

Does Environmental Compliance Impact Port Competitiveness?

METRANS International Urban Freight Conference October 18, 2017

Author: Philip Davies, Principal Davies Transportation Consulting Inc.

Executive Summary

The Southern California Air Quality Management District recently approved a new Air Quality Management Plan (AQMP) which is estimated to result in \$15.7 billion in incremental costs between 2017 and 2031. However, it is assumed 93% or \$14.6 billion of the total costs of the AQMP will be funded directly by government spending. Container fees have been suggested as a means of financing the necessary government contributions. These proposals have generated opposition from port stakeholders due to their potential impact on the competitiveness of Southern California as a container gateway.

This paper addresses the question: Does environmental compliance impact port competitiveness? This requires examination of two issues: the impact of relative transportation costs on the volume of containerized imports through the Ports of Los Angeles and Long Beach (i.e. the demand elasticity), and the portion of costs attributable to environmental initiatives.

Previous studies have generated widely varying estimates of demand elasticity by analyzing market segments based on product value and inland mode of transport. The model developed in this paper analyzes aggregate market share rather than individual market segments to generate a more accurate estimate of overall demand elasticity for POLA/POLB container traffic.

The model is based on a regression analysis of POLA/POLB transportation cost and vessel transit times relative to the Port of New York/New Jersey, using Inland Point Intermodal (IPI) traffic as a benchmark. The model successfully tracks POLA/POLB market performance from 1Q 2012 to 1Q 2017, including the influence of two major events: POLA/POLB port congestion due to a labour dispute from November 2014 to February 2015, and the opening of the expanded Panama Canal in June 2016.

Based on the model results, POLA/POLB import traffic is inelastic, with an average elasticity of .26 (i.e. a 10% increase in costs would result in a 2.6% decline in traffic). Current cost estimates were developed for the three major environmental/congestion mitigation user pay programs in place at POLA/POLB (the Alameda Corridor, PierPass and the Clean Trucks Program). The

programs are estimated to reduce annual traffic by approximately 196,000 TEUs or 1.3%. Implementation of a \$100 per container fee as recommended by the SCAQMD Legislative Committee would result in a decline of 277,000 TEUs or 1.8%.

This analysis provides an early indication of the impact of the Panama Canal expansion on POLA/POLB traffic. The shift in liner services from the Suez Canal to the shorter Panama Canal route results in lower weighted average transit times for the all-water routes, and ocean rates to East/Gulf Coast ports have fallen more rapidly than rates to the West Coast.

The model developed for this paper suggests that to date user-pay environmental and congestion mitigation programs have had only a small impact on port traffic, as would be expected given the low elasticity and relatively minor impact on overall costs. However, POLA/POLB market share fell from 46.2% in the first quarter of 2016 to 44.2% in the first quarter of 2017 in spite of the low elasticity due to significant reductions in the West Coast advantage over East/Gulf coast ports in ocean shipping costs following opening of the Panama Canal expansion. Based on this experience, POLA/POLB are likely to face ongoing competitive challenges from East Coast routings even in the absence of additional environmental compliance costs. The magnitude of impacts of additional user-pay programs will depend on the extent to which they increase overall costs for containers through POLA/POLB.

Regional and port authority infrastructure and environmental strategies should be targeted to enhance regional competitiveness as an origin-destination routing, or at least to mitigate the impacts of necessary environmental costs. However this requires an ability to measure and monitor competitiveness on an ongoing basis; an understanding of the factors influencing competitiveness and which of them are within the port's control, which can be influenced by the port's strategy, and which are entirely beyond their control; and a deeper understanding of shipper characteristics and the factors influencing their routing choices. The success of the modelling approach in this paper in developing data-based quantitative estimates of the influence of cost and transit time variables on aggregate port traffic levels suggests that development of more detailed quantitative models is possible. The primary requirement for undertaking this task is assembly of detailed data on origin-destination transportation costs and performance parameters on an ongoing basis, including ocean and inland costs, transit times, and other performance criteria for individual origins and destinations. There are a number of currently available data sources which could be employed, including BlueWater Reporting data on North American liner operations; PIERS data on port volumes and

inland destinations; Intermodal Association of North America data on regional intermodal traffic; and other sources. If a project sponsor could be found, development of a database on ongoing supply chain competitiveness factors is a logical first step in developing the models necessary for informing strategic initiatives.

Introduction

The Southern California Ports of Los Angeles and Long Beach handled a combined volume of 10.4 million laden TEU's in 2016, representing 25.6% of overall North American container trade. Both ports are undertaking massive capital investment projects to accommodate anticipated traffic growth and protect their market share from competing for North American gateways.

However, Southern California continues to struggle to attain National Ambient Air Quality Standards (NAAQS) for ozone and fine particulate matter. To address this issue, the Southern California Air Quality Management District recently approved a new Air Quality Management Plan (AQMP) which is estimated to result in \$15.7 billion in incremental costs between 2017 and 2031.

