Fall 2018

A Study of Public Seaport Governance in the United States

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A STUDY OF PUBLIC SEAPORT GOVERNANCE

IN THE UNITED STATES

by

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A Dissertation Submitted to the Faculty of
Old Dominion University in Partial Fulfillment of the
Requirement for the Degree of

DOCTOR OF PHILOSOPHY

PUBLIC ADMINISTRATION AND URBAN POLICY

OLD DOMINION UNIVERSITY
October, 2018

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ABSTRACT

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Seaports are important economic engines serving many metropolitan areas in the United States. Most seaports in the U.S. are public-owned and managed by a set of elected or politically appointed board members. Indeed, this is public governance in action but the field of port governance seems to be focused on the study of operating efficiencies and less concerned with the public governance aspects of seaports.

The term “governance” in a public organization conveys a level of democratic accountability to the citizenry for management of public-owned resources but, until now, studies of seaport governance in the U.S. have not focused on the important elements of public governance. The fields of port governance and public administration will benefit from this research inside of the U.S. and in the global context. This dissertation identifies economic development, environmental stewardship and financial sustainability as common missions amongst U.S. public seaports’ and assesses mission accomplishment.

A content analysis of U.S. public seaports mission statements enabled insight into what seaports claim as their collective purposes for existence. Once the missions were identified, constructs were operationalized to assess how seaports impact local economies and the natural environment as well as reviewing fiscal health. This research finds that on average U.S. public seaports make good on stated missions, but there is room for improvement.

"The advancement and diffusion of knowledge…is the only true guardian of liberty."

James Madison

This body of knowledge is dedicated to the public servants who come from humble backgrounds and find themselves in a struggle to maintain the principles envisioned by the Founding Fathers that have sustained this Great Democracy.

ACKNOWLEDGEMENTS

Writing a dissertation is not a one-person endeavor. This dissertation is only a success because of the many people who came together to help me along my way, and I will attempt to acknowledge those who made it possible throughout my academic journey.

These few hundred pages of research took an enormous amount of time to put together. Even before writing began, a large amount of time was spent reading and understanding issues in port governance and finding ways to liberate the knowledge that I sought from the available data. However, before any work began on this dissertation, a large amount of precious knowledge was passed on to me by a few key professors. First, Dr. Berhanu Mengistu provided a first-class education on ways of thinking. As difficult and abstract as it was, the philosophical component of this graduate program is the backbone of this work. Thank you for showing me that there are multiple truths out there.

Drs. John Lombard, Wie Yusuf, David Chapman, and Danica Hayes are responsible for arming me with the qualitative, quantitative, and research design skills needed to answer the research questions that this study poses. At the beginning of my program, I considered those subjects to be the requisite tools needed to accomplish this dissertation. I am happy to report that these tools were required, and I could not have accomplished this work without having learned from these great scholars.

Drs. Katrina Miller-Stevens and John Morris are responsible for arming me with knowledge in policy and governance. I cannot thank each you enough for instilling in me the tools required to lay the theoretical foundation for this dissertation. The research questions in this work were founded on the principles I took away from interactions with each of you.

This dissertation occurred in spurts of effort across a four-year period. Along the way, the Committee Chairperson, Dr. Katrina Miller-Stevens, moved and had to be replaced. Dr. John Lombard stepped up and took over as the Committee Chairperson despite his current workload as Department Chair and having to come up to speed at the close of Chapter 2, Dr. Lombard was able to shepherd the dissertation through the process. He is a huge part of its success. Your selflessness is truly appreciated.

During the three years it took to write this dissertation, I became discouraged on several occasions. Dr. Katrina Miller-Stevens served as the chair and mentor until she accepted a position in Colorado College and moved away. Even after her move, she served as the co-chair and continued to mentor me, never abandoning me or my research interests. Katrina’s continuous encouragement to complete the dissertation and her sage advise on how to deal with seemingly insurmountable problems was a key factor in its completion. Thank you so very much for your help with this dissertation.

Putting this work together was not always enjoyable, and primarily because I was not all that organized along the way. The dissertation committee members must have wondered if I would ever finish. I wish to thank Drs. Erika Marsillac and David Chapman for their patience and tolerance. This work was not always fun and, at times, it might have appeared to meander instead of following any anticipated trajectory. Thank you for nudging me back onto the beaten path each time.

This research took a lot of self-discipline, hard work, and most importantly, curiosity. These are innate qualities that my parents, Mike and Melinda Williams, began instilling in me at a very early age, and they have served me well in every personal goal that I have pursued. Thank you very much for teaching me the value of hard work and the importance of honesty.

Lastly, to my family, Sheila, Christopher and Melinda. This body of knowledge exists because of sacrifices that each of you made. Being absent in mind and body for so long has taken a toll on our family, and I am truly grateful to each of you. Thank you, Sheila, for taking care of all family matters and making my life as uneventful as possible for these past few years. I intend to repay you in kind. Christopher, thank you for being a sounding board for writing ideas. I have always envied your talent in putting prose together and I have often tried to emulate it. I think that William Faulkner would be just as proud of what you have become as I am. Melinda, my Editor-in-Chief, I am severely in debt to you for all of the editorial help you provided. If I found the laws of English even half as interesting as you do, I might be better at grammar. Instead, I am immensely grateful.

