Intermodal corridor alternatives between Asia and Central & Eastern Europe

By Sagar Neel De
Thesis Supervisor: Dr. Ioannis N. Lagoudis

Summary: The research aims to solve the challenges in integration of point-to-point transportation through intermodal networks, with a framework that evaluates the most effective network connecting Asia and Central & Eastern Europe as an example. The research also evaluates the impact and implications of carbon tax enforcement on intermodal network design.

Introduction

Businesses are increasingly facing greater challenges for continued growth and sustenance of manufacturing facilities in China. As a consequence, Central and Eastern European (CEE) countries are being considered as an alternative and/or support for business interests in China. This has increased complexity of supply chains between Far East and CEE countries, with increasing volumes of components and semi-finished products being shipped from Far East to CEE countries every year. As a consequence, transportation companies are constantly seeking efficient and eco-friendly networks to become more integrated with manufacturing and retailing supply chains. Collaboration among operators are also on a rise enabling faster and cost effective modes of transport through intermodal networks.

Environment has become critical for business sustainability and continuity. And maritime sector has not been immune to such developments. An agreement was concluded in 2011 on mandatory, international energy-efficient vessel design standards. Although the suggested carbon tax rates on maritime transport is being debated by governments and law enforcement agencies, the business community can expect global enforcement of carbon taxes impacting preferred routes of global trade in the near future. Thus it requires decision makers to account for such probable changes in future to decide on their strategy or current investments.

Methodology

Freight rates, transit time, inventory costs and carbon taxes determine the preferred route and thus the preferred route varies with intrinsic propeties of consignments. A combination of routes from Shanghai to Budapest, Bucharest or Warsaw, through a number of transshipment ports, such as, Constantza, Piraeus, Trieste, Rotterdam, Hamburg, and Gdańsk, are evaluated. Also, impact of carbon taxes on economic viability of intermodal options are estimated.

Data from reliable sources, such as, Organisation for Economic Co-operation and Development (OECD); Versatile, Efficient and Longer Wagon for European Transportation (Project VEL-Wagon); Alphaliner; Google Maps API; and JC Trans Group; are used in the analysis. The selection of data sources is

based on evaluation on following dimensions: Robustness; Real-time and futuristic; and Accurate. The time horizon of the analysis is February 2013 to May 2013.

The European Commission plans to charge firms a minimum tax on emissions at a suggested rate of €4 to €30 per ton of CO_2. In the absence of its enforcement on maritime transport, the authors evaluated scenarios with carbon tax rates up to $500 ($\sim$€330) per ton of CO_2 emissions. The framework is scalable to include other forms of emission tax rates.

The following mathematical structure has been used throughout the analysis:

- f: Transportation Cost → (Ocean Freight Rate, Rail Freight Rate, Container Units)
- g: Inventory Cost → (Value of Inventory, Cost of Funds, Transit Time)
- h: Carbon Cost → (Carbon Tax Rate, Distance, Mass of consignment)

The Freight Contract Selection Algorithm (FCSA), developed to incorporate robust real-time capabilities to the framework, is developed to include all freight contracts in real time. The algorithm is robust, scalable and optimal, i.e. it does not compromise on the quality of solution. In the current researrch, the algorithm shortlisted a set of 156 contracts across three months and six PODs from the initial set of 1018 contracts, i.e. an effectiveness of 84.7%.

Results

The research classifies two types of freight rates, defined for each route: cost effective, defined as the cheapest freight rate for a route; and time effective, defined as the cheapeast freight rate for the shortest transit

time. And there is a critical inventory value for each route, beyond which time effective mode is the most economical option. The figure below illustrates the critical inventory value of few ports considered in the analysis. The critical inventory values appeared to be higher for routes through ports with higher traffic.
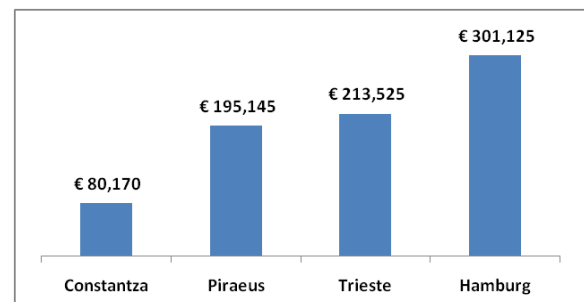
The transportation costs from Shanghai to multiple destinations in CEE using a combination ocean and rail transport modes were fluctuating across months but the trends were consistent across routes. In most cases, routes through the port closest to the destination (in terms of land distance) have the least transportation costs.

The research also evaluates the impact of inventory cost in addition to transportation costs. The authors estimated the best route for 88 categories listed in HS 1988. And also estimated the preferred routes across inventory worth up to $ 100 million per TEU at current freight rates. The figure titled *Inventory Stress Results,* in next page, summarizes the stress test results.

The research also estimates the average carbon emissions for transporting a container from Shanghai to Bucharest, Budapest or

Warsaw. The estimates are valid for shipments carried from Shanghai to transshipment ports via Suez canal in container vessels, and subsequently to their final destinations by rail. The routes through southern European ports have up to 33% lower carbon emissions than routes through north of European Union. European Commission suggested a minimum carbon tax rate of $6 to $45 per ton of CO_2 emissions. The research estimated financial viability of routes for futuristic scenarios with carbon tax rates as high as 10-times of suggested rates (upto $500 per ton of of CO_2 emissions). For

> **The routes through southern European ports have up to 33% lower carbon emissions than routes through north of European Union.**

most cases, the route through Constanta will hold dominance over other routes for shipments destined for Bucharest. The route through Trieste will evolve or dominate for shipments destined for Budapest. And in most cases, the route through Hamburg will be the most economical transshipment port for shipments to Warsaw.