Despite emissions reductions in recent years, the Los Angeles-Long Beach port complex remains the largest single air pollution source in Southern California, with diesel-fueled cargo ships and trucks among the top contributors. The Final Socio-Economic Report on the AQMP estimates that the Transportation and Warehousing Sector (which includes port-related activity) will incur direct costs of \$791 million (SCAQMD 2016 p. 2-7), but assumes that 93% or \$14.6 billion of the total costs of the AQMP will be funded directly by government spending.

The analysis in the Socio-Economic Report does not deal with impacts of potential programs to finance the government spending. The draft Financial Incentives Funding Action Plan for the 2016 AQMP suggested the possibility of a \$35 per TEU fee to generate \$385 million per year for adoption of near- zero and zero emission technology, and a \$100 per TEU tax was recently recommended by the SCAQMD Legislative Committee. These proposals have generated opposition from port stakeholders due to their potential impact on the competitiveness of Southern California as a container gateway.

While various stakeholders have weighed in on the potential impacts of container fees, none appear to consider lessons from the actual market performance of the Ports of Los Angeles and Long Beach. From 2003 to 2016, their share of competitive traffic (i.e. Asia-Pacific imports to the US) fell from 55.7% to 45.8%. This coincided with a gradual decrease in the cost differential

between West Coast and all-water routes to East Coast ports, a portion of which is attributable to the cost of environmental initiatives implemented in Southern California.

This paper will address the question: Does environmental compliance impact port competitiveness?

This requires examination of two issues:

1. What is the impact of relative transportation costs on the volume of containerized imports through the Ports of Los Angeles and Long Beach (i.e. the elasticity of demand)?
2. What portion of these costs is attributable to environmental initiatives?

Previous Research

Previous studies on Southern California container traffic have focused on relative costs and transit times for U.S. imports from Asia. Analysis has focused on individual market segments based on:

- Destination: defined either as a specific city or a representative economic region.
- Inland transport mode: typically segmented into truck (local), Inland Point Intermodal (IPI) which consists of direct shipment of loaded international containers, or transloaded (cargo is unloaded in Southern California and reloaded into trucks or domestic containers for forwarding by rail to an inland destination).
- Product value: previous studies have assumed or concluded that the elasticity for higher value commodities is lower i.e. these commodities are less likely to be diverted to other ports. This is based on the assumption (or conclusion) that lower transit times through the Ports of Los Angeles and Long Beach have a major influence on traffic volumes due to lower supply chain inventory costs.

Previous studies have used different methodologies and come up with widely varying estimates of the elasticity of container traffic to cost differentials, as shown below.

Previous Studies Elasticity Estimates Southern California Container Traffic			
Study	Moffat & Nichol for POLA/POLB (2008)	Leachman et al for SCAG (2010)	Mercator/Oxford Economics for POLA/POLB (2016)
Methodology	Regression Analysis	Simulation Model	Scenarios
Demand Data	PIERS Regional Shares	Estimated Regional Shares	Estimated Regional Shares
Cost Data	Modal Cost Functions	Shipper Reported Rates	Modal Cost Functions
Elasticity Local Traffic	0.30	Varies depending on product value and destination	0
Elasticity Transload	1.00	Varies depending on product value and destination	0
Elasticity IPI	1.00	Varies depending on product value and destination	Varies depending on product value and destination
Elasticity Total Traffic	0.55	7.2 - 12.2 (Long Term), 2.9 - 3.6 (Short Term)	0.18

The Container Diversion and Economic Impact Study conducted for the Ports of Los Angeles and Long Beach by Moffat and Nichol and BST Associates (Moffat & Nichol, 2007) was commissioned to estimate the potential impacts of the Clean Trucks Program on port traffic and the regional economy in 2007. The impact of cost differentials for Asian imports was estimated using a cross-sectional regression analysis of regional POLA/POLB market shares based on PIERS data. Based on this analysis, Moffat & Nichol estimated elasticities of .3 for local traffic and 1.0 for IPI and transload traffic. Impacts for the different market segments were estimated based on representative trucking costs for each, resulting in an elasticity of .55 for total traffic.

Leachman and Associates undertook two phases of a study which developed a simulation model of port choice based on relative transportation and inventory costs for various port routing options for the Southern California Association of Governments (SCAG). (Leachman, 2005; Leachman, 2010.) The Phase 1 and Phase 2 models allocated imports among ports and modes so as to minimize total transportation and inventory costs from the point of view of importers. The results indicated that container traffic at the Ports of Los Angeles and Long Beach is highly sensitive to cost increases.

Mercator International and Oxford Economics undertook a study for the Ports of Los Angeles and Long Beach in 2016 (Mercator 2016). They developed a number of macroeconomic and port competition scenarios to forecast port traffic. The analysis assumed that the elasticity for local and transloaded is zero (i.e. this traffic is not at risk of diversion to other ports due to the POLA/POLB transit time advantage), and that the elasticity for IPI traffic is dependent on product value and destination. Based on their Base Case forecast and using IPI costs to Chicago as the cost benchmark, the estimated elasticity of total traffic was .18.

Among these studies, only the Moffat & Nichol study based their estimates on the actual relationship between market shares and relative costs. None of the studies analyzed the impact of actual changes in transit times on demand.

