University Transportation Research Center - Region 2

Final Report

Panama Canal Expansion: The Effect of Imports and Exports Diverted from California Seaports on the Port of New York and New Jersey

Performing Organization: The State University of New York (SUNY)

December 2016

Sponsor:
University Transportation Research Center - Region 2

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The Region 2 University Transportation Research Center (UTRC) is one of ten original University Transportation Centers established in 1987 by the U.S. Congress. These Centers were established with the recognition that transportation plays a key role in the nation's economy and the quality of life of its citizens. University faculty members provide a critical link in resolving our national and regional transportation problems while training the professionals who address our transportation systems and their customers on a daily basis.

The UTRC was established in order to support research, education and the transfer of technology in the field of transportation. The theme of the Center is "Planning and Managing Regional Transportation Systems in a Changing World." Presently, under the direction of Dr. Camille Kamga, the UTRC represents USDOT Region II, including New York, New Jersey, Puerto Rico and the U.S. Virgin Islands. Functioning as a consortium of twelve major Universities throughout the region, UTRC is located at the CUNY Institute for Transportation Systems at The City College of New York, the lead institution of the consortium. The Center, through its consortium, an Agency-Industry Council and its Director and Staff, supports research, education, and technology transfer under its theme. UTRC's three main goals are:

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16. Abstract

In 2006, the Panama Canal Authority decided to expand the Canal by investing more than $5 billion to accommodate bigger vessels than now to traverse the current facility. Along with the Nicaragua Canal construction that is optimally expected to finish 2019 (Miller, 2014), the widening of the Panama Canal will allow larger tankers to be able to go directly to the East or Gulf of Mexico ports and bypass the West Coast ports where so many imports currently change modes to cross-continental trucks or rail. The West Coast ports will become less important while the freight shares of the East Coast and Gulf ports will increase. Hence, the Panama Canal expansion project is expected to impact U.S. water and ground freight transportation systems significantly (including cargo distribution, port development, U.S. supply chains, and logistics).

A greater flow of container trade between various Asian countries and the U.S. is expected. Increased trade volumes that arrive at South and East Coast ports are expected, reducing the congestion experienced in West Coast ports because of the high shipping cargo shift. By how much is not easy to predict, but this study attempts to define some of the key parameters: the baseline of cross-country shipments; current and proposed investments by individual ports in capacity expansion; the export-import ratios at different ports (return freight to origins will have a significant impact on estimation decisions); and the rationale for truck and rail operators and business corporations to change their behavior.

Estimating the U.S. economic effect of the Panama Canal expansion is complicated. The simplest way to approach the problem is to apply a spatially disaggregate input-output (IO) model. The National Interstate Economic Model (NIEMO), which models all interstate trade relations among the U.S. states, is a useful application model for this purpose. As Park (2008) suggested, imports and exports require a separate IO model application, and NIEMO's capability to estimate demand- and supply-side impacts is important to this type of study. Larger ships passing through the Canal will redirect sizable water-borne trade among U.S. ports, affecting the use of other freight modes.

In this study we provide estimates using secondary import and export data available from WISERTrade (www.wisertrade.org). We measured the positive effects of *reduced seaborne imports and exports to the West Coast Customs Districts (WCCD: Los Angeles Customs District, San Francisco Customs District, Columbia-Snake Customs District, and Seattle Customs District)* on the Port of New York and New Jersey. With the Canal expansion, reduced port activities would occur in California, Oregon, and Washington, the states that receive foreign imports and send U.S. exports abroad. However, concurrent positive effects in the South and East Coast states should be considered from increased imports and exports.

To measure positive effects of the Port of New York and New Jersey, we assumed: all foreign imports and U.S. exports that currently arrive and leave in the WCCD ports to be transported to the South and East Coast states via truck and rail modes would be directly shipped to the Port of New York and New Jersey through the deepened Panama Canal then distributed to the other states in the South and East Coast by the equivalent or smaller vessels

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1. INTRODUCTION

The economic history of the United States illustrates how the role of so many cities has been changed by being seaports or located on navigable rivers or lakes. This paper discusses some of the more important examples, but its primary focus will be on the future not the past. In 2006, the Panama Canal Authority decided to expand the Canal by investing more than $5 billion to accommodate bigger vessels than now to traverse the current facility. Along with the Nicaragua Canal construction that is optimally expected to finish 2019 (Miller, 2014), the widening of the Panama Canal to be completed in 2015 will allow larger tankers to be able to go directly to the East or Gulf of Mexico ports and bypass the West Coast ports where so many imports currently change modes to cross-continental trucks or rail. The West Coast ports will become less important while the freight shares of the East Coast and Gulf ports will increase. Hence, the Panama Canal expansion project is expected to impact U.S. water and ground freight transportation systems significantly (including cargo distribution, port development, U.S. supply chains, and logistics).

Indeed, a greater flow of container trade between various Asian countries and the U.S. is expected. Increased trade volumes that arrive at South and East Coast ports are expected, reducing the congestion experienced in West Coast ports because of the high shipping cargo shift. By how much is not easy to predict, but this study attempts to define some of the key parameters: the baseline of cross-country shipments; current and proposed investments by individual ports in capacity expansion; the export-import ratios at different ports (return freight to origins will have a significant impact on estimation decisions); and the rationale for truck and rail operators and business corporations to change their behavior.

Before we discuss the model and its economic impacts, the first part of the paper focuses on several relevant background topics: history of the Canal's construction and development; an analysis of some recent statistics about trade in major US ports (both the likely winners [East Coast and Gulf ports] and losers [West Coast ports]); a review of the development of aspects of the Los Angeles-Long Beach ports complex, probably the most adversely affected by the Canal's expansion of all US ports; and a brief review of some initial studies about the expansion of the Canal.

The U.S. port authorities and policy makers at the local and national levels who respond and develop plans for coping with the new realities of the Panama Canal need to understand the extent to which changes in shippers' and truckers' behavior will undermine the logistics and the costs of their activities. This is because they cannot maintain their status as major economic hubs via traditional port development strategies. Along with historical descriptions, this study reports the estimated reduced impacts of transportation and warehousing activities for foreign imports and exports on the port of New York and New Jersey consistent with the studies conducted by Park et al. (2014) and Park and Park (2014).

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2. HISTORY OF THE PANAMA CANAL

Although this paper focuses on the near future based on the analysis of recent data, we have included a relatively brief discussion of some aspects of recent U.S. port history in addition to this section on the history of the Panama Canal. This paper is primarily focused on the economic impacts of the widening of the Panama Canal on the distribution of international trade at US seaports and their surrounding regions. However, we will begin with a discussion of the history of the Canal's development. The Panama Canal was built by 1914, with its expansion planned for its 100th anniversary in 2014, but the timetable has slipped by at least a year. This is not surprising because the original building of the Canal took up so much time. The rationale for the Canal is that this 48 mile waterway joining the Atlantic and Pacific Oceans saved having to make a sometimes dangerous trip around the Cape Horn (the tip of South America) of about 8,000 miles.

The construction period went through several major obstacles, both physical and financial. Nevertheless, the project remains one of the largest and most ambitious engineering projects in history. Ideas were floated about the desirability of a canal from the 1820s, excavations were begun in the early 1880s by a French company but abandoned towards the end of the decade, and serious construction began in 1904 under American ownership.

In the early years of building the Canal two major obstacles were the risk of potentially fatal infectious diseases (malaria and yellow fever) that killed thousands of construction workers and the initial attempt (championed by the architect of the Suez Canal, Ferdinand de Lessups) to build a sea-level Canal. The idea of trying to replicating digging a ditch through desert sand in an area that crosses the Continental Divide was unsound, probably impossible. The

substitution of a Canal with locks to accommodate height differences was much more expensive but feasible. It is difficult to be precise about the total cost of the Canal after it was built, but the best estimate is $375 million (at current not today's prices).

With its ups and downs, the history of the development of the Canal is fascinating but it is well documented and not closely related to the issues discussed in this paper. Also, the engineering components (such as cutting through the high sections [especially the Culebra Cut, that was later named the Gaillard Gap], building the new locks and the two artificial lakes [Lake Gatun and Miraflores Lake] facilitated by four new dams, and very important the construction of new transportation infrastructure to bring in construction equipment and take out billions of cubic yards of excavated dirt) are very interesting to read about but not very closely related to this paper, but nevertheless deserve a mention.

The reason is that some of these aspects can have a major influence on the economic impact results, e.g. the scale of new investments in East and Gulf Coast seaports as a means of capturing a larger share of international trade from the twin ports of Los Angeles-Long Beach and, to a lesser extent, from other West Coast ports.

After political conflicts in the early 1970s, in 1977 the United States agreed to return 60 percent of the Canal Zone to Panama (it happened in 1979). For the next twenty years a bi-national Commission controlled the Zone. By 1996 more than 90 percent of Canal employees were from Panama, and in 1999 a complete handover to Panama took place and proceeded smoothly. From then onwards, outside commentators have argued that the ACP (the Panama Canal Authority)) has run the Canal very effectively.

In September 2007 work began on a project (estimated cost of $5.2 billion) to widen and deepen the Panama Canal. The key consequence of the project is to increase the potential size of the most recent PanaMax tankers passing through the Canal by 2 – 2 ½ times.

3. RECENT HISTORY OF U.S. PORTS

Within the scope of a single paper, there is insufficient space to deal with the histories of the large number of U.S. ports that will be affected by the expansion of the Canal. Hence, this section will deal with three issues: i. some comments on the major changes in U.S. port trade since the 1950s; ii. recent statistics that may help to analyze the future impacts on U.S. West Coast port trade; and iii. reference to the twin ports of Los Angeles-Long Beach that are almost certain to be the most adversely affected. The effects of the expansion of the Panama Canal expansion on U.S. ports trade (especially its regional distribution) remain unclear. An examination of recent statistics may help to shed light on the outcomes. These data sources include Port Industry Statistics available in the American Association of Port Authorities (AAPA; www.aapa-ports.org).

As a starting point, the general trade history of U.S. ports is demonstrated in Figure 1. Dollar and tonnage values of exports and imports for all U.S. Customs Districts have increased but dropped down sharply in 2009 because of the recent economic recession. In terms of dollar value amount, total exports rebounded greater than at the 2008 level in 2010, while total imports took two years to recover to the level before the recession. The trade value pattern of the WCCD ports (W) is similar to the pattern of total trade value for both foreign exports and imports; the trade values for WCCD are consistently greater than those of the South and East Coast ports (SE), averaging 1.8 and 1.6 times for exports and imports respectively.

