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Shipping efficiency comparison between Northern Sea Route and the conventional Asia-Europe shipping route via Suez Canal

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ABSTRACT

The continuous retreat of Arctic sea ice and seemingly appealing cost competitiveness of transarctic shipping routes are expected to boost shipping activities in the region. However, in reality, the number of Arctic transits remains meagre compared with major shipping routes. This study first develops a profit estimation model for containership sailing from an original port to a destination port with multiple port calls and a cost estimation model for oil tanker sailing from an origin port to a destination port. The authors then proceed to compare the shipping efficiency between the Northern Sea Route (NSR) and the Asia-Europe shipping route via Suez Canal by using the developed models and real shipping operational data. The results demonstrate that NSR shipping is not economically favored compared to traditional one in container shipping, but may be only appealing to small or medium-size tanker operators.

1. Introduction

The continuous retreat of Arctic sea ice since the 1950s has drawn attention from different fields. Ice retreat is a threat to low-lying islands, and a cause of concern for climatologists. On the other hand, it has offered opportunities to oil-and-gas development and fueled speculations of new transarctic shipping routes to be operational.

Undeniably, there has been increasing dialogues, research activities and global cooperation on Arctic issues. Therein, shipping is definitely a hot topic as transarctic shipping routes are said to provide much shorter alternatives between Europe and Asia and between Europe and North America compared to the conventional shipping routes via the Suez or Panama (Lasserre and Pelletier, 2011). Every summer, when the official statistics about the decline of sea ice are published, the media trumpet the oncoming age of Arctic shipping without any deeper analysis (Lasserre and Bourbonnais, 2015, Lasserre and Pelletier, 2011). They believe that the reduction in distance can transform to savings in time and costs, and transarctic shipping routes will become competitive alternatives to the conventional ones. On the other hand, researchers are more cautious in providing any straightforward conclusions. Many researchers investigated the cost competitiveness of transarctic shipping routes relative to conventional shipping routes (Furuichi and Otsuka, 2014a, 2014b, Lasserre, 2014, Liu and Kronbak, 2010, Schøyen and Bråthen, 2011, Wergeland, 2013), and the majority of these works concluded that transarctic shipping routes were economically favored, at least in some scenarios.

However, after examining the real ship traffic along the Northern Sea Route (NSR), which is regarded as the most promising route among all transarctic shipping routes, the authors note that the real commercial shipping activities are far gloomier than what is expected. In 1997, a Finnish oil tanker, *Uikku*, sailed the length of the NSR from Murmansk to Bering Strait, marked the first Western ship to complete the voyage. Then, after a long wait of 12 years, another two international commercial cargo vessels, *Beluga Fraternity* and *Beluga Foresight*, travelled north of Russia between Europe and Asia in 2009 (DNV, 2010a). Since then, transit shipping along the NSR was performed by 4, 41, 46, 71, 53 and 18 ships respectively from 2010 to 2015 in the summers (NSRA, 2015, Sakhuja, 2014). For the NSR, the number of transits remains meagre compared to other major shipping routes, and most shipping activities are destinational or domestic. In addition, oil-and-gas transportation dominates the transits; the number of bulk transits is quite stable; and there is few containerships that have traversed the route so far (Zhang and Meng, 2016).

The Northwest Passage (NWP) has been a feasible but less popular choice for commercial shipping. In November 2008, the Canadian Coast Guard reported that the first commercial cargo vessel, *MV Camilla Desgagnes*, sailed through the NWP (CBCNews, 2008); and the first commercial bulk carrier, *MV Nordic Orion*, traversed the route in September 2013 (MarEx, 2013).

The divergence between research prospect and reality may result from the following issues. First, the relevant research studies may

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neglect some important factors in real situation. Second, cost analyses in the literature are over-simplified or some assumptions are unrealistic. Third, the shipping industry may not respond as quickly as expected. To bridge the gap, we hope to utilize industrial data in commercial viability analysis, and we aim to develop a tangible profit estimation model for container shipping with multiple port calls and a cost estimation model for port-to-port oil shipping to compare shipping efficiency between the transarctic and conventional shipping routes.

1.1. Relevant studies

The authors reviewed 25 publications on shipping cost analysis related to Arctic shipping, with 9 scientific journal papers, 5 theses, 1 book chapter, 6 technical reports and 4 conference papers. 18 papers were published in or after 2009, reflecting the increasing interest in Arctic shipping after the success of commercial transits at NSR and NWP. Details of the literature review can be referred to Meng et al. (2016b) and an overview is presented in Table 1 for information.

Most studies confirmed that the NSR have more favorable ice conditions in coming decades than the NWP. European and Asian ports were commonly chosen as origins and/or destinations due to high trading demand between Europe and Asia. Moreover, the distance reduction between a Northern Europe port and a Northeast Asia port is the most substantial.

