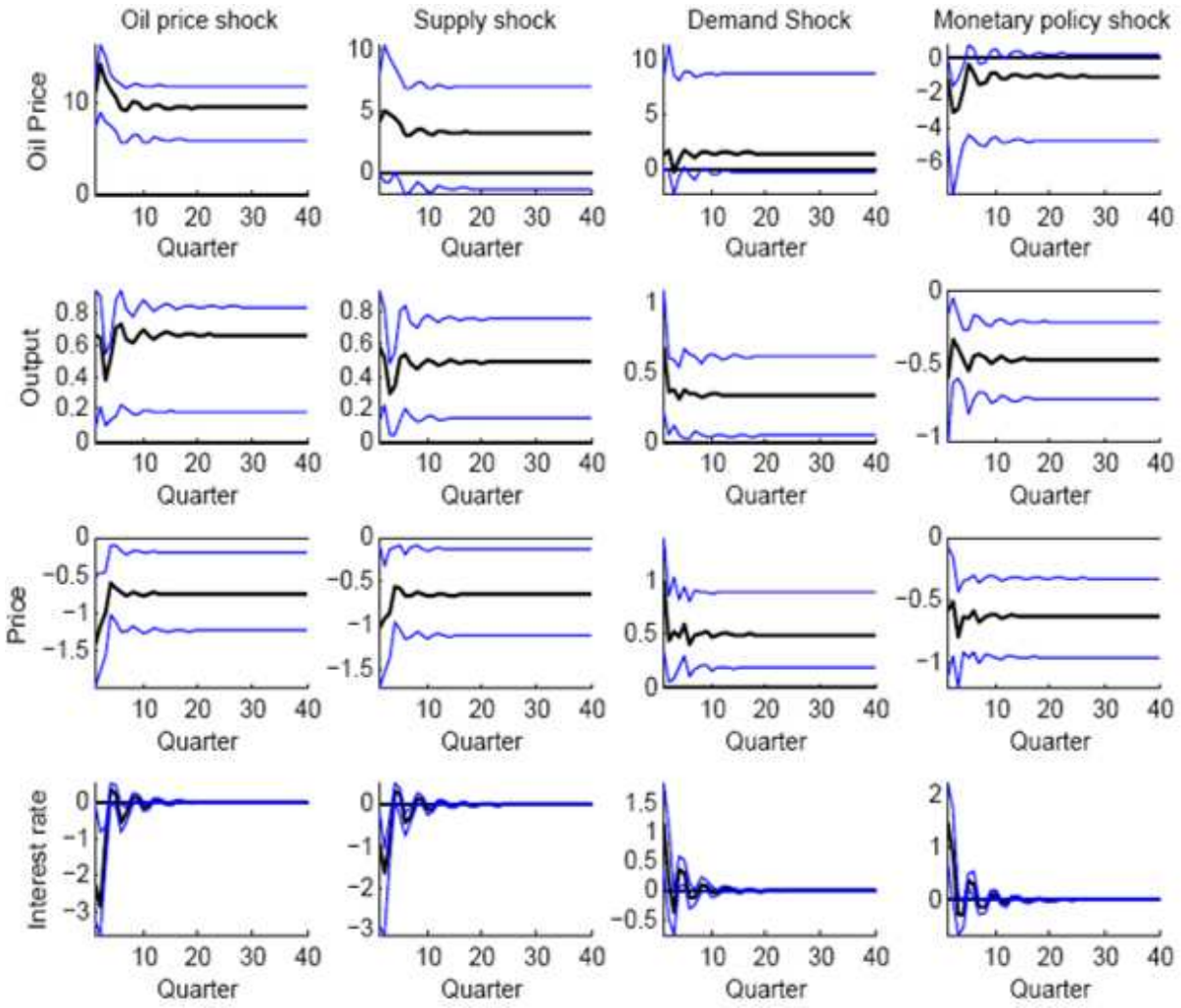

Figure 5: Impulse responses for Indonesia: sign restriction with 90 per cent confidence intervals

price. But for the US case, the aggregate supply shock seems have some effect on the oil price. Considering the enormous increase in the crude oil production in the US in the last several years and the large demands for crude oil, the US should now have an influence on the oil price. The US is not a price taker anymore in the oil market. Therefore, the short run zero restriction for oil price imposed in the traditional identification strategy is probably too strict.

Aggregate demand shocks

As shown in the third columns of Figure 5 and Figure 6, assumptions that demand shocks do not have long run effect on output level still holds for the US economy. Yet, it is no longer held for the Indonesian economy. There is evidence that an aggregate demand shock has a permanent effect on the level of the Indonesian GDP. This result is consistent with Siregar and Ward (2002).