However, the trade weight patterns of U.S. ports were somewhat different from the value patterns. While the total weight pattern of foreign exports has acutely increased since 2005 without being affected by the recession, the weight of foreign imports turned drastically down

from 2006 until the recent recession and has not recovered to the 2006 level. It is clear that there have been some gaps of foreign imports between W and SE in dollar value. However, the tonnage values of foreign imports between the two regions are very close for the given periods; further, the SE tonnage values have been slightly higher than the W tonnage values since 2008.

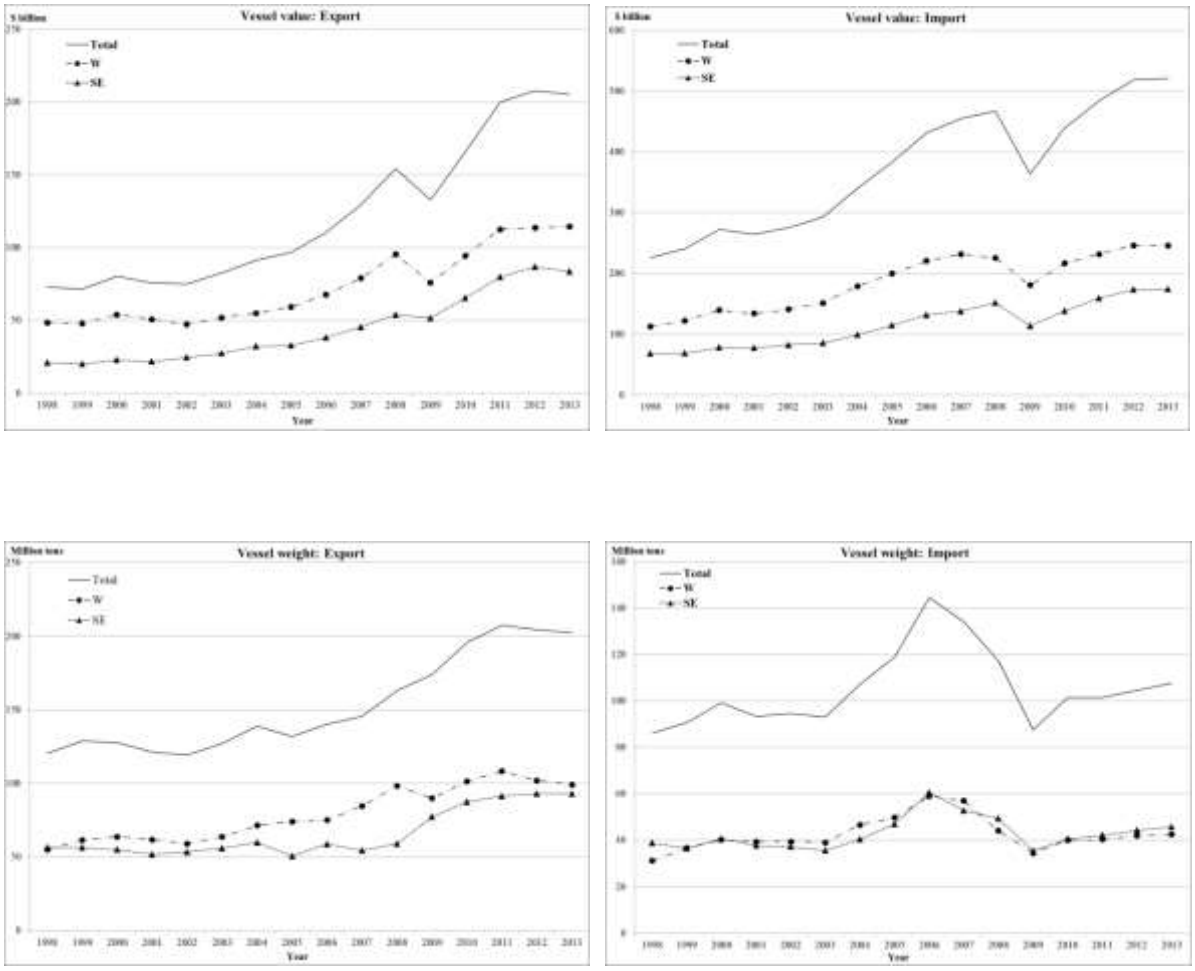

Figure 1. Trade patterns of U.S. Customs District ports

Notes: 1. Total = All U.S. ports

2. W = Customs Districts of Columbia-Snake, Los Angeles, San Francisco, and Seattle

3. SE = Customs Districts of Baltimore, Charleston, Houston/Galveston, Miami, Mobile, New Orleans, New York City, Norfolk, Philadelphia, Savannah, and Tampa

4. Source: WISERTrade (www.wisertrade.org)

The top ten U.S. ports accounted for 55.5% of all oceangoing vessel calls in all the ports in 2011. Rankings in the top ten varied by type of cargo. Here we provide data on the three main categories (tankers, containers and dry bulk) and overall. For vessel calls by tanker, Houston, New York-New Jersey and Los Angeles were the top three. For containerships, the leaders were Los Angeles-Long Beach, New York-New Jersey and San Francisco were the leaders and Virginia Ports and Savannah were #4 and #6 respectively. The dry bulk carrier leaders were very different, with the top seven being Columbia River, New Orleans, Virginia Ports, Houston, San Francisco, Baltimore and Los Angeles-Long Beach. Other prominent ports among the top ten include Houston (#9) and Seattle (#10) for containers, New Orleans (#6) and San Francisco ((#10) for tankers, Mobile (#8) for dry bulk, and New Orleans (#6), Columbia River (#7), Savannah (#8) and Baltimore (#10) for overall trade.

For all trade, the leading ports were Houston, Los Angeles-Long Beach, New York-New Jersey, San Francisco and Virginia Ports. Using cargo tonnage rather than vessel calls and ports rather than customs districts, the top ranked were Houston (167.1m.), Los Angeles-Long Beach (125.1m.), S. Louisiana (120.9m.), New York-New Jersey (89.5m.) and Hampton Beach, VA (62.6m.). Other somewhat lower ranked but well known ports include Seattle-Tacoma (#10, 39.8m. tons), New Orleans (#11, 38.2m.), Baltimore (#12, 38.2m.), Savannah (#13, 33.1m.), Mobile (#15, 29.6m.), Portland (#22, 17.5m.), Oakland (#23, 15.8m.) and Charleston, SC (#24, 15.5m.).

Other vessel calls information includes the following points:

i. In 2011, 7836 oceangoing vessels made 68,036 calls, up 7.9% from 2006;

ii. 35.0% of the vessels were tankers (most of them double-hull), 32.5% were containers, 16.1% dry cargo vessels and 9.1% RO-ROs (Roll-on/Roll-off vehicles);

iii. Containership calls increased by13.3%, 2006-2011, but dry bulk carriers increased even more (by 20.4 percent, much of the increase accounted for by coal exports).

iv. Post-Panamax vessel calls increased by 78.2%, 2006-2011, and the 5,000+ tons TEUs increased their share from 17.1% to 27.0%;

v. The distribution of calls among coastal regions were 34.1% for the Gulf ports, 21.2% for the South Atlantic, 16.6% for the Pacific Southwest, 15.8% for the North Atlantic, 10.5% for the Pacific Northwest and 1.9% for Puerto Rico;

vi. Vessels were becoming somewhat younger, averaging 9.7 years in 2011 compared with 11.2 hours in 2006;

vii. The U.S. share of global vessel calls was 7.3% in 2011, ranking #2 behind China (57% of the Chinese level), but ahead of Japan, Singapore, South Korea, Brasil, Italy, Malaysia, Taiwan and Australia;

viii. U.S. flag carriers account for 10.8% of all calls at US ports.

Because different types of cargo have very different prices in terms of $ per ton, rankings of ports in terms of the cargo value are more significant. The 2011 leaders were: Los Angeles-Long Beach ($381.7b.), Houston ($242.5b.), New York-New Jersey ($208.0b.), New Orleans ($153.4b.), Seattle ($87.8b.), Savannah ($85.7b.) and San Francisco ($69.2b.). The total U.S. value of foreign trade was $1,729.4b.

The world rankings in world ports in 2011 for cargo volume were Shanghai followed by Singapore, Tianjin, Rotterdam and Guangzhou (Busan was ranked #9 and Hong Kong was ranked #10 while the well-known U.S. ports were ranked much lower: New York-New Jersey #29, Long Beach #52, Los Angeles #65). The rankings in TEU containers were somewhat different: the top five are Shanghai, Singapore, Hong Kong, Shenzhen and Busan. Los Angeles is ranked #16 and Long Beach #20; however, treated as usual as a twin port completely contiguous but with different managements and a competitive spirit, the joint ranking jumps to #8. The conclusion to be drawn from world rankings data is the dominance of Pacific Rim ports (especially in East Asia), and this might have a major impact on post-Canal expansion trade diversions. The effects on cargo volumes might be less because of the high tolls of passing through the Panama Canal; hence the consequences of trade value and container ships are probably going to be much more significant.

4. THE LOS ANGELES-LONG BEACH PORTS COMPLEX

The twin ports (under separate management) of Los Angeles-Long Beach are the largest international seaport complex in the United States, although its ranking varies by cargo type. It is by far the largest West Coast port complex that will be impacted by the expansion of the Panama Canal. Also, its growth has been closely linked to economic development in the Pacific Rim, not only the fastest growing macro-region globally but the one where trade will be diverted more to the Panama Canal. This paper attempts to analyze by how much, but the answer is uncertain because the extent of the shift does not depend upon transport cost differentials alone but also on changes in the behavior of port authorities, shippers, truckers and other transportation agents.

The two ports developed at slightly different dates. The origins of the Port of Los Angeles go back to 1542 with major changes in the 1880s with deepening via dredging but its formal status did not begin until the establishment of the Harbor Board of Commissioners in 1907. The Port of Long Beach was established very soon after in 1911. A major development was the local discovery of oil in 1921 reinforced a decade later (1932) by the fourth-largest oilfield in the United States (the Wilmington Oil Field). Afterwards (from the mid-1930s), there was a major growth in oil exports leading to expansion of the port.

