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The Potential Impact of the Panama Canal Expansion on the Port of Virginia

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The Port of Virginia is important to the state's economic future. It has the potential to increase its share of container shipments to the east coast of the US when the Panama Canal expansion is open for traffic in 2015. However, increased container shipments to the Port of Virginia are not guaranteed. There are three primary conditions that will largely determine how much new container traffic is processed by the Port of Virginia: (1) how much U.S.-bound traffic from Asia currently being off-loaded on the west coast will be diverted through the canal to east coast ports for inland distribution; (2) the competitive position of the Port of Virginia relative to other east coast and gulf ports; and (3) the inland connectivity to non-Virginia markets and related distribution costs associated with the Port of Virginia for container shipments from Asia. These conditions are assessed in the following report.

Background

In 2006 the Panama Canal Authority (APC) drafted a proposal for a new set of locks. The primary motivation was increasing demand for the locks, with predicted annual throughput reaching maximum capacity of roughly 330 million PCUMS (Panama Canal/Universal Measurement System) between 2009 and 2012[1]. Although the locks added nighttime passages and a bidding process for time-sensitive goods, it was clear that transit demand would soon surpass capacity. This forecast came to pass, as 333 million PCUMS transited the locks in 2012. The proposal for the new set of locks was put to a national vote in 2006. It was approved and ground was broken in 2007.[2,3] The new locks were planned to open in late 2014, but due to delays are now expected to begin operation by mid-year 2015[4].

The new locks will be significantly larger than the current locks, allowing for larger ships to transit the canal. Portions of cargo from Asia currently being off-loaded at west coast ports and shipped by rail across the U.S., known as the "land-bridge", are anticipated to shift to east coast ports as costs are driven down through economies of scale offered by larger vessels and more reliable transit times offered by the increased capacity of the locks. These expectations have motivated ports up and down the east coast of the U.S. to deepen harbors and acquire larger cranes capable of accommodating these larger vessels.

East Coast Ports

Ports along the east coast are expecting an increase in both the numbers and size of vessels calling their ports. Previously the "Panamax" vessels, the largest able to fit through the current locks, reached a maximum carrying capacity of 4,500 TEUs (standard container unit) and had drafts of 39.5'.

With the new locks, “Post-Panamax” vessels of over 12,000 TEUs and drafts of 49' will be able to transit the canal. In addition to the present size limitations, transit times have also been increasing due to congestion. This problem will be alleviated with the expansion increasing transit slots at this bottleneck. Ports are undertaking major investments in channels, harbors and cranes on expectations of larger ships and more traffic. Railroads also see opportunities and east coast-based carriers are improving rail-lines into the Midwest.

Among east coast U.S. ports, currently only the Port of Virginia at Hampton Roads and the Port of Baltimore are ready for Post-Panamax.[5] The Virginia Port Authority operates three ports at Hampton Roads: Norfolk International Terminal, Newport News Marine Terminal and Portsmouth Marine Terminal, and is also currently leasing the APM terminal in Portsmouth. Of these four terminals, NIT is the largest and has the 50' deep berth necessary for Post-Panamax vessels. However, due to data reporting these four terminals will be referred to collectively as Hampton Roads throughout this report. Hampton Roads and Baltimore each possess the 50' harbors and cranes capable of handling vessels 26 containers wide. Hampton Roads also has authorization to dredge up to 55'. Another advantage for the ports at Hampton Roads is the 2010 completion of the Heartland Corridor railroad by Norfolk Southern.[6] This project included raising the clearance of 28 tunnels to allow passage of double stacked rail cars and decreased rail time from Hampton Roads to Chicago from four days to two.[7]

Although the Port of Baltimore can accommodate Post-Panamax vessels, it cannot yet double stack rail cars due to clearance issues at the Howard Street tunnel out of the Seagirt Marine Terminal intermodal facility. CSX and the City of Baltimore have settled on a site and plan to have the new intermodal facility operational by 2015.[8] CSX also recently finished the first phase of the $850 million "National Gateway" rail project, that will fix 40 obstructions and six supports allowing double stack rail cars to travel from Ohio to Pennsylvania.[9] The second phase of the project will expand double stack rail to Baltimore. [10] The National Gateway will also have access down to Hampton Roads and Wilmington, NC offering an additional advantage the ports at Hampton Roads.

Several other ports competing on the east coast of the U.S. are investing to be capable of handling Post-Panamax vessels. These include: Miami, Savannah, Charleston and New York. New York has the 50' harbor necessary for Post-Panamax vessels and work to raise the Bayonne Bridge, currently too low for Post-Panamax ships to pass under, is expected to be complete in 2015. [11,12] Miami recently received Post-Panamax cranes and dredging to 50' is expected be complete by 2015.[13,14] With delays in the construction of the new locks at the Panama Canal and the expedited raising of the Bayonne Bridge, there will be four ports on the east coast ready by the opening of the expanded canal: Baltimore, Hampton Roads, New York, and Miami.

