Do fluctuations in crude oil prices have symmetric or asymmetric effects on the real exchange rate? empirical evidence from Indonesia

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Previous Studies

- Studying the oil price-exchange rate nexus has been the subject of a rapidly growing area of research over the past two decades.

- Many of these studies use time series methods to analyze the oil price impacts on exchange rates.
  - Examples: Amano and Van Norden (1998); Chaudhuri and Danieal (1998); Akram (2004); Benassy-Quere et al. (2007); Ding and Vo (2012); Basnet and Upadhyaya (2015).
Previous Studies (Contd.)

- Other studies have approached the topic with panel data methods.
  - Examples: Camarero and Tamarit (2002); Chen and Chen (2007); Behmiri and Manso (2012); Brahmasrene et al. (2014); Kisswani (2016).

- However, no matter what country is included for the research, studies assume that the price of crude oil symmetrically affects a country’s exchange rate.
Previous Studies (Contd.)

- This tells that if a 1% rise in oil prices appreciates (depreciates) the value of the currency in a country, by, say, x%, then a 1% decline in oil prices should depreciate (appreciate) it by the same magnitude, that is, x%.

- Since the foreign exchange market tends to react differently to increases and decreases in crude oil prices, however, such assumption does not always necessarily hold true in the real word.
Furthermore, studies to date have concentrated mostly on developed countries (e.g., G7, EU and OECD countries) with few studies investigating the issue in developing countries.
Objective

- To empirically examine whether the impact of oil price changes on real exchange rates is asymmetric in the context of a developing country, specifically Indonesia.
Objective (Contd.)

- The oil sector has traditionally contributed significantly to the economy of Indonesia through total export revenues and foreign exchange reserves.
  - In 2017, for example, the oil sector alone accounts for nearly 20% of Indonesia’s overall exports, valued at approximately US$28 billion.

- Hence, it would seem worthwhile to explore the oil price impacts on exchange rates in the case of Indonesia.
Empirical Model

- A nonlinear autoregressive distributed lag (ARDL) approach to cointegration (Shin et al., 2014).

- This approach has advantages over standard cointegration methods (i.e., Johansen 1995).
  - Can be applied irrespective of whether the underlying regressors are purely I(0), or I(1).
  - Since an error-correction model (ECM) can be derived from the ARDL, it is widely used to estimate the short- and long-run model simultaneously.
Empirical Model (Contd.)

To test asymmetric hypothesis of oil prices, we split oil price changes into oil price increases and oil price decreases using the partial sum of positive and negative changes in $\log(op_{it})$:

$$
op_{it}^+ = \sum_{p=1}^{t} \Delta \log(op_{ip}^+) = \sum_{p=1}^{t} \max[(\Delta \log(op_{ip}^+)), 0]$$

$$
op_{it}^- = \sum_{p=1}^{t} \Delta \log(op_{ip}^-) = \sum_{p=1}^{t} \min[(\Delta \log(op_{ip}^-)), 0]$$
Empirical Model (Contd.)

\[
\Delta \log(rer_t) = \beta_0 + \sum_{k=1}^{p} \beta_{i1,t-k} \Delta \log(rer_{t-k}) + \sum_{k=0}^{p} \beta_{i2,t-k} \Delta op_{i,t-k}^+ + \sum_{k=0}^{p} \beta_{i3,t-k} \Delta op_{i,t-k}^-
\]

\[
+ \lambda_0 \log(rer_{t-1}) + \lambda_1 op_{i,t-1}^+ + \lambda_2 op_{i,t-1}^- + \xi_{it}
\]

- \( \Sigma \) represents the short-run dynamics among the variables and \( \lambda_i \) corresponds to the long-run (cointegration) relationship(s).

- Null hypothesis of no cointegration \( (\lambda_0 = \lambda_1 = \lambda_2) \) is tested using \( F \)-test with two sets of critical values (bounds testing procedure).
Empirical Model (Contd.)

\[ \Delta \log(rer_t) = \beta_0 + \sum_{k=1}^{p} \beta_{i1,t-k} \Delta \log(rer_{t-k}) + \sum_{k=0}^{p} \beta_{i2,t-k} \Delta op_{i,t-k}^+ + \sum_{k=0}^{p} \beta_{i3,t-k} \Delta op_{i,t-k}^- \]

\[ + \lambda_0 \log(rer_{t-1}) + \lambda_1 op_{i,t-1}^+ + \lambda_2 op_{i,t-1}^- + \xi_{it} \]

The asymmetry hypothesis is tested using the Wald test.

If the Wald statistic exceeds the critical value, the null of no long-run (short-run) asymmetry, or \( H_0 : \frac{\lambda_1}{\lambda_0} = \frac{\lambda_2}{\lambda_0} (H_0 : \Sigma \beta_{i2} = \Sigma \beta_{i3}) \) can be rejected, thereby providing evidence of long-run (short-run) asymmetry.
Data

  - August 1997 is chosen because at that time Indonesia moved to freely floating exchange rate regime due to the 1997 Asian financial crisis.
  - June 2017 is the last date for which complete data are available.
Data (Contd.)