The port complexes are of massive size (7,500 acres for Los Angeles with 43 miles of waterfront and 3,200 acres with 25 miles of waterfront for Long Beach), they have been able to install many terminals and other types of infrastructure, and they are preparing new investments to compete with the Canal expansion (they are not alone; several ports on the East Coast and in the Gulf are on the same path).

The burgeoning growth of the LA-LB complex has been closely associated with the dynamics of Pacific Rim development. For example, in 1981 the China Ocean Shipping Co. designated Long Beach as its premier port. A decade later, South Korea's Hanjin Shipping Co. opened a large container terminal of 57 acres on Pier C. A few years later (1997) another Chinese company (COSCO) established facilities in Long Beach. There were similar facilities established at the Port of Los Angeles.

According to the AAPA data, a major factor at both ports has been the rapid growth of container traffic (measured in TEUs [twenty-ton equivalent units]). In 1980 there were 633,000 units in Los Angeles; the number rose to 2.1m. in 1990, 4.9m. in 2000 and 7.8m. in 2010, paralleled by a similar trend in Long Beach (1.6m., 4.6m. and 5.1m. respectively). The combined inbound numbers were 3.7m., 9.5m. and 12.9m., and these approximately doubled counting outbound traffic.

The twin ports are ranked highly among US ports in all types of cargo: #1 in containers, #3 in tankers, #7 in dry bulk, and #1 overall. The top five trading partners of the Port of Los Angeles are all Asian: China, Japan, Taiwan, South Korea and Thailand. With $120.7 billion in 2010, China had almost double of the trade of the next four (the five combined was $184 billion). The leading imported commodities (all by container) are furniture, footwear, toys, automobile parts, and women's and children's apparel. Most of these were from China.

Turning to the example of the Port of Long Beach and its economic impacts, its $100 billion of imports and exports generated 30,000 jobs in the City of Long Beach (12% of the total),

230,000 jobs in the City of Los Angeles, and 370,000 jobs in the State of California (these numbers include the employment multiplier effects). The associated state and local tax revenues amounted to $5.6 billion.

An important issue, worthy of mention but not highly relevant to the Panama Canal expansion unless it would favor the ports' slower growth or even stagnation in trade, relates to the environment, especially air pollution. The twin ports are the highest polluters in the Los Angeles metropolitan region, accounting for 14% of the air pollution in the region's Air Quality Management District. The two main sources are trucks accessing the port and ships that continue to keep their engines on when at berths because of inability to substitute lower-polluting electricity connections. In the past decade both ports have taken major steps to mitigate the problem. These include a Clean Trucks Program requiring that trucks dealing with the port have to be recent low diesel vehicles, investments in accessing electricity berth connections, and pressure on shippers to slow down speeds when they get within 20 miles of the port.

An interesting development at the Port of Los Angeles is the establishment of the World Cruise Center. It is the largest West Coast terminal. It has three passenger berths accommodating one million passengers a year, backed up with 2,560 parking spaces. Will the expansion of the Canal generate economic benefits? It is possible, but not with certainty. First, cruises from the West Coast via the Canal to, say, Caribbean countries will take a long time. Partial cruises, entering the Canal as a tourist attraction but not traversing it, are a more likely result with entry and exit points both in the East and the West. Second, although the widening of the Canal and its lengthening within the locks will permit larger cruise ships, the largest of them will not be

able to get through. The reason is the Bridge of Americas which is 201ft high while the largest cruise ship is 232 ft above the water. Nevertheless, there may be some stimulus with ships starting in Los Angeles, moving down the Mexican coast, and then entering and exiting the Canal on the west side.

5. RECENT STUDIES ON THE PANAMA CANAL EXPANSION

Some recent research reports and papers have discussed plausible implications of the Panama Canal expansion. Rodrigue (2010) outlined the present Panama Canal functions and provided arguments for the expansion of the Canal. He categorized three main factors that may contribute to the expansion: macroeconomic factors (associated with changes in aggregate demand and the production structure), operational factors (related to freight distribution along the maritime shipping), and competitive factors (affecting other transport chains). However, predicting the economic impacts of the canal expansion is also a multidimensional function. As Knight (2008) summarized, it is necessary to consider the timing and location of the impacts on freight distribution to avoid possibly inconsistent economic assumptions associated with the Panama Canal expansion.

The timing and location complexity involves investment strategies planned in each port. A number of ports on the Atlantic and Gulf Coasts have initiated work on port expansion and modernization efforts to ensure taking a greater proportion of global trade to their ports, responding to the Panama Canal expansion (CanagaRetna, 2013). More specifically, Boske and Harrison (2013) analyzed major aspects of trade between the U.S. and Asian countries as well as U.S.-Latin American trade, suggesting opportunities and challenges from canal expansion faced by Texas ports from competition of international trade. However, it is still unknown which states will be losers or winners in terms of economic impacts.

Most of freight that arrive at LA/LB ports is transported to other regions via different modes such as rail and truck. These multimodal modes and related industries will play a critical role in the region in terms of economic and environmental impacts. Because the Panama Canal

Expansion allows class ‘E’ vessels which are approximately up to 14,000 TEUs to travel directly to major ports in other coastal areas with reduced toll-fee, severe shrinkage in the West Coast ports and the connected inland transport modes is to be expected, reducing GHG emissions and other pollutants in the West Coast region. Hence, another important research topic associated with canal expansion is to estimate environmental impacts. Using imports and exports projection data available from the Freight Analysis Framework 3 (FAF^3) database of the Federal Highway Administration, Bittner et al. (2012) estimated the potential impacts of canal expansion on greenhouse gas (GHG) emissions from trade between the U.S. and East and Southeast Asian countries. Focusing on GHG emissions changes and linking the size of ships and water-borne route distances, Corbett et al. (2012) probed the impacts in more detail: substitution to larger ships traversing the expanded Canal can reduce CO_2 emissions; however, longer water-borne route distances offset modal efficiencies in CO_2 emissions. It is not clear that diversion from the west coast ports to the south and east coast ports would reduce total CO_2 emissions.

While all the studies reported recently, including environmental impact studies, did not address economic impacts because of many uncertainties, they nevertheless offer useful information. For example, which states would experience a potential increase in water-borne shipping by the Panama Canal expansion? How can an IO model make use of route-distance data by mode when addressing the economic impacts for states which have different locations from each port and different time frame deliveries? Section 6 explains how we modeled complex questions which have not been addressed in economic impact analyses.

6. MODEL AND DATA

We applied supply- and demand-side NIEMOs for the analysis and estimated the state-by-state and industry-by-industry economic impact on the Panama Canal expansion for imports and exports. As input data for the application of NIEMO models to trade diversion effects for the WCCD area, we collected and modified foreign import and U.S. export data available from WISERtrade, which is collected from the U.S. Census Bureau's Foreign Trade Division. We selected 15 Pacific Rim countries that traded with the WCCD ports. These include China, Japan, Republic of Korea, Hong Kong, Singapore, Australia, Taiwan, Malaysia, Philippines, Indonesia, New Zealand, Macao, Papua New Guinea, Brunei, and Thailand. Three-year average values of total U.S. imports and exports between 2010 and 2012 were calculated to mute the effects of outlier values. The second column in Table 1 shows the resulting import and export data by customs districts of the West Coast states.

We also derived transportation (each truck and rail mode) and warehousing margins for total foreign imports and U.S. exports, respectively. For this purpose, we used a use table from the National Input-Output Accounts available from the Bureau of Economic Analysis (www.bea.gov). Multiplying these margins by the total imports and exports of each Customs District, we calculated the transportation and warehousing related activity values for foreign imports (upper table) and U.S. exports (lower table). These results are displayed in the third and fourth columns of Table 1 by each WCCD.

Table 1. Selected water-borne trade amount and related costs to West Coast Customs Districts.

Customs District	Total imports	Transportation cost		Warehousing cost
		rail	truck	
Los Angeles	169,518.14	4,059.60	10,954.29	4,109.48
San Francisco	23,733.60	568.37	1,533.67	575.35
Columbia-Snake	9,452.28	226.36	610.81	229.14
Seattle	28,831.68	690.46	1,863.11	698.94
Total	231,535.70	5,544.79	14,961.88	5,612.91

Customs District	Total exports	Transportation cost		Warehousing cost
		rail	truck	
Los Angeles	65,359.67	1,565.23	4223.55	1,584.46
San Francisco	13,461.79	322.38	869.90	326.34
Columbia-Snake	10,335.69	247.52	667.89	250.56
Seattle	17,784.75	425.91	1149.25	431.14
Total	106,941.91	2,561.03	6,910.61	2,592.50

Note: Imports and exports values are averaged from 2010 through 2012.
Units: million dollars

We allocated transportation and warehousing values of freight destined for the Southern and East Coast states. Based on the studies of Rodrigue (2010) and Knight (2008), we chose 12 states with seaports potentially impacted by the Panama Canal expansion. They are Alabama, Delaware, Florida, Georgia, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, South Carolina, Texas, and Virginia. To distribute transportation and warehousing amounts to these states, we applied the modal proportions of the Freight Analysis Framework version 3 (FAF^3). More specifically, we used the Origin-Destination State Database for 2007 available from the U.S. Department of Transportation, Federal Highway Administration. Even though the FAF data have some limitation, the data source is still useful because it provides substantial freight movement data among U.S. states and major metropolitan areas by every major freight mode used for transport (Park et al., 2011).

Equation 1 explains the distribution process. From the 2007 FAF[3] database, we calculated the portion of foreign imports and U.S. exports that are distributed to the selected destination states from WCCD ports via both truck and rail modes.

$$P\_IMP_i^j = \frac{IA\_TR_i^j}{TI_i}, \qquad P\_EXP_i^j = \frac{EA\_TR_i^j}{TE_i} \tag{1}$$

where, P_IMP = the portion of foreign imports,
P_EXP = the portion of U.S. exports,
TI = total imports,
TE = total exports,
IA_TR = amount of foreign imports distributed by truck and rail modes,
EA_TR = amount of U.S. exports distributed by truck and rail modes,
i = each origin state of the WCCD ports, and
j = each destination states.

