

The opportunity cost of domestic oil consumption for an oil exporter: Illustration for Saudi Arabia

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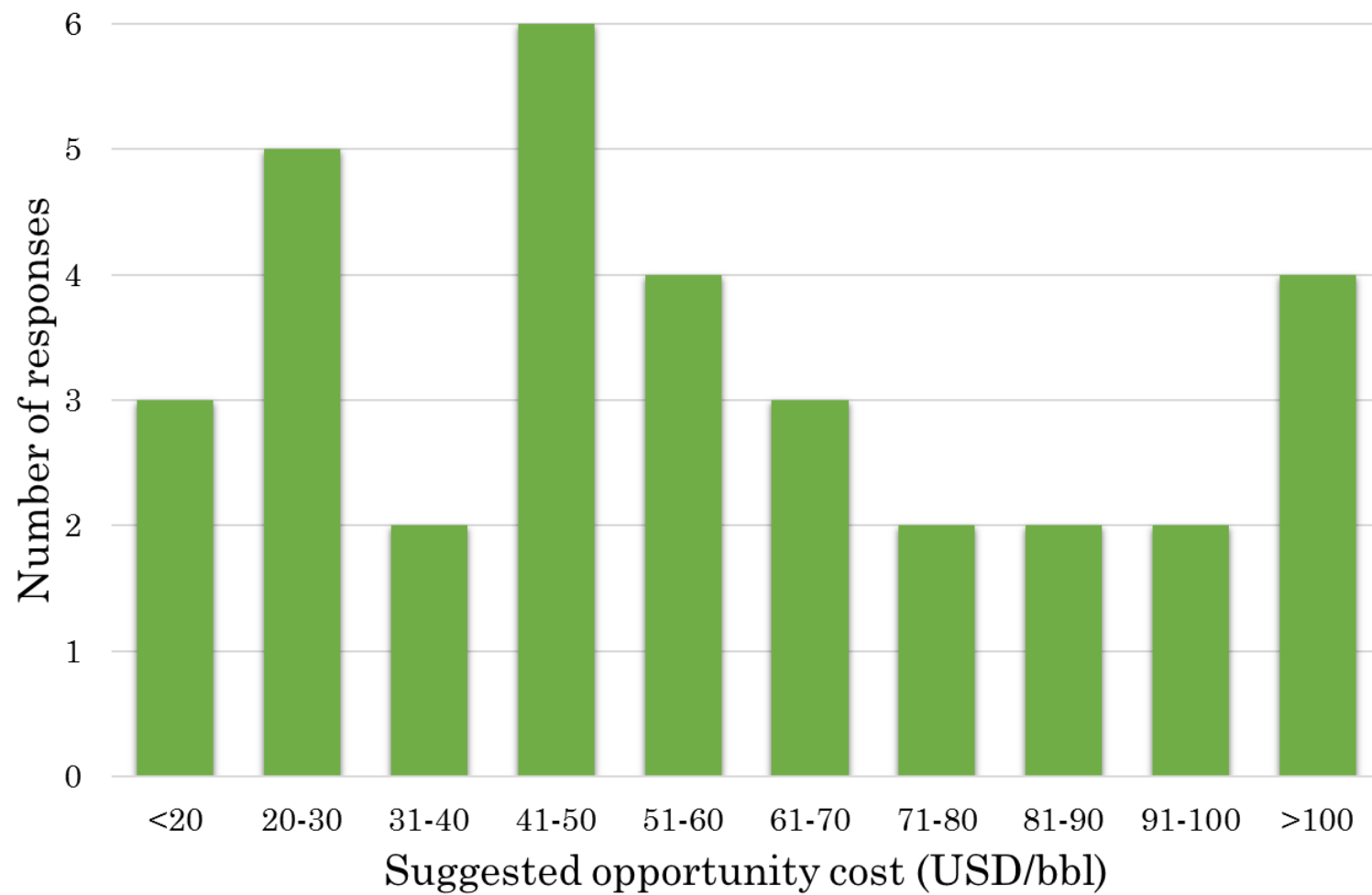
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Why does the opportunity cost of oil matter?

- Besides being an export earner, oil is sometimes seen as a tool for economic development
- Making public decisions based on incorrectly calculated opportunity costs could lead to over-investment in some projects and under-investment in others
- Input for public investment project valuation, modelling studies, resource allocation...