Legislation for various other waterway projects has recently passed through both Houses of Congress and is slated for committee action. The Waters Resources Reform and Development Act included the authorization for the deepening of the Savannah Harbor,[15] although much still needs to be sorted out, as it is not an appropriations bill, but simply authorizes the money being spent for the project. The Army Corps of Engineers is currently studying the possibilities of dredging the Port of Charleston, with plans set to be completed in 2015[16]. Both the Savannah and Charleston deepening

projects could finish as early as 2018,[17] three years after the opening of the expanded Panama Canal locks. Although they don't have 50' deep harbors, Charleston and Savannah will be able to handle some Post-Panamax vessels, just not fully laden vessels requiring 50' berths. Of the ports on the east coast, the Ports of New York, Miami, Baltimore and Hampton Roads will likely gain the most new traffic as they will be ready for the larger ships when the new locks are completed. However, early increases in vessel traffic at these ports may decline when Savannah and Charleston finish deepening their harbors.

Shipping Trends

Most U.S. container trade originates or terminates in Northeast Asia. In 2010, Northeast Asia supplied 61 percent of all containers imported into the U.S. and was the recipient of 42 percent of exports.[18] In real terms, this represents 10.2 million TEUs imported from Northeast Asia and 4.9 Million TEUs exported to Northeast Asia.[19] Of the 10.2 million TEUs imported from Northeast Asia approximately 7 million TEUs (69 percent) were handled by ports on the west coast of the U.S. with ports on the east and Gulf coasts of the U.S. handling the remainder. Much of the container traffic from Northeast Asia is shipped to the east coast of the U.S. via the land-bridge. In 1999, 86 percent of cargo from Northeast Asia destined for the east coast of the U.S. was shipped via west coast ports and land-bridge, with just 11 percent taking the all-water route through the Panama Canal. However, the percent of traffic taking the all water route increased to 55 percent by 2007 before starting to level off.[20] By 2010 east and gulf coast ports handled 61 percent of containerized and vehicle imports from Northeast Asia.[21] One area that may see a substantial shift as a result of the new locks is Southeast Asia. The east coast of the U.S. imports roughly 400,000 TEUs trafficked through the Suez Canal annually from southeast Asia, roughly 25 percent of total U.S. imports from southeast Asia.[22]

The dominance of trade with Asia is further seen along principal trade routes through the Panama Canal (Table 1). According to data from the Panama Canal Authority, trade with Asia accounted for 64 percent of all east coast trade through the Panama canal in 2012, as measured by long tons. Asia is by far the leading source of Panama Canal-based trade from the east coast: Asian trade accounted for three times as much cargo weight as second-place South America. However, canal-routed trade between east coast ports and Asia decreased 3.3 percent from fiscal year 2011 to 2012 while trade with South America increased 5.4 percent during the same period. Northeast U.S. trade with Asia is also extremely important to the Panama Canal, representing 38.7 percent of traffic through the Panama Canal by long tons in 2012.

Table 1

Panama Canal Traffic: East Coast U.S. Principal Trade Routes

Vessel Trade Route	Long Tons (thousands)		% of E.C.-U.S. Total: 2012	% Change: 2011-2012
	Fiscal Year 2011	Fiscal Year 2012		
East Coast U.S. - Asia	87,210	84,313	63.9%	-3.3%
East Coast U.S. - W.C. South America	26,202	27,622	20.9%	5.4%
East Coast U.S. - W.C. Central America	11,742	12,178	9.2%	4.0%
U.S. Inter-coastal*	5,777	5,700	4.3%	-1.3%
East Coast U.S./Canada - Oceania	1,653	2,043	1.5%	20.3%
Total East Coast U.S. Traffic	132,584	131,856	100.0%	-1.8%
Total Panama Canal Traffic	222,355	218,058	-	-1.9%

Source: Panama Canal Authority. Large Vessels. *including Alaska and Hawaii

The single largest trading partner with traffic through the Panama Canal for the east coast of the U.S. is China (Table 2). Along principal trade routes through the Panama Canal, China accounts for 39 percent of trade with Atlantic ports and 32 percent of trade with Gulf ports by weight. Other Northeast Asian countries such as South Korea and Taiwan follow, but account for far less activity than China.

Table 2

Commodity Movement through the Panama Canal: Principal Trade Routes

Top Trade Routes (Long Tons)

	East Coast United States Trade			% of Regions Shipping		
	North Atlantic Ports	South Atlantic Ports	Gulf Ports	North Atlantic ports	South Atlantic ports	Gulf ports
China*	6,194,985	8,683,536	25,900,125	39.3%	38.8%	31.6%
South Korea	1,201,125	2,892,975	9,152,761	7.6%	12.9%	11.2%
Taiwan	1,140,062	1,615,569	977,313	7.2%	7.2%	1.2%
Chile	3,576,444	1,109,408	6,846,389	22.7%	5.0%	8.3%
Regional Total	15,768,871	22,375,408	82,007,706	100.0%	100.0%	100.0%

