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A comparison of oil supply risks in EU, US, Japan, China and India under different climate scenarios

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HIGHLIGHTS

- External oil supply risks are assessed up to 2035 under different scenarios.
- Included countries are EU, US, China, Japan and India (largest importers of oil).
- India, China and EU show increasing oil supply risks in all scenarios.
- Strong climate policies are needed to reduce future risks.
- A constructed peak oil scenario predicts major oil supply disruptions.

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ABSTRACT

For many countries, the inflow of energy is essential to keep economies running. Oil is typically considered to be the most critical fuel as an input for the petro-chemical and transportation sector and due to limited and less spread reserves. In this study external oil supply risks are assessed for the period up to 2035 for the European Union, United States, China, Japan and India (being the five largest importers of oil in the world), based on their current supplier portfolio. Scenarios are constructed for several climate policy and oil-supply projections.

It is found that risks increase strongly, when stringent climate policies are prevented from being implemented, especially when a peak in oil supply is taken into account, resulting in major oil supply-disruptions. China faces the lowest oil supply risks in most scenarios but the trends of India, China and US converge over time due to increasing import dependency of China and India. Japan faces high risks since the country has the highest oil import dependency combined with a low oil import diversification. For the EU, all figures are strongly influenced by Russia, accounting for 32% of total imports, and to a lesser extent Norway (11%), with high overall risks.

1. Introduction

The world is heavily dependent on oil for meeting its energy requirements, fulfilling about 32% of global energy demand, and 90% of total transportation energy demand (IEA, 2013; Gupta, 2008). This dependency has had serious consequences on economies in the past, in the form of price volatility and shocks (Yergin, 2011). The two oil shocks of 1973 and 1979, the Gulf War in the 90's and the so-called"Aggregate Disruption' of the 2000's in which major oil-exporting countries reduced production due to geopolitical motivations, caused major oil-price peaks (Yergin, 2011).

The oil industry is largely globalised, with about 60% of global oil supply being internationally traded, mostly driven by a mismatch in supply and demand (BP, 2014). On the supply side, oil reserves are unequally distributed, with the OPEC holding about 73% of world's proven oil reserves and controlling about 43% of global oil production in 2012 (BP, 2014). Many of these oil-exporting countries are characterized by a high degree of political instability (Leggett, 2014). The concentrated nature of oil reserves and the political unrest in countries with the largest deposits creates pressures for the security of energy supply (Yergin, 2006).

Oil demand is present mainly in North America, Europe and Asia-Pacific, consuming 77% of global oil supply in 2012 (BP, 2014), with about two-thirds of this amount being transported by sea through various"chokepoints' such as the Strait of Hormuz, the Strait of Malacca, the Suez Canal and the Strait of Bab el-Mandeb (Yergin, 2011; Gupta, 2008).

However, the centre of gravity of energy and oil demand is switching rapidly to emerging economies, particularly China, India

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and the Middle East, and drives global energy use one-third higher up to 2035, in comparison to 2012 (IEA, 2013). It is expected that China will become the largest importer of oil, and India the largest importer of coal by the early 2020s. The United States is expected to move steadily towards meeting all of its energy needs from domestic sources by 2035 (IEA, 2013). Together, these changes represent a re-orientation of energy trade from the Atlantic basin to the Asia-Pacific region, creating implications for cooperative efforts to ensure oil security.

Large consuming countries/regions such as the European Union, Japan, India and China are increasingly becoming dependent on oil imports to meet their energy requirements. As the production in non-OPEC (Organisation of the Petroleum Exporting Countries) regions (such as the North Sea) is declining, all the consuming countries are becoming more dependent on OPEC countries for their oil needs (Gupta, 2008; BP, 2014). The OPEC-cartel will therefore increase its already dominant position in the world in global oil production (BP, 2014; Yergin, 2011).

The rise in the need for energy worldwide, geopolitical challenges, depletion of resources, new exploration technologies and regulations to combat global climate change, will have a major impact on policy formulation and worldwide geopolitics in the coming decades. For policy makers, it is important to assess long-term oil security risks under different policies and market conditions to secure the nation's competitiveness and stability since energy investments usually have long development periods and lifetimes. Also the possible impact of peak oil on future oil production and associated supply risks, as e.g. shown in Aleklett et al. (2010), is important to evaluate.