- Real exchange rate
  - Expressed in Indonesian rupiah per U.S. dollar.
  - A rise in the real exchange rate reflects a real depreciation of the Indonesian rupiah.
  - International Financial Statistics

- Crude oil prices
  - WTI and Brent: U.S. Energy Information Administration (EIA)
  - Dubai: Federal Reserve Bank of St. Louis
Empirical Results

<table>
<thead>
<tr>
<th>Long-run coefficient estimates</th>
<th>$i = WTI$</th>
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<tr>
<td>$(\text{Oil prices})_i^+$</td>
<td>-0.182</td>
<td>-0.144</td>
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<td>(-3.479)**</td>
<td>(-2.631)**</td>
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<td>$(\text{Oil prices})_i^-$</td>
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<td>(-2.314)**</td>
<td>(-1.634)*</td>
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<td>$F$-statistic</td>
<td>6.337**</td>
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- $F$-statistics on the lagged level variables for three oil prices > 5% upper critical value (4.85) $\rightarrow$ cointegrated.
Empirical Results (Contd.)

A rise (decline) in oil prices causes the real exchange rate to decrease (increase), thereby appreciating (depreciating) the Indonesian rupiah in the long-run.

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*Significance levels: *10%, **5%.
Wald tests across models show that the null of no long-run asymmetry can be rejected at the 5% level, confirming strong evidence of long-run asymmetry effects.

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### Empirical Results (Contd.)

#### Short-run coefficient estimates

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<tr>
<td>$\Delta (\text{Oil prices})_{i,t}^+$</td>
<td>0.066 (0.940)</td>
<td>0.145 (2.168)**</td>
<td>0.133 (1.912)*</td>
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<td>$\Delta (\text{Oil prices})_{i,t-1}^+$</td>
<td>-0.020 (-3.190)**</td>
<td>0.064 (1.090)</td>
<td>0.082 (1.292)</td>
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<tr>
<td>$\Delta (\text{Oil prices})_{i,t-2}^+$</td>
<td>-0.079 (-1.292)</td>
<td>-0.078 (-1.338)</td>
<td>-0.097 (-1.546)</td>
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<tr>
<td>$\Delta (\text{Oil prices})_{i,t-3}^+$</td>
<td>-0.144 (-2.343)**</td>
<td>-0.217 (-3.767)**</td>
<td>-0.224 (-3.588)**</td>
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<td>$\Delta (\text{Oil prices})_{i,t-4}^+$</td>
<td>0.078 (1.258)</td>
<td>0.086 (1.441)</td>
<td>0.149 (2.355)**</td>
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<tr>
<td>$\Delta (\text{Oil prices})_{i,t-5}^+$</td>
<td>0.114 (1.848)*</td>
<td>0.099 (1.706)*</td>
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<td></td>
</tr>
<tr>
<td>$\Delta (\text{Oil prices})_{i,t}^-$</td>
<td>-0.105 (-1.868)*</td>
<td>-0.143 (-2.747)**</td>
<td>-0.139 (-2.701)**</td>
</tr>
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<tr>
<td>Wald-S</td>
<td>0.620</td>
<td>3.049</td>
<td>0.999</td>
</tr>
</tbody>
</table>

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**Note:**
- $\Delta$ denotes the change in oil prices.
- The values in parentheses are t-statistics.
- * indicates significance at the 10% level.
- ** indicates significance at the 5% level.
- Wald-S refers to the Wald test statistic for the model.
Empirical Results (Contd.)

- As in the long-run case, the different magnitudes of the coefficients coupled with different signs in $\Delta op^+$ and $\Delta op^-$ may seem to indicate short-run asymmetry effects.

- However, Wald test statistics across models are well below the 5% critical level, thereby providing little evidence of the short-run asymmetry effects.
Summary and Conclusions

- A rise in oil prices is found to induce a real appreciation of the Indonesian rupiah in the long-run.

- It implies that, since higher oil prices yield a current account surplus for oil-exporting countries (i.e., Indonesia) and current account deficits for oil-importing countries, the resulting reallocation of wealth causes the Indonesian rupiah to appreciate.

- It further suggests that the movement of rupiah is indeed attributed to oil price changes.
Summary and Conclusions

- We discover overwhelming evidence that oil price changes indeed *asymmetrically* impact the Indonesian rupiah in the long-run.
  - That is, the movement in the Indonesian rupiah is more responsive to oil price hikes than to oil price plunges.

- In the short-run, however, the asymmetry of oil price changes is not observed.
Thus, we conclude that potential asymmetric effects of any change in the price of crude oil on the real exchange rate is a long-run rather than short-run phenomena in the case of Indonesia.

When examining the oil price – exchange rate nexus in Indonesia, analysts need to incorporate the (long-run) asymmetry of oil price fluctuations; otherwise, the empirical models are likely to be misspecified, thereby providing misleading results.
Thank you!