Along with the portions allocated to each state and the transportation and warehousing costs of each WCCD suggested in Table 1, we estimated transportation and warehousing activities values of foreign imports and U.S. exports distributed to each destination state by truck and rail modes. Equations 2 and 3 showed the process for calculation these estimated transportation and warehousing activity values; estimated results are presented in Table 2.

$$TAV\_IMP_i^j = P\_IMP_i^j \times TPC_i, \qquad WAV\_IMP_i^j = P\_IMP_i^j \times WHC_i \tag{2}$$

$$TAV\_EXP_i^j = P\_EXP_i^j \times TPC_i, \qquad WAV\_EXP_i^j = P\_EXP_i^j \times WHC_i \tag{3}$$

where, TAV_IMP = transportation activity value of foreign imports,
WAV_IMP = warehousing activity value of foreign imports,

TAV_EXP = transportation activity value of U.S. exports,

WAV_EXP = warehousing activity value of U.S. exports,

TPC = transportation cost of each WCCD state, and

WHC = warehousing cost of each WCCD state.

Table 2. Decreased transportation and warehousing activity values of trade data due to diversion from each West Coast Customs District state to destination states

Foreign Imports

States	Los Angeles		San Francisco		Columbia-Snake		Seattle	
	TP value	WH value	TP value	WH value	TP value	WH value	TP value	WH value
AL	85.34	23.36	0.73	0.20	0.01	0.00	2.05	0.56
DE	2.05	0.56	0.13	0.04	0.00	0.00	0.84	0.23
FL	106.83	29.24	4.57	1.25	0.23	0.06	1.92	0.53
GA	193.28	52.90	5.82	1.59	0.41	0.11	9.14	2.50
MD	27.58	7.55	1.41	0.39	0.01	0.00	6.62	1.81
MA	40.68	11.13	6.88	1.88	0.03	0.01	3.24	0.89
NJ	468.05	128.11	7.25	1.99	5.49	1.50	19.67	5.38
NY	435.13	119.10	74.89	20.50	2.98	0.82	59.56	16.30
PA	120.97	33.11	6.77	1.85	0.82	0.23	20.01	5.48
SC	30.64	8.39	2.32	0.64	0.06	0.02	1.99	0.54
TX	909.63	248.98	32.57	8.91	92.09	25.20	9.28	2.54
VA	36.19	9.90	4.43	1.21	0.96	0.26	4.47	1.22
Total	2,456.36	672.33	147.78	40.45	103.09	28.22	138.77	37.98

U.S. Exports

States	Los Angeles		San Francisco		Columbia-Snake		Seattle	
	TP value	WH value	TP value	WH value	TP value	WH value	TP value	WH value
AL	9.85	2.70	0.27	0.07	0.18	0.05	0.58	0.16
DE	7.53	2.06	0.35	0.09	0.00	0.00	1.41	0.39
FL	6.56	1.79	0.42	0.11	9.65	2.64	8.66	2.37
GA	11.21	3.07	1.47	0.40	3.21	0.88	1.14	0.31
MD	2.85	0.78	0.54	0.15	0.49	0.13	3.56	0.98
MA	4.71	1.29	0.44	0.12	1.52	0.42	1.84	0.50
NJ	22.68	6.21	1.94	0.53	8.02	2.20	4.35	1.19
NY	44.48	12.17	4.28	1.17	112.19	30.71	20.43	5.59
PA	19.84	5.43	1.29	0.35	27.48	7.52	4.80	1.31
SC	2.54	0.69	0.10	0.03	0.03	0.01	1.81	0.50
TX	378.22	103.52	16.78	4.59	3.78	1.03	2.76	0.76
VA	24.22	6.63	1.02	0.28	0.05	0.01	5.91	1.62
Total	534.68	146.35	28.89	7.91	166.59	45.60	57.24	15.67

Note: TP – Transportation; WH - Warehousing
Units: millions of dollars

Transportation and warehousing activity values of foreign imports and U.S. exports presented in Table 2 are assumed to decrease in the West Coast states. To address new transportation and warehousing activities that occur in each state designated, we measured the difference between baseline transportation and alternative transportation modes. This accounts for transportation activity benefits in the Southern and East Coast states. We also allocated decreased warehousing activity values to destination states as increases, assuming the warehousing margin of the West Coast states is identical to destination states. Note that we did not account for any other transportation mode cost changes in the short-term.

Container port capacity can be evaluated with following dimensions of container terminal capacity: container yard storage density (stacking height), operating hours, and vessels and crane use. Accommodating the readily available port and terminal data, the Tioga Group, Inc. (2010) estimated East and Gulf Coast container ports' capacity by container yard storage, crane, and berth capacities. They also calculated each indicator's utilization using 2008 container trade amount (TEU). Adopting the approach of this study, estimated current container yard storage utilization of the Port of New York and New Jersey was 77.9% with 2013 container TEU. Based on this information, we developed following scenarios for the Port of New York and New Jersey which account for the accommodation rate of trade diversion amount from the WCCD ports:

Scenario 1: Accommodating trade diversion up to 80% of container yard storage utilization.

Scenario 2: Accommodating trade diversion up to 85% of container yard storage utilization.

Scenario 3: Accommodating trade diversion up to 90% of container yard storage utilization.

The trade diversion amount accommodated by the Port of New York and New Jersey in scenarios 1 to 3 were 20.6%, 69.7%, and 99.1% of total imports and exports presented in Table 1, respectively.

Several assumptions are needed to estimate the change of transportation activity values in destination states by modal shift. First, the transportation distance by ship from each WCCD to the Port of New York and New Jersey and from the Port of New York and New Jersey to destination states are assumed to be identical to the geographical distance between origin and destination states. Second, the freight that would arrive at destination states will travel to the nearby areas for 310 miles only using truck mode. We approximated the highway distance miles from the core city of each WCCD to the principal cities of destination states using *Google map*. Finally, we used dollar values of the import and export data; we also used the weight data to calculate transportation activity values. We assumed these freight transport costs per ton-mile: water mode is $0.0074/ton-mile, truck mode $0.2619/ton-mile, and rail mode $0.0228/ton-mile, as Ballou (2004) suggested. The change of transportation activity value and warehousing activity value in each destination state are shown in Table 3 by each scenario for the Port of New York and New Jersey.

Table 3. The change of transportation activity value and warehousing activity value of trade data diverted from each Customs District to destination states

Foreign imports						
States	Scenario 1		Scenario 2		Scenario 3	
	TP_delta	WH	TP_delta	WH	TP_delta	WH
AL	15.71	4.96	53.22	16.81	75.72	23.91
DE	0.77	0.17	2.60	0.58	3.70	0.82
FL	26.75	6.39	90.61	21.66	128.92	30.82
GA	44.01	11.75	149.08	39.79	212.12	56.62
MD	8.46	2.01	28.65	6.79	40.77	9.67
MA	13.97	2.86	47.34	9.69	67.36	13.79
NJ	125.84	28.17	426.29	95.44	606.56	135.81
NY	133.16	32.23	451.12	109.19	641.89	155.37
PA	38.34	8.36	129.88	28.34	184.80	40.32
SC	8.16	1.97	27.63	6.68	39.31	9.50
TX	146.55	58.75	496.45	199.02	706.39	283.18
VA	11.46	2.59	38.82	8.78	55.23	12.49
Average	47.76	13.35	161.81	45.23	230.23	64.36
Total	573.16	160.22	1941.67	542.77	2762.78	772.30

U.S. exports						
States	Scenario 1		Scenario 2		Scenario 3	
	TP_delta	WH	TP_delta	WH	TP_delta	WH
AL	6.56	0.61	22.21	2.07	31.60	2.95
DE	10.06	0.52	34.06	1.77	48.47	2.52
FL	74.74	1.42	253.20	4.82	360.27	6.86
GA	26.39	0.96	89.40	3.25	127.21	4.62
MD	12.43	0.42	42.12	1.42	59.93	2.02
MA	16.45	0.48	55.73	1.62	79.29	2.31
NJ	51.31	2.08	173.82	7.05	247.33	10.04
NY	533.32	10.21	1806.71	34.59	2570.74	49.22
PA	146.44	3.01	496.10	10.19	705.90	14.50
SC	6.11	0.25	20.69	0.85	29.44	1.22
TX	154.37	22.60	522.95	76.58	744.09	108.96
VA	36.86	1.76	124.88	5.95	177.69	8.47
Average	89.59	3.69	303.49	12.51	431.83	17.81
Total	1075.04	44.33	3641.87	150.17	5181.96	213.68

Note: 1. TP_delta = Baseline transportation activity values (via truck and rail modes) – Alternative

transportation activity values (via water and truck modes)
2. WH = warehousing value.
3. Unit: million dollars.

Based on the National Interstate Economic Model (NIEMO) constructed by Park et al. (2007), we applied demand-side and supply-side NIEMO models in this part of the study. Park (2007; 2008) and Park et al. (2008) elaborated both demand-side and supply-side NIEMO models, including empirical tests. Equations 4 and 5 suggest the structure of demand-side and supply-side NIEMO models as a matrix form:

$$X^O = (I - C^D N^D)^{-1} F \quad (4)$$

where, X^O = the total output column vector for s (=1, … , 47) USC Sectors and r (=1, … ,52) regions,

C^D = $C(\hat{C}_j^s)^{-1}$ and $\hat{C}_j^s$ is a sr×sr diagonal matrix of 1×sr row vector,

C_j^s = $\sum_i C_{ij}^s$ and C_{ij}^s is a trade flows for USC sector s between regions i and j,

N^D = $Z(\hat{X}^I)^{-1}$and $\hat{X}^I$ is a sr×sr block diagonal matrix of vector X^I,

X^I= the total input row vector,

Z = the block diagonal matrix of direct technical flows between industries, and

F = a row vector of region specific final demand.

$$X^I = A(I - N^S C^S)^{-1} \quad (5)$$

where, X^I = the total input row vector for s (=1, … , 47) USC sectors and r (=1, … ,52) regions,

A = a row vector of region specific value added factors,

N^S = $(\hat{X}^O)^{-1} Z$ and $\hat{X}^O$ is a sr×sr block diagonal matrix of vector X^O,

X^O = the total output column vector,

Z = the block diagonal matrix of direct technical flows between industries, and

$C^S = (\hat{C}_j^s)^{-1}C$ and $\hat{C}_j^s$ is a sr×sr diagonal matrix of 1×sr row vector,

$C_j^s = \sum_i C_{ij}^s$ and C_{ij}^s is a trade flows for USC Sector s between regions i and j.