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CHAPTER 1:

AN OVERVIEW OF THE PROBLEM AND INTRODUCTION TO THE STUDY

This dissertation is a study of how public seaports are governed in the United States. Port governance is a field of study that is primarily directed by maritime economics scholars (Baltazar & Brooks, 2007; Brooks & Cullinane, 2007; Brooks & Pallis, 2008; Talley, 2007, 2009), but the publicness[1] of seaports in the U.S. warrants analyses from a perspective that takes into account the notion of public resource management. Viewing management of U.S. seaports from a public administration perspective will provide novel and valuable insight given that the scholars of that discipline have specific expertise in public governance (Kettl, 2002; Lynn, 2010; Rhodes, 1996; Stoker, 1998).

Seaports across the world operate under public or private ownership arrangements with differing levels of privatization. With the exception of the United States, seafaring nations have shown a devolving trend towards complete privatization (Brooks & Cullinane, 2007). U.S. seaports have not entered the devolution movement and the reasons are somewhat unclear. However, Fawcett (2007) explains that the lack of U.S. participation in the devolution movement may be attributable to the evolution of private seaports into local and state-owned assets, coupled with the federal government's hands-off approach to port governance. The lack of U.S. seaports' participation in the devolution trend indicates a potential difference in port governing objectives that warrants further analysis.

[1] Bozeman and Bretschneider (1994) explain that a definition of publicness should encompass formal legal (ownership) status as well as "the extent the organization is influenced by political authority" (p. 197). Public ports are state or municipal agencies, owned by the public and the port authority board members are either elected or appointed by elected officials.

The contextual differences between how public and private-owned seaports are governed is important, but it is an area that is largely unexplored in the public administration and port literature. The significance of the contextual differences can be understood by comparing seaports across ownership types. For example, all seaports in the United Kingdom have been fully privatized (Baird & Valentine, 2007), and nearly all U.S. seaports are public owned (Fawcett, 2007). The governance objectives of private businesses are not expected to be the same as the objectives of public organizations, but, in the case of self-sustaining seaports, the profit motive is critical regardless of ownership type. Governance of U.S. public seaports demands that public administrators shepherd port infrastructure and equipment over long periods, usually several decades, while using the port to generate sufficient revenue to cover all operating, maintenance and modernization costs.

Much is known about seaport governance from a maritime economics perspective, but the field appears to have grounded itself primarily in the study of ports' operating efficiencies and profit margins (Brooks & Cullinane, 2007). In essence, the existing literature offers very little descriptive explanation of port governance from a public resource management perspective. Additionally, this research endeavors to provide a comprehensive approach to the study of how public ports are governed in the United States context by 1) gaining an understanding of the common mission elements of public seaports, and 2) assessing how seaports' performance, as explained by cargo throughput, contributes to accomplishment of the common mission elements. This research is a necessary precursor to advance the body of knowledge of public port governance in the global context.

The U.S. Seaport Context

U.S. public seaports are government-owned at the federal,[2] state and municipal levels, and are operated by the public sector or by the private sector through outsourcing of port functions. Due to the publicness of U.S. seaports, the good of the public should lie at the foundation of each seaport's operating strategy.[3] Operating strategies could be oriented towards a profit motive, towards the public's wellbeing, or a combination of both which seems logical in the U.S. context.

Additionally, U.S. public seaports broadcast what their constituents can expect from the public asset in their mission statements, which are essentially proclamations of what citizens and port users can expect from the organization. David, David, and David (2014) define a mission statement as "a declaration of an organization's 'reason for being' and distinguishes one organization from other similar enterprises" (p. 96). Studies on the relationships between mission statements and organizational performance have seen mixed results (Bart & Baetz, 1998; Patel, Booker, Ramos, & Bart, 2015), but there seems to be consensus on the definition of a mission statement.

This research finds that the most common elements among all U.S. public seaports' mission statements are economic development for their host regions, good environmental stewardship of the resources the ports are charged with maintaining, and financial sustainability. In essence, ports are government-owned public enterprises and their mission statements tell us that they exist to strengthen their host regions' economies, operate in a financially self-sustainable manner that is independent of municipal or state-level governments' budgets, and

[2] Federally owned seaports are special purpose ports such as naval bases and are not used for domestic and international trade.
[3] Operating strategy refers to the methods used to reach organizational objectives or missions.

serve as good stewards of the environment. This research refers to these commonalities as the "common mission elements."

The Definition of a Seaport

The definition of a seaport has not been standardized in the literature. Seaports can be defined by their geographical location or their accessibility by seagoing vessels (Meersman, Van de Voorde, & Vanelslander, 2006). This research uses a definition that relies on a port's location to make a distinction between seaports and inland waterway ports. The term "seaport" describes a trade facility located in a coastal area or on a Great Lake where seagoing vessels transfer cargo and passengers between the shore and sea. Seaports are situated along coastlines often enclosed by protected harbors and can be inside of navigable sounds with access to the sea. In contrast, ports located beyond the mouths of rivers that are not accessible by seagoing vessels are not considered seaports, but instead are considered inland waterway ports. According to Henk (2003), an inland waterway port is a "site located away from traditional land, air and coastal borders. It facilitates and processes international trade through strategic investments in multimodal transportation assets and by promoting value-added services as goods move through the supply chain" (p. 23). This research uses the public port facilities that meet the seaport definition to gain an understanding of how public seaports are governed in the United States.

The scope of this study includes public seaports and does not include private ports or inland waterway ports. Private seaports are excluded because of the differences identified between public and private organizations. Bozeman (1987) discusses the differences between public and private organizations in terms of personnel and personnel systems, work contexts, and organizational structures. The differences Bozeman (1987) points out each have the propensity to impact organizational performance, calling to question the ability to pool data from public and

private seaports. Therefore, in order to gain a true understanding of how public seaports are governed in the United States, this dissertation focuses on public seaports and a comparison of public and private U.S. seaports can be conducted in future research.