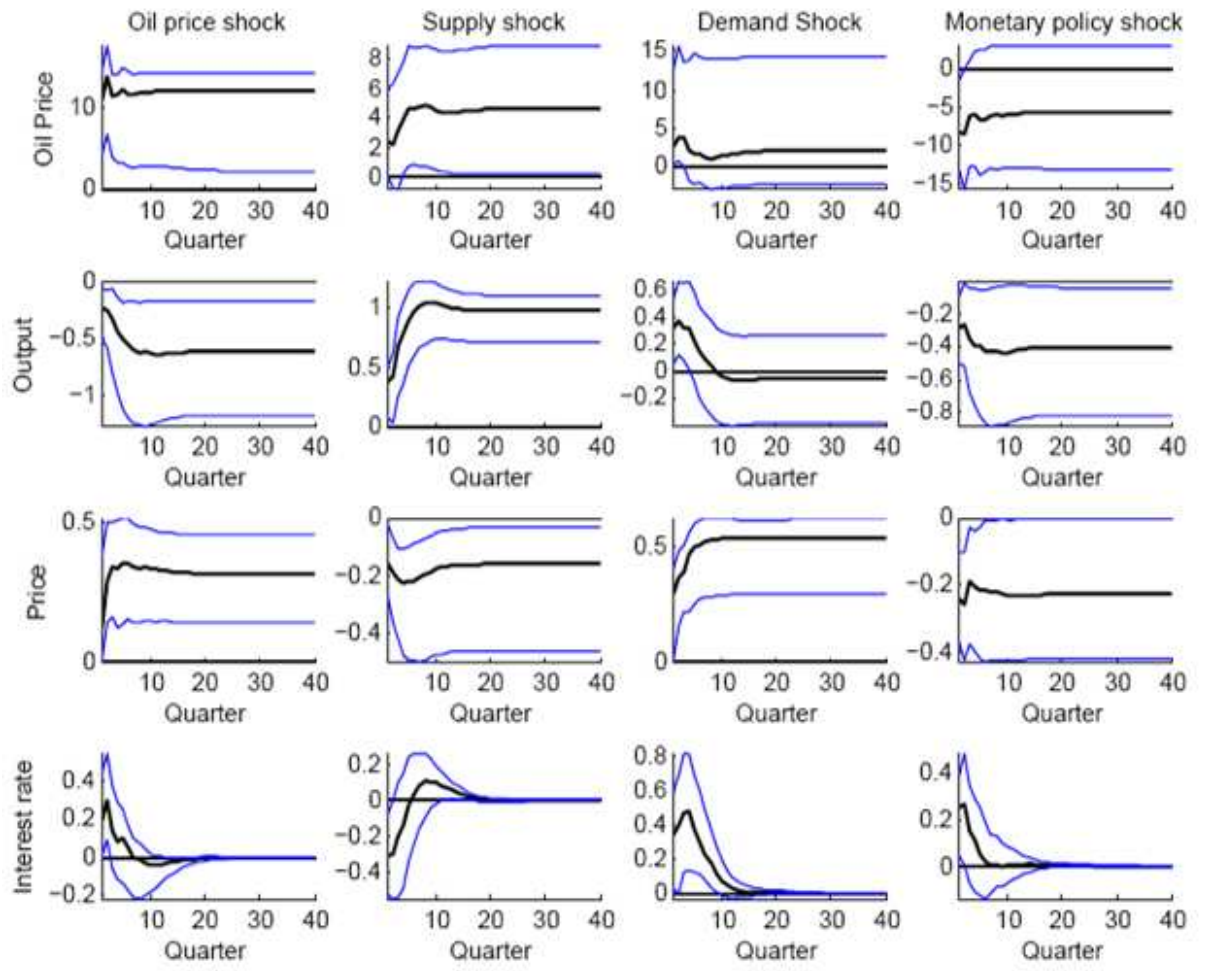

Figure 6: Impulse responses for the US: sign restriction with 90 per cent confidence intervals

Money shocks

Again, there is evidence that the neutrality of monetary policy does not hold in both countries showing that a tightening of monetary policy has permanent effects on outputs (last columns of Figure 5 and Figure 6). It is perhaps inaccurate for US economy since its interest rate is now almost zero. But it is probably true for the Indonesian economy. How tightening monetary policy affects Indonesian output is discussed in more detail in Section 3.4.

3.2.2 Role of industrial sector to the Indonesian economy and explaining *puzzle*: Traditional restriction

The composition of the Indonesian economy is dominated by the industrial sector and accounts for 45 per cent of the total GDP (Figure 7).

An unanticipated positive shock in oil price is instantaneously followed by a substantial increase of industrial production (see first column of Figure 8). The expansion of the economy in fact stems from this sector through the exports channel. Aggregate supply

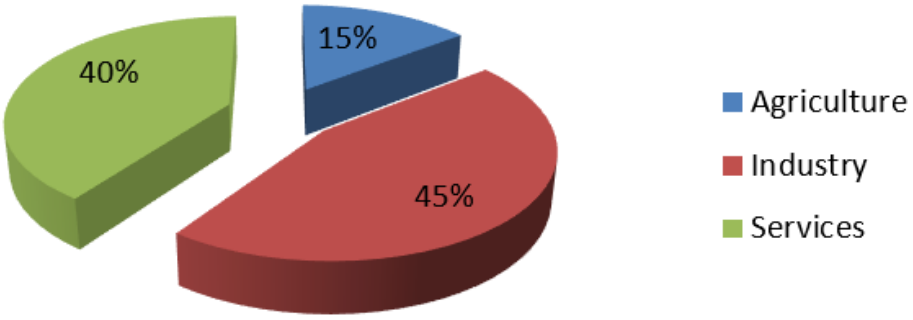

Figure 7: Share of Indonesia GDP (2013)
Source: Indonesia Bureau of Statistics (2014)

and aggregate demand shocks in industrial production are also found a lot larger (see second and third columns of Figure 8) and as a result, the overall economy is escalated. Apart from dissipating effect of aggregate demand shock onto the output in the long run, oil price and aggregate supply shocks have permanent effects on the industrial production.

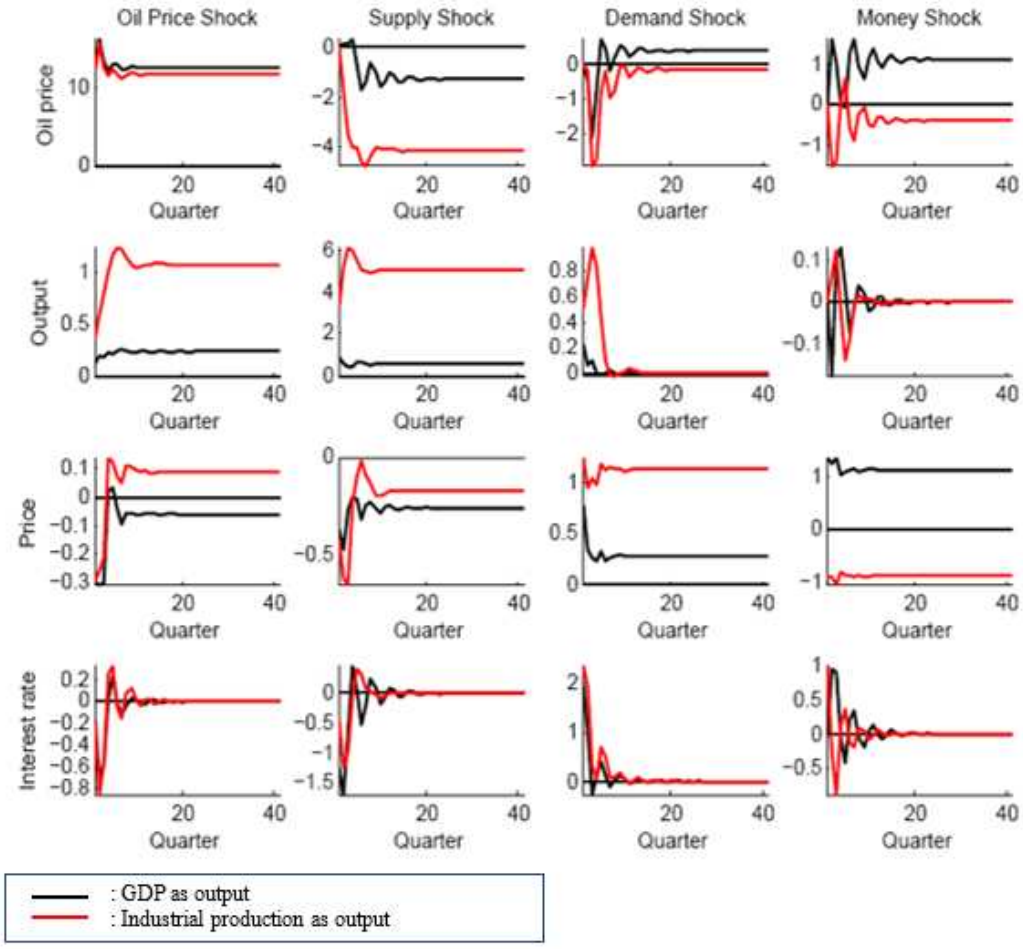

Figure 8: Impulse responses for Indonesia: industrial production as a proxy for output

When GDP is used as a proxy for output, following a tightening of monetary policy, goods prices immediately and permanently shoots up (see last column of Figure 8). Common VAR papers label it as a *price puzzle*. The absence of output gap (Giordani 2004) and omitted variable which captures expected inflation (Castelnuovo & Surico 2010) are found as the reasons why a *price puzzle* shows up. This *puzzle* is gone when industrial production is used as a proxy for output. It is because the industrial production captures the information of output gap.