The USC Sector definition is found in Table 4.

Table 4. Definitions for USC Sector system

USC sector	Description
USC01	Live animals and live fish & Meat, fish, seafood, and their preparations
USC02	Cereal grains & Other agricultural products except for Animal Feed
USC03	Animal feed and products of animal origin, n.e.c.
USC04	Milled grain products and preparations, and bakery products
USC05	Other prepared foodstuffs and fats and oils
USC06	Alcoholic beverages
USC07	Tobacco products
USC08	Nonmetallic minerals (Monumental or building stone, Natural sands, Gravel and crushed stone, n.e.c.)
USC09	Metallic ores and concentrates
USC10	Coal and petroleum products (Coal and Fuel oils, n.e.c.)
USC11	Basic chemicals
USC12	Pharmaceutical products
USC13	Fertilizers
USC14	Chemical products and preparations, n.e.c.
USC15	Plastics and rubber
USC16	Logs and other wood in the rough & Wood products
USC17	Pulp, newsprint, paper, and paperboard & Paper or paperboard articles
USC18	Printed products
USC19	Textiles, leather, and articles of textiles or leather
USC20	Nonmetallic mineral products
USC21	Base metal in primary or semi-finished forms and in finished basic shapes
USC22	Articles of base metal
USC23	Machinery
USC24	Electronic and other electrical equipment and components, and office equipment
USC25	Motorized and other vehicles (including parts)
USC26	Transportation equipment, n.e.c.
USC27	Precision instruments and apparatus
USC28	Furniture, mattresses and mattress supports, lamps, lighting fittings, and illuminated signs
USC29	Miscellaneous manufactured products, Scrap, Mixed freight, and Commodity unknown
USC30	Utility
USC31	Construction
USC32	Wholesale Trade
USC33	Transportation
USC34	Postal and Warehousing
USC35	Retail Trade
USC36	Broadcasting and information services*
USC37	Finance and Insurance
USC38	Real estate and rental and leasing
USC39	Professional, Scientific, and Technical services
USC40	Management of companies and enterprises
USC41	Administrative support and waste management
USC42	Education Services
USC43	Health Care and Social Assistances
USC44	Arts, Entertainment, and Recreation
USC45	Accommodation and Food services
USC46	Public administration
USC47	Other services except public administration

7. RESULTS

We estimated the increased impact of transportation and warehousing activities for foreign trade in the Southern and East Coast states including positive effect of the Port of New York and New Jersey as an entry port from the Panama Canal Expansion. Both demand- and supply-side NIEMO models were applied. Because “direct impact” refers to the initial economic impact experienced in each sector in each state, it is the change of foreign imports and U.S. exports in the states presented in Tables 2 and 3 relating to the Canal expansion. “Indirect impact” indicates the economic impact arising due to inter-industry linkages; this is measured via the inverse coefficients of NIEMO models. A Type I multiplier describes the sum of direct and indirect impact relative to direct impact.

The main summary results of the increased impacts into the Southern and East Coast states are presented in Tables 5 and 6. The full positive impacts are suggested in APPENDICES 1 to 4. The increased impacts of transportation and warehousing values for foreign imports and U.S. exports in the Southern and East Coast states positively affected the national economy. We showed results of the top three impacted states in Table 5 by each scenario.

Table 5. Top three positively impacted states of increased transportation and warehousing activities due to trade diversion from the WCCD ports

U.S exports

State	Scenario 1			Scenario 2			Scenario 3		
	DI	II	TI	DI	II	TI	DI	II	TI
NY	543.53	346.31	889.84	1,841.30	1,173.14	3,014.44	2,619.96	1,669.24	4,289.20
TX	176.97	160.36	337.33	599.53	543.24	1,142.76	853.06	772.97	1,626.03
PA	149.45	121.03	270.48	506.29	410.01	916.30	720.39	583.40	1,303.80
UST	1,119.37	964.89	2,084.26	3,792.04	3,268.71	7,060.74	5,395.64	4,650.99	10,046.63
ROW	0.00	61.3550	61.35	0.00	207.8539	207.85	0.00	295.7544	295.75
WT	1,119.37	1,026.24	2,145.61	3,792.04	3,476.56	7,268.59	5,395.64	4,946.74	10,342.38

Foreign imports

State	Scenario 1			Scenario 2			Scenario 3		
	DI	II	TI	DI	II	TI	DI	II	TI
TX	205.30	116.46	321.75	695.47	394.51	1,089.98	989.58	561.34	1,550.92
NY	165.40	85.07	250.47	560.31	288.19	848.50	797.26	410.06	1,207.32
NJ	154.01	71.62	225.63	521.73	242.62	764.35	742.37	345.22	1,087.59
UST	733.38	445.85	1,179.23	2,484.44	1,510.37	3,994.82	3,535.08	2,149.10	5,684.18
ROW	0.00	14.1611	14.16	0.00	47.9735	47.97	0.00	295.7544	295.75
WT	733.38	460.01	1,193.39	2,484.44	1,558.35	4,042.79	3,535.08	2,444.85	5,979.93

Units: million dollars

Note: 1. DI: Direct Impact
2. II: Indirect Impact
3. TI: Total Impact
4. UST: U.S. Total
5. ROW: Rest of World
6. WT: World Total

Total economic gains acquired from the shift of transportation modes and new warehousing activities for U.S. exports in the destination states by scenarios 1 to 3 were estimated $2,146 million, $7,269 million, and $10,342 million, respectively. The positive gains of entry port's state, New York, were largest in each scenario; Texas and Pennsylvania followed for all scenarios.

Total gains for foreign imports by scenarios 1 to 3 were $1,193 million, $4,043 million, and $5,980 million, respectively. The most affected state of foreign imports diversion was Texas;

New York would be second, and New Jersey third for all scenarios. Since the imports distributed to Texas by truck and rail modes were relatively large among the 12 port states, the total gain to Texas was relatively sizable for all scenarios.

As entry port (the Port of New York and New Jersey) and transportation modes changed and warehousing activity of U.S. exports to 12 South and East Coast states increased, the economic gains were estimated to be dominant in USC sectors 33 (Transportation), 10 (Coal and petroleum products (Coal and Fuel oils, n.e.c.)), and 39 (Professional, Scientific, and Technical services) in each scenario (To see Table 6). The share of these major three sectors in each scenario accounted for almost 68% of the total gains. Type I multiplier for all scenarios was 1.92.

As shown in Table 6, the positive impacts of foreign imports was highest in USC sector 33; USC sectors 34 (Postal and Warehousing) and 43 (Health Care and Social Assistances) followed. These three USC sectors took 70.2% of total impacts in each scenario and Type I multiplier of this case for all scenarios was 1.63.

Table 6. Top three positively impacted USC sectors of increased transportation and warehousing activities due to trade diversion from the WCCD ports

U.S. exports (Type I multiplier: 1.917)									
USC sector	Scenario 1			Scenario 2			Scenario 3		
	DI	II	TI	DI	II	TI	DI	II	TI
USC33	1075.04	157.20	1232.24	3641.87	532.53	4174.40	5181.96	757.73	5939.69
USC10	0.00	122.61	122.61	0.00	415.36	415.36	0.00	591.02	591.02
USC39	0.00	104.11	104.11	0.00	352.67	352.67	0.00	501.81	501.81
Total	1119.37	1026.24	2145.61	3792.04	3476.56	7268.59	5395.64	4946.74	10342.38
Foreign imports (Type I multiplier: 1.627)									
USC sector	Scenario 1			Scenario 2			Scenario 3		
	DI	II	TI	DI	II	TI	DI	II	TI
USC33	573.16	64.50	637.66	1941.67	218.49	2160.16	2762.78	310.88	3073.66
USC34	160.22	7.92	168.14	542.77	26.85	569.62	772.30	38.21	810.52
USC43	0.00	31.82	31.82	0.00	107.80	107.80	0.00	153.39	153.39
Total	733.38	460.01	1193.39	2484.44	1558.35	4042.79	3535.08	2217.36	5752.44

Units: million dollars

Note: 1. DI: Direct Impact
2. II: Indirect Impact
3. TI: Total Impact

8. CONCLUSIONS AND DISCUSSION

Estimating the U.S. economic effects of the Panama Canal expansion has raised many analytical difficulties because simultaneous responses of the impacted and the other states in the U.S. should be considered. While it is the issue of selecting an appropriate economic impact model, the problem of developing plausible scenarios that account for the investment strategy of the Port of New York and New Jersey and are applied to the economic model is another challenge. We addressed these challenges in this study empirically.

We applied the supply-side and demand-side NIEMO models and subtracted foreign imports and U.S. exports of Pacific Rim countries, which are destined for the WCCD ports and diverted to various competing U.S. water-borne ports on the Southern and East coasts. To estimate the positive effect of the Port of New York and New Jersey as a new entry port, we set up various scenarios which account for the accommodation rate of trade diversion amount from the WCCD ports. The total direct increase of transportation and warehousing activities associated with foreign imports diversion in the Southern and East ports were estimated by $733 million, $2,484 million, and $3,535 million for scenarios 1 to 3, respectively. This direct impact leaded to the total economic gains by $1,193 million, $4,043 million, and $5,752 million in each scenario. Total positive gains from the shift of transportation modes with the choice of an entry port and new warehousing activities for foreign imports were largest in Texas; New York and New Jersey followed. Transportation, Postal and Warehousing, and Health Care and Social Assistances are the dominant gainer of the Canal expansion in the U.S. In the case of U.S. exports, New York, Texas, and Pennsylvania may be benefited in the U.S. Transportation, Coal

and petroleum products (Coal and Fuel oils, n.e.c.), and Professional, Scientific, and Technical services sectors had the largest gains among 47 USC sectors.

