



## Exploring crude oil production and export capacity of the OPEC Middle East countries

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### HIGHLIGHTS

- ▶ We simulate the future scenario of crude oil export and production using ACEGES.
- ▶ The simulated results are analyzed using the GAMLSS framework.
- ▶ The peak points of oil export and production will come early in this century.
- ▶ The OPEC Middle East will produce most of the world crude oil in the near future.
- ▶ These countries will continuously be the key players in the crude oil markets.

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### ABSTRACT

As the world economy highly depends on crude oil, it is important to understand the dynamics of crude oil production and export capacity of major oil-exporting countries. Since crude oil resources are predominately located in the OPEC Middle East, these countries are expected to have significant leverage in the world crude oil markets by taking into account a range of uncertainties. In this study, we develop a scenario for crude oil export and production using the ACEGES model considering uncertainties in the resource limits, demand growth, production growth, and peak/decline point. The results indicate that the country-specific peak of both crude oil export and production comes in the early this century in the OPEC Middle East countries. On the other hand, they occupy most of the world export and production before and after the peak points. Consequently, these countries are expected to be the key group in the world crude oil markets. We also find that the gap between the world crude oil demand and production broadens over time, meaning that the acceleration of the development of ultra-deep-water oil, oil sands, and extra-heavy oil will be required if the world continues to heavily rely on oil products.

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### 1. Introduction

Crude oil consumption, particularly the relatively inexpensive conventional oil, is linked closely to the wealth of industrialized countries as well as the dramatic economic expansion of emerging economies. Many of the fast growing economies have relatively few crude oil resources of their own while most of the remaining crude oil resources are geographically concentrated

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in a few countries around the world. By way of an example, Table 1 shows the gap between demand centers and production centers as well as the geographic concentration of the crude oil resources.

Because of the critical importance of crude oil to modern economic activity, it is important to try to estimate plausible trajectories of future country-specific crude oil production and export capacities while accounting for below and above ground uncertainties that might limit the export capacity of the major world crude oil players. For example, Hallock et al. (2004) and Voudouris et al. (2011) argue that the world is going to be increasingly dependent on fewer and fewer crude oil exporters located mostly in the Middle East and nearby regions.

Here we explore the export capacity of the OPEC (Organization of the Petroleum Exporting Countries) member countries in the Middle East, namely Saudi Arabia, Iran, Iraq, Kuwait, United Arab Emirates (UAE), and Qatar. These countries are critically important crude oil producers and exporters, because these countries occupy about one third of the world crude oil production (and more than 90% of the Middle East) in 2010 (EIA, 2011) and IEA (2010) places the onus of increased oil supplies on the six major national oil companies in these countries (Stevens, 2012). Besides, five of these countries are in the five highest crude oil reserves countries as shown in Table 1 and Qatar is in the 12th (25.4 billion bbl). Collectively, the six countries analyzed here hold more than 60% of the world crude oil proved reserves and 99% of the proved reserves in the Middle East (BGR, 2009).

In addition to the high geographic concentration of crude oil reserves, the OPEC Middle East countries produce and export crude oil to the rest of the world. Fig. 1 shows that these countries play important roles as the sources of fueling the world economy for several decades. The OPEC Middle East provided around 40% of the world net export in this period with Saudi Arabia a dominant player by far. Stevens (2012) argues that the main Gulf Cooperation Council

exporters (i.e. Saudi Arabia, Kuwait, and UAE) have sufficient capacity to cover the loss of exports from all the other Arab exporting countries. As shown in Fig. 2, the OPEC Middle East countries are consistently producing more crude oil compared with their domestic demand for crude oil. It is important to note that some other countries such as Russia, Canada, and Venezuela are also important oil producers and potentially influential crude oil exporters. However, we focus on the six OPEC Middle East countries as we consider that these countries will be the key players in the world crude oil export markets at least until ultra-deep-water oil, oil sands, and extra-heavy oil enhance their market shares and extraction rates.

Based on these circumstances, it is anticipated that these six OPEC Middle East countries are likely to play an increasingly dominant role in the world oil export markets as we move forward and their behavior and plausible export capacity will have a significant impact in the world oil markets.