In addition, the *price puzzle* actually explains the structure of Indonesian economy. The Indonesian GDP is mainly shaped by consumption accounted for more than 60 per cent and most of the consumption is for foods and beverages. Since both have relatively low price elasticity, they are less sensitive to the monetary policy.

3.2.3 Structural change in the US economy: Traditional restriction

Overall there is a structural change in the US economy since Peersman's work in 2005. The magnitude of the oil price shock remains almost the same through time (see first column of Figure 9). However the responses of other variables are now different. The output contraction due to an unexpected oil price shock is now a lot smaller than a decade ago. Consistent with this finding, EIA (2015) reports that the US production of crude oil keeps shooting up in recent years and its growth in 2014 was the largest since 1940. As a result, the US imports of crude oil also drop remarkably in the last ten years (EIA 2015). Both channels explain the finding of lower effect of the oil price shock. Although the instant effect of the oil price shock on prices is now greater in the short term, it is lower in the long term.

There is also evidence that the response of interest rate to an unanticipated oil price shock is smaller than before and it dies out a lot more quickly. Higher interest rate is expected to hold back the demand for oil. As the demand is now not only met by mostly imported crude oil but also from domestic production, this oil demand is then more rapidly influenced. Accordingly, the response of interest rate to oil shock now dissipates faster. Moreover, as shown in the last column of Figure 9, a tightening monetary policy no longer hurts the US economy since the monetary policy rate is now very low approaching zero.

3.3 Dynamic inter relationships: Variance decompositions (traditional restriction)

Table 3 and Table 4 present more statistical information on the resulted dynamic properties of the SVAR model for Indonesia and the US, respectively. Consistent with the results of impulse responses, oil price is truly exogenous for both countries at which it is dominantly controlled by oil shock itself both in the short run and long run. However,

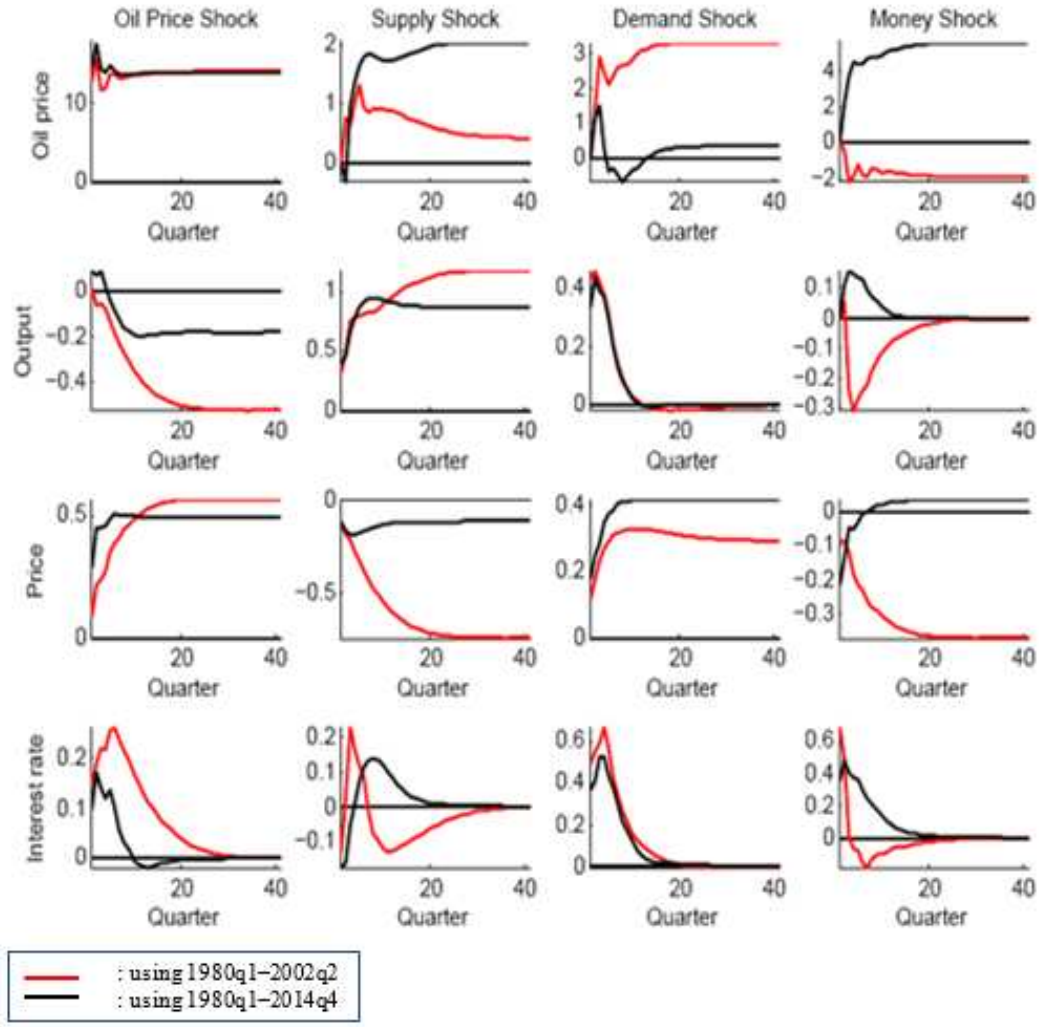

Figure 9: Impulse responses for the US: Comparing between periods

there is evidence that in the long run the US monetary policy has some contribution to the oil price.

Comparing the contributions to output of both countries, the Indonesian economy is mainly determined by the aggregate supply shock with slight influence of aggregate demand shock in the short run. Oil price shock has an important involvement in the long run. Unlike Indonesia, the US economy is almost equally shaped by aggregate supply and aggregate demand shock in the short run. As the effect of aggregate demand shock quickly dissipates, aggregate supply shock merely influences the US economy in the long run. There is no role of oil price shock in the long run since the US is now less dependent on crude oil.

The above result also underlines that the role of aggregate spending in the short run in the US (>41 per cent) is a lot stronger than in Indonesia (<7 per cent). It is because private spending in Indonesia is mostly for staple and foods. Also, it shows that the government spending in Indonesia is not efficiently utilized.

Quarter	Oil price			
	oil price shock	supply shock	demand shock	money shock
1	100.000	0.000	0.000	0.000
4	98.834	0.023	0.659	0.483
8	98.586	0.391	0.412	0.612
40	98.286	0.833	0.162	0.719
Quarter	Output			
	oil price shock	supply shock	demand shock	money shock
1	1.560	92.040	6.400	0.000
4	7.638	85.193	3.764	3.405
8	10.749	85.267	1.975	2.010
40	13.492	85.653	0.420	0.435
Quarter	Price			
	oil price shock	supply shock	demand shock	money shock
1	3.418	5.081	21.980	69.520
4	3.480	6.012	10.362	80.146
8	2.158	5.497	8.344	84.001
40	0.695	4.998	6.017	88.289
Quarter	Interest rate			
	oil price shock	supply shock	demand shock	money shock
1	0.540	28.545	70.896	0.019
4	6.651	39.965	38.997	14.387
8	6.697	39.899	37.492	15.912
40	6.643	39.909	37.178	16.270

Table 3: Variance decomposition resulting from different shocks for Indonesia: Percentage of total

Money shock is the main determinant of prices in the goods market for Indonesia both in the short run and long run. Aggregate demand shock itself only has significant role in the short run (just over 21 per cent). It indicates that the monetary policy in Indonesia is effective in controlling inflation. It is in line with the inflation targeting monetary policy in Indonesia. Surprisingly, prices in the goods market in the US are primarily influenced by oil price shock in both short run and long run. Money shock and aggregate demand shock are the next important contributors. The latter becomes stronger in the long run, but money shock tapers off due to the neutrality of monetary policy.

