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Crude oil trade and green shipping choices

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ABSTRACT

Petroleum fuels the world economy but also burdens the environment due to greenhouse gas (GHG) emissions. Forty percent of annual global crude oil production is transported by ships, which are fueled by residual heavy fuel oil, yet GHG released during transportation is not required to be included in emission reporting for oil and gas companies. We investigate, for the first time, the extent to which oil buyers apply "green" operational practices in their maritime supply chain. We utilize a unique micro-level oil shipment dataset derived from commercial oil market data and the Automated Identification System (AIS) for vessel tracking. Our empirical results highlight the differences between being "green on paper" and "green in practice" and are important for policy makers in the future environmental upgrading of the tanker shipping and oil industry.

1. Introduction

Growth in the global economy over the past century has led to increased use of energy and emissions of greenhouse gases (GHG), and about 80% of global energy comes from fossil fuels (IEA, 2016). The oil & gas industry faces a difficult transition to a low carbon economy according to projections from the Intergovernmental Panel on Climate Change (IPCC). In the face of these challenges, the industry recognizes that fossil fuel use is a contributor to higher GHG concentrations, and that emissions should be minimized where possible (IPIECA, 2013). So far, most academic research has been focusing on sustainability in the upstream production in the oil & gas sector, see, for instance, Arscott (2004), Khan et al. (2007), Guilford et al. (2011), Schneider et al. (2013), Anis and Siddiqui (2015). While the direct emissions (e.g. gas flaring, extraction) of the oil and gas sector are significant contributors to total global GHG emissions, a large share of GHG emissions is generated in the downstream value chain, such as the transportation and distribution of crude oil, gas and refined oil products. Reducing the energy intensity in transport operations, so that less energy is required to provide the same product or service, can significantly reduce the oil & gas industry's environmental impact, especially given that over 4 billion tonnes of crude oil is produced annually and 40 percent of the volume is currently seaborne trade (Clarksons, 2016). In order to potentially improve the energy efficiency in the downstream supply chain, it is imperative to map the current behavior of participants.

In this paper, we investigate the environmental performance of oil buyers based on micro-level data for the global seaborne crude oil trade. We investigate whether oil companies make green shipping choices from two angles: (1) Do oil companies choose "green" vessels (i.e. vessels with better nominal energy efficiency specifications) when fixing a vessel for their cargo, and (2) Do oil companies subsequently allow the vessels to be operated in an energy efficient manner? Specifically, we investigate whether there are behavioral differences among companies from different regions and with different ownership structures – National Oil Companies (NOCs), public listed and private companies. We may expect differing behavior and performance due to the impact of ownership, either by geographic location (e.g. the national economic and political situation) or financial controls (i.e. business priorities). Importantly, our

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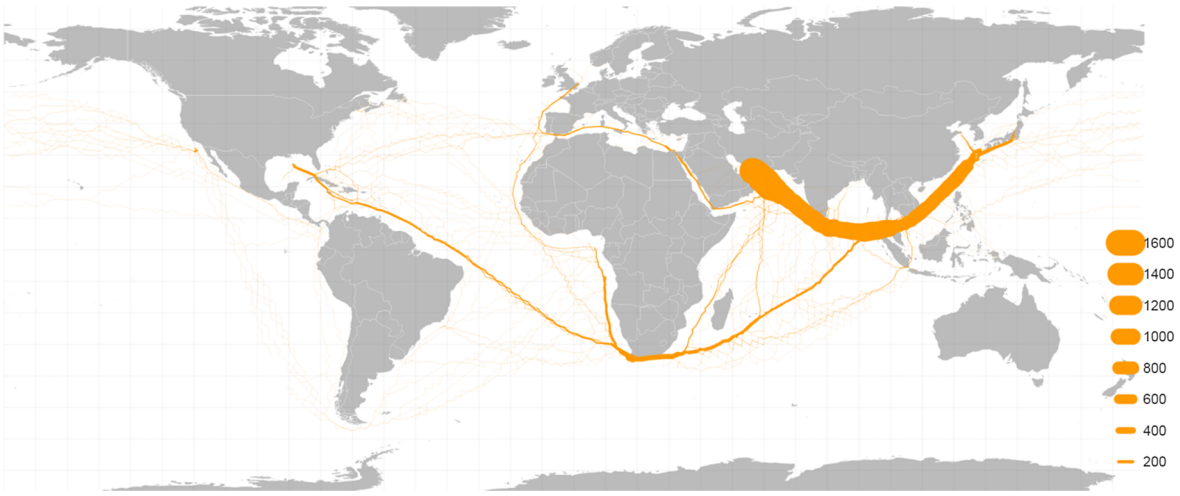