Source: Panama Canal Authority. * Including Hong Kong

Cargo containers represented 19.8 percent of all commodities by weight from the east coast of the U.S. to Asia. By contrast, 43.4 percent of cargo from Asia to the east coast was container cargo, although this has decreased in recent years (Table 3). From 2010 to 2012 the amount of container cargo transiting the Panama Canal from Asia to the east coast declined by 2,715,000 long tons, a 20.6 percent decrease. Conversely, container traffic from the east coast to Asia increased 17.0 percent over the same period. Overall, container flows between the east coast and Asia decreased 5.1 percent. This decrease may represent short term fluctuations in markets; alternatively it could be a factor of the Panama Canal's limited throughput capacity, which may have led operators to seek alternate routes. One notable alternative route is the Suez Canal, and particularly pertaining to southeast Asia. Vessels currently taking this route that switch to the Panama Canal would leave total containers entering the

east coast unchanged. This trade is also relatively small, only 5 percent of all-water traffic from Asia to the U.S. east coast transits the Suez Canal.[23]

Table 3
Commodity Movement through the Panama Canal over Principal Trade Routes:
Container Cargo (Thousands of Long Tons)

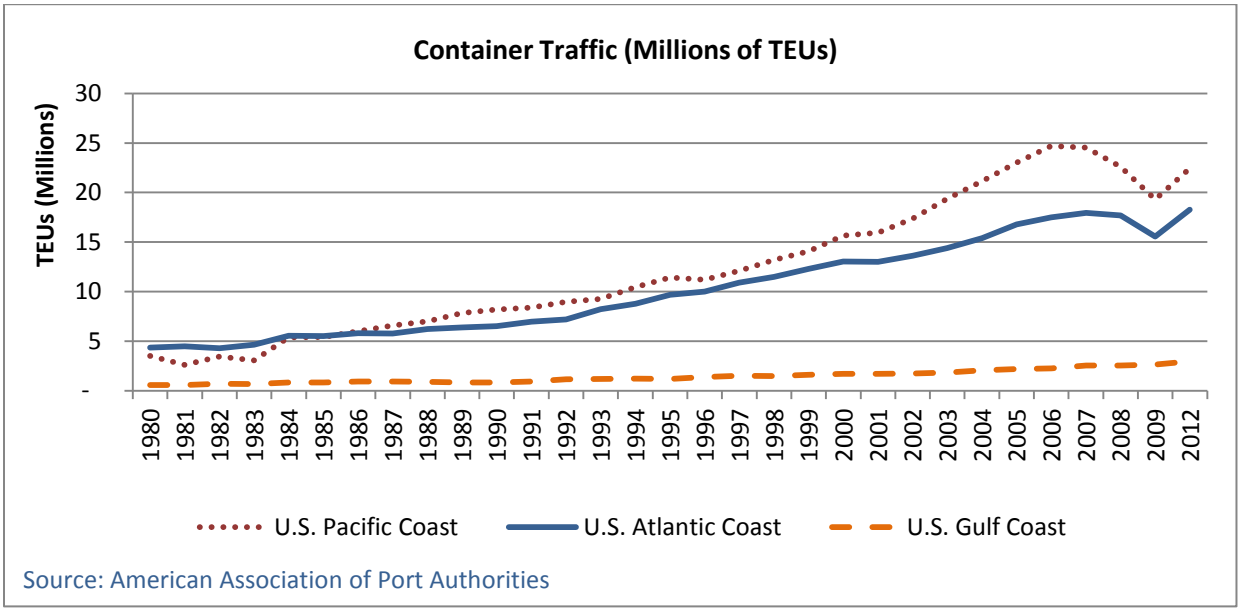
	Fiscal Year			%Change
	2010	2011	2012	2010-12
Asia to the East Coast of the United States	13,185	12,611	10,470	-20.6%
East Coast of the United States To Asia	9,253	10,614	10,823	17.0%
Total East Coast US - Asia	22,438	23,225	21,293	-5.1%

Source: Panama Canal Authority

Container traffic has grown rapidly on both coasts of the U.S. (Figure 1), though Pacific coast ports have led the way since 1986. The difference in container traffic handled between ports at each coast reached a peak in 2006 when the Pacific coast had 41.1 percent more container traffic than the Atlantic coast. However, the significant gains made by the Pacific coast receded quickly during the 2008-2009 recession.

After peaking at 24.7 million TEUs in 2006, container activity at Pacific coast ports declined by 21.7 percent to 2009. Atlantic coast container activity reached 17.9 million TEUs in 2007, then decreased by 12.0 percent between 2008 and 2009. Growth since 2009 has been led by the Atlantic coast, which gained 17.3 percent between 2009 and 2012, compared with 16.1 percent for the Pacific coast. Atlantic coast ports have since topped pre-recession highs whereas Pacific coast port have not. While container traffic to the Gulf coast continued to increase during the recession, at 3.0 TEUs it still represents a small fraction of total container activity (16.3 percent).