Aside from the aggregate demand shock being the main factor affecting the interest rate (just over 70 per cent) in Indonesia, aggregate supply shock is the other substantial determinant in the short run. Again, it shows that the Indonesian monetary policy follows the inflation targeting rule. In the long run, aggregate supply and aggregate demand shock are equally shared together with some contribution of money shock itself. Similar to Indonesia, the US interest rate is predominantly influenced by the aggregate demand shock in the short run. However, money shock has a stronger impact in the US interest rate compared with interest rate in Indonesia. There is also some short run effect

Quarter	Oil price			
	oil price shock	supply shock	demand shock	money shock
1	100.000	0.000	0.000	0.000
4	95.550	0.290	0.362	3.798
8	92.673	0.808	0.239	6.280
40	86.997	1.476	0.082	11.445
Quarter	Output			
	oil price shock	supply shock	demand shock	money shock
1	3.247	54.917	41.836	0.000
4	1.030	67.445	28.518	3.007
8	1.282	83.571	13.162	1.986
40	3.717	93.526	2.380	0.377
Quarter	Price			
	oil price shock	supply shock	demand shock	money shock
1	47.498	8.271	17.916	26.315
4	59.526	9.597	24.855	6.022
8	58.225	7.764	31.531	2.480
40	56.265	4.229	38.867	0.640
Quarter	Interest rate			
	oil price shock	supply shock	demand shock	money shock
1	3.410	10.084	44.626	41.880
4	4.597	3.626	51.530	40.247
8	4.340	4.553	51.865	39.242
40	4.108	6.423	50.115	39.355

Table 4: Variance decomposition resulting from different shocks for the US: Percentage of total

from aggregate supply shock (>10 per cent), but it quickly vanishes in the long run. At the same time, the role of aggregate demand shock gets stronger.

3.4 Dynamic inter relationships: Historical decompositions (traditional restriction)

In order to investigate the contribution of each shock to the economic fluctuations in both countries over time, the shocks are decomposed for each time period. In particular, this section highlights the sources of the Indonesian economic slowdown and the role of oil price shock to both Indonesian and the US's economies. With the purpose of having analysis in detail, time periods are divided into three parts. The first period is during the 1990s up to the Asian financial crisis. The second period is after the crisis up to the global financial crisis starting in 2008 and finally, the last period is after the global financial crisis up to recently. In addition, the shocks decomposition to prices, oil prices and interest rates are presented in the last two sections.

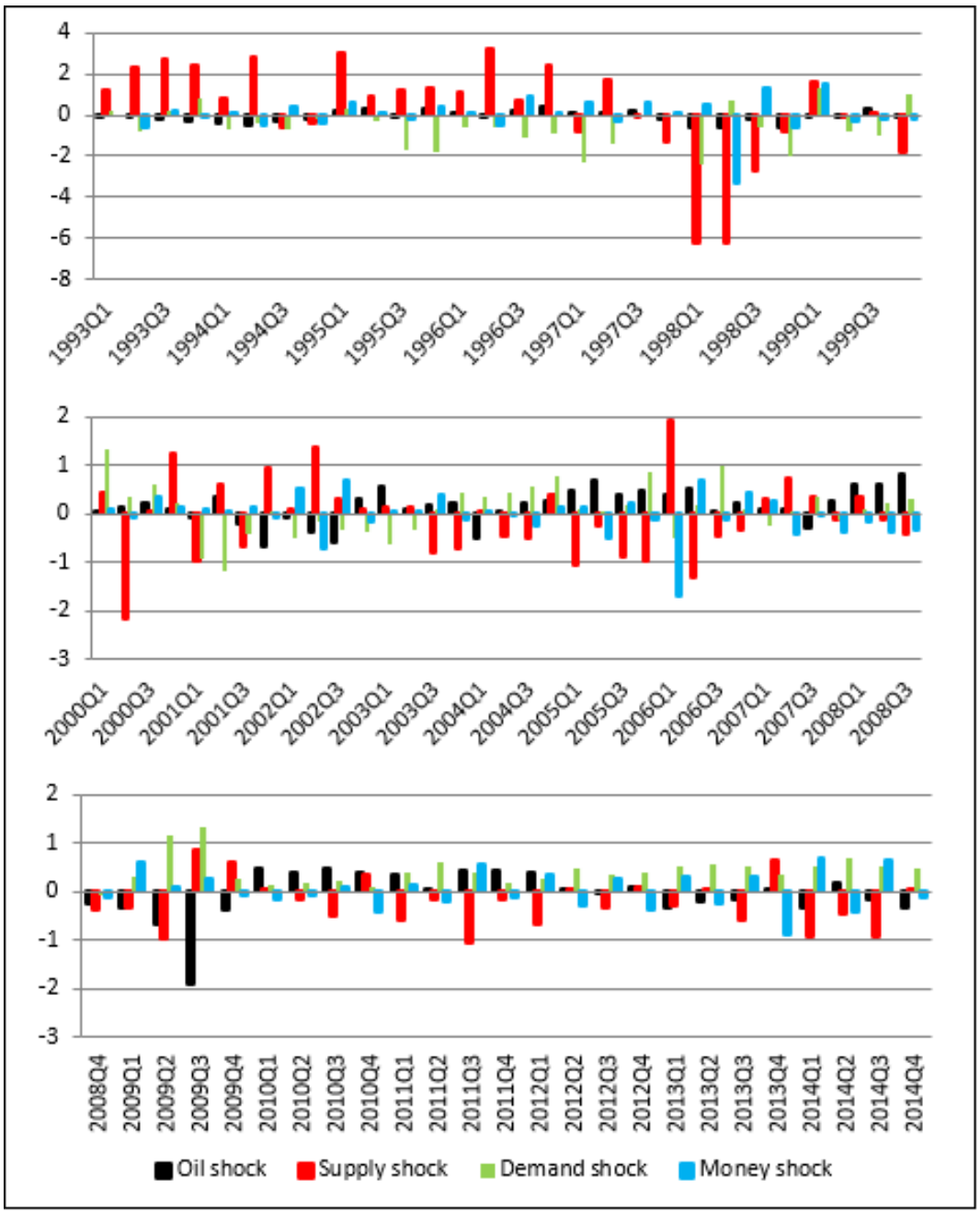

Figure 10: Contribution to the Indonesian GDP 1993q1 - 2014q4

3.4.1 Decomposing the shocks to Indonesian output

Prior to the Asian financial crisis

Before the Asian financial crisis hit the Indonesian economy in the late 1990s, positive aggregate supply shocks were so dominant to the Indonesian economy (see Figure 10). Although there were some negative oil price shocks between 1993 and 1994, the positive aggregate supply shocks outweighed all other shocks. The source of the positive shocks stems from the industrial sector. Foreign investments were allowed to enter the Indonesian economy especially flowing into the industrial sector starting in the early 1990s. At

the same time, there were considerable government policy supports for industrial sector particularly for heavy industries, such as credit easing and introduction of tariff barriers. Starting in 1997q4, the Asian financial crisis forced the industrial sector to go bust.