However, this type of economic impact study includes its various limits. First of all, modeling economic impacts is appropriated to be applied for short term effects because an uncountable number of prices adjust in the longer term and the economic impacts analyzed for the longer term are inconceivable. Also, we did not account for the change of an entry point port for foreign trade in the U.S. Midwest region and the Mountain Division of West region. It needs to understand each state's behavioral change in the region, which depends on the decision process minimizing the sum of multi-modal delivery costs. Third, we only focused on the change of transportation and warehousing activity values for foreign imports and U.S. exports and could not account for the port investment amount planned exclusively for deepening channels located in South and East coasts. The investment data can be used for a cost-benefit analysis combined with the current cost measures. Finally, as Giuliano (2010) suggested, a local multi-modal freight modeling may be helpful to measure the local delivery costs instead of the 310 mile assumption as applied in this study.

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APPENDIX 1. The full impacts of transportation and warehousing activities increasing in the Southern and East Coast states for foreign imports diversion: Scenario 1

State	Direct Impact	Indirect Impact	Total Impact
AL	20.67	12.11	32.78
AK	0.00	0.14	0.14
AZ	0.00	1.15	1.15
AR	0.00	0.85	0.85
CA	0.00	9.54	9.54
CO	0.00	1.21	1.21
CT	0.00	1.57	1.57
DE	0.94	0.87	1.81
DC	0.00	0.31	0.31
FL	33.14	22.52	55.66
GA	55.75	26.37	82.13
HI	0.00	0.21	0.21
ID	0.00	0.21	0.21
IL	0.00	2.86	2.86
IN	0.00	1.29	1.29
IA	0.00	1.27	1.27
KS	0.00	0.80	0.80
KY	0.00	1.15	1.15
LA	0.00	1.85	1.85
ME	0.00	0.42	0.42
MD	10.46	6.84	17.30
MA	16.84	11.57	28.40
MI	0.00	2.49	2.49
MN	0.00	1.47	1.47
MS	0.00	0.97	0.97
MO	0.00	1.27	1.27
MT	0.00	0.20	0.20
NE	0.00	0.61	0.61
NV	0.00	0.42	0.42
NH	0.00	0.49	0.49
NJ	154.01	71.62	225.63
NM	0.00	0.65	0.65
NY	165.40	85.07	250.47
NC	0.00	2.90	2.90
ND	0.00	0.15	0.15
OH	0.00	3.42	3.42
OK	0.00	1.08	1.08
OR	0.00	0.63	0.63
PA	46.70	28.85	75.55
RI	0.00	0.39	0.39
SC	10.13	6.54	16.67
SD	0.00	0.19	0.19
TN	0.00	2.13	2.13
TX	205.30	116.46	321.75
UT	0.00	0.56	0.56
VM	0.00	0.26	0.26
VA	14.05	8.55	22.60
WA	0.00	1.11	1.11
WV	0.00	0.43	0.43
WI	0.00	1.71	1.71
WY	0.00	0.12	0.12
US Total	733.38	445.85	1,179.23
Rest of World	0.00	14.16	14.16
World Total	733.38	460.01	1,193.39

Units: million dollars

APPENDIX 2. The full impacts of transportation and warehousing activities increasing in the Southern and East Coast states for foreign imports diversion: Scenario 2

State	Direct Impact	Indirect Impact	Total Impact
AL	70.02	41.04	111.06
AK	0.00	0.48	0.48
AZ	0.00	3.89	3.89
AR	0.00	2.88	2.88
CA	0.00	32.32	32.32
CO	0.00	4.09	4.09
CT	0.00	5.33	5.33
DE	3.18	2.96	6.14
DC	0.00	1.06	1.06
FL	112.27	76.29	188.55
GA	188.87	89.34	278.21
HI	0.00	0.71	0.71
ID	0.00	0.70	0.70
IL	0.00	9.70	9.70
IN	0.00	4.38	4.38
IA	0.00	4.31	4.31
KS	0.00	2.70	2.70
KY	0.00	3.89	3.89
LA	0.00	6.28	6.28
ME	0.00	1.42	1.42
MD	35.44	23.16	58.60
MA	57.04	39.18	96.22
MI	0.00	8.43	8.43
MN	0.00	4.98	4.98
MS	0.00	3.28	3.28
MO	0.00	4.29	4.29
MT	0.00	0.68	0.68
NE	0.00	2.08	2.08
NV	0.00	1.44	1.44
NH	0.00	1.65	1.65
NJ	521.73	242.62	764.35
NM	0.00	2.19	2.19
NY	560.31	288.19	848.50
NC	0.00	9.82	9.82
ND	0.00	0.52	0.52
OH	0.00	11.59	11.59
OK	0.00	3.67	3.67
OR	0.00	2.14	2.14
PA	158.21	97.72	255.93
RI	0.00	1.31	1.31
SC	34.31	22.16	56.47
SD	0.00	0.64	0.64
TN	0.00	7.21	7.21
TX	695.47	394.51	1,089.98
UT	0.00	1.89	1.89
VM	0.00	0.88	0.88
VA	47.60	28.95	76.55
WA	0.00	3.76	3.76
WV	0.00	1.45	1.45
WI	0.00	5.80	5.80
WY	0.00	0.42	0.42
US Total	2,484.44	1,510.37	3,994.82
Rest of World	0.00	47.97	47.97
World Total	2,484.44	1,558.35	4,042.79

Units: million dollars

APPENDIX 3. The full impacts of transportation and warehousing activities increasing in the Southern and East Coast states for foreign imports diversion: Scenario 3

State	Direct Impact	Indirect Impact	Total Impact
AL	99.64	58.39	158.03
AK	0.00	0.69	0.69
AZ	0.00	5.54	5.54
AR	0.00	4.09	4.09
CA	0.00	45.98	45.98
CO	0.00	5.82	5.82
CT	0.00	7.59	7.59
DE	4.52	4.22	8.73
DC	0.00	1.51	1.51
FL	159.74	108.55	268.29
GA	268.74	127.13	395.87
HI	0.00	1.01	1.01
ID	0.00	1.00	1.00
IL	0.00	13.80	13.80
IN	0.00	6.23	6.23
IA	0.00	6.14	6.14
KS	0.00	3.84	3.84
KY	0.00	5.54	5.54
LA	0.00	8.93	8.93
ME	0.00	2.02	2.02
MD	50.43	32.95	83.38
MA	81.16	55.75	136.91
MI	0.00	12.00	12.00
MN	0.00	7.08	7.08
MS	0.00	4.66	4.66
MO	0.00	6.11	6.11
MT	0.00	0.97	0.97
NE	0.00	2.96	2.96
NV	0.00	2.05	2.05
NH	0.00	2.34	2.34
NJ	742.37	345.22	1,087.59
NM	0.00	3.11	3.11
NY	797.26	410.06	1,207.32
NC	0.00	13.97	13.97
ND	0.00	0.75	0.75
OH	0.00	16.49	16.49
OK	0.00	5.22	5.22
OR	0.00	3.05	3.05
PA	225.12	139.04	364.16
RI	0.00	1.86	1.86
SC	48.81	31.53	80.35
SD	0.00	0.91	0.91
TN	0.00	10.25	10.25
TX	989.58	561.34	1,550.92
UT	0.00	2.69	2.69
VM	0.00	1.26	1.26
VA	67.73	41.20	108.92
WA	0.00	5.35	5.35
WV	0.00	2.06	2.06
WI	0.00	8.25	8.25
WY	0.00	0.60	0.60
US Total	3,535.08	2,149.10	5,684.18
Rest of World	0.00	295.75	295.75
World Total	3,535.08	2,444.85	5,979.93

Units: million dollars

APPENDIX 4. The full impacts of transportation and warehousing activities increasing in the Southern and East Coast states for U.S. exports diversion: Scenario 1

State	Direct Impact	Indirect Impact	Total Impact
AL	7.17	7.83	15.00
AK	0.00	1.06	1.06
AZ	0.00	1.00	1.00
AR	0.00	1.49	1.49
CA	0.00	12.16	12.16
CO	0.00	1.54	1.54
CT	0.00	4.43	4.43
DE	10.58	8.00	18.58
DC	0.00	0.23	0.23
FL	76.16	63.63	139.80
GA	27.35	22.20	49.54
HI	0.00	0.64	0.64
ID	0.00	0.75	0.75
IL	0.00	6.38	6.38
IN	0.00	4.58	4.58
IA	0.00	2.18	2.18
KS	0.00	1.87	1.87
KY	0.00	4.97	4.97
LA	0.00	11.15	11.15
ME	0.00	2.01	2.01
MD	12.85	11.99	24.84
MA	16.93	16.48	33.41
MI	0.00	10.16	10.16
MN	0.00	2.18	2.18
MS	0.00	2.27	2.27
MO	0.00	4.22	4.22
MT	0.00	0.42	0.42
NE	0.00	0.71	0.71
NV	0.00	0.21	0.21
NH	0.00	0.68	0.68
NJ	53.39	45.90	99.29
NM	0.00	1.08	1.08
NY	543.53	346.31	889.84
NC	0.00	4.26	4.26
ND	0.00	1.39	1.39
OH	0.00	13.39	13.39
OK	0.00	4.55	4.55
OR	0.00	2.06	2.06
PA	149.45	121.03	270.48
RI	0.00	0.59	0.59
SC	6.36	7.56	13.92
SD	0.00	0.50	0.50
TN	0.00	3.81	3.81
TX	176.97	160.36	337.33
UT	0.00	0.81	0.81
VM	0.00	0.91	0.91
VA	38.62	30.01	68.63
WA	0.00	2.12	2.12
WV	0.00	4.57	4.57
WI	0.00	5.75	5.75
WY	0.00	0.55	0.55
US Total	1,119.37	964.89	2,084.26
Rest of World	0.00	61.35	61.35
World Total	1,119.37	1,026.24	2,145.61

Units: million dollars

APPENDIX 5. The full impacts of transportation and warehousing activities increasing in the Southern and East Coast states for U.S. exports diversion: Scenario 2