Figure 1



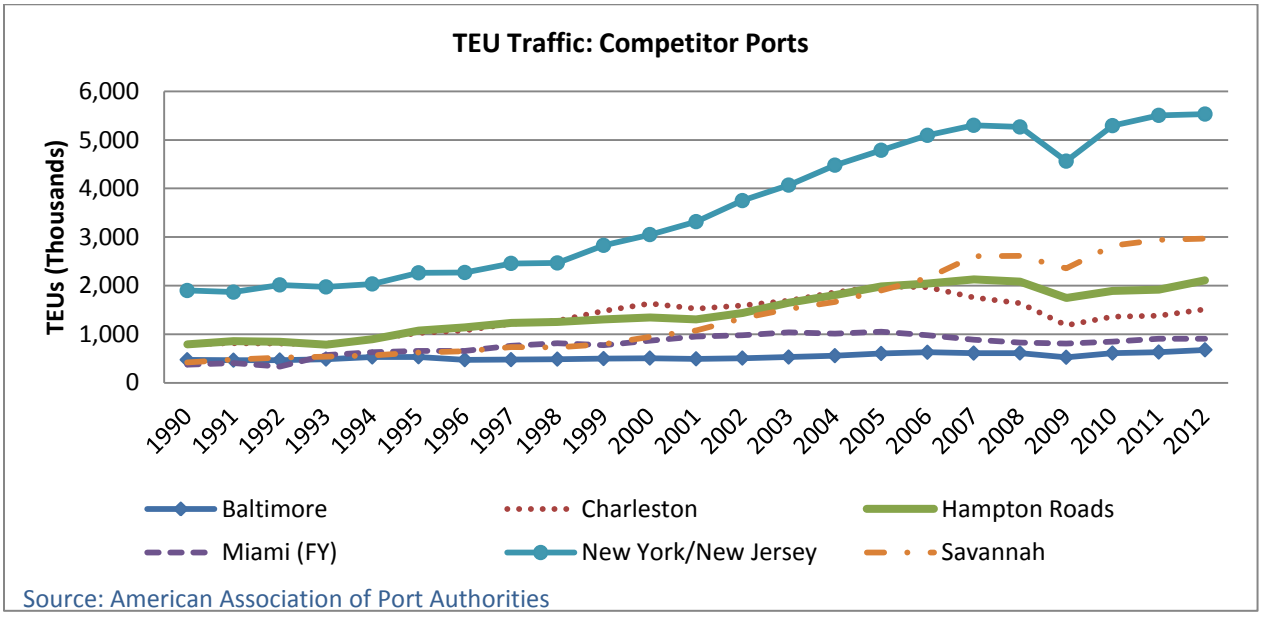
Source: American Association of Port Authorities

The dramatic decline and slower recovery for shipping into Pacific coast ports compared with the Atlantic coast has closed the container traffic gap. As of 2012 the Pacific coast only handled 22.8 percent more traffic than the Atlantic coast. The subtle but noticeable shift away from west coast ports over the past five years has stabilized and increased the Atlantic coast's market share (see appendix). The Gulf coast has held a steady market share with an average of 6.2 percent of container traffic over the past three decades.

Though ports on the east coast have been gaining container traffic fairly consistently since 1990, the Port of New York/New Jersey (NY/NJ) accounts for the largest share of container cargo (Figure 2). Traffic in New York has grown the most over the last two decades, handling 5.5 million TEUs in 2012. Activity at Hampton Roads has been flat over this period remaining at around two million TEUs since 2005. This is in contrast to rapid growth Savannah, which handled 2.9 million TEUs in 2012, more than double its 2002 level.

In 2012, NY/NJ handled 26 percent of the container traffic among Atlantic and Gulf ports. Although its market share dipped in the 1990s, it has remained above 25 percent since 2003 (see appendix). Baltimore and Miami have had little success capturing market share since 1990, with 3.2 percent and 4.3 percent respectively in 2012. The biggest decline in market share was in Charleston, which decreased from 10.7 percent in 2004 to 7.1 percent in 2012. Savannah, on the other hand, more than doubled its share from 6.4 percent in 2000 to 14.0 percent in 2012. Ports at Hampton Roads have stayed extremely stable in terms of market share. Since 1990 they have been between 8.4 percent and 10.8 percent, processing 9.9 percent of TEUs coming into the Atlantic and Gulf ports in 2012.

Figure 2



Source: American Association of Port Authorities

Container Cargo Vessels

The extent to which vessels along shipping lines will switch to "Post-Panamax" vessels with 50' drafts is crucial to driving down shipping costs and enticing traffic to re-route to an all-water route. There is considerably uncertainty surrounding the market reaction to the opening of the new locks due to these unknowns. In order to provide reasonable projections for container traffic at Hampton Roads two key factors must be considered: vessel size and cost savings.

The canal expansion may not lead companies to switch to larger vessels that would require ports with deep channels and harbors. Current evidence, however, suggests that shipping companies are working quickly to convert to Post-Panamax vessels. As of January 2013, 469 of 5,108 containerships in service were Post-Panamax vessels with capacity of at least 8,000 TEUS[i], representing just 9.2 percent of the world fleet. However, due to the large capacity of each vessel, these vessels already account for 28.9 percent of the in-service world fleet's total TEU capacity. Additionally, there are 579 Post-Panamax vessels that carry less than 8,000 TEUs, representing another 11.3 percent of the world fleet and 21.0 percent of total TEU capacity. Combined, these two groups of Post-Panamax vessels account for 20.5 percent of the world fleet and 49.9 percent of container capacity.