Inland waterway ports are excluded for two reasons. First, many inland waterway ports are governed at the municipal level (World Port Source, 2016), and public records are often not maintained beyond five years as required by some governments. Second, the difference in the scale of operations between most U.S. public seaports and inland waterway ports indicates contextual differences that should be addressed prior to assuming equivalent operating characteristics. Specifically, container services are prevalent in U.S. seaports having direct access to the sea, but almost non-existent in inland waterway ports. Moving goods through a containerized seaport creates an economy of scale that is difficult to match by non-containerized ports. The differences in cargo handling efficiencies, in terms of loading and unloading times, could impact cargo throughput capacities. A study of inland waterway ports should be conducted in the future to understand the differences in operating characteristics discussed above.

Also, the majority of U.S. inland waterway ports cannot be reached by seagoing vessels due to vessel draft constraints. Inland ports in the U.S. are typically located in relatively shallow rivers which are primarily serviced by barges drawing 9-12 feet. Because containerized cargo movement is virtually nonexistent in U.S. inland waterway ports, port superstructure for transferring cargo is less efficient than what is found on U.S. seaports. Therefore, comparing seaports with inland waterway ports based on performance levels requires more knowledge of the differences between inland waterway ports and seaports.

The Benefits of a Seaport

Seaports provide benefits to a region in several ways. First, seaports are the interface between oceangoing vessels and the hinterlands (Talley, 2009). Facilitating the transfer of goods and passengers in and out of the region is a fundamental purpose of a port. Second, seaports are used by governments as engines for economic development (Acosta, Coronado, & Cerbán, 2011). A port can host a variety of industries that contribute to a local economy through economic activity between local industries and by providing employment opportunities. Ports that are public-owned might strive to plan and execute operating strategies that make the most efficient use of the public resource with citizens' best interests in mind. However, these same ports are also a source of environmental pollution; thus, any economic benefits to the public could come at a cost to the natural environment (Acciaro, 2008) and citizens' health (Thurston, Ito, & Lall, 2011). While public seaports should have the public's best interests as part of their operating strategies, there remain unanswered questions regarding the extent to which stated port strategies actually reflect a public purpose.

This research begins to fill the knowledge gap by answering three broad, interrelated research questions. 1) What are the common elements of governance within the mission statements of U.S. public seaports? 2) Are the common elements of governance within the mission statements of U.S. public seaports reflective of port performance? 3) Do U.S. public seaport governing boards exhibit stewardship behavior?

Overview of the Problem

The problem that this research addresses is the lack of an understanding of how U.S. public seaports are governed in the context of operating strategies supporting the best interest of the public. The port governance body of literature houses a wealth of knowledge from seaports

across the world, but U.S. seaports are under-represented, and the available studies do not capture the important "public" elements associated with public governance. It is logical that resource tradeoffs occur between ports' mission areas, but the nature of those tradeoffs has not been modeled in a manner that explains public seaports' operating strategies.

This research takes a mission-based approach to derive the common mission elements of U.S. public seaport governance and to explore the relationships between port performance and the common elements. The common mission elements of U.S. public seaport governance were derived using a content analysis of governing boards' mission statements and include economic development, environmental stewardship, and financial sustainability.

Theoretical Formulation

In order to conceptualize an analytical framework for evaluating governance elements of a public seaport, this research draws upon stewardship theory (Davis, Schoorman, & Donaldson, 1997; Donaldson & Davis, 1991; Muth & Donaldson, 1998). Stewardship theory is founded on the notion that in principal-steward relationships, "stewards are motivated to act in the best interest of their principals" (Davis et al., 1997, p. 24). This perspective of organizational relationships runs counter to agency theory which postulates that agents will act in their own self-interests to maximize their own utility (Jensen & Meckling, 1976). In the U.S. seaport context, public ports are governed by boards of directors (called port authorities hereafter)[4] that do not hold shares in port stocks, but are overseeing management of the seaport. Although there is still potential for opportunistic behavior by board members, the organizational structure and

[4] Governing boards for U.S. seaports are authorities, commissions, districts, boards of trustees, and in some cases, municipal governments.

voluntary aspect of serving on public boards indicates a greater degree of compatibility with stewardship theory than agency theory as described by Davis et al. (1997).

Research Purpose and Questions

Research Purpose

The purpose of this research is to increase the body of knowledge in port governance by analyzing how U.S. public seaports are governed. There are three specific objectives: 1) determine the common mission elements amongst public seaports; 2) examine the relationships between public port performance and the common mission elements; and 3) analyze the behavior of U.S. public seaports for steward-like characteristics.

Research Questions

This research addresses three broad research questions. First, what are the common elements of governance within the mission statements of U.S. public seaports? Answering this question enables the development of a mission-based framework for analyzing seaport governance in the U.S. context. Second, are the common mission elements within the mission statements of U.S. public seaports reflective of seaport performance? U.S. public seaports exist to achieve specified purposes and are revenue-earning public enterprises. Therefore, the performance of the port should be reflected in achieving stated missions. Lastly, do U.S. public seaport governing boards exhibit stewardship behavior? If U.S. public seaports behave as stewards, relationships beneficial to the port region should be evident between port performance and mission accomplishment.