After the Asian financial crisis

The positive aggregate supply shocks never bounce back to their levels as before the Asian financial crisis. They were even negative for most of the time between 2000 and 2007. This negative trend was driven by falling commodity prices in the global markets. It partly explains why the Indonesian economy slowed down during this time. On the other hand, the contribution of oil price shocks fluctuates depending on the variation of the world's oil prices. The Indonesian economy gains when the prices go up and it eases off when prices go down. For instance, there was a positive oil shock contributed to the GDP when oil prices rocketed in 2008 (see Figure 10). However, oil price shocks are a double-edged sword for Indonesia. On one side, Indonesia gains through exports and generated revenues for government's budget. But on the other side, the shocks also act as a burden through the existence of fuel subsidy, for example during the late 2005. Indonesia experienced a 'mini crisis' at that time. Initiated by an oil price increase, the government was pushed to raise the subsidized fuel price. It then resulted in rising goods prices. As a result, the central bank was forced to raise the interest rates (see Figure 10 from 2005q3 to 2006q2).

Posterior to the global financial crisis and afterwards

When the global financial crisis knocked many countries in 2008 particularly the US and the Euro area, the world demand for crude oil crashed down. As a result, the oil price fell sharply at that time implying that negative oil price shocks appeared. Also, Indonesia was withdrawn from the Organization of the Petroleum Exporting Countries (OPEC) in 2009. Combined with the plummeting oil price, such an event gives Indonesia a large hit of negative oil shock to the economy. This finding provides a conflicting result with some other previous studies (for example Barnes 1995 & Hill 2000) at which they claim that the OPEC membership is not too significant influencing Indonesian economy. However, whether the negative oil shocks comes from decrease in oil price or from withdrawal of OPEC membership remains unclear.

At the same time, as the world economy contracted, negative supply shocks followed contributed to the Indonesian GDP. Nevertheless, the GDP growth of Indonesia was still positive in 2008-2009 even though negative oil price shocks and negative aggregate supply shocks were persistent. This is because of positive aggregate spending shocks and loosening monetary policy. The government provided a considerable fiscal stimulus package in 2009. Together with private spending, it fueled the economy to still grow. Despite the fact that the monetary policy effect was only short lived and aggregate spending shocks lasted for two quarters only, they were found enough to keep the GDP

growth still positive at that time. This result is consistent with the findings in Section 3.3.

After the global financial crisis period, the contribution of oil price shocks was stagnant and they have even become negative recently. It is because of falling oil production over time and dropping oil prices in recent times. Additionally, the aggregate supply shocks between 2009 and 2014 were mostly negative. This is because the factories and machineries used in the industrial sector are getting old. As a consequence, the production capacity falls indicating that the cost of production balloons. There was also some evidence of restrictive monetary policy between 2009 and 2014. All these parts explain the recent slowdown of the Indonesian economy.

3.4.2 Decomposing the shocks to US output

1990s

Before 1996, negative supply shocks dominated the US economy although there was loosening of the monetary policy. From this time up to late 1999, the economy grew due to positive aggregate supply shocks. Peersman (2005) describes this phenomenon as the US 'new economy'[1]. It is also strengthened by rebounding oil price shocks from some negative shocks prior to 1998 to remarkable positive shocks thereafter until late 1999 as the oil prices declined during this period. Between 1996 and 1999, aggregate demand shocks mostly made a positive contribution to the US output. However, these shocks suddenly fell in 1999q2 remaining until beginning 2000.

New millennium era

The millennium era started with negative aggregate supply and aggregate demand shocks. The former shock became more persistent onwards. There was also a negative aggregate demand shock in late 2001. This period (1999 - 2001) was recognized as the US recession period since the last recession in the early 1990s. It was marked with dot-com bubble up to 9/11 attack. At the same time, up until 2002 negative oil price shocks appeared prominently. To counteract the whole effects, the central bank implemented restrictive monetary policy during the periods of time. All these jointly negative shocks explain why the US economy slowed down during the early millennium[2].

After 2003, the economy recovered as the aggregate supply shocks were positive and the inflation rate was kept low. Romer (2012) marks this period as a stability period. Unfortunately, this stability period drastically ended in 2008.

Global financial crisis 2008 and afterwards

Initiated with properties and real estate bubble, the financial market collapsed in

[1] It is associated with technological acceleration, i.e. remarkable declines in semiconductors and computers' prices (Jorgensen & Stiroh 2000)

[2] These findings are consistent with Peersman (2005)