Modelling the Elasticity of POLA/POLB Port Traffic 2012 - 2016

While it is reasonable to believe that different market segments of POLA/POLB container traffic may have different elasticities, analysis is hindered by a lack of data. In particular, there is no reliable data on either the quantities or commodity distributions of inland flows to destination regions within the US. This makes it impossible to verify the accuracy of the market segment estimates.

This study takes a different approach by analyzing aggregate market share for POLA/POLB rather than market shares for individual market segments. The advantage of this modelling approach is that the results can be readily evaluated by comparison to verifiable data.

The methodology for estimating the elasticity of POLA/POLB container traffic in this study is similar to that used in the Moffatt & Nichol study, i.e. it incorporates a regression of market share based on cost differentials. However, it differs in a number of significant respects:

- The regression analysis is based on time series rather than cross-sectional data on market shares, which facilitates analysis of changes over time. Market shares in this analysis are based on port-level import data published by the US Bureau of the Census.
- Relative transit time is explicitly incorporated as an explanatory variable.
- Changes in relative costs are based on shipping line and railway revenues rather than modal cost models to provide more reliable estimates of the prices shippers actually pay.

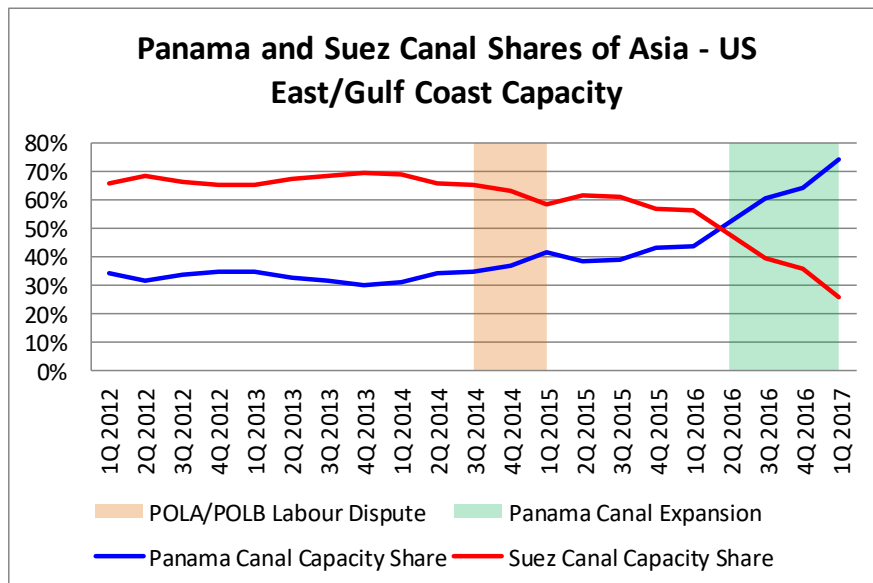
Transit Time

Previous studies have identified relatively faster transit time for shipments from Asia through POLA/POLB as a key competitive advantage, but have implicitly assumed that this advantage is constant. However, there are two routes for Asian imports through East Coast ports: the Panama Canal and the Suez Canal. Transit time for Suez shipments is longer due to the greater distance involved. Consequently the average transit time from Asian ports to the US East Coast is a function of the share of traffic on each of these routes.

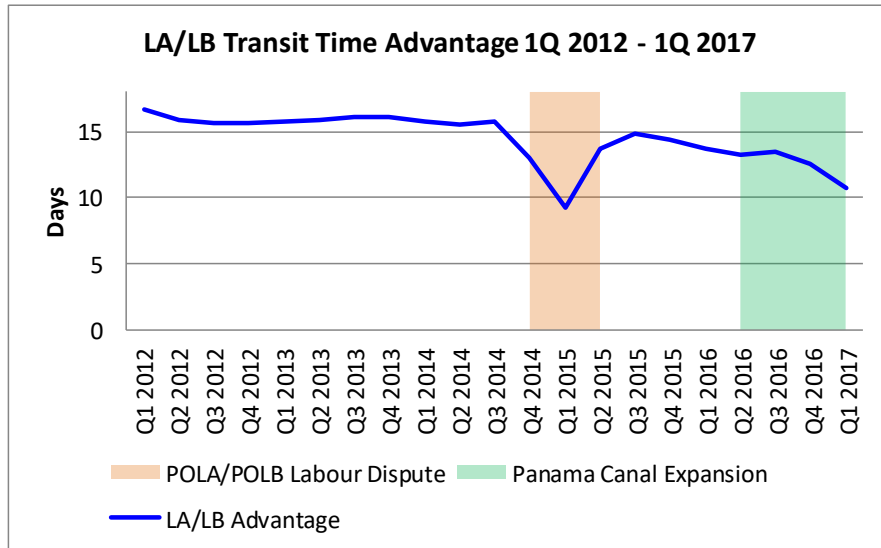
Data on shipping line capacity and transit times for this research was provided courtesy of BlueWater Reporting. Data is available starting the first quarter of 2012, so this date was used as the starting point for the analysis.

The figure below depicts the share of liner capacity using the Panama and Suez Canals between Asia and the US East/Gulf Coasts from the first quarter of 2012 to the first quarter of 2017.