Statement of Importance

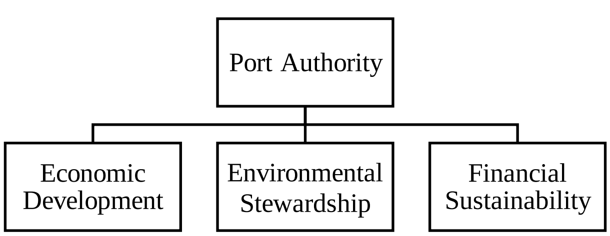
This study contributes to port governance literature and the field of public administration in three ways. First, very little research has been conducted on port governance through the lens

of self-actualizing man,[5] described by Argyris (1973). Stewards making decisions involving public resources should consider the good of the public. Second, this study will help to advance stewardship theory by applying it to organizations that are inherently designed to be stewards over public assets. Third, a representative model of U.S. public seaport governance will be added to the port governance body of knowledge. Currently, no available study captures the elements that define the governance of U.S. public seaports.

Research Framework

This study puts forth a conceptual framework of public port governance that is derived from the common mission elements. A port authority's board of directors and the port director typically make up the executive committee that sets the course for each seaport to achieve stated missions. Progress towards achieving stated missions is reflected in port performance and how it relates to mission accomplishment. The research framework in Figure 1-1 illustrates the common mission elements as subordinate to port governance and therefore subject to the influence of decisions made at the board level.

Figure 1-1. *Conceptual framework of port governance*



[5] Davis et al. (1997) state "the model of man described Argyris is essentially the model of stewardship theory, and many of the predictions regarding the differences in the two theories of governance can be traced back to the basic arguments of the Simon-Argyris debate" (p. 27).

Overview of Methodology

This mixed-methods research is conducted using four stages. The qualitative portion of the study compares public seaports' mission statements to identify commonalities. The remaining three stages are quantitative and each stage uses a database comprised of time-series data across 10 years. Collectively, the databases capture seaports' cargo throughput in short tons, financial audit reports, local air quality records, local weather conditions, and regional economic impact data.

The unit of analysis for the research is public port authorities, as reflected through the accomplishment of stated missions. The mission statements analyzed in this research were the most current available in ports' publications during calendar year 2016, when the data was collected. Essentially, this research identifies the missions of U.S. public seaports and measures how well those missions are accomplished. In an effort to simplify explanation of the test method, this research is divided into four stages.

In Stage 1, mission statements from U.S. public seaports, as defined previously in this chapter, were collected and analyzed to identify commonalities amongst missions. A content analysis was conducted to identify common themes in seaports' mission statements which are referred to as "common mission elements." The result of Stage 1 is the Conceptual Framework of Port Governance (Figure 1-1).

Stages two and three use panel regressions to identify and examine relationships between public port performance and the common mission elements revealed in Stage 1. Stage 2 examines the relationship between public seaport performance and regional economies. Stage 3 examines the relationship between public seaport performance and local air quality. Lastly, Stage 4 analyzes the financial sustainability of U.S. public seaports through a financial ratio analysis.

Organization of this Dissertation

This dissertation is presented in five chapters: Chapter 1 – Introduction; Chapter 2– Literature Review; Chapter 3 – Methodology; Chapter 4 – Results and Discussion; and Chapter 5– Conclusions. Chapter 1 introduced the research problem and purpose, explained the importance of the study, and provided an overview of the research framework and methodology. Chapter 2 provides a review of stewardship theory and port governance literature. Chapter 3 describes the methodology used to assess the relationships between port governance and the common mission elements. Chapter 4 presents the results of hypothesis testing and discusses the impacts of port governance. Lastly, Chapter 5 presents the research conclusions, discusses the implications to the port governance and public administration fields, describes the strengths and limitations of the study, and recommends areas for future research in U.S. seaports.

CHAPTER 2:

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

This chapter provides a review of the applicable literature and draws upon it to further define and operationalize the conceptual framework introduced in Chapter 1. Chapter 2 is organized as follows: First, a discussion of how U.S. public seaport governance will show how they differ from other ports of the world; second, a review of stewardship theory will be conducted to address its relevance in this application; third, an examination of the competing notions of governance in the literature will be used to develop a holistic understanding of governance as it relates to seaport management; and lastly, literature from the three most common mission elements of economic development, environmental stewardship and financial sustainability will be reviewed to operationalize a model for analyzing public seaport governance in the U.S. context.

This dissertation uses a multidisciplinary approach to address the research questions and it is likely that the reader will encounter words or phrases that are unfamiliar. Therefore, a reference list of key terms and definitions are provided in Table 2-1 that the reader will encounter while reading this and subsequent chapters.

Table 2-1. *Chapter 2 key terms*

Name	Definition
Corporatization	According to Brooks and Pallis (2012), “corporatization is a particular form of commercialization that involves the creation of a separate legal entity…. [where the] distinguishing feature … is the creation of a legal entity with share capital” (p. 513).
Economic development	Tied to microeconomic conditions. A function of innovation and entrepreneurship that transforms an economy into achieving value-added activities designed to boost productivity.
Economic growth	Tied to macroeconomic conditions and a function of market forces.
Economic man	A perfectly rational utility maximizer.
Environmental stewardship	Stewarding natural resources in a manner that mitigates harm to the environment.
Financial sustainability	the financial capacity to meet current obligations, to withstand shocks, and to maintain service, debt, and commitment levels at reasonable amounts relative to both state and local expectations and likely future income, while maintaining public confidence.
Gross Domestic Product (GDP)	The sum of all consumer spending in the economy, all government spending, all consumer investments, and the sum of total net exports (exports – imports).
Landlord port	Landlord ports are managers of land next to the desirable resource (water) who operate the port through long-term lease agreements and service contracts (Fawcett, 2007).
Liquidity	A measure of a firm’s ability to meet its short-term obligations.
Operating port	Operating ports manage routine port activities using the port authority staff, and are fewer in number than landlord ports (Fawcett, 2007).
Performance	A measure of how efficiently a firm uses its assets. Also called activity.
Port performance	The amount cargo moving through a seaport which is measured in short tons.
Profitability	A measure of a firm’s profits relative to its assets.
Real GDP	Gross domestic product values that have been deflated, or have had the effects of inflation removed.
Self-actualizing man	A man with a need for higher order achievement and intrinsic rewards.
Solvency	A measure used to determine a firm’s ability to repay its long-term debts.
Surface-level ozone	Ozone collecting at or near the surface of the earth. Also called ground-level ozone and tropospheric ozone.