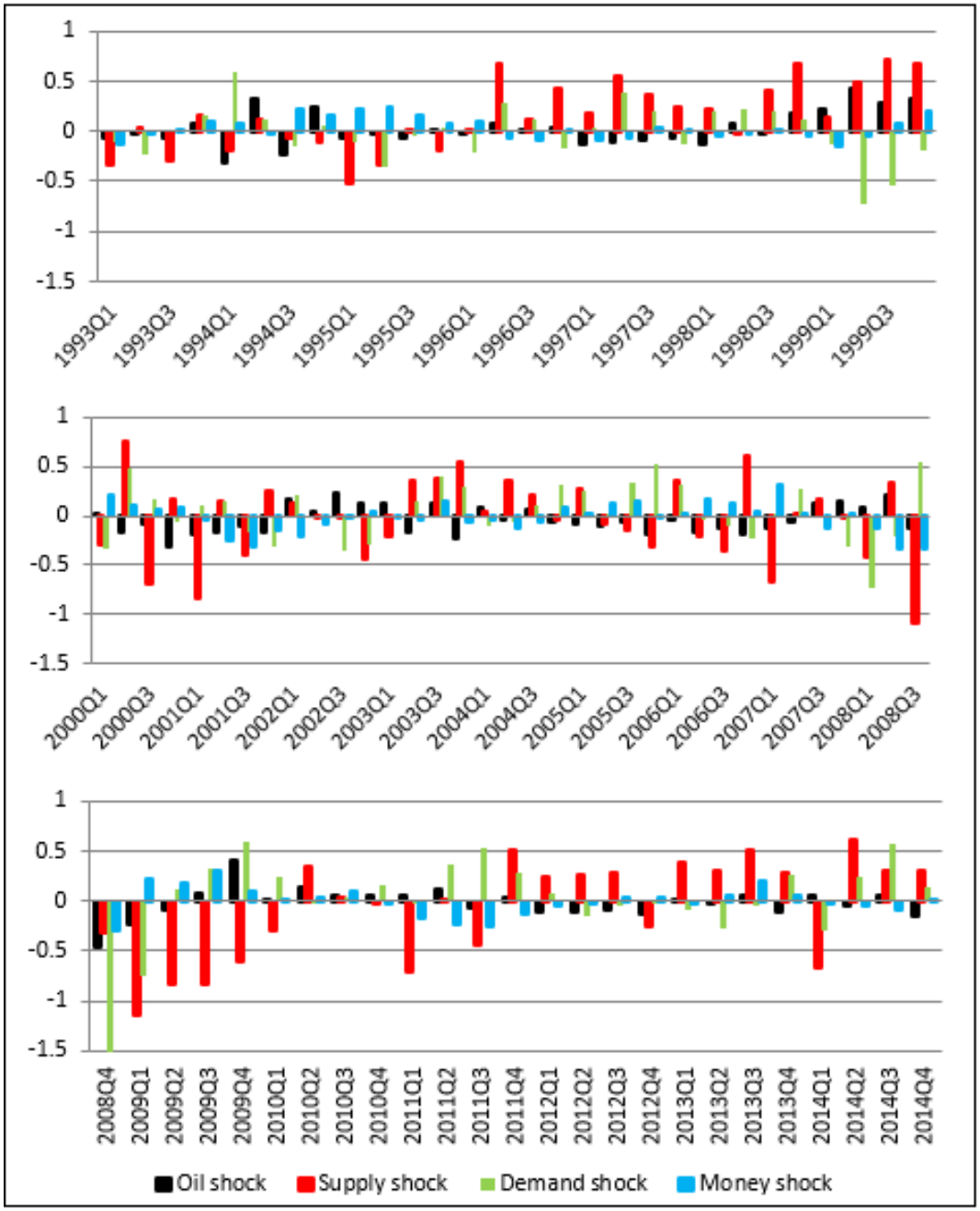

Figure 11: Contribution to the US GDP 1993q1 - 2014q4

late 2008. The US real GDP recorded its utmost falloff for two consecutive quarters since 1957-1958 (Romer 2012). Between 2008q3 and 2010q1 negative aggregate supply shocks appeared continually, whilst negative aggregate demand and oil price shocks just lasted for three quarters (see Figure 11). Negative money shocks were there within the same periods in response to the two latter negative shocks. Starting in 2009q1 money socks became positive followed by positive growing demand shocks since the next quarter. These positive shocks were attributed to the government's actions, such as the bailouts, Troubled Asset Relief Program (TARP) and large reduction in the federal budget deficit. In turn, the US economy had fully recovered in 2010.

3.4.3 Decomposing the shocks to prices and oil prices

Before the Asian financial crisis, prices in the goods market of Indonesia were around 0.3 per cent lower than the baseline. It was because of the strong aggregate spending shocks as well as positive aggregate supply shocks. Oil price shocks also showed its contribution to some extent. These results are in line with the results in Section 3.4 (i), for example when Indonesia suffered from 'mini crisis' in 2005. Prices went up by more than 70 per cent relative to the base line due to oil price shocks together with aggregate supply shocks (see Figure 12).

Year	Indonesia						US					
	Actual	Baseline	Oil	Supply	Demand	Money	Actual	Baseline	Oil	Supply	Demand	Money
1993	2.43	**3.72**	0.25	-2.82	0.31	0.96	0.68	**0.81**	0.03	0.07	-0.13	-0.10
1994	2.30	**2.37**	0.52	-1.90	0.97	0.35	0.64	**0.79**	-0.02	0.00	0.02	-0.14
1995	2.11	**2.54**	-0.27	-2.01	3.02	-1.18	0.65	**0.77**	-0.03	0.05	-0.10	-0.04
1996	1.54	**2.39**	-0.29	-2.66	3.55	-1.44	0.80	**0.75**	0.16	-0.10	-0.10	0.09
1997	2.19	**2.39**	-0.13	-0.70	2.49	-1.86	0.47	**0.73**	-0.21	-0.05	0.00	0.00
1998	14.47	**2.37**	0.70	7.00	0.86	3.54	0.38	**0.71**	-0.49	-0.05	0.13	0.08
1999	0.42	**2.37**	0.03	-1.02	-0.48	-0.48	0.65	**0.69**	0.37	-0.10	-0.15	-0.17
2000	2.10	**2.36**	-0.18	1.45	-0.45	-1.09	0.85	**0.67**	0.12	0.10	-0.12	0.07
2001	2.98	**2.36**	0.19	-0.27	1.74	-1.05	0.46	**0.65**	-0.27	0.03	-0.13	0.18
2002	2.43	**2.36**	0.31	-1.00	0.81	-0.06	0.56	**0.63**	0.13	0.03	-0.19	-0.05
2003	1.38	**2.36**	-0.31	0.32	-0.44	-0.55	0.50	**0.61**	0.08	-0.12	-0.10	0.02
2004	1.53	**2.36**	-0.11	0.52	-1.44	0.20	0.83	**0.60**	0.31	0.02	-0.08	-0.02
2005	4.09	**2.36**	-0.86	0.84	-0.48	2.22	0.90	**0.58**	0.20	0.05	0.13	-0.05
2006	1.47	**2.36**	-0.45	0.18	-0.72	0.10	0.49	**0.56**	-0.02	-0.04	0.16	-0.18
2007	1.63	**2.36**	-0.24	-0.44	-0.22	0.17	0.99	**0.54**	0.07	0.01	0.17	0.20
2008	2.63	**2.36**	-0.46	0.19	-0.81	1.34	0.40	**0.52**	-0.03	0.13	-0.18	-0.05
2009	0.64	**2.36**	0.94	0.32	-1.92	-1.06	0.37	**0.50**	-0.15	0.15	-0.17	0.04
2010	1.53	**2.36**	-0.47	-0.10	-0.60	0.35	0.31	**0.48**	-0.02	-0.10	-0.10	0.05
2011	1.01	**2.36**	-0.49	0.64	-1.07	-0.43	0.82	**0.46**	0.19	0.03	0.10	0.04
2012	1.08	**2.36**	-0.23	0.43	-1.24	-0.25	0.47	**0.44**	-0.02	-0.04	0.10	0.00
2013	1.87	**2.36**	0.29	0.21	-1.49	0.50	0.31	**0.42**	-0.03	-0.10	0.06	-0.05
2014	1.57	**2.36**	0.26	0.77	-1.46	-0.37	0.30	**0.40**	-0.23	-0.02	0.15	0.00

Figure 12: Decomposition of CPI

In the US, during the 'new economy' period from 1996 to just before the dot-com bubble, prices in the goods market were about 50 per cent below the baseline. It was attributed to the oil price shocks and positive aggregate supply shocks. In the last few years, goods prices were on average lower than the baseline as a result of lower impact of oil price shocks compared to the 1990s - early 2000s period. Also, these oil price effects were canceled out by aggregate supply and aggregate demand shocks.