Background

- The opportunity cost is the value that society attaches to the best-rejected option.
- When assessing investment projects from a public perspective, what is the value to attribute to a barrel of oil displaced from or added to domestic consumption?
- No specific literature on the opportunity cost of oil, but:
 - With economic distortions or market imperfections, observed prices do not reflect the true opportunity costs of resources
 - Opportunity costs have to be assessed given the existing distortions



Distribution of responses to “*What is the opportunity cost of a barrel of oil for Saudi Arabia?*” by local stakeholders and international experts

KAPSARC/Baker Institute workshop, July 24, 2018, Riyadh (Brent price was 73.5 dollars per barrel)

What we do

- We assess the opportunity cost, taking into account:
 - Domestic oil pricing policy
 - Departure from the “small economy” assumption
 - Oil production or exports can be constrained
 - Meeting domestic demand is mandatory or not

- We produce:
 - Analytical results for a generic oil exporter
 - Numerical estimates for Saudi Arabia

The model

The Producer's welfare maximization problem

$$\sum_{t=0}^T \frac{1}{(1+d)^t} \left(x_t P_t(x_t) + \int_0^{q_t} D_t^{-1}(s) ds - c(o_t) \right)$$

$$\begin{aligned} \text{s.t.} \quad & q_t + x_t \leq o_t && (\mu_t) \\ & D_t(aP_t(x_t) + b) \leq q_t && (\varphi_t) \\ & o_t \leq M_t && (\theta_t) \\ & x_t \leq U_t && (\beta_t) \\ & -x_t \leq -L_t && (\omega_t) \\ & o_t \leq u_{t-1} - u_t && (\lambda_t) \end{aligned}$$

Domestic pricing equation

$$\pi_t = aP_t(x_t) + b$$

- fully deregulated price: $\pi_t = P_t$
- fixed administered price: $\pi_t = b$
- fixed fraction of the international price: $\pi_t = aP_t$
- international price less a fixed subsidy: $\pi_t = P_t + b$

General formula for the opportunity cost of oil:

$$\mu_t = \left(1 + \frac{x_t + a q_t \varepsilon_q \left(1 - \frac{P_t}{\pi_t} \right) - \frac{x_t \varepsilon_{x,t} (1+d)^t (\beta_t - \omega_t)}{P_t}}{g_t \varepsilon_g - r_t \varepsilon_r} \right) \frac{P_t}{(1+d)^t}$$

The role of constraints

Values of formula's parameters depend on constraints faced by the Producer:

- Meeting domestic demand is mandatory, no other constraints
- Meeting domestic demand is mandatory; exports are constrained
- Meeting domestic demand is mandatory; production is constrained
- Abandoning the obligation of meeting domestic demand

Constraints can be caused by structural, technical, logistical, policy or financial factors

e.g., OPEC quota on production, lack of access to technology or financial resources, volume of oil exports that has to be maintained in order to earn the foreign currency that finances the Producer's imports...

Comparison of opportunity cost formulas

Case	Opportunity cost
<ul style="list-style-type: none"> - No other constraints - Constraint on production 	<p><i>Fully deregulated price:</i> $\left(1 + \frac{x_t}{g_t \varepsilon_g - r_t \varepsilon_r}\right) P_t$</p> <p><i>Fixed administered price:</i> $\left(1 + \frac{1}{\varepsilon_{x,t}}\right) P_t$</p> <p><i>Fixed fraction of international price:</i> $\left(1 + \frac{x_t + q_t \varepsilon_q (a-1)}{g_t \varepsilon_g - r_t \varepsilon_r}\right) P_t$</p> <p><i>International price less a fixed subsidy:</i> $\left(1 + \frac{x_t + \frac{b q_t \varepsilon_q}{P_t + b}}{g_t \varepsilon_g - r_t \varepsilon_r}\right) P_t$</p>
<ul style="list-style-type: none"> - No other constraints - Constraint on exports 	$c_m(o_t) + (1 + d)^t \lambda_t$
<ul style="list-style-type: none"> - Meeting domestic demand is not mandatory 	$D_t^{-1}(q_t) \quad (\geq \pi_t)$

Net welfare gains from reforming the domestic oil price

To what extent changes in domestic pricing affect the Producer's welfare?

We apply the envelope theorem to the problem's Lagrangian.

The most efficient pricing policy is to set the domestic price equal to the opportunity cost.

This result is similar to one found in Balke et al. (2015), which found that the optimal subsidy from the point of view of an oil exporter is not zero.

Illustration with Saudi Arabia

Meeting domestic demand is mandatory, no other constraints

Type of elasticity	Short run (Caldara et al., 2019)		Long run (Caldara et al., 2019; IMF, 2011)
Price elasticity of global demand (ε_g)	-0.055	-0.14	-0.35
Price elasticity of non-Saudi production (ε_r)	0.056	0.056	0.112
Demand elasticity for Saudi exports (ε_x)	-1.44	-2.61	-6.12
Opportunity cost in percentage of the international price	30.6%	61.7%	83.7%