U.S. Seaports

According to World Port Source (2016), there are 121 seaports[6] in the United States, and 16 are privately owned. Fawcett (2007) states that private seaports in the U.S. are typically "single purpose, often owned over a long history, utilized mainly for bulk commodities and often for liquid bulk products" (p. 224). An example of a privately owned, single purpose liquid bulk transfer facility is the Sun Marine Terminals in Nederland, Texas. The terminals are owned and operated by Sunoco Logistics for the purpose of transferring their own crude oil and other refined products.

U.S. public seaports, in contrast, are multipurpose ports owned by state or municipal governments, and function as landlord or operating ports (Hershman, 1988). Landlord port authorities are managers of land next to the desirable resource (water) who operate the port through long-term lease agreements and service contracts (Fawcett, 2007). Operating ports manage routine port activities using the port authority staff and are fewer in number than landlord ports (Fawcett, 2007). For the remainder of this dissertation, the term "U.S. seaport" refers to a public owned seaport that exists for the purpose of trade. Any other meaning of seaport is specifically stated.

Seaport governance in the U.S. differs from other countries, and the U.S. has not participated in the devolving trend that is occurring in seaports across the world. Brooks and Cullinane (2007) posit that "governments have moved to extract themselves from the business of port operations and, for the most part, have focused their efforts on the monitoring and oversight responsibilities" (p. 3). Since the beginning of the nation, U.S. seaports have been managed

[6] This figure represents seaports that are developed for the purpose of trade. Federally owned ports such as naval bases and natural deep-water seaports not developed for cargo and passenger transfer are omitted.

through a structure based on federalism. Fawcett (2007) states that "[o]wing to its history as a nation fashioned from a federation of relatively autonomous states, port governance in the United States is largely in the hands of those 50 states rather than the federal government" (p. 207). Fawcett (2007) goes on to explain that most U.S. ports began as private entities and largely under railroad ownership. The railroads needed an intermodal[7] supply chain node to transfer and move goods across the hinterlands to the expanding frontier. Over time, citizens became angry with the working conditions and the monopolistic behavior of privately-owned ports, so U.S. seaport ownership began a period of evolution where ownership was transferred to state and municipal governments. Hershman (1988) provides a detailed description of U.S. seaport evolution:

> Resentment toward the railroad companies was very similar in both coastal and inland cities. Over a period of years, waterfront areas had developed into dirty and congested sites that imposed intense social and economic costs on communities…. When civic leaders realized that the public interest, as they conceived it, could not be served with continued private control of the port, many communities, at varying times and rates, began a process of shifting harbor ownership and control from the private sector to the public sector. This signified the beginning of the public port entity, created to oversee harbor development and effectively manage port operations (p. 40).

The U.S. federal government has not been as involved in port administration like what is seen in other countries that are currently experiencing devolvement from central governmental control. The U.S. federal government takes an active role in port management as it pertains to

[7] Intermodal refers to the ability to transfer cargo between different modes of transport such as ship to rail, or barge to truck.

national security, [8] harbor maintenance,[9] and keeping sea lanes open for commerce.[10,11] However, seaport ownership and operations are the responsibility of a port authority which are governed by a board of directors who are elected or selected at the municipal or state level. The board members of U.S. seaport authorities are public servants and the analysis of mission statements indicates that they are working for the betterment of the regions they serve. This is a clear indication that the overall objective of U.S. seaports is not the profit motive alone but encompasses how the profits are used for the benefit of the host region.

The devolution movement brought some countries' port systems into a similar context as the United States. Two countries, in particular, began devolving in the late 1970s and early 1980s to transfer control from central to local and regional governments: China and New Zealand, respectively. According to Wang and Slack (2004), China began the devolution process in 1978 as a result of "its 'open door' policy and economic reforms in the post-Mao era" (p. 362). Cullinane and Wang (2007) explain that the Chinese central government relinquished control to lower governments over a quarter-century period and corporatized ports with a 49-percent share ceiling on foreign stakeholders in any single port. This ensured that the Chinese government retained majority control.

[8] The Maritime Transportation Security Act of 2002 was passed to address the country's concerns over waterway security, post 911.

[9] The Harbor Maintenance Revenue Act of 1986 levies a 0.125-percent tax on the value of cargo moving through a U.S. seaport. The revenue is held in trust for waterway maintenance of the nation's seaports.

[10] The Naval Act of 1794 authorized the establish of a six-frigate Navy for the purpose of protecting seaborne commerce from piracy.

[11] The Submerged Lands Act of 1953 obligates the federal government to ensure navigable waters remain unobstructed in the United States. This is a mission shared by the U.S. Army Corps of Engineers and the U.S. Coast Guard.

New Zealand began corporatizing[12] its ports as a result of the Port Companies Act of 1988 (Memon, Markus J. Milne, & Selsky, 2004). Much like China, the port reforms in New Zealand lead to corporatization and privatization of ports. Memon et al. (2004) state “[t]he new [port] governance regime is characterised by a corporatised ‘arms length’ local government ownership structure, limited privatisation of port companies, [and the] absence of a national policy body to coordinate distribution of port facilities…” (pp. 15-16). The decentralization of control in China and New Zealand indicates that these countries could be moving towards a decentralized style of seaport governance that is similar to the U.S. context. However, the partial privatization of their ports also points to differences in operating objectives. All seaports should be assessed in the proper context in order to make generalized observations of performance.