Post-Panamax containership vessels are set to increase their share of world's shipping capacity. As of January 2013, 348 of 475 (73.3 percent) of containerships on-order were Post-Panamax. Once the on-order vessels come into service, Post-Panamax vessels will account for 57.2 percent of worldwide containership TEU capacity. Moreover, 215 of all containerships on-order are Post-Panamax with a capacity in excess of 8,000 TEUs, representing 72.6 percent of on-order container capacity. Post-Panamax above 8,000 TEUs on-order also average 11,565 TEUs per ship, 1,559 TEUs larger than those currently in service in this size category.

The larger ships expected to come through the locks are forecasted to yield significant cost savings for traffic. The U.S. Maritime Administration (MARAD) found that new Post-Panamax vessels can save up to 25 percent on fuel costs, however not all savings will be passed through.[24] CSX estimates that it will trim 9.6 percent from the cost of shipping each 40' container traveling from Shanghai to Hampton Roads by using an 8,000 TEU vessel instead of a 4,400 TEU vessel.[25]

Cost savings from the use of Post-Panamax ships would result in the westward movement of the line of indifference[ii] for shippers, which implies an increasing in potential markets for east coast ports. Although the line of indifference can be expected to move west, it is highly dependent on several factors. Shippers consider not only water and land transport costs, but inventory costs, including lost revenues while products are in transit and warehousing, as well as other costs such as transferring between modes of transport known as transloading .

According to CSX, the current line of indifference for vessels shipping average value goods into Hampton Roads runs roughly from the western part of New York to the panhandle of Florida. When cost

[i] AAPA World Cellular Containership Fleet in Profile, 2013

[ii] The line of indifference is the line at which costs on either side for shipping are roughly equal.

estimates from larger vessels are used, the line shifts west, running from Ohio down to the Mississippi/Alabama border on the Gulf Coast[26]. MARAD recently released a report that confirms this contestable market area, reporting one almost identical to that presented by CSX. Cities such as Pittsburgh, Detroit, Cleveland, Columbus and Nashville were among contestable markets cited. MARAD notes that about 11 percent of goods imported from Northeast Asia to the U.S. are destined for this region. Higher value goods are more time sensitive and will continue to use west coast ports offering shorter transit times, but lower value goods will likely see a shift to east coast ports. MARAD reports that, as of 2010, 76.5 percent of total high value imports from Northeast Asia arrived through the west coast, compared with just 66.2 percent of total low value imports.[27]

One additional variable in projecting indifference lines and contestable markets relates to the tolls assessed by the Panama Canal. Recent increases raised tolls from $150,000 per containership in 2008 to $450,000 in 2013, about $110 per TEU.[28] Increased tolls effectively move the indifference line east, implying reduced inland markets for east coast ports. Toll levels will continue to be the biggest uncertainty.[29] Bunker fuel costs are also a substantial variable in determining contestable markets. Slow steaming can reduce fuel cost leading to market share gains for lower value good, but will reduce market share for time sensitive higher value goods. Another major variable are rates charged by both rail lines on the west coast and the east coast. West coast rail lines may reduce rates to keep market share, however east coast lines will likely respond to gain market share, particularly in light of the recent major competing rail line developments, the National Gateway and Heartland Corridor.

Container Increase Projections

With four ports set to be capable of handling the larger Post-Panamax vessels upon completion of the locks in 2015 and several more likely being added just a few years later, competition will remain strong on the east coast. Still, with a noticeable increase in container traffic expected once the new locks are open, east coast ports may have opportunities for growth. Two projections will be compared here: 1) based on statements by Drewry Supply Cain Consultants as reported by the Southern Legislative Council; and 2) based on data from MARAD that is consistent with its contestable area definitions. While neither provides exact forecasts of future container activity, it is possible to make rough projections for container traffic at Hampton Roads and compare results based on statements.

Other studies have used assumed increases in traffic such as in Baltimore and Texas. The Port of Baltimore used three projections from industry experts for increases in traffic: no increase, 10 percent, and 25 percent increases.[30] A study undertaken for the Texas Department of Transportation assumed an even distribution of cargo growth among ports on the east coast through 2025 using projections from the APC.[31] As the maximum throughput of the Panama Canal has, for practical purposes, been reached and the opening of the new locks just two years away, it is reasonable to use current conditions to forecast a discrete increase in container traffic associated with the opening of the new locks.