Inventory Stress Results
Preferred Routes for various degrees of Inventory Value
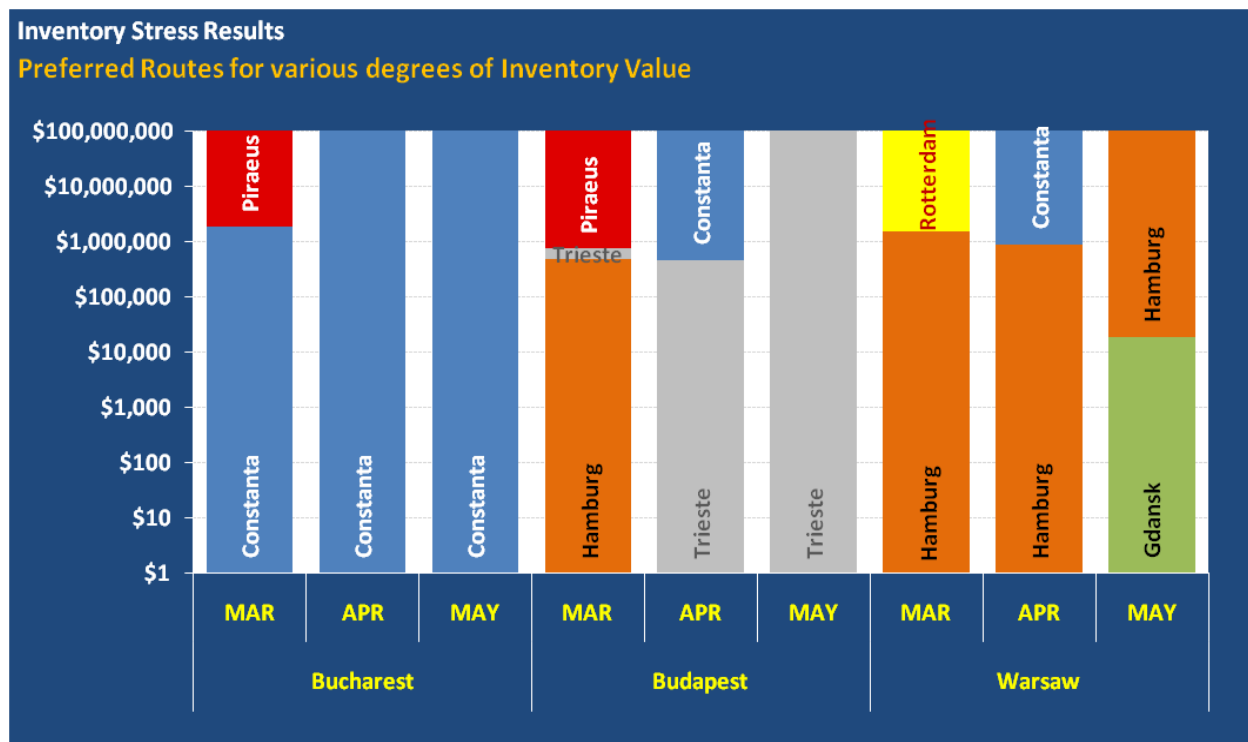
Conclusions

The analysis concludes that for shipments destined for Bucharest, transshipment through Constanta is the most economical and viable route; Trieste is evolving as the leading transshipment port for shipments to Budapest; and in most cases Hamburg is the most economical transshipment port for containers to Warsaw. Few routes are

preferable for high value products. And the definition of high value products (HVP*) varies across routes, with the minimum worth of inventory ranging between $ 0.5 million and $1.5 million per container.

In future, maritime industry can expect enforcement of carbon taxes. Thus it requires decision makers to account for such probable changes in future to decide on their long-term

strategy or current investment strategy. And the research proves that the status quo of preferred routes remain largely unaltered by imposition of carbon taxes. Thus, at a broader strategic level, liner operators will not be impacted by enforcement of carbon taxes because it would be an even playground for all players operating in a region. And in most cases, uniform carbon taxes in the region will not negatively impact traffic through ports

> **Liner operators will not be impacted by enforcement of carbon taxes.**

and other transshipment infrastructure facilities.

The table below summarizes the choice of preferred routes under multiple scenarios.

Destination		Only Transportation	Transportation + Inventory Holding	Transportation + Carbon Emission
	Bucharest	Constanta	Constanta Piraeus** (HVP*)	Constanta
	Budapest	Trieste Hamburg**	Trieste Hamburg ** Constanta ** (HVP*) Piraeus ** (HVP*)	Trieste Hamburg** (Tax Rate < $200 /ton-CO2)
	Warsaw	Hamburg Gdansk**	Hamburg Gdansk** Rotterdam** (HVP*) Constanta** (HVP*)	Hamburg Gdansk**

** The trend is not consistent across months

Future Work

The framework does not account for contract reliability. The inclusion of this parameter in the framework will enhance insights with choice of operator across routes. In addition, the Trans-Siberian rail route and Arctic route should be also considered in future research. The developments in those routes may be in a nascent stage as of now, but the routes hold significant promise in the future. The relationship of critical inventory value and traffic in ports might pose some interesting opportunities for the industry. And it would be of academic interest to evaluate if competitive freight rates between the busiest seaports follow power law.

About the Author

Sagar Neel De joined the MSCM program after five years of professional experience in the big data analytics industry. He also holds bachelor and master degrees in mathematics and computing from Indian Institute of Technology (IIT), Kharagpur.