Assessing port performance in the proper context is nuanced with multiple meanings of “performance.” Operating efficiencies could be the desired measure of performance in some applications as well as regional economic impacts. Brooks and Cullinane (2007) correctly point out that measures of performance are sometimes organizational outcomes, which are difficult to measure. This dissertation does not attempt to measure outcomes beyond the impacts of cargo throughput on local economies and environments as well as seaports’ financial health.

Literature Review Approach

This literature review begins with a discussion of stewardship theory and how it is used to characterize U.S. seaport governance. Several theories were considered such as bounded rationality (Simon, 1947), the theory of the firm (Coase, 1937), economic development (Schumpeter, 1934), and stewardship theory (Davis et al., 1997; Donaldson & Davis, 1991) for

[12] According to Brooks and Pallis (2012), “corporatization is a particular form of commercialization that involves the creation of a separate legal entity…. [where the] distinguishing feature … is the creation of a legal entity with share capital” (p. 513).

only the environmental component. However, the most parsimonious and logical choice for an overall theory was determined to be stewardship theory. This literature review will explain why the theory was chosen to characterize U.S. seaport governance.

The body of port governance literature is small but evolving and primarily found in the maritime economics field. As a result, the U.S. seaport governance context has not been properly characterized from a public service perspective. Brooks and Cullinane (2007) identify this shortfall in their description of port performance:

> In the context of port performance, the focus of academic research to date has largely been on efficiency. However, not all ports have set economic performance objectives; the assessment of performance as an outcome, therefore, is measured against the objectives of the entity providing port services and/or of the government that has instituted a program of port reform (p. 58).

Although U.S. seaports did not participate in the worldwide port reform, the notion of using outcomes to measure port performance is relevant for this research. U.S. seaports are concerned with regional economic health, the ability to operate in a financially self-sufficient manner, and their impacts on the natural environment - all of which are outcomes. Therefore, this literature review will focus on the proper characterization and measurement of U.S. seaports' performance.

Multiple meanings of “governance” further exacerbates proper characterization of how U.S. seaports are governed. Governance as a term has a difficult time being defined because there are several definitions that span across multiple fields. This dissertation narrows the governance review to the maritime economics, and public administration fields. Also, as

observed in the works of Lynn (2010), Kettl (2002), and Stoker (1998), governance from a public administration perspective, is not a static, one-size-fits-all process. Therefore, a review of the extant meanings of governance is in order to understand the varying connotations and their contexts.

Lastly, U.S. seaport performance outcomes are measurable, and several examples lie within the economics, finance, and environmental disciplines. Measuring seaport performance and the significance between port operations and the regional outcomes identified as common mission elements is the focus of this review. Therefore, an important part of this chapter is operationalizing measures to assess U.S. seaports' performance.

Stewardship Theory

Stewardship theory (Davis et al., 1997) was introduced as an alternative to agency theory due to the need to explain relationships that are based on behavioral, rather than economic assumptions such as the economic man in agency theory.[13] Briefly, agency theory postulates that a rational actor will seek to maximize his or her own utility (Jensen & Meckling, 1976). For example, in a contracting environment both the principal and the agent are acting rationally to increase their own utility; therefore, the principal has to find a means of incentivizing the agent to act in the principal's best interests. This is known as the agency problem which Jensen and Meckling (1976) point out as a conflict of interest between principals and agents.

Stewardship theory assumes that the interests of both principals and stewards are in alignment (Donaldson & Davis, 1991). If both parties' share common interests, the agency problem becomes null and void. Stewards are in fact motivated by achieving organizational

[13] Economic man is a term that came about as a result of describe John Stuart Mill's (1836) work on the political economy.

objectives rather than self-interests, thereby maximizing both parties' utilities (Davis et al., 1997).

Distinguishing Factors

During the conceptualization of stewardship theory, Davis et al. (1997) discuss certain psychological and situational factors that differentiate the two theories and serve as the foundation of the authors' propositions for future research. The distinguishing factors are summarized in Table 2-2.

Table 2-2. *Distinguishing factors between agency and stewardship theories*

Factor	Agency Theory	Stewardship Theory
Psychological factors		
Motivation	Extrinsic rewards	Intrinsic rewards
Identification	Low	High
Use of power	Institutional power	Personal power
Situational factors		
Management philosophy	Control oriented	Personal oriented
Culture – Individualism-collectivism	Individualistic	Collective
Culture - Power distance	High	Low

Adapted from Davis, J. H., Schoorman, F. D., & Donaldson, L. (1997). Toward a stewardship theory of management. *The Academy of Management Review, 22*(1), 20-47.

Agency theory's reliance on the economic model of man has drawn criticism from several scholars for being too simplistic (Davis et al., 1997; Doucouliagos, 1994; Jensen & Meckling, 1994; Muth & Donaldson, 1998). Doucouliagos (1994), writing on the rationality of economic man, argues that the "criticisms are not rejections of the rationality inherent in *Paleo-Homo Economicus*, but modifications to it; they represent the evolution of a fitter (more useful) species" (p. 877). In his original form, the economic man is a perfectly rational utility

maximizer. However, humans suffer from cognitive limitations which is explained by Simon (1957) as bounded rationality. Therefore, a clear issue of human-like realism manifests when applying agency theory to a public stewardship context. Stewardship theory assumes the self-actualizing model of man (Argyris, 1973) who has a need for higher order achievement and intrinsic rewards. According to Davis et al. (1997) a "steward protects and maximizes shareholders' wealth through firm performance, because, by so doing, the steward's utility functions are [also] maximized" (p. 25).