The data shows a dramatic shift from the Suez Canal to the Panama Canal following the opening of the Expanded Panama Canal in June 2016. Since the Panama Canal has a faster transit time, this results in a lower average transit time for Asian imports to the US East and Gulf Coasts.



Port-to-port transit times for liner services to POLA/POLB and to NY/NJ via the Panama and Suez Canals were estimated from data provided by BlueWater Reporting. Transit times vary among different shipping lines based on port rotations and other factors; for purposes of this analysis representative transit times were based on express services from Shanghai. Weighted transit times for NY/NJ shipments were then calculated based on the share of liner capacity on each route. The resulting estimates of POLA/POLB's transit time advantage over the East/Gulf Coast weighted average from 2012 to 2017 are depicted below.



The POLA/POLB advantage was substantially affected by congestion due to a labour disruption from November 2014 to February 2015. It recovered somewhat following resolution of the dispute but has trended downward due to the shift in traffic from the Suez to the Panama Canal.

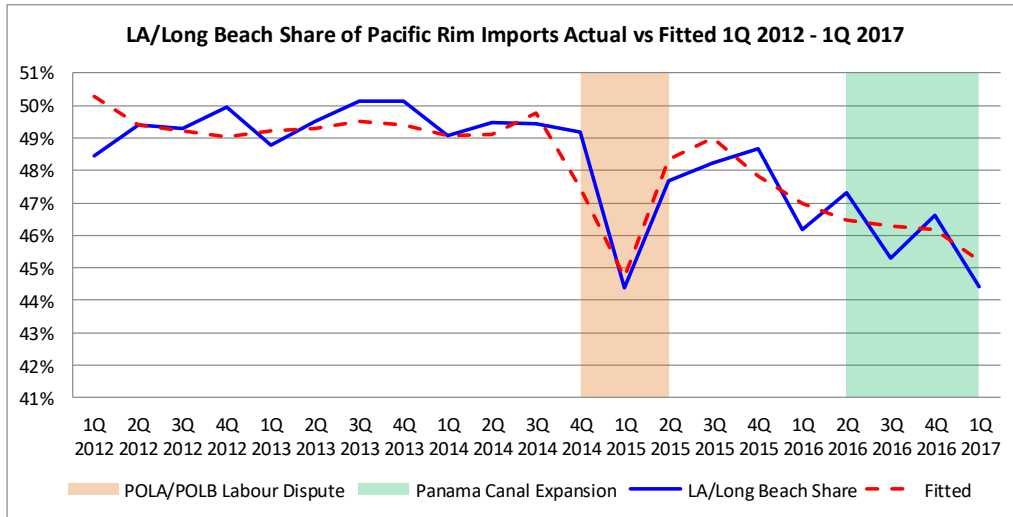
Shipper Costs

The methodology for estimating relative shipper costs is based on that used in previous papers (Davies, 2013). IPI cost estimates from POLA/POLB and PANY/NJ are used as the benchmark due to the dominance of the Midwest in intermodal markets. According to data assembled by the Association of American Railroads, Chicago (5.8 million containers and trailers) and the LA/Long Beach region (5.2 million containers and trailers) dominated intermodal traffic in 2014. The next largest intermodal hub was Dallas/Fort Worth with only 1.4 million (Association of American Railroads 2017). Historically the Midwest accounts for the largest portion of both IPI and transloaded cargo shipped from POLA/POLB by rail (BST Associates 2004 p.12.). Mercator estimated that the Midwest market accounted for 46% of IPI traffic from POLA/POLB in 2014 (Mercator 2016 p. 48).

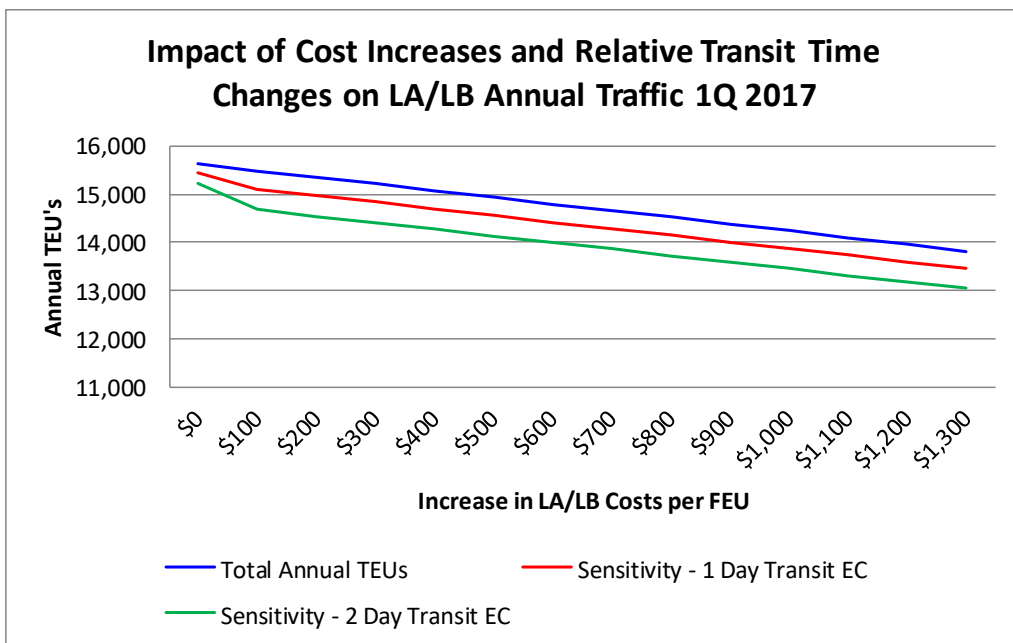
Estimates of individual cost components (rail rates, ocean shipping rates, and bunker fuel surcharges) are based on available public data. Data sources include:

- The TransPacific Stabilization Agreement, the discussion group for ocean carriers on the Eastbound Transpacific routes, publishes an index showing the average revenue (net of bunker surcharges) received by carriers on West Coast and East Coast routes. The data is indexed to rates prevailing in the second quarter of 2008 and includes monthly data from January 2010. To

Where: LALB Share is the market share of Asian imports; LALB IPI/NYNJ IPI is the ratio of IPI cost to Chicago via POLB/POLB divided by IPI costs via New York/New Jersey; and LALB/NYNJ transit time is transit time from Shanghai to LA/LB divided by the weighted average transit time to New York/New Jersey. The figure below shows actual vs fitted values for POLA/POLB market share.



Based on these results, the estimated elasticity of demand for transportation cost increases is .26. The impact of cost increases on annual traffic based on the 2016 total for POLA/POLB is depicted below. The sensitivity to further reduction in East Coast transit times is also shown.



Impact of Environmental Fees

There are three major user-pay programs for mitigation of environmental impacts and/or congestion at the Ports of Los Angeles and Long Beach: the Alameda Corridor, PierPass, and the Clean Trucks Program.

The Alameda Corridor is a 20 mile long grade separated rail corridor linking the ports of Long Beach and Los Angeles to major rail yards in downtown Los Angeles. The two ports created the Alameda Corridor Transportation Authority (ACTA) to oversee construction and operations on the corridor in 1989. Construction was completed at a cost of US\$2.4 billion and operations commenced in 2002. The project was funded by bond debt to be repaid by user charges paid by the railways. As of 2017 the charge is US\$23.77 per loaded waterborne TEU, US\$5.69 per empty TEU, and \$11.39 for other railcars. ACTA revenue totalled US\$100.3 million in 2016; based on total loaded container traffic this amounted to an average of US\$21.42 per FEU.

PierPASS is a not-for-profit company created by marine terminal operators at the ports of Los Angeles and Long Beach in 2005 to address multi-terminal issues such as congestion, security and air quality. Under the program, all international container terminals in the two ports established additional shifts per week. As an incentive to use the new OffPeak shifts and to cover the added cost of the shifts, a Traffic Mitigation Fee (TMF) is required for most cargo movement during peak hours (Monday through Friday, 3 a.m. to 6 p.m.). As of the first quarter of 2017, the TMF was set at US\$70.47 per TEU. Pierpass revenue totalled \$191.1 million in 2016; based on total loaded container traffic this amounted to an average of US\$40.82 per loaded FEU.

The Clean Trucks Program was designed by the Ports of Los Angeles and Long Beach to reduce air emissions related to drayage activity through upgrading of the drayage truck fleet to 2007 emissions standards over a period of 5 years. A 2007 study estimated this would require replacement or retrofitting of 16,800 trucks. Of these, it was estimated that 63% would have to be replaced with new units at a cost of approximately \$100,000 per unit (Economics and Politics Inc. 2007). It was estimated that carrier revenue would have to increase by 16% to cover the additional costs. Current costs are estimated below, based on average revenue per truck in 2007 and the current drayage fleet size, indexed to the Producer Price Index for trucking for 2017. This results in an estimated average cost for all port traffic of \$69.22 per FEU.

Environmental/Congestion Mitigation Program Cost Estimates 2017	
POLA/POLB Loaded TEUs 2016	9,363,423
Alameda Corridor Costs 2017	
Alameda Corridor Revenue	\$100,300,451
\$ Per Loaded TEU (Imports)	\$10.71
\$ per Loaded FEU (Imports)	\$21.42
PierPass Costs 2017	
PierPass Revenue	\$191,110,000
\$ Per Loaded Teu	\$20.41
\$ per Loaded FEU	\$40.82
Clean Trucks Program Cost Estimates 2017	
CTP Diversion Avg Revenue per truck 2007	\$107,100
Drayage Fleet	16800
Total Trucking Cost	\$1,799,280,000
CTP Increase %	16%
CTP Cost 2007	\$287,884,800
CTP Cost 2017	\$324,053,688
Cost per TEU	\$34.61
Cost per FEU	\$69.22

Combined cost estimates for the three programs for 2017 are shown below. Based on the elasticity estimated in the regression model, the impact is a reduction in annual traffic of 183,017 TEUs; of this, the Clean Trucks Program accounts for 96,367 TEUs or .6% of total traffic.