In an estimate, Drewry Consultants projected that up to 25 percent of all container traffic could be diverted to east coast ports. A more conservative 20 percent of traffic will be used in projections here. If 20 percent of all west coast container traffic is diverted through the canal to the east coast, this would

be an increase of roughly 4.5 million TEUs for east coast ports. Assuming each port were to capture a portion of this traffic equal to its current east coast market share of TEUs, Hampton Roads would capture 445,000 more TEUs, 21.1 percent of its total in 2012, bringing total container traffic to 2.6 million TEUs. The 21.1 percent increase is very close to early forecasts by officials at the Port of Virginia.[32]

Since only four ports will be prepared to handle Post-Panamax vessels in 2015, a second scenario can be created by assuming that diverted traffic will be spread among these ports equal to their current market shares of this subset. In this case, 60 percent of diverted TEU traffic would go to NY/NJ, Hampton Roads would receive 23 percent, representing approximately one million extra TEUs, and the remaining 17 percent would be divided by Baltimore and Miami. Extra traffic in this scenario represents a 49.1 percent increase over current traffic at each of these four ports, more than double what port officials had forecasted. Both estimates based on Drewry Consultants are consistent with reported statements and include all container traffic and both seem overly optimistic.

The second set of projections uses Census trade statistics and Federal highway freight flows reported by MARAD. As stated earlier, the most important flow of goods is from Asia- specifically China. MARAD concludes that this route will be the most affected by the opening of the new locks. It is reported that 10.2 million TEUs were imported into the U.S. from Northeast Asia in 2011, representing 61 percent of all U.S. containerized imports. Of the 10.2 million TEUs, 69 percent entered through west coast ports with the other 31 percent entering east coast and gulf ports.

The contestable market area defined by MARAD is reported to be the destination of 11 percent, or 1,122,000 TEUs, of imports from Northeast Asia. Of the TEUs shipped to the contestable market area, 77 percent was reported to be routed through west coast ports with east coast ports handling the other 23 percent. In real terms, the west coast handles 863,940 imported TEUs heading to the contested market area and the east coast handles the other 258,060 imported TEUs. Although estimates are not given for exports, if the distribution is assumed to be the same, given the reported 4.9 million U.S. exported TEUs to Northeast Asia, the contestable market area would export 539,000 TEUs with 415,030 handled by the west coast and 123,970 handled by east coast ports. Combining imports and exports, west coast ports currently handle 1,278,970 TEUs in the contestable market area as compared to the 382,030 TEUs handled by east coast ports.

MARAD also reports that east coast ports handled 61 percent of all container cargo heading to the east coast in 2010, implying that the other 39 percent ultimately destined for the east coast is off-loaded at west coast ports before heading east either by rail or truck. Given that high value goods are likely to continue to use west coast ports due to their time-sensitivity, it is reasonable to predict the contestable market will reflect this distribution once the new locks open. If 61 percent of imported TEUs destined for the contestable market are shipped through the Panama Canal to east coast ports post-expansion, the east coast will gain an additional 426,360 TEUs. Applying this distribution to assumed exports implies that the east coast ports will export 204,820 more TEUs. Given this distribution assumption, the east coast will increase its container trade with northeast Asia by 631,180 TEUs, bringing the total to 1.0 million TEUs.

If these TEUs are distributed among all east coast ports in proportion to their market share, ports can expect to see an increase in TEUs of roughly 3.0 percent. For Hampton Roads, this translates to an additional 62,615 TEUs annually. NY/NJ would gain 164,421 TEUs annually, the most on the east coast. As before, if the increase in container traffic is distributed by the market shares among the four ready ports, this will increase total container traffic by 6.8 percent. For Hampton Roads, this would mean an extra 144,113 TEUs annually. Again, NY/NJ would gain the most at 378,431 TEUs. In either scenario, estimates are far lower than those derived from Drewry's projections.

Conclusion

The two sets of projections given for increases in container traffic for Hampton Roads vary substantially. The first set of projections were based on Drewry Consultants statements that up to 25 percent of goods coming into the west coast could be captured by east coast ports; a more conservative 20 percent was used in this analysis that led to estimates for increases in container traffic ranging between 20 and 50 percent, far higher than those based on MARAD data of between three and seven percent. The main reason for the discrepancy is the contestable market definition.

Considering only the contestable market reported by MARAD, adjusting distribution to match what is currently seen for the east coast and distributing among Post-Panamax ready ports produces more reasonable results. Increases in container cargo around seven percent for Hampton Roads seem the most likely scenario upon the opening of the new locks at the Panama Canal.

The increase is likely to be affected by the several unknowns discussed as well as some more secondary effects. Toll rates at the Panama Canal will continue to be the most substantial unknown. If tolls continue to climb, seven percent increases are unlikely as gains for higher value goods are lost. A second uncertainty are the rates of rail lines post-expansion. Western rail lines are likely to reduced rates to keep market share, but eastern lines may follow suit to ensure recent investments are more fully utilized.

Although MARAD reports that the Chicago market is unlikely to be contestable, it may not be universally true. The lowest value goods may enter through east coast ports before being shipped back west, particularly if they stop at east coast distribution centers. Another factor that would drive increased container traffic post-expansion is the possibility of east coast ports gaining a larger market share of the east coast markets they currently serve, though this would be primarily for low-value products.

References

[1] Panama Canal Authority, " Proposal for the Expansion of the Panama Canal: Third Set of Locks Project", Proposal, Panama Canal Authority, 2006.