Psychological factors.

The psychological factors identified by Davis et al. (1997) are motivation, identification and use of power. Motivation refers to the rewards received by the agent or steward. From a utility maximization perspective, both the agent and the steward are maximizing their individual utilities, but the steward's utilities are based on the higher order intrinsic needs explained by Maslow (1970), Alderfer (1972), and McClelland (1975), and the agent's needs for rewards are more extrinsic in nature.

Identification with the organization describes how managers deal with successes and failures. In stewardship and agency theories, managers are assumed to exhibit reward seeking behavior, but in stewardship theory the rewards are intrinsic and in line with organizational goals (Davis et al., 1997). Agency theory's reliance on the economic model of man dictates that a self-serving utility maximizer will not always identify with the organization, especially in order to avoid blame over organizational shortcomings (D'Aveni & MacMillan, 1990; Staw, McKechnie, & Puffer, 1983).

The use of power refers to the type of power exhibited by agents and stewards. Davis et al. (1997) state that institutional power is more compatible with principal agent relationships and

personal power is closely related to stewardship theory. In agency theory, the principal exercises what French and Raven (1959) describe as coercive, legitimate, and reward power over the agent to ensure the proper level of control. In stewardship theory, however, the principal uses what French and Raven (1959) describe as referent and expert power to develop interpersonal relationships which can bolster commonality of principal-steward purposes.

Situational factors.

The situational factors identified by Davis et al. (1997) are management philosophy, cultural individualism-collectivism, and cultural power distance. The Management philosophy factor of stewardship theory stems from the works of Argyris (1973), where he argued for a model of man that is based on self-actualizing assumptions of human behavior as a counter to economic man. In separate but similar works, Walton (1980, 1985) and Lawler (1986, 1992) explained two different types of management philosophy orientations: control and involvement. Davis et al. (1997) explain that the control-oriented approaches assume “the thinking and controlling part of the work must be separated from the doing part of the work.... [and the] involvement-oriented approaches emphasize self-control and self-management and do not create a separation among thinking, controlling, and doing the work” (p. 32). The control-oriented approaches are conducive to economic man’s behavior and by extension, principal agent theory. Steward-like behavior is more in line with involvement-oriented approaches.

Cultures have impacts on human behavior which have been used to differentiate between agent and steward-like behaviors. Hofstede (1984, 1991, 1993) postulates that in the individualism-collectivism dimension, individualism is characterized by individuals placing their personal objectives over group objectives. Conversely, collectivism assumes the individual

places his or her own objectives secondary to group objectives (Triandis, 1995) which is in close alignment with steward-like behavior.

Hofstede (1991) also explained the concept of power distance which has been used to distinguish between agent and steward-like behavior (Davis et al., 1997). Some cultures accept a dichotomy between those with power and those with less power. Cultures where inequalities exist between the powerful and the less powerful are considered to have a high power distance. Davis et al. (1997) state that "[h]igh power distance cultures are conducive to the development of agency relationships, because they support and legitimize the inherent inequality between principal and agent" (p. 36). Stewardship theory is founded on minimizing inequalities and decreasing the power distance between the powerful and less powerful.

U.S. seaport authorities and steward-like behavior.

Public port authorities in the U.S. take on missions intended to benefit the community which makes them stewards of public resources. Economic development, environmental stewardship, financial sustainability of a public enterprise, and public recreation point to steward-like characteristics that are not necessarily founded on profit seeking motives. Economic development for instance, is often unfruitful and extremely costly. Private (profit-seeking) organizations engage in philanthropic, community development ventures, but it is usually not a primary mission. Environmental stewardship is not only a moral responsibility, but for agencies using federal government funding, it becomes a regulatory obligation.[14] U.S. seaport authorities operate on the notion that they have to earn money to spend money. The financial sustainability mission means that a port authority should not burden local and state tax coffers. This is not always the case, but it is the mission that U.S. seaports strive to achieve. Lastly, the public

[14] The National Environmental Policy Act (1970) requires federal organizations and organizations using federal funding for projects to conduct an investigation into the potential environmental impacts.

recreation mission pursued by some of the smaller seaports is inherent in public agencies and is typically not a large revenue earner beyond operating cost requirements. In essence, U.S. seaport authorities are stewards to the public principal and their missions are aligned as such. Consequently, the altruistic features of U.S. seaport authorities indicate a greater degree of compatibility with stewardship theory than agency theory.

Defining Governance

Definitions of governance in maritime economics and public administration literature are plentiful, and lacking standardization. As a result, governance has taken on many meanings based on the context in which it is used. For example, corporate governance will have a different set of purposes than public governance. Brooks and Cullinane (2007) state that "corporate governance is the structure, roles and responsibilities that provide the means by which the organization is managed as an economic entity, based upon the objectives of the corporation" (p. 12). This definition may work for a private port, but when viewed through the lens of public administration, it becomes inadequate, and largely because it lacks accountability to the citizenry.

Differences in Public and Private Organizations

The differences between public and private organizations deserve some attention. In the recent U.S. history there has been some support for employing entrepreneurial and business-like strategies to public management. Osborne and Gabler (1993) are credited with the movement during the Clinton administration. As a result, the ability to employ private sector strategies in a public management environment has been discussed by some prominent public administration scholars (Bozeman, 1987; Lynn, 2010).