Impact of Environmental Costs on Annual Traffic				
	Cost per FEU	%	Impact TEUs	% of Annual Traffic
ACTA	\$21.42	16%	-29,821	-0.2%
PierPass	\$40.82	31%	-56,830	-0.4%
CTP	\$69.22	53%	-96,367	-0.6%
Total	\$131.46	100%	-183,017	-1.2%

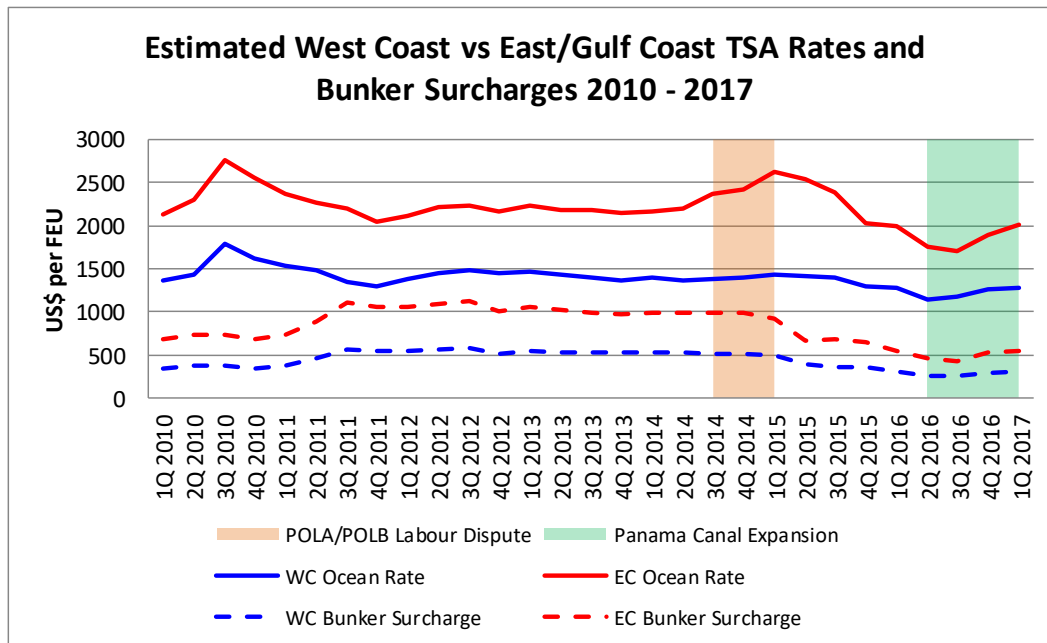
For purposes of comparison, the 2007 Moffat & Nichol study estimated the impact of the Clean Trucks Program at 75,000 TEUs per year or approximately .5% of total traffic in 2007 (Moffat & Nichol 2007 p. 19). Total port throughput in 2007 (15.7 million TEUs) was almost the same as in 2016 (15.6 million TEUs).

On the basis of these estimates, a container fee of US\$100 per TEU (US\$200 per FEU) would result in a decline of approximately 277,000 TEUs based on the 2016 volume, or approximately 1.8% of total traffic.

Impact of the Panama Canal Expansion on POLA/POLB Traffic

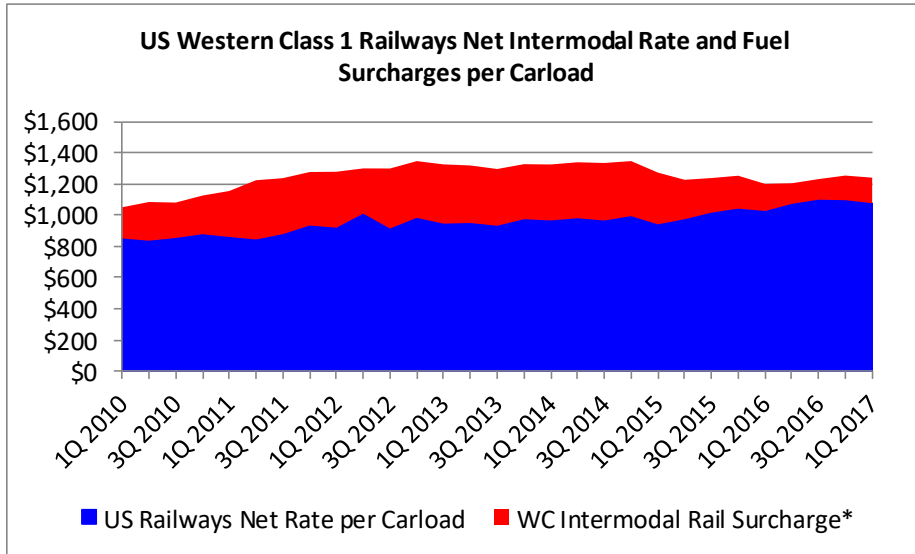
An early indication of the impact of the Panama Canal expansion on POLA/POLB traffic volumes can be seen in the changes in relative costs and transit times since operations began in June 2016.

Estimated ocean rates and bunker surcharges for West Coast and East Coast shipments are shown below. The spike in East Coast rates in the 1st quarter of 2015 occurred as shipping lines redeployed additional capacity to take advantage of the opportunity to divert traffic from POLA/POLB during the labor dispute.