Fig. 1. Seaborne crude oil trade patterns.
Source: Jia et al. (2017).

approach highlights the important difference between choosing vessels that look good on paper (i.e. nominal energy efficiency calculated based on vessel design parameters) and actually operating vessels in an energy-efficient (low-emission) manner. This distinction is crucial for policy-makers, as actual operational performance is what determines actual emissions.

The contributions of the paper are threefold. Firstly, we reveal, for the first time, oil companies' environmental preferences with regards to their seaborne crude oil transportation chain. Secondly, we show empirically the important difference between using nominal (i.e. technical design) data and actual operational data in the evaluation of energy efficiency in the supply chain on a per voyage basis, as a means to track more accurate, actual operational ship energy efficiency performance. Thirdly, we utilize a unique micro-level dataset, derived from maritime 'big data' and port agent reports, comprising of seaborne crude oil shipments on Very Large Crude Carriers (VLCCs) between January 2013 and March 2016, that include information on buyers' and sellers' identities. The results are based on robust econometric models that control for vessel time-invariant fixed effects and market dynamics.

The remainder of the paper is structured as follows: Section 2 reviews the literature and defines the research questions; Section 3 illustrates energy efficiency measures in ocean transportation; Section 4 outlines the methodology; Section 5 introduces the data; Section 6 presents the empirical results and Section 7 contains policy implications and Section 8 concludes.

2. Literature review

Oil, being the dominating fuel of the world economy, serves society through a diversity of functions including heating, electricity generation, transportation and industrial applications. Petroleum is a major factor in national politics regarding development, national security and the environment. Oil is also the most valuable commodity in world trade - it was the world's first trillion-dollar industry in terms of annual sales (Doyle, 1994) and the global crude oil trade reached 42.4 million barrels per day (mb/d) in 2016 (BP, 2017). Approximately 90 countries produce oil, although the fourteen member states[1] of the Organization of the Petroleum Exporting Countries (OPEC) control over 80% of world crude oil reserve (OPEC, 2016). The Persian Gulf remains the dominating oil exporting region, with a current production rate of 26.6 mb/d, which is 33% of total world oil production of 80.6 mb/d (EIA, 2017). Oil consumption is mainly driven by the developed economies in the Organisation for Economic Co-operation and Development (OECD[2]), China and India. As the result of the geographic separation between the location of oil reserves/production and refineries/consumption countries, crude oil is transported great distances to refineries and consuming markets.

International transport of oil takes place using ocean-going tankers, railway, trucks and pipelines, depending on the distance, quantity to transport and geographic connectivity. Oil tankers are the primary means of intercontinental crude oil transportation. Fig. 1 illustrates the seaborne crude oil trade patterns based on the number of shipments by VLCCs over a four-month period in 2013/14. The thickness of the lines represents the transportation volume on the main routes in terms of the number of shipments. Major oil routes stretch from the Middle East to China/Japan, from Middle East to Europe/US, and from Africa to Europe/US. Asian countries (China, India, and Japan) account for the highest crude oil importing volume, with China being the largest net importer in the world. USA is the second largest net importer, however, much of its imported oil comes from Canada (BP, 2017) via pipelines which are not included in Fig. 1.

[1] OPEC members include Iran, Iraq, Kuwait, Saudi Arabia, Venezuela, Qatar, Indonesia (currently suspended), Libya, UAE, Algeria, Nigeria, Ecuador, Gabon, Angola and Equatorial Guinea.

[2] OECD members include 35 countries, Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak R., Slovenia, Spain, Sweden, Switzerland, Turkey, UK and US.