Impact of Dredging New York Harbor

The recent emergence of post-Panamax containerships operated by global alliances of shipping lines has accelerated many ports' long-evolving trend of load-centering. The U.S. East Coast, with about 1,200 miles of shoreline, has 11 major container ports, all of which aspire to become load centers. All these ports require deep access channels to accommodate the newer and deeper ships. Navigation channels are the responsibility of the U.S. federal government, including the cost of deepening and maintaining them. The government is aware that not *all* ports can become load centers and thus not *all* need deep channels. Yet, how should the government decide which port to dredge and, more critically, *not to dredge*?

This article introduces a novel policy analysis tool to address this difficult question which, unfortunately, in real life has more to do with politics and less with economics. It describes a methodology for evaluating the impact of deepening/not deepening access channels on ports, focusing on containerized traffic in a competitive, intermodal setting. The methodology may be adopted as a basis for developing a national policy for dredging access channels for U.S. public ports. An illustration is presented, based on New York Harbor, where an unprecedented $750 million dredging project is currently at stake.

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by Asaf Ashar

New York Harbor, with 46.5 million tons of cargo and about two million, twenty-foot equivalent units (TEUs), accommodates the largest port complex on the U.S. East (Atlantic) Coast, and the third largest nationwide. New York's terminals are accessed through a series of dredged navigation channels. The most important channel, the Kull Van Kill (KVK), leads to New York's major container terminals in Port Elizabeth/ Newark, New Jersey.[1]

The channel, with a natural depth of 19 feet, has been kept at 35 feet until late 1994. In early 1995, following a ten-year process of approval and construction and at an investment of about $350 million, the channel was deepened to 39.5 feet. Yet, even with a 40-foot depth, the KVK does not allow for uninterrupted navigation of fully-laden, large containerships. Currently, New York is pursuing further deepening of the KVK to 45 feet, with an initial cost of about $750 million and an annual maintenance cost of about $5 million.

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Costs Coverage and Environmental Barriers for Channel Deepening

All U.S. access channels that serve public ports are controlled by the federal government's U.S. Army Corps of Engineers (COE). The COE constructs and maintains the channels, with each channel having a federally authorized depth. The related costs are shared by the federal and local governments according to a formula which varies by channel depth. At the range between 40 and 45 feet the federal government covers 65% of the initial (investment) cost and the entire maintenance cost, with the rest covered by the bi-state Port Authority of New York and New Jersey.[2] The authority needs, first, to convince the federal government to spend $490 million (65%) and, second, to come up with its own $260 million (35%). In addition, New York has to cover the entire cost (estimated at $20 million) of deepening the terminals.

Dredging New York terminals involves not only heavy investments, but also a long and arduous environmental permitting process. Some dredged materials have already been shown to contain chemical contaminants, ruling out the use of existing ocean disposal sites. An alternative site for contaminated dredged materials has not yet been designated in New York Harbor, with no other economical solutions in sight, despite efforts by various agencies.[3]

Loss of Maritime Activity and Related Economic Impact

Recently, New York has been fielding highly publicized complaints from its main customers for its limited channels. Lines protested that their vessels have either to "wait for the tide," or sail partially loaded "leaving cargoes on the dock." Moreover, New York customers indicated that the current 40-foot channel will not be able to accommodate their future larger and deeper containerships. Consequently, they may be forced to quit New York and divert their ships and cargoes to New York's competitors, which have deeper channels.[4]

The Port of New York is the nucleus of regional maritime and maritime-related industries, supporting 166,500 direct and indirect jobs and $19 billion in sales. Not deepening New York channels, followed by a massive "desertion" of ships and cargoes, may result in a devastating economic setback to the entire region.

Objective and Methodology

New York faces a difficult situation. Deepening its channels is an arduous and expensive undertaking; not deepening may result in the eventual demise of the port. While costs involved in the deepening project can be estimated with reasonable accuracy, benefits and disbenefits of not deepening are difficult to assess. This article presents a methodology to assess these disbenefits and illustrates it with the case of New York.[5]

This article specifically addresses the likely response of New York's users, shipping lines and shippers to restrictions imposed on access channels' depth. The article only relates to liner (containerized) shipping, the largest segment of the maritime and related economic activities. The liner segment is much more difficult to analyze than the other two segments (bulk and breakbulk shipping), because of its complex structure based on multiple trade routes and service patterns. Moreover, liner shipping in the United States has undergone a restructuring process (the intermodal revolution), resulting in a highly competitive setting. The traditional hinterlands of ports have been eroded so that presently "all U.S. ports compete against all U.S. ports."[6]

Approach and Methodology

The negative impact of channel restrictions is measured here as the difference in ship services (calls) and cargo (TEUs) between New York with 45-foot channels and New York with channels limited to depths varying from 30 to 40 feet. This reflects New York's concern that the current 40 feet will not be maintained because of future shortfalls in federal funds and/or opposition from environmentalists. Since channel construction projects have a long amortization period, the impact is calculated for a 20-year period (1995 to 2015).