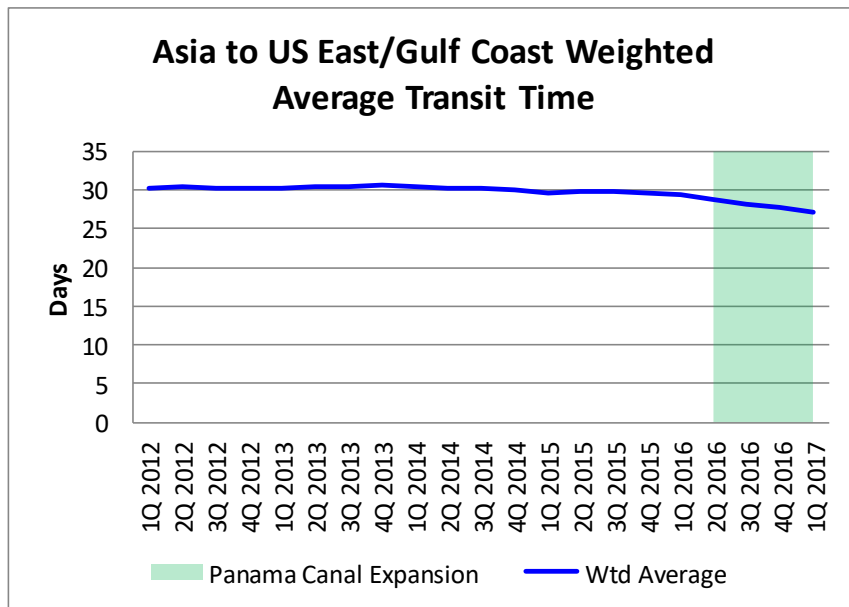


Since the opening of the expanded Panama Canal in June 2016 the differential between East Coast and West Coast rates has declined. However, the decline in ocean surcharges due to low bunker prices has had a greater effect on relative ocean costs.

Historically, the competitive position of the West Coast ports has been eroded by increasing intermodal rail rates. Rates have moderated since 2015, though this appears to be a result of reduced fuel surcharges due to low diesel prices. The figure below shows average rate per carload for intermodal traffic for the Western Class 1 railways from 2010 to 2017, disaggregated into the net rate per carload and fuel surcharge. Fuel surcharges are TSA West Coast intermodal surcharges estimated from figures published on the TSA website. TSA bases their inland fuel surcharge on the BNSF fuel surcharge.

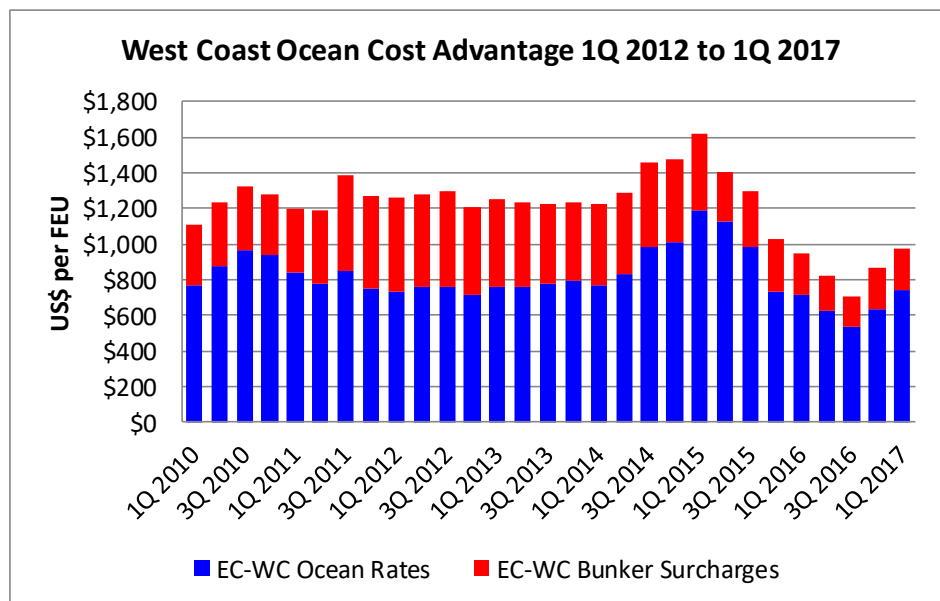


The weighted average vessel transit time for Asia to East Coast ports has also declined due to the shift in traffic from the longer Suez Canal route.



POLA/POLB market share fell from 46.2% in the first quarter of 2016 to 44.2% in the first quarter of 2017, a decline of 4.2%. This decline took place in spite of the low elasticity due to the large magnitude of the reduction in the ocean cost advantage for POLA/POLB traffic beginning in the 4th quarter of 2015. The figure below shows the erosion of the POLA/POLB ocean shipping cost advantage resulting from a substantial reduction in East Coast ocean rates and the decline in shipping line bunker surcharges due to lower bunker fuel prices. Based on

this experience, POLA/POLB are likely to face ongoing competitive challenges from East Coast routings even in the absence of additional environmental compliance costs.



Conclusions

This paper addresses the question: Does environmental compliance impact port competitiveness? This requires examination of two issues: the impact of relative transportation costs on the volume of containerized imports through the Ports of Los Angeles and Long Beach (i.e. the demand elasticity), and the portion of costs attributable to environmental initiatives.