Since different publications had distinctive assumptions, they naturally derived multifarious conclusions. Among all, 20 models compared either total cost or unit cost of transits, 3 compared freight rate, and 2 compared profit. Given all parameters involved, 12 models concluded the transarctic shipping routes were commercially viable; 11 presented some relatively balanced results by concluding the routes were economically favorable in some scenarios; and 2 argued that the transarctic routes could hardly be a feasible alternative at present.

In most studies, factors of shipping time and costs are assumed without proper validation. Hence, it is hard to justify that the results are reliable. In addition, some models over-simplify the comparisons by including only selected factors.

1.2. Objectives and contributions

Capitalizing on previous studies, the authors aim to develop a tangible shipping profit estimation model for container shipping and a cost estimation model for oil shipping. The differences in models of the two shipping types arise due to their nature of transportation. Container shipping involves transshipment, and demands in different ports along the shipping route affect both revenue and cost. On the other hand, oil shipping is usually from origin to destination, and thus revenue is determined at the original port, regardless the shipping route taken, i.e. cost is the only determining factor for oil shipping companies. With the developed models, the authors aim to compare shipping efficiency of a transarctic transit versus that of a conventional one for selected OD pairs, taking into account physical reality and latest real operational data. Most data of conventional shipping routes are collected from shipping companies or well-recognized industrial reports, and data of transarctic shipping routes are partly based on ship traffic analysis at NSR (Zhang and Meng, 2016).

The contribution of this study is two-fold. First, this study develops a tangible profit estimation model which takes into account transshipment demand for container shipping and a concrete cost estimation model for port-to-port oil shipping. None of the previous studies considered transshipment demand, and few of them included all cost components of running ships. Second, the authors collect the latest operational and ship traffic data from various sources to ensure valid assumptions on variables in the models. Hence, the results are reliable and up-to-date.

Table 1
Literature review overview.

	Factors	Publications and assumptions in models
General portraits	Transarctic shipping route selected	• NSR (20 articles) • NWP (8 articles) • Transpolar Sea Route (3 articles)
	Traditional shipping route for comparison	• Route via Suez Canal (21 articles) • Route via Panama Canal (6 articles) • Route vis Cape of Good Hope (1 article) • Trans-Siberian rail link (1 article)
	Original or destination port	• Hamburg (8 articles) • Rotterdam (10 articles) • Yokohama (15 articles) • Shanghai (7 articles)
	Type and size of ship utilized	• Containerships (15 articles) [650 TEU to 10,000 TEU] • LNG, bulk carrier and general cargo ship (1 article) • Multiple ship types (6 articles)
	Ice class	• Double Acting Ship (DAS) and CAC3 (3 articles) • 1AS and 1B (2 articles) • *A*1, A3, A5, PC4, 1 A, 1C and Arc 4 (1 article) (Note: articles have referred to classifications of different societies).
Shipping time	Shipping distance	• Stated without considering uncertainties; • Depended on the origin-and-destination (OD) pair.
	Sailing speed	• SOF (2001) and Somanathan et al. (2009): determined based on ice conditions and ice class of vessels. • The rest: a deterministic value; varied from 5 to 22 knots.
	Stopovers	Only 3 publications (Chernova and Volkov, 2010, Verny and Grigentin, 2009, Xu et al., 2011) considered stopover(s) along transarctic shipping routes.
Shipping cost	Fuel cost	• 25% (Raza, 2013) to 61% (Srinath, 2010) of total costs • Ship fuel consumption rate: • Guy (2006): the same daily fuel consumption rate for the transarctic route and conventional route. • Furuichi and Otsuka (2013), Lasserre (2014), Schøyen and Bråthen (2011), Wergeland (2013), Xu et al. (2011): fuel consumption per distance unit is proportional to the square of sailing speed. • Somanathan et al. (2009), Furuichi and Otsuka (2013) and Lasserre (2014): fuel consumption rate is higher for ice-class vessels due to increasing weight of vessels or extra required power to transit through ice. • Fuel price: differed greatly due to tremendous fluctuations of bunker price in the past decade
	Capital cost	• Chartering cost: Guy (2006), Schøyen and Bråthen (2011) and Raza (2013) • Depreciation cost: other 18 publications • Premiums on building cost: varied from 6.5% (Omre, 2012) to 120% (DNV, 2010b).
	NSR transit fees	• 6 did not discuss the issue of NSR transit fee ○ Chernova and Volkov (2010), DNV (2010b) and Niini et al. (2006): used DAS which can navigate through thick ice without icebreaker escort ○ Lasserre (2014): assumed a hypothetical future scenario where ice conditions have greatly changed and icebreaker support is not essential. • Other 14 models: transit fees did not converge.
	Insurances	All proposed an insurance premium for Arctic shipping: increments ranged from 25% (Wergeland, 1992) to 100% (SOF, 2001, Somanathan et al., 2007).