The shocks contribution to the oil price as shown in Figure 13 indicates that oil price was not truly exogenous throughout the period of time. For Indonesia, aggregate supply and aggregate demand shocks explained some parts of the oil price decline before the Asian financial crisis. However, the oil price fluctuations were completely explained by the oil price shocks itself afterwards. Unlike Indonesia, despite the fact that aggregate

Year	Indonesia						US					
	Actual	Baseline	Oil	Supply	Demand	Money	Actual	Baseline	Oil	Supply	Demand	Money
1993	-5.29	**0.14**	-7.99	2.30	0.42	-0.16	-1.98	**0.21**	1.28	-0.22	0.06	-3.31
1994	1.04	**2.66**	1.01	-1.39	-1.71	0.48	-1.76	**0.32**	-1.20	-0.14	0.25	-0.99
1995	1.09	**1.94**	4.05	-2.12	-3.33	0.55	0.78	**0.43**	-1.66	-0.77	-0.45	3.23
1996	7.44	**1.65**	7.16	-0.90	0.59	-1.07	9.56	**0.54**	6.33	0.64	0.65	1.40
1997	-4.99	**1.52**	-6.17	-3.20	3.46	-0.61	-5.87	**0.65**	-8.94	0.54	0.25	1.63
1998	-11.90	**1.46**	-4.69	-8.08	1.45	-2.04	-13.39	**0.76**	-15.35	0.17	-0.22	1.25
1999	17.49	**1.44**	1.28	8.34	3.29	3.14	19.65	**0.87**	18.05	0.93	-1.61	1.41
2000	5.97	**1.43**	2.65	0.21	2.34	-0.67	7.09	**0.98**	-1.19	1.08	1.59	4.63
2001	-11.78	**1.42**	-11.57	2.08	-3.40	-0.32	-12.78	**1.09**	-11.66	-0.86	-0.37	-0.98
2002	10.40	**1.42**	8.07	1.10	0.61	-0.80	9.45	**1.20**	8.78	0.53	-0.39	-0.67
2003	1.49	**1.42**	-0.42	-1.27	2.17	-0.41	2.66	**1.31**	1.59	-0.39	0.69	-0.55
2004	8.51	**1.42**	5.74	-0.60	2.12	-0.18	10.90	**1.42**	11.09	0.91	-0.53	-1.99
2005	7.04	**1.42**	6.60	0.13	-1.16	0.05	6.26	**1.53**	4.01	0.12	0.09	0.52
2006	0.87	**1.42**	-0.57	0.83	-0.19	-0.61	-0.42	**1.64**	-3.51	-0.05	-0.62	2.13
2007	10.93	**1.42**	7.76	1.04	-1.41	2.12	11.22	**1.75**	6.55	-0.46	0.30	3.08
2008	-12.97	**1.42**	-14.32	-0.39	0.05	0.27	-10.77	**1.86**	-9.19	0.38	0.13	-3.95
2009	8.79	**1.42**	4.64	-0.31	1.85	1.19	6.50	**1.97**	1.95	-2.18	0.51	4.26
2010	3.47	**1.42**	4.43	0.48	-2.37	-0.49	2.99	**2.08**	0.10	-0.20	-0.43	1.45
2011	6.30	**1.42**	6.26	-0.66	-0.24	-0.47	4.92	**2.19**	5.98	-0.65	0.60	-3.20
2012	-0.72	**1.42**	-2.72	0.46	-0.14	0.27	-1.73	**2.30**	-2.39	0.43	-1.04	-1.02
2013	-0.40	**1.42**	-2.64	0.61	-0.09	0.31	0.46	**2.40**	-1.50	0.03	-0.25	-0.22
2014	-9.38	**1.42**	-9.68	-0.21	-0.50	-0.41	-7.53	**2.51**	-9.26	0.01	0.95	-1.75

Figure 13: Decomposition of oil price

supply and aggregate demand shocks in the US had nothing to do with the oil price fluctuations over the time periods, US monetary policy had some role to the fluctuations. For instance, the sharp plummeting oil price in 2008 was around 30 per cent explained by the US monetary policy.

3.4.4 Decomposing the shocks to interest rates

Starting in 2005 Indonesia implemented inflation targeting framework for its monetary policy altering from money base targeting. If the time periods as presented in Figure 14 are divided into two parts i.e. before and after 2005, the monetary policy framework shows a number of significances. From 1995 to 2002, the interest rates were always higher than the baseline. These were almost totally explained by the aggregate supply and aggregate demand shocks. Next, the interest rates were below the baseline from 2003 to 2014. Emphasizing the periods since 2005, the interest rates no longer responded only to aggregate supply and aggregate demand shocks. They also responded substantially to oil price shocks. In other words, the inflation targeting framework had allowed oil price shocks to influence the Indonesian monetary policy behavior.

Similar to Indonesia, between 1995 and 2001, interests rate in the US are found significantly higher than the baseline. Nonetheless, aside from the period 2004 - 2008, they were lower than the baseline for all over periods of time. This behavior was dominantly

Year	Indonesia						US					
	Actual	Baseline	Oil	Supply	Demand	Money	Actual	Baseline	Oil	Supply	Demand	Money
1993	10.62	**16.13**	0.47	-8.56	1.04	1.54	3.02	**5.96**	0.05	0.06	-0.92	-2.12
1994	10.29	**14.87**	2.41	-12.91	4.08	1.85	4.20	**5.68**	-0.04	-0.08	-0.24	-1.12
1995	14.11	**12.94**	0.26	-10.08	12.09	-1.10	5.84	**5.40**	0.01	0.05	-0.57	0.96
1996	13.82	**12.66**	-1.03	-13.33	17.74	-2.22	5.30	**5.12**	0.10	-0.39	-0.77	1.23
1997	14.50	**12.30**	-1.26	-8.17	16.26	-4.63	5.46	**4.84**	-0.06	-0.10	-0.35	1.13
1998	49.32	**12.23**	2.17	21.51	8.81	4.60	5.35	**4.56**	-0.63	0.15	0.46	0.81
1999	23.14	**12.17**	1.32	8.11	1.60	-0.06	4.97	**4.28**	-0.17	0.05	-0.14	0.96
2000	12.55	**12.15**	-0.63	5.88	-3.58	-1.28	6.24	**4.00**	0.53	0.60	-1.06	2.17
2001	16.62	**12.14**	-0.20	1.06	6.12	-2.50	3.89	**3.72**	-0.02	0.40	-0.87	0.67
2002	14.95	**12.13**	1.94	-2.97	5.48	-1.64	1.67	**3.44**	-0.18	0.03	-1.29	-0.33
2003	9.94	**12.13**	-0.55	-0.90	0.86	-1.60	1.13	**3.16**	0.17	-0.19	-1.51	-0.50
2004	7.45	**12.13**	-0.65	2.28	-6.07	-0.25	1.35	**2.87**	0.33	0.04	-0.94	-0.96
2005	9.12	**12.13**	-3.17	3.52	-4.31	0.95	3.21	**2.59**	0.43	0.29	0.12	-0.22
2006	11.83	**12.13**	-3.24	2.05	-3.77	4.67	4.97	**2.31**	0.22	0.07	1.34	1.02
2007	8.60	**12.13**	-1.20	-0.19	-2.11	-0.02	5.02	**2.03**	-0.12	0.02	1.44	1.64
2008	8.67	**12.13**	-3.31	-0.43	-3.21	3.49	1.93	**1.75**	0.25	0.21	0.11	-0.39
2009	7.15	**12.13**	2.84	1.72	-8.86	-0.69	0.16	**1.47**	-0.40	0.18	-1.72	0.62
2010	6.50	**12.13**	0.76	-0.58	-5.37	-0.44	0.18	**1.19**	-0.15	-0.80	-1.03	0.97
2011	6.58	**12.13**	-2.66	2.23	-5.46	0.35	0.10	**0.91**	0.21	-0.30	-0.12	-0.60
2012	5.77	**12.13**	-1.88	2.99	-6.41	-1.06	0.14	**0.63**	0.18	-0.44	0.82	-1.04
2013	6.48	**12.13**	0.49	1.44	-7.80	0.23	0.11	**0.35**	-0.03	-0.20	0.57	-0.59
2014	7.54	**12.13**	0.73	2.91	-8.30	0.08	0.09	**0.07**	-0.20	0.11	0.82	-0.71

Figure 14: Decomposition of interest rates

influenced by the aggregate demand shocks and money shocks itself. These results are consistent with the findings in Section 3.3.