Based on the model developed in this paper, container traffic through POLA/POLB is inelastic with respect to increases in costs relative to competing East Coast ports, with an estimated elasticity of .26. This means that an increase of 10% in POLA/POLB costs would result in a 2.6% decline in traffic.

Based on this elasticity and estimates of costs in the first quarter of 2017, the three major user pay environmental/congestion mitigation programs in place at POLA/POLB – the Alameda Corridor Program, PierPass and the Clean Trucks Program – resulted in a reduction of approximately 183,000 TEU's or 1.2% of total traffic levels in 2016. Implementation of a \$100 per container fee as recommended by the SCAQMD Legislative Committee would result in a decline of 277,000 TEUs or 1.8%.

The model developed for this paper suggests that to date user-pay environmental and congestion mitigation programs have had only a small impact on port traffic, as would be

expected given the low elasticity and relatively minor impact on overall costs. However, POLA/POLB market share fell from 46.2% in the first quarter of 2016 to 44.2% in the first quarter of 2017 in spite of the low elasticity due to significant reductions in the West Coast advantage over East/Gulf coast ports in ocean shipping costs following opening of the Panama Canal expansion. Based on this experience, POLA/POLB are likely to face ongoing competitive challenges from East Coast routings even in the absence of additional environmental compliance costs. The magnitude of impacts of additional user-pay programs will depend on the extent to which they increase overall costs for containers through POLA/POLB.

Regional and port authority infrastructure and environmental strategies should be targeted to enhance regional competitiveness as an origin-destination routing, or at least to mitigate the impacts of necessary environmental costs. However this requires an ability to measure and monitor competitiveness on an ongoing basis; an understanding of the factors influencing competitiveness and which of them are within the port's control, those which can be influenced by the port's strategy, and those which are entirely beyond their control; and a deeper understanding of shipper characteristics and the factors influencing their routing choices. The success of the modelling approach in this paper in developing data-based quantitative estimates of the influence of cost and transit time variables on aggregate port traffic levels suggests that development of more detailed quantitative models is possible. The primary requirement for undertaking this task is assembly of detailed data on origin-destination transportation costs and performance parameters on an ongoing basis, including ocean and inland costs, transit times, and other performance criteria for individual origins and destinations. There are a number of currently available data sources which could be employed, including BlueWater Reporting data on North American liner operations; PIERS data on port volumes and inland destinations; Intermodal Association of North America data on regional intermodal traffic; and other sources. If a project sponsor could be found, development of a database on ongoing supply chain competitiveness factors is a logical first step in developing the models necessary for informing strategic initiatives.

The author wishes to thank BlueWater Reporting for providing data on liner capacity and transit times for use in this research; and Darryl Anderson of Wave Point Consulting for his critical review and useful suggestions. Responsibility for all analysis and conclusions rests with the author.

References

ASSOCIATION OF AMERICAN RAILROADS Rail Intermodal Keeps America Moving April 2017.

BST ASSOCIATES Consolidation Activity in the Southern California Area Prepared for the Alameda Corridor Transportation Authority March 2004.

DAVIES, PHILIP Cost Elasticity and Port Choice for West Coast Container Traffic Paper presented at the Transportation Research Forum, Long Beach CA, March 10-12, 2011.

DAVIES, PHILIP US and Canadian Port Competitiveness for Asia-Pacific Import Traffic Paper presented at the METRANS National Urban Freight Conference, Long Beach, CA October 12, 2011.

DAVIES, PHILIP Thinking Outside the Box: Macroeconomic and Inland Network Impacts on Port Competitiveness January 2013.

DAVIES, PHILIP Exchange Rate Impacts on West Coast Container Port Traffic Paper presented at the Transportation Research Board 2013 Annual Conference in Washington, DC January 14, 2013.

DAVIES, PHILIP Market Segmentation and Competitiveness for the Ports of Los Angeles and Long Beach Paper presented at the METRANS International Urban Freight Conference in Long Beach, California October 9, 2013.

ECONOMICS AND POLITICS INC. AND CGR CONSULTING (2007) San Pedro Bay Ports Clean Air Action Plan Economic Analysis Proposed Clean Truck Program, Study for the Ports of Los Angeles and Long Beach p. 48.

LEACHMAN & ASSOCIATES LLC IN ASSOCIATION WITH T. PRINCE & ASSOCIATES LLC, STRATEGIC DIRECTIONS LLC, & GEORGE R. FETTY & ASSOCIATES, INC. Modal Elasticity Study Prepared for Southern California Association of Governments, Sept. 8, 2005.

LEACHMAN & ASSOCIATES LLC Final Report Port and Modal Elasticity Study Phase II Prepared for Southern California Association of Governments, Sept. 14, 2010.

MOFFAT AND NICHOL AND BST ASSOCIATES (2007) Container Diversion and Economic Impact Study Effects of Higher Drayage Costs at the San Pedro Bay Ports, Study for the Ports of Los Angeles and Long Beach.

SOUTHERN CALIFORNIA AIR QUALITY MANAGEMENT DISTRICT Final Socioeconomic Report 2016 Air Quality Management Plan March 2017.