State	Direct Impact	Indirect Impact	Total Impact
AL	24.28	26.53	50.81
AK	0.00	3.59	3.59
AZ	0.00	3.39	3.39
AR	0.00	5.04	5.04
CA	0.00	41.18	41.18
CO	0.00	5.21	5.21
CT	0.00	15.00	15.00
DE	35.83	27.10	62.93
DC	0.00	0.78	0.78
FL	258.02	215.57	473.58
GA	92.65	75.20	167.85
HI	0.00	2.16	2.16
ID	0.00	2.53	2.53
IL	0.00	21.63	21.63
IN	0.00	15.51	15.51
IA	0.00	7.37	7.37
KS	0.00	6.32	6.32
KY	0.00	16.85	16.85
LA	0.00	37.77	37.77
ME	0.00	6.81	6.81
MD	43.54	40.61	84.14
MA	57.35	55.83	113.18
MI	0.00	34.42	34.42
MN	0.00	7.37	7.37
MS	0.00	7.69	7.69
MO	0.00	14.29	14.29
MT	0.00	1.44	1.44
NE	0.00	2.39	2.39
NV	0.00	0.72	0.72
NH	0.00	2.31	2.31
NJ	180.88	155.50	336.37
NM	0.00	3.65	3.65
NY	1,841.30	1,173.14	3,014.44
NC	0.00	14.43	14.43
ND	0.00	4.70	4.70
OH	0.00	45.35	45.35
OK	0.00	15.42	15.42
OR	0.00	6.97	6.97
PA	506.29	410.01	916.30
RI	0.00	1.99	1.99
SC	21.55	25.62	47.17
SD	0.00	1.68	1.68
TN	0.00	12.90	12.90
TX	599.53	543.24	1,142.76
UT	0.00	2.75	2.75
VM	0.00	3.08	3.08
VA	130.83	101.68	232.51
WA	0.00	7.20	7.20
WV	0.00	15.47	15.47
WI	0.00	19.49	19.49
WY	0.00	1.86	1.86
US Total	3,792.04	3,268.71	7,060.74
Rest of World	0.00	207.85	207.85
World Total	3,792.04	3,476.56	7,268.59

Units: million dollars

APPENDIX 6. The full impacts of transportation and warehousing activities increasing in the Southern and East Coast states for U.S. exports diversion: Scenario 3

State	Direct Impact	Indirect Impact	Total Impact
AL	34.55	37.75	72.30
AK	0.00	5.10	5.10
AZ	0.00	4.82	4.82
AR	0.00	7.17	7.17
CA	0.00	58.59	58.59
CO	0.00	7.41	7.41
CT	0.00	21.34	21.34
DE	50.99	38.56	89.55
DC	0.00	1.11	1.11
FL	367.13	306.73	673.85
GA	131.83	106.99	238.82
HI	0.00	3.08	3.08
ID	0.00	3.60	3.60
IL	0.00	30.77	30.77
IN	0.00	22.08	22.08
IA	0.00	10.49	10.49
KS	0.00	8.99	8.99
KY	0.00	23.97	23.97
LA	0.00	53.75	53.75
ME	0.00	9.69	9.69
MD	61.95	57.78	119.73
MA	81.60	79.43	161.04
MI	0.00	48.97	48.97
MN	0.00	10.49	10.49
MS	0.00	10.94	10.94
MO	0.00	20.34	20.34
MT	0.00	2.04	2.04
NE	0.00	3.40	3.40
NV	0.00	1.02	1.02
NH	0.00	3.29	3.29
NJ	257.37	221.26	478.62
NM	0.00	5.19	5.19
NY	2,619.96	1,669.24	4,289.20
NC	0.00	20.53	20.53
ND	0.00	6.69	6.69
OH	0.00	64.53	64.53
OK	0.00	21.94	21.94
OR	0.00	9.92	9.92
PA	720.39	583.40	1,303.80
RI	0.00	2.83	2.83
SC	30.66	36.46	67.12
SD	0.00	2.39	2.39
TN	0.00	18.35	18.35
TX	853.06	772.97	1,626.03
UT	0.00	3.92	3.92
VM	0.00	4.38	4.38
VA	186.15	144.68	330.83
WA	0.00	10.24	10.24
WV	0.00	22.01	22.01
WI	0.00	27.73	27.73
WY	0.00	2.65	2.65
US Total	5,395.64	4,650.99	10,046.63
Rest of World	0.00	295.75	295.75
World Total	5,395.64	4,946.74	10,342.38

Units: million dollars

APPENDIX 7. The full impacts of transportation and warehousing activities increasing in the Southern and East Coast states for foreign imports diversion by USC sector: Scenario 1

USC sector	Direct Impact	Indirect Impact	Total Impact
USC01	0.00	5.27	5.27
USC02	0.00	1.99	1.99
USC03	0.00	2.00	2.00
USC04	0.00	3.11	3.11
USC05	0.00	8.81	8.81
USC06	0.00	3.00	3.00
USC07	0.00	0.90	0.90
USC08	0.00	0.59	0.59
USC09	0.00	0.08	0.08
USC10	0.00	16.68	16.68
USC11	0.00	4.53	4.53
USC12	0.00	3.88	3.88
USC13	0.00	0.79	0.79
USC14	0.00	7.32	7.32
USC15	0.00	9.30	9.30
USC16	0.00	2.93	2.93
USC17	0.00	6.38	6.38
USC18	0.00	7.86	7.86
USC19	0.00	7.60	7.60
USC20	0.00	6.33	6.33
USC21	0.00	4.86	4.86
USC22	0.00	4.38	4.38
USC23	0.00	5.99	5.99
USC24	0.00	8.21	8.21
USC25	0.00	5.97	5.97
USC26	0.00	2.48	2.48
USC27	0.00	1.77	1.77
USC28	0.00	1.81	1.81
USC29	0.00	2.54	2.54
USC30	0.00	24.94	24.94
USC31	0.00	27.61	27.61
USC32	0.00	28.50	28.50
USC33	573.16	64.50	637.66
USC34	160.22	7.92	168.14
USC35	0.00	26.39	26.39
USC36	0.00	9.53	9.53
USC37	0.00	23.37	23.37
USC38	0.00	17.46	17.46
USC39	0.00	15.36	15.36
USC40	0.00	0.93	0.93
USC41	0.00	8.37	8.37
USC42	0.00	1.22	1.22
USC43	0.00	31.82	31.82
USC44	0.00	1.93	1.93
USC45	0.00	11.05	11.05
USC46	0.00	5.29	5.29
USC47	0.00	16.47	16.47
Total	733.38	460.01	1193.39

Units: million dollars

APPENDIX 8. The full impacts of transportation and warehousing activities increasing in the Southern and East Coast states for foreign imports diversion by USC sector: Scenario 2

USC sector	Direct Impact	Indirect Impact	Total Impact
USC01	0.00	17.85	17.85
USC02	0.00	6.72	6.72
USC03	0.00	6.79	6.79
USC04	0.00	10.52	10.52
USC05	0.00	29.85	29.85
USC06	0.00	10.18	10.18
USC07	0.00	3.05	3.05
USC08	0.00	1.98	1.98
USC09	0.00	0.28	0.28
USC10	0.00	56.50	56.50
USC11	0.00	15.35	15.35
USC12	0.00	13.14	13.14
USC13	0.00	2.66	2.66
USC14	0.00	24.78	24.78
USC15	0.00	31.50	31.50
USC16	0.00	9.94	9.94
USC17	0.00	21.61	21.61
USC18	0.00	26.62	26.62
USC19	0.00	25.75	25.75
USC20	0.00	21.46	21.46
USC21	0.00	16.48	16.48
USC22	0.00	14.83	14.83
USC23	0.00	20.28	20.28
USC24	0.00	27.81	27.81
USC25	0.00	20.23	20.23
USC26	0.00	8.39	8.39
USC27	0.00	5.99	5.99
USC28	0.00	6.13	6.13
USC29	0.00	8.61	8.61
USC30	0.00	84.49	84.49
USC31	0.00	93.54	93.54
USC32	0.00	96.53	96.53
USC33	1941.67	218.49	2160.16
USC34	542.77	26.85	569.62
USC35	0.00	89.39	89.39
USC36	0.00	32.28	32.28
USC37	0.00	79.15	79.15
USC38	0.00	59.15	59.15
USC39	0.00	52.03	52.03
USC40	0.00	3.14	3.14
USC41	0.00	28.37	28.37
USC42	0.00	4.13	4.13
USC43	0.00	107.80	107.80
USC44	0.00	6.54	6.54
USC45	0.00	37.44	37.44
USC46	0.00	17.92	17.92
USC47	0.00	55.79	55.79
Total	2484.44	1558.35	4042.79

Units: million dollars

APPENDIX 9. The full impacts of transportation and warehousing activities increasing in the Southern and East Coast states for foreign imports diversion by USC sector: Scenario 3

USC sector	Direct Impact	Indirect Impact	Total Impact
USC01	0.00	25.40	25.40
USC02	0.00	9.57	9.57
USC03	0.00	9.66	9.66
USC04	0.00	14.97	14.97
USC05	0.00	42.48	42.48
USC06	0.00	14.48	14.48
USC07	0.00	4.34	4.34
USC08	0.00	2.82	2.82
USC09	0.00	0.40	0.40
USC10	0.00	80.39	80.39
USC11	0.00	21.85	21.85
USC12	0.00	18.70	18.70
USC13	0.00	3.78	3.78
USC14	0.00	35.26	35.26
USC15	0.00	44.83	44.83
USC16	0.00	14.14	14.14
USC17	0.00	30.75	30.75
USC18	0.00	37.88	37.88
USC19	0.00	36.64	36.64
USC20	0.00	30.53	30.53
USC21	0.00	23.45	23.45
USC22	0.00	21.10	21.10
USC23	0.00	28.85	28.85
USC24	0.00	39.57	39.57
USC25	0.00	28.79	28.79
USC26	0.00	11.94	11.94
USC27	0.00	8.53	8.53
USC28	0.00	8.73	8.73
USC29	0.00	12.26	12.26
USC30	0.00	120.22	120.22
USC31	0.00	133.09	133.09
USC32	0.00	137.35	137.35
USC33	2762.78	310.88	3073.66
USC34	772.30	38.21	810.52
USC35	0.00	127.19	127.19
USC36	0.00	45.92	45.92
USC37	0.00	112.63	112.63
USC38	0.00	84.16	84.16
USC39	0.00	74.03	74.03
USC40	0.00	4.47	4.47
USC41	0.00	40.36	40.36
USC42	0.00	5.88	5.88
USC43	0.00	153.39	153.39
USC44	0.00	9.31	9.31
USC45	0.00	53.28	53.28
USC46	0.00	25.50	25.50
USC47	0.00	79.38	79.38
Total	3535.08	2217.36	5752.44