4 Conclusions and Policy Implications

This paper investigated the sources of the Indonesian economic slowdown as well as US economic fluctuations within a range of four-variable structural vector autoregression models. Identifications are attained either through a combination of short-run and long-run restrictions or by using the more recent sign restrictions technique. The identified structural shocks were oil price, aggregate supply, aggregate demand (spending) and monetary policy shocks. Impulse responses, variance decompositions as well as historical decompositions were used to analyze the dynamic inter relationships between variables. The results highlight that the sources of the Indonesian economic slowdown were because of falling contribution of oil, negative supply shocks and tightening monetary policy.

In terms of international oil price shocks, Indonesia is still a price taker in oil market, but the US is no longer a price taker due to its vast increase in the crude oil production as well as considerable decrease in imports of oil in the last decade. Overall, the oil price shocks still benefit Indonesia, but hurt the US economy although is not as large as in the past. Also, the US dependence on oil now falls.

To stimulate higher economic growth, Indonesia needs new investment in fixed capi-

tal, such as machineries and factories to escalate the production of the industrial sector. Additionally, Indonesia needs new investments in oil refineries to boost up the oil production. The results also underline the role of government spending together with private spending in driving economic growth, at least in the short term.

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Appendix 1: Data source

No.	Data description	Units	Frequency	Source	Original source
1	Oil price (crude oil price)	USD/Barrel	Monthly	CEIC	Directorate General of Oil and Gas
2	GDP	Index 2010=1.00	Quarterly	FRED	OECD
3	Industrial production	Index 1993=100	Quarterly	CEIC	Central Bureau of Statistics
4	CPI (all commodities)	Index 2010=100	Monthly	FRED	OECD
5	Interest rate (policy rate: reference rate (BI rate))	per cent per annum	Monthly	CEIC	Bank of Indonesia

Table 5: Indonesia (1992Q1 2014Q4)

No.	Data description	Units	Frequency	Source	Original source
1	Oil price (crude oil price, refiner acquisition: composite)	USD/Barrel	Monthly	CEIC	Energy Information Administration
2	GDP	Index 2009=100	Quarterly	CEIC	Bureau of Economic Analysis
3	CPI (all commodities)	Index 1982-1984=100	Monthly	CEIC	Bureau of Labor Statistics
4	Interest rate policy rate (Fed Funds Rate)	per cent per annum	Monthly	FRED	Federal Reserve Board

Table 6: US (1980Q1 2014Q4)

Appendix 2: Data plots

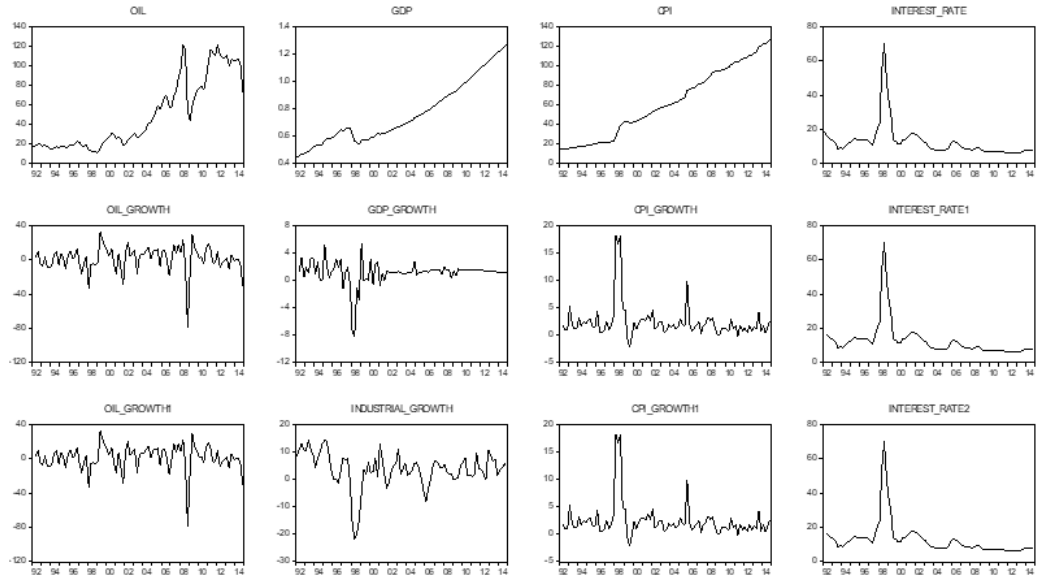

Figure 15: Data plots (Indonesia: 1992Q1 2014Q4)

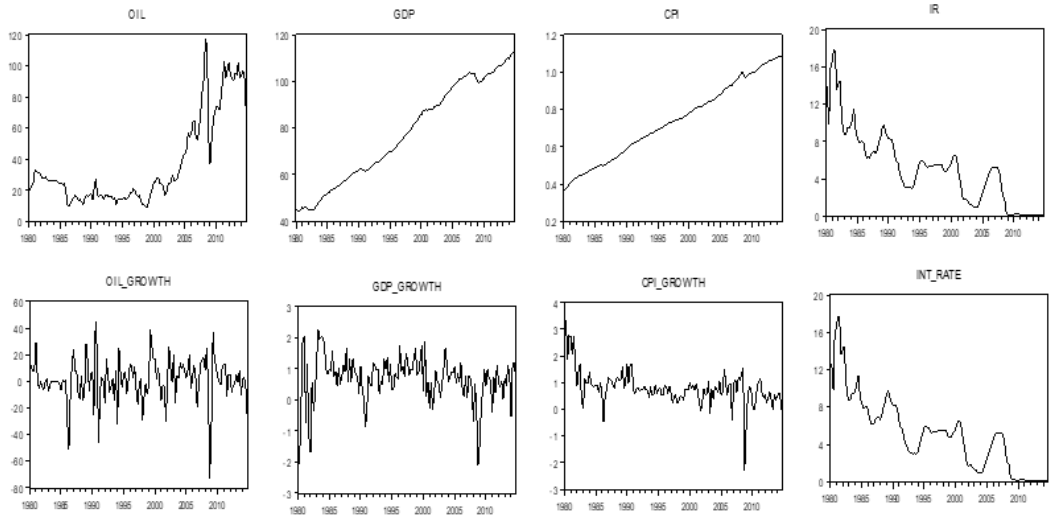

Figure 16: Data plots (US : 1980Q1 2014Q4)