Fuel Subsidies, the Oil Market, and the World Economy

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The results presented here are my own and do not necessarily reflect the official views of the Federal Reserve Bank of Dallas nor the Federal Reserve System as a whole.
Introduction

- Consumer subsidies on fuel products found in many countries
- Subsidies found in both producing and non-producing countries
- But oil producers are most important subsidizers
We explore how these subsidies qualitatively and quantitatively impact:

- World oil market
- Macroeconomic variables
- Welfare
## Data

<table>
<thead>
<tr>
<th>Country</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Algeria</td>
<td>Indonesia</td>
<td>Qatar</td>
</tr>
<tr>
<td>Angola</td>
<td>Iran</td>
<td>Saudi Arabia</td>
</tr>
<tr>
<td>Azerbaijan</td>
<td>Iraq</td>
<td>Sudan</td>
</tr>
<tr>
<td>Bahrain</td>
<td>Kuwait</td>
<td>Syria</td>
</tr>
<tr>
<td>Bolivia</td>
<td>Libya</td>
<td>Turkmenistan</td>
</tr>
<tr>
<td>Brunei</td>
<td>Malaysia</td>
<td>UAE</td>
</tr>
<tr>
<td>Ecuador</td>
<td>Nigeria</td>
<td>Venezuela</td>
</tr>
<tr>
<td>Egypt</td>
<td>Oman</td>
<td>Yemen</td>
</tr>
</tbody>
</table>

Table: Countries identified as subsidizers
Some statistics about the 24 countries:

- Consume 13.5 percent of world’s oil
- Produce 48 percent of world’s oil
- Current retail prices about 1/3 of U.S. prices (ex. tax)
Model

- Two country model with countries $a$ and $o$
- Country $o$ produces oil, represents group of subsidizers
- Country $a$ produces oil and non-oil goods
- Countries $a$ is a net importer of oil
Model

In country $a$:

- Competitive firm produces non-oil good using labor, capital, oil
- Competitive firm produces oil using non-oil good
- Household consumes oil and non-oil goods
- Household maximizes utility subject to a budget constraint
Oil production in a

Oil producing firm’s problem

\[
\max_{Y_{o,t}^a} \Pi_{o,t}^a = P_{o,t} Y_{o,t}^a - A_{y,t}^a,
\]

where

\[
A_{y,t}^a = \kappa_a \frac{(Y_{o,t}^a)^{1+\frac{1}{\eta_a}}}{1 + \frac{1}{\eta_a}}.
\]
Oil production in a

Oil producing firm’s problem

\[
\max_{Y^a_{o,t}} \Pi^a_{o,t} = P_{o,t} Y^a_{o,t} - A^a_{y,t},
\]

where

\[
A^a_{y,t} = \kappa_a \left( Y^a_{o,t} \right)^{1 + \frac{1}{\eta_a}} \frac{1 + \frac{1}{\eta_a}}{1 + \frac{1}{\eta_a}}.
\]

- Price elasticity of supply given by \( \eta_j \) for \( j = a, o \)
- Costs increasing in oil output
- Lower marginal cost as \( \eta \) increases
In country $o$:

- Government-run oil company produces oil using non-oil good
- Portion of oil sold domestically at subsidized price $P_s$ (set by modeler)
- Remainder exported to country $a$ at world price $P_o$
In country $o$:

- Oil revenues flow into economy lump-sum
- Household spends income on oil and non-oil goods
- Household maximizes utility subject to a budget constraint
Calibration

Table: Oil market variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil production in $o$</td>
<td>48 percent of world production</td>
</tr>
<tr>
<td>Consumption of fuel in $o$</td>
<td>13.5 percent of world consumption</td>
</tr>
<tr>
<td>Ratio of subsidized fuel price to world price</td>
<td>.35</td>
</tr>
<tr>
<td>Consumption-expenditure share of fuel in $a$</td>
<td>5 percent</td>
</tr>
<tr>
<td>Firm use of oil in $a$</td>
<td>2 percent of $a$’s GDP</td>
</tr>
<tr>
<td>Elasticities of oil demand</td>
<td>.75</td>
</tr>
<tr>
<td>Elasticity of oil supply ($\eta_a$, $\eta_o$)</td>
<td>.30</td>
</tr>
</tbody>
</table>
Exercise

