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Lifting the US crude oil export ban: A numerical partial equilibrium analysis

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HIGHLIGHTS

- We study the impacts of lifting the US crude ban on global oil flows and investments.
- We find massive expansion of US sweet crude oil exports.
- We analyze the resulting welfare effects for US producers, refiners and consumers.
- We indicate the changes on global trade patterns.
- We conclude that lifting the ban is the right policy for the US and the global economy.

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ABSTRACT

The upheaval in global crude oil markets and the boom in shale oil production in North America brought scrutiny on the US export ban for crude oil from 1975. The ban was eventually lifted in early 2016. This paper examines the shifts of global trade flows and strategic refinery investments in a spatial, game-theoretic partial equilibrium model. We consider detailed oil supply chain infrastructure with multiple crude oil types, distinct oil products, as well as specific refinery configurations and modes of transport. Prices, quantities produced and consumed, as well as infrastructure and refining capacity investments are endogenous to the model. We compare two scenarios: an insulated US crude oil market, and a counter-factual with lifted export restrictions.

We find a significant expansion of US sweet crude exports with the lift of the export ban. In the US refinery sector, more (imported) heavy sour crude is transformed. Countries importing US sweet crude gain from higher product output, while avoiding costly refinery investments. Producers of heavy sour crude (e.g. the Middle East) are incentivised to climb up the value chain to defend their market share and maintain their dominant position.

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1. Introduction

As a response to the first oil crisis, in 1975 the United States introduced restrictions on the export of domestically produced crude oil. In the following the export of crude oil was only allowed if granted a special license. The objective at the time was to insulate the US energy market from global price volatilities and strategic price-setting by the Organization of Petroleum Exporting Countries (OPEC). Licenses were easily granted for exports to Canada (for local consumption) and some niche oil fields. In later years also condensates and crude exports to Mexico were liberalized. Fig. 1 shows the overall development of US crude exports from 2010 to 2016 and the share destined for Canada (EIA, 2016a). The magnitude of the US shale oil boom led to an expansion of US crude exports from 2014 on. Hence, the eventual lift of the US crude export ban in January 2016 was a mere *ex-post* validation of the status quo since mid-2014. The lift of the ban, however, will further diversify the destination of these exports, as the liberalization of condensates already indicated in recent years. Which types of crude oils are being exported is not published by the EIA, however. We claim that the majority will be sweet light crude oil.

Despite the recent rise in exports, only about 4% of US oil production was exported in 2014, about 5% in the first quarter of

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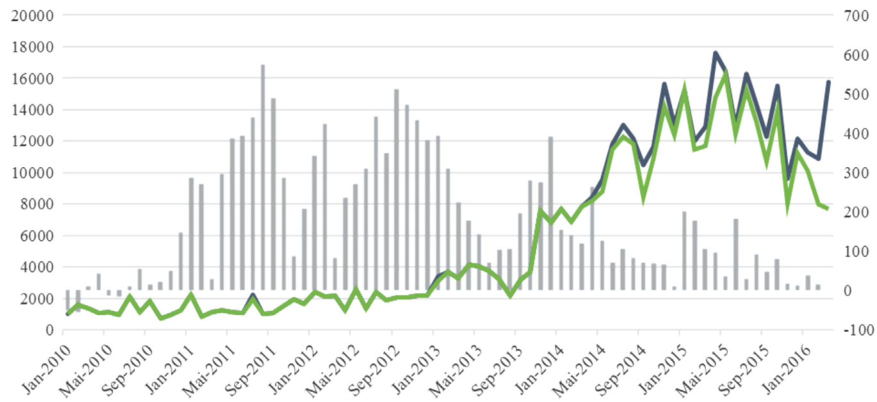

Fig. 1. US crude oil exports in thousand barrels in total (dark) and to Canada (light) as well as the price gap between Brent and WTI in $ per barrel indicated by the bars.