Units: million dollars

APPENDIX 10. The full impacts of transportation and warehousing activities increasing in the Southern and East Coast states for U.S. exports diversion by USC sector: Scenario 1

USC sector	Direct Impact	Indirect Impact	Total Impact
USC01	0.00	1.80	1.80
USC02	0.00	1.01	1.01
USC03	0.00	0.33	0.33
USC04	0.00	1.27	1.27
USC05	0.00	2.28	2.28
USC06	0.00	2.03	2.03
USC07	0.00	0.00	0.00
USC08	0.00	1.41	1.41
USC09	0.00	0.51	0.51
USC10	0.00	122.61	122.61
USC11	0.00	3.09	3.09
USC12	0.00	0.21	0.21
USC13	0.00	0.58	0.58
USC14	0.00	4.85	4.85
USC15	0.00	11.87	11.87
USC16	0.00	4.47	4.47
USC17	0.00	6.39	6.39
USC18	0.00	6.62	6.62
USC19	0.00	2.56	2.56
USC20	0.00	2.74	2.74
USC21	0.00	8.41	8.41
USC22	0.00	11.05	11.05
USC23	0.00	17.86	17.86
USC24	0.00	16.44	16.44
USC25	0.00	23.72	23.72
USC26	0.00	15.25	15.25
USC27	0.00	1.74	1.74
USC28	0.00	0.40	0.40
USC29	0.00	35.58	35.58
USC30	0.00	11.58	11.58
USC31	0.00	6.13	6.13
USC32	0.00	55.65	55.65
USC33	1075.04	157.20	1232.24
USC34	44.33	19.17	63.50
USC35	0.00	13.51	13.51
USC36	0.00	34.11	34.11
USC37	0.00	66.52	66.52
USC38	0.00	76.93	76.93
USC39	0.00	104.11	104.11
USC40	0.00	16.08	16.08
USC41	0.00	72.49	72.49
USC42	0.00	2.22	2.22
USC43	0.00	2.39	2.39
USC44	0.00	2.47	2.47
USC45	0.00	19.60	19.60
USC46	0.00	1.30	1.30
USC47	0.00	57.69	57.69
Total	1119.37	1026.24	2145.61

Units: million dollars

APPENDIX 11. The full impacts of transportation and warehousing activities increasing in the Southern and East Coast states for U.S. exports diversion by USC sector: Scenario 2

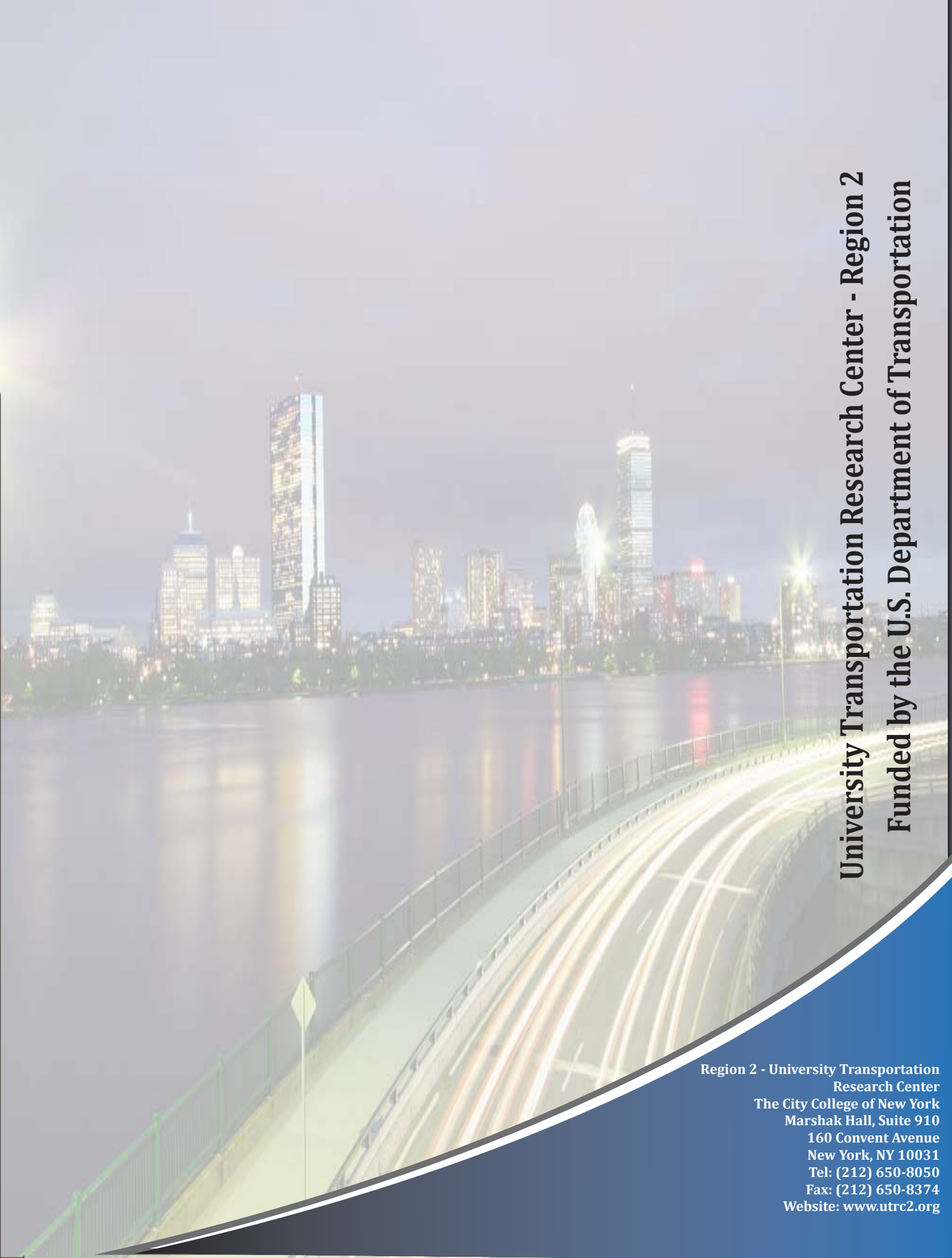
USC sector	Direct Impact	Indirect Impact	Total Impact
USC01	0.00	6.09	6.09
USC02	0.00	3.41	3.41
USC03	0.00	1.11	1.11
USC04	0.00	4.32	4.32
USC05	0.00	7.73	7.73
USC06	0.00	6.89	6.89
USC07	0.00	0.01	0.01
USC08	0.00	4.79	4.79
USC09	0.00	1.71	1.71
USC10	0.00	415.36	415.36
USC11	0.00	10.47	10.47
USC12	0.00	0.70	0.70
USC13	0.00	1.97	1.97
USC14	0.00	16.44	16.44
USC15	0.00	40.20	40.20
USC16	0.00	15.14	15.14
USC17	0.00	21.66	21.66
USC18	0.00	22.44	22.44
USC19	0.00	8.67	8.67
USC20	0.00	9.28	9.28
USC21	0.00	28.49	28.49
USC22	0.00	37.43	37.43
USC23	0.00	60.51	60.51
USC24	0.00	55.68	55.68
USC25	0.00	80.34	80.34
USC26	0.00	51.65	51.65
USC27	0.00	5.90	5.90
USC28	0.00	1.36	1.36
USC29	0.00	120.54	120.54
USC30	0.00	39.23	39.23
USC31	0.00	20.75	20.75
USC32	0.00	188.53	188.53
USC33	3641.87	532.53	4174.40
USC34	150.17	64.94	215.11
USC35	0.00	45.78	45.78
USC36	0.00	115.56	115.56
USC37	0.00	225.35	225.35
USC38	0.00	260.63	260.63
USC39	0.00	352.67	352.67
USC40	0.00	54.47	54.47
USC41	0.00	245.56	245.56
USC42	0.00	7.51	7.51
USC43	0.00	8.11	8.11
USC44	0.00	8.38	8.38
USC45	0.00	66.40	66.40
USC46	0.00	4.41	4.41
USC47	0.00	195.44	195.44
Total	3792.04	3476.56	7268.59

Units: million dollars

APPENDIX 12. The full impacts of transportation and warehousing activities increasing in the Southern and East Coast states for U.S. exports diversion by USC sector: Scenario 3

USC sector	Direct Impact	Indirect Impact	Total Impact
USC01	0.00	8.67	8.67
USC02	0.00	4.85	4.85
USC03	0.00	1.59	1.59
USC04	0.00	6.14	6.14
USC05	0.00	11.01	11.01
USC06	0.00	9.81	9.81
USC07	0.00	0.01	0.01
USC08	0.00	6.81	6.81
USC09	0.00	2.44	2.44
USC10	0.00	591.02	591.02
USC11	0.00	14.90	14.90
USC12	0.00	0.99	0.99
USC13	0.00	2.80	2.80
USC14	0.00	23.39	23.39
USC15	0.00	57.20	57.20
USC16	0.00	21.55	21.55
USC17	0.00	30.82	30.82
USC18	0.00	31.93	31.93
USC19	0.00	12.34	12.34
USC20	0.00	13.21	13.21
USC21	0.00	40.54	40.54
USC22	0.00	53.26	53.26
USC23	0.00	86.09	86.09
USC24	0.00	79.22	79.22
USC25	0.00	114.31	114.31
USC26	0.00	73.49	73.49
USC27	0.00	8.40	8.40
USC28	0.00	1.94	1.94
USC29	0.00	171.51	171.51
USC30	0.00	55.82	55.82
USC31	0.00	29.53	29.53
USC32	0.00	268.25	268.25
USC33	5181.96	757.73	5939.69
USC34	213.68	92.40	306.08
USC35	0.00	65.14	65.14
USC36	0.00	164.43	164.43
USC37	0.00	320.65	320.65
USC38	0.00	370.84	370.84
USC39	0.00	501.81	501.81
USC40	0.00	77.51	77.51
USC41	0.00	349.40	349.40
USC42	0.00	10.68	10.68
USC43	0.00	11.54	11.54
USC44	0.00	11.93	11.93
USC45	0.00	94.47	94.47
USC46	0.00	6.27	6.27
USC47	0.00	278.10	278.10
Total	5395.64	4946.74	10342.38

Units: million dollars



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