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Use of AIS Data to Estimate Trade Volumes: The Case of LNG

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Problem

Global trade statistics by commodity type and transport mode is (if available at all) either available with delay or through reports produced by specialized firms. The reports are often based on official customs data and knowledge through brokers, agents and analysts. It is inefficient, expensive and a potential source of error. This thesis try to utilise vessel positions through the Automatic Identification System (AIS) to obtain world-wide trade volumes on a micro level (individual cargo) and analyse its reliability.

Basic Concept

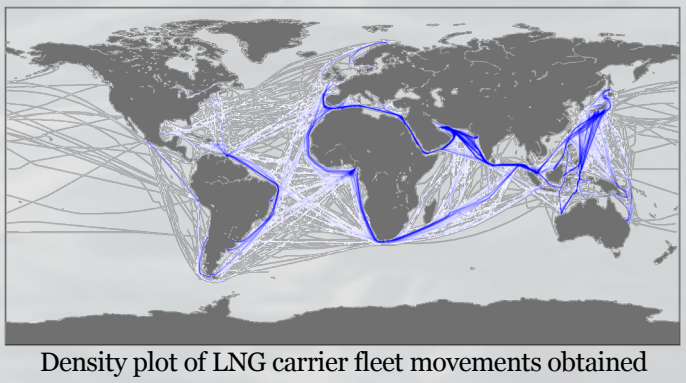
Trade flow in or out of pure liquefaction or regasification terminals can be measured by taking the sum of all unique vessel visits multiplied by their respective gas capacity and cargo utilisation rate:

$$F = \sum_{V} \mu C_v N_v$$

Where F is the total trade flow, V is the fleet of vessels v, C_v is the gas capacity of vessel v, N_v is the number of unique visits by vessel v and μ is the cargo utilisation factor.

AIS Data

Automatic Identification System (AIS) is a communication system introduced by the United Nations maritime organisation IMO to improve safety, environmental impact and to regulate and monitor the shipping traffic. The system communicates through the maritime Very High Frequency (VHF) bands to transmit ship movements and technical data at specific intervals. The data includes, but is not limited to speed, course, position and navigational status. Four satellites owned by the Norwegian Coastal Administration has collected the data used in this thesis (S-AIS data).



Density plot of LNG carrier fleet movements obtained from AIS data

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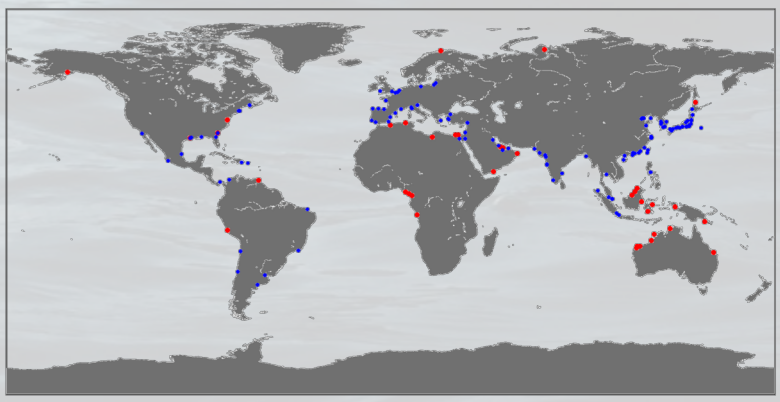
Methodology

Raw S-AIS data is decoded, and a database on a readable format has been built. The database has then been cleaned, and filtered to only include LNG carriers by using an external vessel identification list (IMO numbers).

Our theory is that trade flow in or out of LNG terminal areas can be measured by applying the "Basic Concept" presented on all LNG liquefaction and regasification terminals worldwide. Certain regasification terminals can both import and export LNG. In order to measure trade flow both in and out of these terminals, historical vessel positions are used to predict if the vessel is delivering cargo or collecting cargo.

A key in this concept is to obtain all the unique visits, without including vessels only passing by. A geo-fence approach is used to collect unique visits. As there are large gaps in the data due to satellite connection, the geo-fences needs to be as large as possible in order to increase the time window of detection. Different geo-fence sizes are tested, as well as utilising the navigational status of the vessels.

Depending on the precision of the concept, and data quality, the method should allow us to obtain a world-wide LNG trade flow network by keeping record of all vessel operations obtained: How much LNG all countries import and export, and where every single cargo comes from.



Plot of all LNG import/export terminals world-wide which is the basis of the trade network

Preliminary Results

Trinidad as LNG export country and Kuwait as LNG import country have been used for preliminary test results. Both terminals have been tested with three different geo-fence sizes:

LNG Export Trinidad 2015 (MTPA*)

Actual**		5 km radius		40 km radius		60 km radius		5 km radius***	
MTPA	% of actual	MTPA	% of actual	MTPA	% of actual	MTPA	% of actual	MTPA	% of actual
12.53	100 %	5.30	42 %	11.82	94 %	13.66	109 %	4.47E-07	0.0 %

LNG Import Kuwait 2015 (MTPA*)

Actual**		5 km radius		40 km radius		60 km radius		5 km radius***	
MTPA	% of actual	MTPA	% of actual	MTPA	% of actual	MTPA	% of actual	MTPA	% of actual
2.9	100 %	0.39	14 %	0.92	32 %	1.19	41 %	0.00	0.0 %

*Assumption: 1 m3 LNG = 0.41 tonnes LNG

**Source: International Gas Union

***Included no speed and navigational status "moored" or "at anchor"

The preliminary results indicate that a huge geo-fence is needed due to week AIS data quality/satellite coverage. Nevertheless, the results also show that the methodology used can hit close to the actual export with big enough geo-fences. In the results above we have assumed 100% cargo utilisation rate, which is the main reason for the overshoot in the export estimation. LNG carriers are normally filled between 90%-98% full. A cargo utilisation factor can be tuned with better data and by analysing more time windows.

To conclude, the results are very promising showing that a simple algorithm potentially can compete with expensive research from analyst firms.