2015 and 5.5% in March 2016, according to the Energy Information Administration (EIA, 2015a, 2016a). In 2013, the US still imported about 50% of their refinery input (Kilian, 2015). Because the US demand for oil products exceeds domestic production in spite of the shale oil revolution, consumers and industry in the US remain vulnerable and exposed to global price shocks (Brown and Huntington, 2015; Grossman, 2013). Also, the profitability of the United States shale oil expansion relies on global crude prices (API, 2014; Aguilera, 2014; Aguilera et al., 2009). To investigate the effects, we therefore run two scenarios: one with a continued crude export ban and one with the export ban lifted.

Recently, some studies were investigating the effects of the lift of the crude export ban. Medlock (2015) provides an overview on their results and assumptions. From the diverse models used, the most comparable to ours is the NERA global petroleum model (Baron et al., 2014). It is also formulated as a spatial partial equilibrium model. It however includes 14 aggregated world regions with 8 of them being in North America; leading to very little insights into the adaptions of global trade flows. Baron et al. (2014) also do not allow for endogenous refinery capacity investments but set them exogenously. They do not model the refiners and transportation as separate players but maximize solely on the surplus of producers and consumers. In addition, they model supply and demand using an elasticity factor depending on crude oil type only, not taking into account regional differences. Elasticities for oil products are the same globally and do not differ with the specific product. They then adapt these factors over the time horizon exogenously. Global impacts like OPEC's reaction to the lift or fluctuations in Asia's demand are modeled via different scenarios. But even then, Baron et al. (2014) limit their analysis to the implications on the US economy only, disregarding the global context.

Another model is the WORLD model by EnSys Energy on which the American Petroleum Institute (API) relied for its recommendation to lift the export ban.[1] It is a deterministic input model which takes exogenous prices, production and infrastructure and obtains supply and demand levels via adapting refinery capacities (Vidas et al., 2014). Due to the simpler formulation it achieves a higher level of detail than the NERA and our model; the crude oil types are less aggregated and a detailed refinery and transport infrastructure of the US are mapped. Vidas et al. (2014) focus on the US economy in their report (e.g. supply sources of crude in the US states) yet also highly aggregate the global consumers.

Moreover, NEMS (EIA, 2015a) as well as the simpler models by Resources for the Future (Brown et al., 2014) and the Aspen Institute (Duesterberg et al., 2014) do also not take into account the global implications of the lift of the crude export ban. In addition, they aggregate on the representation of the refineries and products, if taken into account at all. For a comparison of the results of the different models we refer to Bordoff and Houser (2015). They do not only summarize the results, but also check the model outputs by running NEMS with the same input parameters. Over and above, they deliver insights into the deeper public policy dimensions of the crude ban lift. Summing up, to our knowledge there is no publication investigating the global implications of the US crude ban lift so far.

We embed the structure of the United States crude oil market in a global trade framework. When comparing our scenarios, we consider production levels, strategic investments and crack spread. The crack spread as the price differential between the used crude oil type and the refined product, along with the costs of processing and the product yields, determines the profit margins of a refiner. In addition, the imports and exports of the United States, their magnitude and type of crude oil, as well relevant shifts in the global trade patterns are analyzed. This way, our paper adds to the literature by being the first combining a detailed, disaggregated supply chain model of the global crude oil market, while endogenously including investments and adaptations by key producers, refiners and consumers across the world. Thereby in our model analysis, we are able to determine the consequences of the recent US policy shift on the global oil market from an upstream, midstream and downstream perspective.[2] This paper focuses on the induced changes on the midstream players, especially refinery capacities and investments, as well as the shifts of global crude and product flows. In addition, we outline the implications for the US oil market in greater detail.

Our detailed techno-economic model considers substitution effects between different types of crude oils and petroleum products, and allows to quantify long-term equilibrium shifts in global trade flows and utilization ratios of different refinery technologies.

2. The United States crude oil market

The distinction between different crude oil qualities (types) is key to comprehending the strategic adaptations of the oil sector. Because the given crude oil quality affects the output via product yields, the refineries adapt their technical configuration to match the available crude oil. Economists tend to think of crude oil as a homogeneous good in terms of a bathtub model with crude being

[1] http://www.api.org/news-policy-and-issues/us-crude-oil-exports

[2] We thereby distinguish the different levels of the crude oil supply chain as follows: crude oil production (upstream), trade and processing/refining (midstream), and distribution/consumption (downstream) in line with (CEIP, 2015).

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