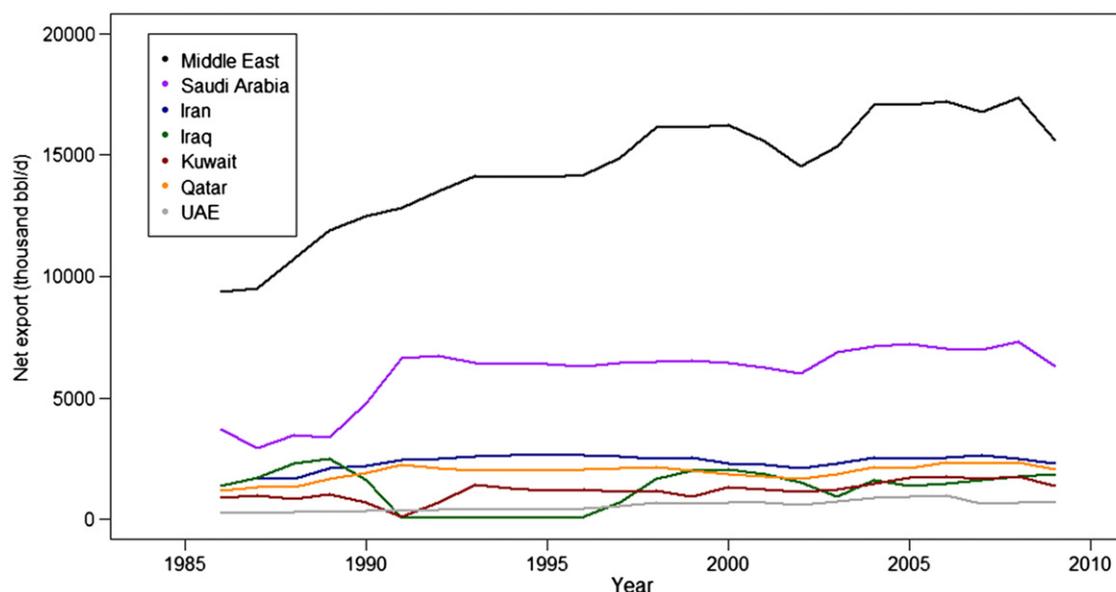
Although there are several studies using a variety of modeling approaches (economic, physical, and statistical) to explore the future production of crude oil based on the concept of representative agent (e.g. Al-Jarri and Startzman, 1997; Bartlett, 2000; Campbell, 1997; Campbell and Heapes, 2008; Caithamer, 2008; Deffeyes, 2002; Duncan and Youngquist, 1999; Hallock et al., 2004; Kaufmann, 1991; Laherrere, 2006; Mohr and Evans, 2007, 2008, 2009; Nashawi et al., 2010; Wells, 2005; Wood et al. 2003), there are few studies analyzing the export capacity of crude oil and no studies doing that for all of individual countries. This is because they focus on assessing the future production of crude oil and little consider the demand. Hallock et al. (2004) is one comprehensive study evaluating production, demand, and export of the 47 major oil-producing countries based on the representative agent modeling.

In this study, we use the ACEGES (Agent-based Computational Economics of the Global Energy System) model (first proposed by Voudouris, 2011 and demonstrated by Voudouris et al., 2011) to explore the future (until 2050) export and production potential of crude oil of the six OPEC Middle East countries by explicitly modeling the crude oil demand and supply for 216 countries. Crude oil in this study primarily includes crude oil and lease condensate as defined by Energy Information Administration (EIA) (see also Section 2.2 below). As discussed by Voudouris et al. (2011), the key advantage of the ACEGES model is the high

**Table 1**  
GDP and crude oil reserves in the top 10 GDP and crude oil reserves countries in 2009.

Top 10 GDP countries	GDP (trillion\$)	Reserves (billion bbl)	Top 10 reserves countries	Reserves (billion bbl)	GDP (trillion\$)
United States	14.05	28.4	Saudi Arabia	262.4	0.37
Japan	5.03	0.04	Iran	137.0	0.33
China	4.99	14.8	Iraq	115.0	0.07
Germany	3.30	0.3	Kuwait	104.0	0.11
France	2.62	0.1	UAE	97.8	0.27
United Kingdom	2.17	5.7	Russia	76.7	1.22
Italy	2.11	0.9	Libya	44.3	0.06
Brazil	1.59	18.0	Venezuela	41.2	0.33
Spain	1.46	0.1	Kazakhstan	39.8	0.12
India	1.38	5.8	Nigeria	37.2	0.17

\*Data sources: World Bank (2012) for GDP; BGR (2009) for crude oil reserves.



**Fig. 1.** Net export (export minus import) of crude oil for the period 1986–2009 (Data source: EIA, 2011).

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