- Model calibrated to recent data
- Policy experiment: Set subsidized price in all equal world price
  - Subsidies removed in all 24 countries
- Comparative statics exercise
- Calculate how variables change across steady states
### Results

Percent change in variables across steady states

#### Prices

<table>
<thead>
<tr>
<th>Variable</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>market oil price ($P_o$)</td>
<td>-6.2</td>
</tr>
<tr>
<td>subsidized oil price ($P_s$)</td>
<td>176</td>
</tr>
</tbody>
</table>
Results

Percent change in variables across steady states

Prices
- market oil price \( (P_o) \) -6.2
- subsidized oil price \( (P_s) \) 176

Country a variables
- oil production \( (Y_o^a) \) -1.9
- oil used in consumption \( (O_c^a) \) 4.9
- oil used in production \( (O_y^a) \) 4.2
- consumption of good A \( (A_c^a) \) 0.004
- non-oil GDP 0.23

Country o variables
- oil production \( (Y_o^o) \) -1.9
- oil consumption \( (O_c^o) \) -45.9
- consumption of good A \( (A_c^o) \) 15.8
- transfers / oil revenue (net) 21.4
Percent change in variables across steady states

**Prices**
- market oil price \((P_o)\) - 6.2
- subsidized oil price \((P_s)\) 176

**Country a variables**
- oil production \((Y_a^o)\) - 1.9
- oil used in consumption \((O^a_c)\) 4.9
- oil used in production \((O^a_y)\) 4.2
- consumption of good A \((A^a_c)\) 0.004
- non-oil GDP 0.23

**Country o variables**
- oil production \((Y_o^o)\) - 1.9
- oil consumption \((O^o_c)\) - 45.9
- consumption of good A \((A^o_c)\) 15.8
- transfers / oil revenue (net) 21.4
Welfare Results

- Welfare changes converted to (aggregate) consumption equivalents
  - How much do I need to change consumption in the new steady state to get utilities equal?

Importer's welfare gain: 0.2% of consumption
Exporter's welfare gain: 0.9% of consumption
Larger relative gains to exporter, larger absolute in importer
Welfare Results

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Conclusions

- Considered impacts of fuel subsidies in a two-country model
- Calibrated model to match recent data
- Removing subsidies would lower world price of oil by about 6%
- Welfare improves in both countries
Table: Statistics about the 24 countries

<table>
<thead>
<tr>
<th>Year</th>
<th>Share of world oil consumption</th>
<th>Share of world oil production</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>9.5</td>
<td>46.1</td>
</tr>
<tr>
<td>1993</td>
<td>9.9</td>
<td>47.3</td>
</tr>
<tr>
<td>1994</td>
<td>10.0</td>
<td>47.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>13.1</td>
<td>48.3</td>
</tr>
<tr>
<td>2011</td>
<td>13.4</td>
<td>48.1</td>
</tr>
<tr>
<td>2012</td>
<td>13.5</td>
<td>47.9</td>
</tr>
</tbody>
</table>

Sources: IMF, EIA
Oil production in $o$

The oil producer hence chooses production, $Y_{o,t}$, to maximize:

$$\Pi_{o,t} = P_{o,t}(Y_{o,t} - O_{o,c,t}) + P_{s,t}O_{c,t} - A_{y,t}$$

where the cost function is similar to country a’s:

$$A_{y,t} = \kappa_{o} \frac{(Y_{o,t})^{1+\frac{1}{\eta_{o}}}}{1 + \frac{1}{\eta_{o}}}.$$