The main analytical tool applied here is a model which emulates the decision-making process of lines calling New York as they face increasing restrictions on channel depth. The model's logic is based on insight gleaned through extensive interviews with New York lines, as well as on general principles of cost minimization and spatial equilibrium. Data on the dimensions and actual draft of vessels calling New York Harbor was provided by the New York Maritime Association; data on cargoes, including origin and destination points, were collected through the U.S. Customs Service. Additional support materials were gathered through an in-depth review of professional literature and trade publications. However, the review did not yield any study that directly addresses the subject of port desertion in response to draft restrictions.[7]

Draft Response Model

A shipping line facing a draft-restricted port may respond in two ways:

- *Remain* in the constrained port, but serve it with partially-loaded ships.
- *Relocate* to a nearby, unconstrained port and feeder the cargo by land or water.

Both responses involve additional costs to the line. The *remain* response results in opportunity costs, or revenues lost due to underutilized ships' capacity. The *relocate* response results in additional feedering costs, usually borne by the line. The common practice is for lines to provide a bill of lading to ports that were previously called. A key assumption here is that lines cannot pass these costs to shippers because of competition from other, unrestricted lines.

The model assesses the situation from the line's point of view. As the draft becomes more restricted, the cost for remaining escalates until, at the *desertion draft*, it exceeds the cost of relocating (deserting).

Model's Inputs and Outputs

The model's main input (independent variable) is the depth of New York access channels, mainly the KVK. Other inputs are: (1) trade routes and service patterns of New York lines; (2) size (slot TEUs) and design draft of vessels deployed by New York lines; (3) regional rotation on the U.S. East Coast of New York lines; (4) cargo allocation between offshore trade regions, U.S. East/West Coast, and East Coast ports; (5) cargo allocation between local and hinterland regions; and (6) drayage costs between New York, regional ports, and hinterland centers.

The model's outputs (dependent variables) are: (1) desertion drafts for each of New York lines and service, (2) loss of ship calls and cargo (TEUs) to New York as a result of the desertion, and (3) added costs to New York lines due to partial-loading and feedering.[8]

New York's Trade Routes, Cargo Flow, Services and Transportation Options

Several basic terms are used in the following analysis of liner shipping.

- Cargo Flow—a volume of cargo shipped along a trade route. The flow is specified by direction (inbound, outbound, or transshipment) and density (TEUs/year).
- Service and Service Pattern—a string of ships calling at a fixed number of ports following a fixed rotation and frequency. A shipping service is usually organized according to patterns, based on the trade routes and vessels' itinerary. The pattern may include one trade route (e.g., Transatlantic) or several routes (e.g., Round-The-World).
- Trade Region—a delimited geographical region served by a related range of adjacent ports (e.g., the U.S. Midwest trade region served by U.S. East Coast ports).
- Trade Route—a connection between two trade regions. A trade route is denoted either by participating regions (e.g., U.S. East Coast/North Europe) or the body of water separating between them (e.g., Transatlantic).
- Transportation Option—a single service or a combination (sequence) of services that provides a complete connection between two trade regions.
- Twenty-Foot Equivalent Unit (TEU)—a standard measure of volume used for measuring throughput in containerized shipping.

Cargo Flow Statistics by Trade Regions and Hinterland

New York, a premier U.S. port, provides connections to most of the world's trade regions. For convenience of presentation, cargo statistics are aggregated according to four "mega" trade regions: (1) Far East and Southeast Asia, (2) North Europe, (3) South and Central America, and (4) others, mainly South Europe, the Middle East, India and Africa. In 1994, New York handled about 1.27 million *loaded* TEUs, of which 486,000 TEUs (38.3%) were traded with the Far East, 417,000 TEUs (32.8%) with North Europe, and 108,000 TEUs (8.5%) with the Americas. New York's imports are about 1.5 times larger than its exports, with the Far East segment being the most dominant.