[2] Martinez, Kathia. "Panama to Vote on Canal Expansion Oct. 22", *Washington Post*, Last Modified July 16, 2006. http://www.washingtonpost.com/wp-dyn/content/article/2006/07/16/AR2006071600470.html

[3] Panama Canal Authority, "Panama Canal Expansion Program", Progress Report, Panama Canal Authority , 2012.

[4] "Further Delay for Panama Canal Expansion", Shipandbunker.com. Last modified October, 31,2013. http://shipandbunker.com/news/am/699366-further-delay-for-panama-canal-expansion

[5]Conway,K.C.."North American Port Analysis: CAPEX OR CAPSIZE." White Paper, Colliers International, 2013.

[6] Crawford, Rick "The Heartland Corridor Status Report: COMPLETE!!!." Presentation, Metropolitan Washington Council of Governments 2009.

[7] "A Double-Stack Runs Through It." Report. Norfolk Southern, 2010.

[8] "Project Timeline: Mount Clare Yard." *Maryland Department of Transportation*. Accessed 12/19/2013. http://www.mdot.maryland.gov/Office_of_Planning_and_Capital_Programming/ICTF/Milestones.html

[9] Brinker, Keith. "The National Gateway: Preparing for Tomorrow." Presentation at American Railway Development Association Annual Meeting, Orlando, FL, June 10-13, 2012.

[10] "National Gateway's first phase now complete," progressiverailroading.com. Last modified September 6, 2013. http://www.progressiverailroading.com/csx_transportation/article/National-Gateways-first-phase-now-complete--37549

[11] "Skansa breaks ground of Bayonne Bridhe project," rew-online.com. Last modified July 3, 2013. http://www.rew-online.com/2013/07/03/skanska-breaks-ground-on-bayonne-bridge-project/

[12] Steve Strunsky, "Port Authority accelerates plan to raise Bayonne Bridge roadway," nj.com. Last modified July 19,2012. http://www.nj.com/news/index.ssf/2012/07/port_authority_to_discuss_proj.html

[13] Oscar Pedro Musibay, "Super cranes: PortMiami gets another key infrastructure piece," bizjournals.com. Last modified October 7, 2013. http://www.bizjournals.com/southflorida/news/2013/10/07/portmiami-gets-another-key.html

[14]Robert McCabe, "Port posts record cargo levels, but concerns loom," PilotOnline.com , Last modified October 20, 2013. http://hamptonroads.com/2013/10/port-posts-record-cargo-levels-concerns-loom

[15] "Port deepening: A major boost," Savannahnow.com, Last modified October 25, 2013. http://savannahnow.com/opinion/2013-10-25/port-deepening-major-boost

[16]Andy Owens, "Water resources act one step closer to president's desk," charlestonbusiness.com. Last modified October 24, 2013. http://www.charlestonbusiness.com/news/49287-water-resources-act-one-step-closer-to-president-rsquo-s-desk?rss=0

[17] Robert McCabe, "Port posts record cargo, but concerns loom."

[18] Maritime Administration , "Panama Canal Expansion Study. Phase I Report: Developments in Trade and National and Global Economies." (Report, U.S. Department of Transportation, 2013)

[19] Maritime Administration, "Panama Canal Expansion Study."

[20] Rodrigue, Jean-Paul. "Factors Impacting North American Freight Distribution in View of the Panama Canal Expansion."(Report. The Van Horne Institute, 2010)

[21] Maritime Administration, "Panama Canal Expansion Study."

[22] Maritime Administration, "Panama Canal Expansion Study."

[23] Rodrigue, Jean-Paul. "Factors Impacting North American Freight Distribution."

[24] Maritime Administration, "Panama Canal Expansion Study."

[25] Lewis, D.B. . "Panama Canal Expansion Overview". CSX Transportation, August,20, 2013. Accessed https://nabe.m3ams.com/Document/Download/18483008

[26] Lewis, D.B. . "Panama Canal Expansion Overview".

[27] Maritime Administration, "Panama Canal Expansion Study."

[28] Hand, Marcus. "Panama Canal defends toll levels after Maersk Asia-USEC pullout." Seatrade-global.com, Last modified April 16, 2013. http://www.seatrade-global.com/news/americas/panama-canal-defends-toll-levels-after-maersk-asia-%E2%80%93-usec-pullout.html