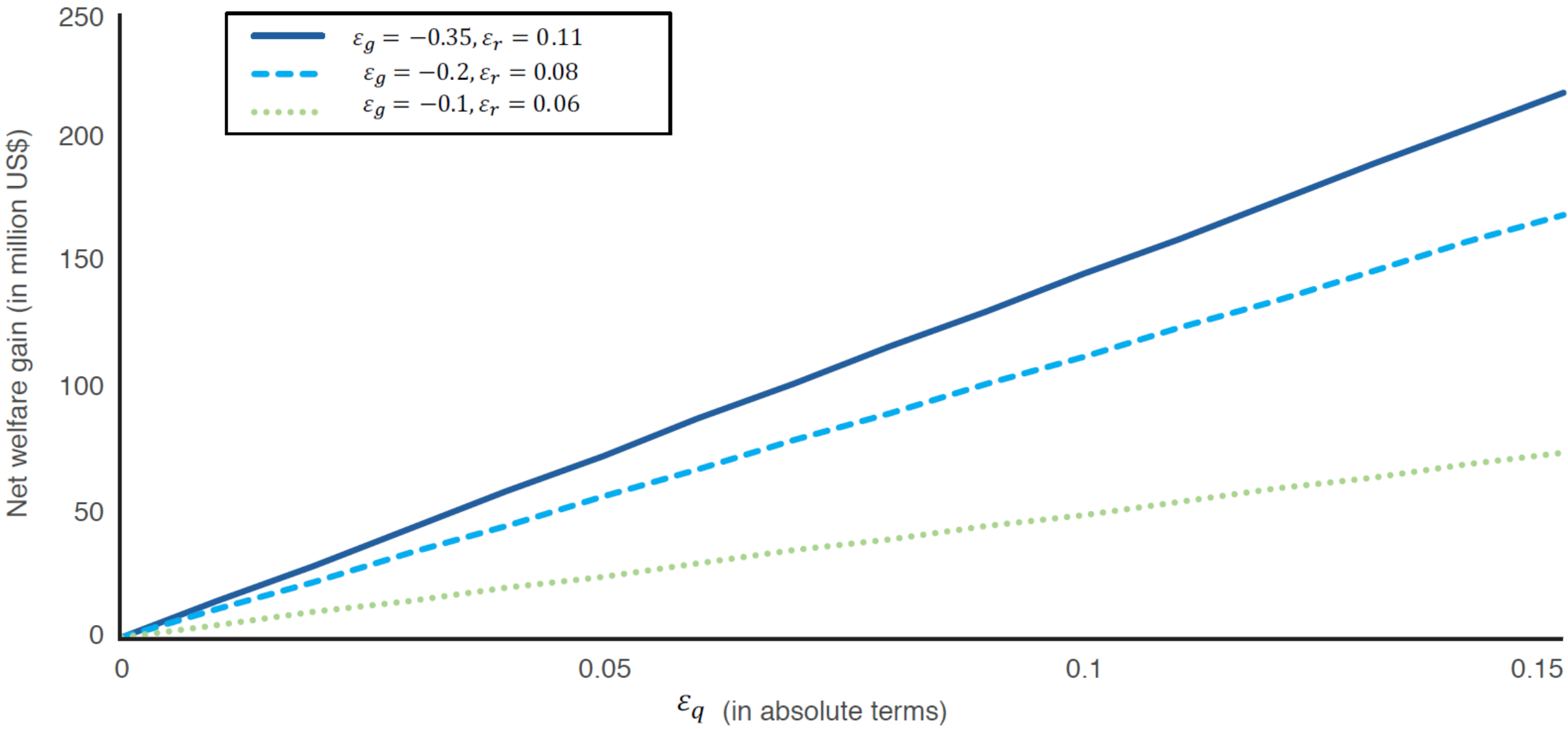
Summary of estimates

Case	Opportunity cost (USD per barrel)
- No other constraints	22 ^a – 43.8 ^a (with short-run elasticity)
- Constraint on production	59.4 ^a (with long-run elasticity)
- No other constraints	14.9 – 24.4
- Constraint on exports ^b	

^a Derived from the lower panel of Table 2. For the international oil price, we consider the average Brent price FOB, 71 US\$ per barrel in 2018 (EIA 2019b).

^b Results are derived under the assumption that export constraints will no longer be binding by 2050.

Net welfare gains from reforming the domestic oil price



Key takeaways

- The opportunity cost of oil depends on various factors, including the constraints to which the oil producer is subject and the domestic oil pricing scheme.
- For projects with only short-term impacts on domestic oil demand, the opportunity cost of a barrel of oil for Saudi Arabia is found to range between US\$15 and US\$25.
- For projects with long-lasting impacts on domestic oil demand, such as investments in energy efficiency or renewables, the range of possible values for the opportunity cost of a barrel of oil is broader, between US\$15 and US\$59.4.
- Increasing the domestic price of a barrel of oil by US\$1 results in a net welfare gain for Saudi Arabia of up to US\$200 million per year.

Thank you