New York's hinterland points are aggregated into five regions: (1) local New York, including 17 counties adjacent to the port; (2) New England; (3) mid-Atlantic; (4) Great Lakes; and (5) others. In 1994, local New York accounted for about 68% of the cargo; mid-Atlantic, 12%; Great Lakes, 8%; and New England, 6%. The share of local New York is higher for import than for export; the share of the mid-Atlantic is higher for export than import.

Exhibit 1 illustrates the cargo flows between four off-shore regions and five U.S. inland regions.

Trade Routes, Service Patterns and Transportation Options

Most trade routes can be served by several service patterns providing shippers with numerous transportation (connection) options. For example, a North European container imported to the U.S. East Coast may be carried by either a Transatlantic service or by a westbound Round-The-World (RTW) service. The two service patterns reflect different trade conditions and geographical settings and may respond differently to draft restrictions. For example, the Transatlantic is a relatively short service, with a 28-day rotation provided by four ships calling six ports. Such a service is geared toward smaller ships and is more likely to adjust to New York's draft limitations. This may not be the case with a RTW service, with an 84-day rotation, provided by 14 ships, which is geared toward larger vessels. Also, a RTW line, based on many trade regions, is less likely to adjust to New

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Exhibit 1
Breakdown of New York Harbor Container Flow - Import and Export (1994)

Inland

Local	TEUs	%
Far-East and South-East Asia	355,700	28.0
North Europe	234,660	18.4
South and Central America	81,307	6.4
Other	195,073	15.3
Total	**866,739**	**68.1%**

New England	TEUs	%
Far-East and South-East Asia	40,169	**3.2**
North Europe	33,694	2.6
South and Central America	6,275	0.5
Other	16,632	1.3
Total	**96,770**	**7.6%**

Mid Atlantic	TEUs	%
Far-East and South-East Asia	47,017	3.7
North Europe	71,160	5.6
South and Central America	11,782	0.9
Other	21,428	1.7
Total	**151,387**	**11.9%**

Great Lakes	TEUs	%
Far-East and South-East Asia	31,307	1.0
North Europe	48,328	2.3
South and Central America	5,609	0.3
Other	16,435	0.9
Total	**101,678**	**8.0%**

Other	TEUs	%
Far-East and South-East Asia	12,263	1.0
North Europe	29,038	2.3
South and Central America	3,451	0.3
Total	**55,850**	**4.4%**

All data in loaded TEUs.

New York Harbor
1,272,424 TEUs
(100%)

Off- shore

Far East and South Asia	TEUs	%
Local	355,700	28.0
New England	40,169	3.2
Mid Atlantic	47,017	3.7
Great Lakes	31,307	2.5
Other	12,263	1.0
Total	**486,455**	**38.2%**

North Europe	TEUs	%
Local	234,660	18.4
New England	33,694	2.6
Mid Atlantic	71,160	5.6
Great Lakes	48,328	3.8
Other	29,038	2.3
Total	**416,881**	**0.3**

South and Central America	TEUs	%
Local	81,307	6.4
New England	6,275	0.5
Mid Atlantic	11,782	0.9
Great Lakes	5,609	0.4
Other	3,451	0.3
Total	**108,423**	**0.1**

Other	TEUs	%
Local	195,073	15.3
New England	16,632	1.3
Mid Atlantic	21,428	1.7
Great Lakes	16,435	1.3
Other	11,098	0.9
Total	**260,665**	**0.2**

York's draft restrictions. The draft response model and, especially, the fleet forecast, treat each service pattern differently.

Altogether, the trade between North Europe and the East Coast has three transportation options: (1) Transatlantic, (2) RTW, and (3) Pendulum[9] North service. A Far Eastern container destined for New York may have seven options: (1) Transpacific to the West Coast in combination with a cross-country rail service, called Mini Land Bridge (MLB), (2) Panama Express, (3) Suez Express, (4) Pendulum North, (5) Pendulum South, (6) RTW, and (7) a combination of a Far East to North Europe and a Transatlantic service.

Exhibit 2 lists the ten main service patterns relevant for New York along with the world's trade regions that they serve.

Exhibit 3 illustrates the relationships between trade routes, service patterns and transportation options available to New York shippers, including those that do not call directly to New York.