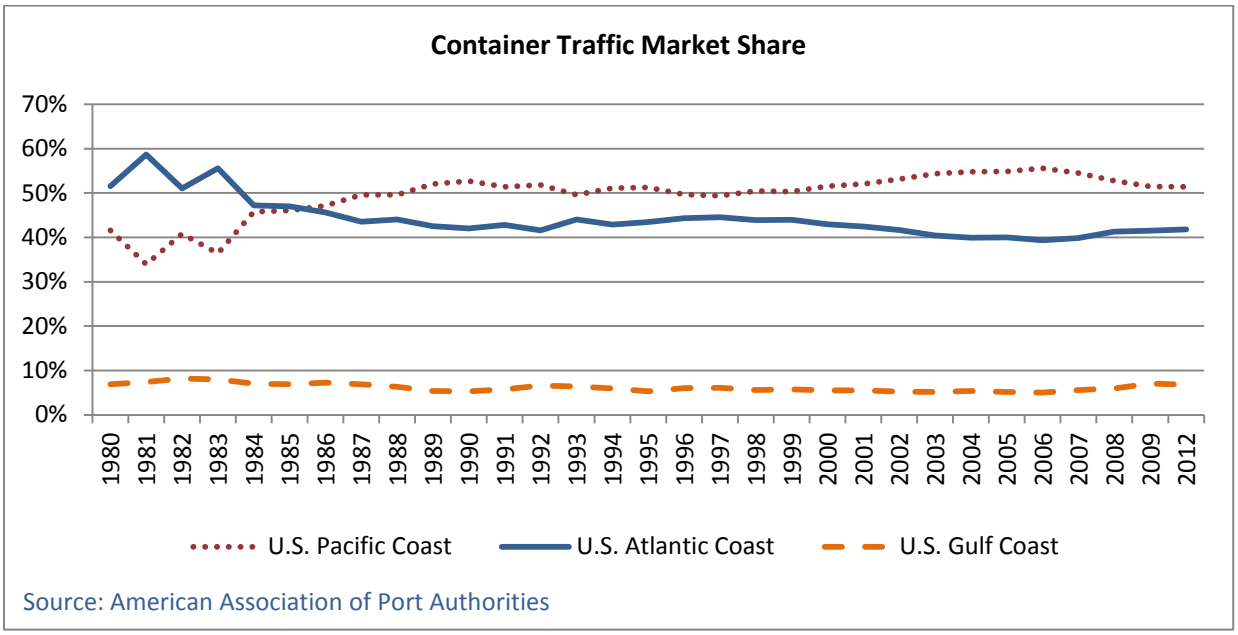
[29] Institute for Water Resources. "U.S. Port and Inland Waterways Modernization. Preparing for Post-Panamax Vessels." (Report, U.S. Army Corps of Engineers, 2012)

[30] Regional Economic Studies Institute."Economic and Fiscal Impacts of the Panama Canal Expansion on the Port of Baltimore." (Report, Economic Alliance of Greater Baltimore, 2012)

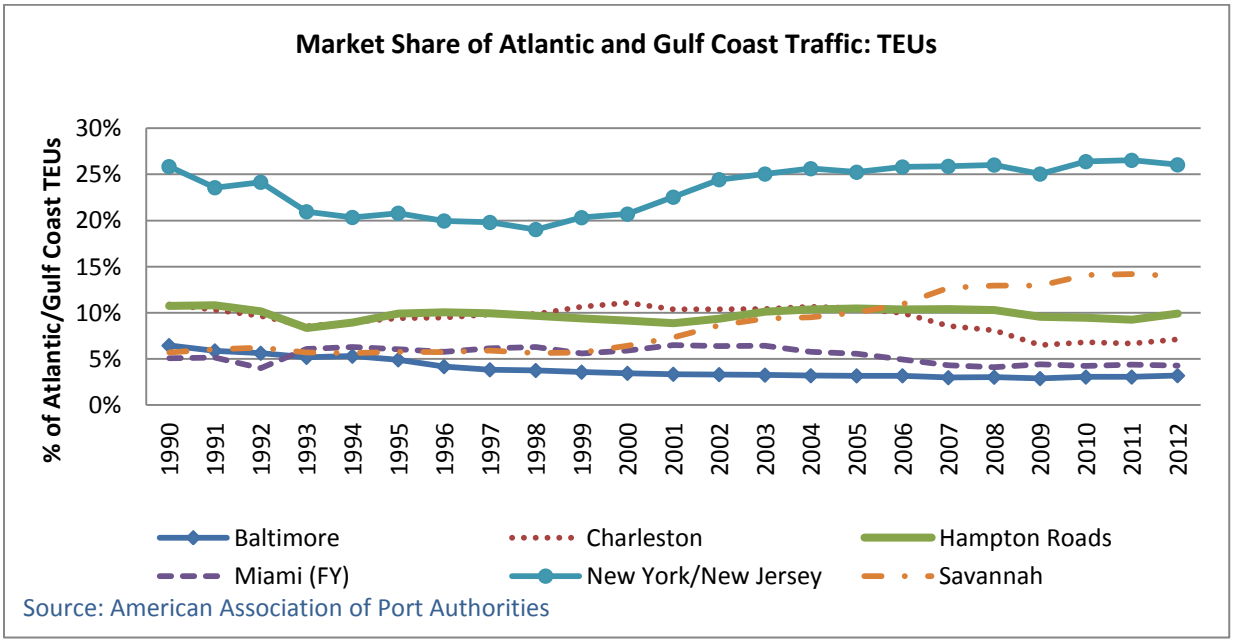
[31] Cambridge Systematics, Inc. "Potential Effects of the Panama Canal Expansion on the Texas Transportation System." (Report, Texas Department of Transportation, 2011)

[32] Sujit M. CanagaRetna, " The Panama Canal Expansion and SLC State Ports." (A Special Series Report, Southern Legislative Council, 2010)

Appendix



Source: American Association of Port Authorities



Source: American Association of Port Authorities