Many studies have assessed risks related to oil supply in a global context. Most studies however focus on one aspect of the concept like; a supply-side focus (excluding demand-side efforts like efficiency improvement – Jansen and Seebregts, 2010); dependence and vulnerability (Markandya and Pemberton, 2010; Helm, 2002; Stirling, 2010). Others look at one country or region such as Vivoda (2009) for South Africa and Wu et al. (2009) for China. Yang et al. (2014) assessed external oil supply risks for four major oil importing countries, China, Japan, the US and EU, in the past. A comprehensive framework is developed which takes into account country risk factors and potential exports of suppliers. No future assessment, as far as we know, is done yet that focusses on the impact of different climate policy scenarios on the development of oil supply risks, combined with changes in the gravity of oil demand (from e.g. the US to Asia) and the possible impact of peak oil. In this study we aim to assess external oil supply risks up to 2035 under such different climate policy and oil-supply projections. We combine the framework provided by Yang et al. (2014) with Aleklett (2010), who provide global figures for oil production, taking into account peak oil. The focus is on the five largest net importers of crude oil in the world in 2012; the European Union, the United States, China, Japan and India, respectively (IEA, 2014). These countries together represent about 60% of total primary energy use in the world, 53% of total oil use (IEA, 2013) and nearly 80% of total net oil imports (IEA, 2014), see Table 1.

Table 1
Net oil imports for five largest net importing oil countries globally in 2012 (based on IEA, 2014).

Net oil imports (EJ)	2012
European Union	23
United States	18
China	11
India	8
Japan	8
Total of net importing countries	85

2. Methodology

Energy security has become a popular catch phrase, both in the scientific as well as in the political arena. However, the term remains rather vague and subject to many different interpretations (Löschel et al., 2010). Due to the ubiquity of energy production and use and the complexity of many of the underlying processes, economic assessment of the welfare effects of energy insecurity are typically uncertain and fail to provide clear guidance to policy makers (Lefèvre, 2009; Bollen et al., 2010; Löschel et al., 2010; Jansen et al., 2004; Ecofys, 2009). Energy security can be defined as "the reliable, stable and sustainable supply of energy at affordable prices and social costs" (World Economic Forum, 2012). This definition combines three key aspects; the environmental-, economic- and strategic geopolitical aspects (Brookings, 2014).

The European Commission (2010) categorizes different types of energy security indicators. The first category comprises the"simple indicators'. The simple indicators typically do not provide an accurate impression of overall energy security in a country since many of the relevant factors in this concept are not included. Examples of simple indicators are: the oil price or the Oil Security Metrics Model (Greene, 2010). Greene (2010) introduced the Oil Security Metrics Model that allows oil dependence costs to be estimated in many possible uncertain futures. This model excludes the political-, economic- and financial risks associated with supplier countries, and also the potential of these countries to deliver oil in the long run.

The second category includes the"diversification indicators'. Diversification indices might yield significantly different results depending on the partitioning of options (e.g. fuel types or suppliers), but may fail to include the problem of disparity (Stirling, 2010) – the degree to which categories are different (e.g. supplier risks from different nations). Some diversity indices, e.g. Jansen et al. (2004), introduce a correction factor for socio-political instability of a supplier country by multiplying with a 0 (unstable) or 1 (stable). This has the limitation that it is difficult to express country risk on such a limited scale while it depends on political-, financial-, and economic conditions (ICRG, 2012). Other correction factors can be introduced by taking into account resource depletion of supplier countries, using the proven reserves-to-production ratio for a given fuel type (Yang et al., 2014). Examples of diversification indicators are: the Shannon-Wiener Index or Herfindahl-Hirshman Index (Stirling, 2010).

The third category of energy security indicators is labelled:"composite indicators'. Composite indicators are formed when individual indicators are compiled into a single index, on the basis of an underlying model of the multi-dimensional concepts that are being measured. An advantage is that many different aspects of energy security may be captured, however, sometimes at the loss of transparency. Specifically for oil, Gupta (2008) proposed a composite indicator, the Oil Vulnerability Index, which comprises 7 simple indicators. The index captures the relative sensitivity of various economic parameters towards the developments of the international oil market. However, it does not take into account the ability of supplier countries to deliver oil-exports on a long-term basis, which is important when selecting a diverse and optimal mix of oil suppliers for an importing nation. Examples of composite indicators are: the EIA Energy Security Indicators (Lefèvre, 2009); Willingness To Pay (Bollen et al., 2010); Supply/Demand Index (Scheepers et al., 2007; Jansen et al., 2004); Ordered Weighted Averaging (Rocco et al., 2011) and the MOSES Model (Jewell, 2011; IEA, 2011).

Energy security indicators can also be incorporated in a climate