Exhibit 2
Classification of New York Main Service Patterns

	East-West Services	SEAS	FE	USWC	USEC	NEur	MED	MEast	P.R.	ECSA	WCSA
1	Transatlantic				x	x					
2	Pendulum North	x	x	x	x	x					
3	Pendulum South	x	x	x	x		x				
4	Panama Express		x		x						
5	Suez Express	x	x		x		x	x			
6	Mediterranean/Middle East				x		x	x			
7	Round-the-World	x	x	x	x	x	x	x			
	North-South Services										
8	East Coast South America				x					x	
9	West Coast South America				x						x
10	Puerto Rico				x				x		

Legend
SEAS = South East Asia (Singapore)
FE = Far East (Japan, Korea, Taiwan, Hong Kong, China)
USWC = U.S. West Coast
USEC = U.S. East Coast
NEur = North Europe
MED = Mediterranean (France, Italy, Israel)
MEast = Middle East (S. Arabia)
ECSA = East Coast South America (Argentina, Brazil)
WCSA = West Coast South America (Chile, Peru)

- The Caribbean, North Coast South America, Central America and Islands are included in the South America services.

Exhibit 3
Trade Routes, Service Patterns and Connection Options

Trade Routes
North Europe
Far East South Asia
East Coast South America
West Coast South America
Mediterranean - Middle East
Puerto Rico

Service Patterns
East-West
Transatlantic
Pendulum North
Pendulum South
Panama Express
Suez Express
Mediterranean - Middle East
Round-The-World
North-South
East Coast South America
West Coast South America
Puerto Rico

Connection Options
North Europe
Transatlantic
Pendulum North
Round-The-World
Far East / South Asia
Suez Express
Panama Express
Pendulum North
Pendulum South
Round-The-World
Far East/Europe and Transatlantic
Transpacific and Landbridge
East Coast South America
East Coast South America
Pendulum North and Regional Feeder
Pendulum South and Regional Feeder
Panama Express and Regional Feeder
Round-The-World and Regional Feeder

-Only major trades, patterns and options are shown here.
-Italic denotes shipping services that do not directly call at New York.

First In, Last Out, Midport and Outport

The U.S. East Coast ports are usually divided into North and South Atlantic port ranges. The North Atlantic range includes six major, deep-draft container ports: Halifax, Boston, New York, Philadelphia, Baltimore and Norfolk. The lines serving this range usually limit their rotation to three ports and provide complementary land or water feeders to serve other ports and hinterland points.

The most coveted role for a port in the North Atlantic region is to become the first port of call in the inbound direction, defined here as First-In (FI). This is because the import volume is larger and consists of more valuable cargo than exports. Also, FI usually handles the import of uncalled ports and the hinterland. For example, if New York is FI and Boston is not called, New York handles the cargoes of both New England and the Midwest that might otherwise be handled through Boston. A second preference for the regional ports is to become Last-Out (LO), or the last port of call. Like FI, LO usually handles both the export of uncalled ports and the hinterland. A port may become both FI and LO if a line double-calls there, an uncommon practice in the North Atlantic.[10]

A port may be included as an intermediary port, or Midport (MID). A MID usually handles only its local cargo, since the hinterland import will be funneled through the FI port and the hinterland export through the LO port. Finally, a port that is not called directly but its cargo is feedered through other regional ports is called Outports (e.g., Boston in the above example).

The draft response model assesses the regional rotation of New York's shipping services according to their calling pattern: FI, LO, and MID (Outport is obviously excluded). Since New York is a large consumption center while its locally generated export is limited, most of the lines call New York FI. New York is concerned that as a result of a restricted channel depth, it may lose its role as FI and thus become an outport.

Vessel Draft and Channel Depth

This section discusses vessel design and operating draft as well as current channel restrictions.

Design and Operating Draft

Containerships do not commonly use their maximum volume or weight capacity, measured by the nominal number of slots (TEUs) and/or deadweight. Vessels are usually limited by insufficient transverse and longitudinal stability, which is the result of the fact that over half of the containers are staged on deck, high above the waterline. Another common constraint is a possible excessive vertical stress on hatch covers.

Accordingly, New York's vessels are not expected to call at their *design draft* even when they are considered to be fully laden, but at their so-called *maximum operating draft*, which is 1 to 3 feet shorter.[11] The model has a built-in formula for calculating maximum operating draft as a function of the design draft, along with the resulting operating capacity. Most vessels do not utilize their entire operating capacity because of periodic changes in demand. In this case, they will not call with their maximum operating draft, but with actual draft, which is usually several feet smaller than maximum operating draft. For example, Maersk "M" ships, with a design draft of 44 feet, called in New York during 1994 with actual average draft of only 36 feet and ranging between 32 and 39 feet. The recorded passage of a 39-foot draft vessel in a channel with authorized depth of 35 feet is explained by the fact that the actual depth was about 2 feet larger than authorized (over-dredged), plus an additional 3 feet of tide. Also, in this