According to Rainey and Chun (2005) difference between public and private organizations are operating environments, public management goals, roles, structures and

processes, and performance. The operating environment for a seaport is a hybrid. Seaports are profit-seeking public organizations with obligations to the citizenry they serve. Seaports' goals roles and structures are also expected to differ between public and private-owned seaports. Public seaports are not motivated by profit-seeking strategies in the same way as private seaports. Public seaports have to consider the impacts to the region where private seaports do not have the same burden which can manifest as varying performance levels. The differences in performance between public and private organizations are numerous and normally support the notion that the private sector is more efficient. Seaports are in fact different. They are a hybrid and in order to understand how to operate a profit-seeking public enterprise, all notions of governance must be considered. The U.S. Seaport Governance Context

Port authorities in the U.S. are concerned with democratic governance because of their degree of publicness, but at the same time, these public-owned resources rely on private actors to run the day-to-day operations. U.S. public seaports are typically public-private partnerships functioning as landlord ports, operating ports, or limited operating ports (Fawcett, 2007; Hershman, 1988). Landlord ports are public-owned and the private sector manages the port through lease agreements with terminal operators, industries, and service providers. Most U.S. seaports are landlord ports (Fawcett, 2007). Operating ports are public-owned and the public operates the port. Limited operating ports are public-owned, and only a small percentage of port functions are carried out by the public owners.

Bevir (2009) points out that the lines of accountability between public service providers and elected officials can be interrupted because of network governance structures that include private actors. This interruption is probable in the case of U.S. seaport governance, and accountability to the host region is secured through board governance. The types of accountability which bind government-owned organizations to citizens are: accountability for finances; accountability for

performance; accountability for the use of power; and accountability for fairness to its citizens and clients (Behn, 2001). To explore how steward-like U.S. seaport authorities behave, this research addresses the first two types of accountability, finances and performance. Accountability for fairness to citizens and use of power are separate but important areas for future research.

Since most ports in the U.S. are public to some degree, any explanation of port governance should consult public administration literature. However, even in public administration literature, there are inconsistencies in definitions of governance. For instance, Bingham, Nabatchi, and O'Leary (2005) offer a description of what governance is by stating "governance seeks to share power in decision making, encourage citizen autonomy and independence, and provide a process for developing the common good through civic engagement" (p. 548). This definition is useful in describing participatory governance, but it does not include accountability nor does it speak to the regulatory responsibility of a port authority. In fact, most definitions of governance from public administration literature will fall short in some manner when attempting to apply them to the U.S. seaport governance context. Therefore, it becomes prudent to gain an understanding of the competing ideas of governance in public administration literature in order to analyze how public seaports are governed in the United States.

Categories of Governance

In 2010, Laurence Lynn summarized several scholars' meanings of governance into five distinct categories: 1) governance meaning ordered rule; 2) governance as being synonymous with government; 3) governance meaning good government; 4) governance as something in addition to, or beyond government; and 5) governance as societal direction being replaced by organizations that are not government. It is likely that U.S. seaports fit into all of these categories which only serves to blur the true definition of governance even more. What became clear to Lynn (2010) and is clear in this research is that there are several perspectives of governance that must be considered in order to arrive

at a robust understanding of the term. Likewise, ports should be viewed through each of these governance perspectives in order to holistically understand the elements that constitute port governance. Therefore, a discussion of each of Lynn's (2010) categories of governance is necessary.

Governance as ordered rule.

Lynn (2010) postulates that governance as ordered rule refers to "how actors are organized and managed in order to accomplish purposes on which they agree or which they have in common" (p. 3). Because of the change in how common (public-private) objectives were to be attained, a collaborative form of governing evolved. Governments were no longer the upper echelon in all actors' chains of command but were coequals with private-sector actors in collaborative ventures. Hence, the process for governing was adapting and so too was the definition of governance. U.S. seaports are collaborations made up of port users and port authorities. The port users are the industries located on and off the port who use it for the purpose of commerce. The oversight and regulatory figurehead in the arrangement is the port authority which shepherds the collaborative group towards its common goals.

Governance as being synonymous with government.

Throughout history, "governance" has been used with slightly different connotations. Lynn (2010) points out that governance once included politics and policy, but now the term also encompasses public administration, or the execution of policy. U.S. public port authorities are self-governing agencies that operate a port through the development and execution of policies. Port policies can be viewed using at least two perspectives: externally induced policies such as enforcement of environmental or navigation regulations; and internally induced policies which are intended to guide the port director and grant certain administrative discretions in managing the port. No matter how "governance" is used, the autonomous nature of U.S. seaports indicates that port governance includes all three attributes described by Lynn (2010): politics, policy, and execution.

Governance meaning good government.

What makes governance "good" is based on the context in which it is used. However, one definition of good governance resonates well with U.S. seaports. Löffler (2009), quoting the United Nations Economic and Social Commission on Asia and the Pacific, explains that "good governance has eight major characteristics. It is participatory, consensus oriented, accountable, transparent, responsive, effective and efficient, equitable and inclusive, and follows the rule of law" (p. 217). These characteristics accurately describe the expected behavior of a public port authority in the United States.

Port directors are accountable to port authority boards for operating public assets in a way that promotes efficiency, equity, and transparency as well as following all federal, state, and local laws (Boschken, 1988). There is no one-size-fits-all governance model so ports must be responsive to changing contexts in order to best serve their citizens. Ports that do not follow these eight characteristics mentioned above are prone to failure and could trigger citizens' discontent. Therefore, U.S. port authorities should understand these principles and develop governance methods that best fit their context.

Governance as something in addition to, or beyond government.

At the turn of the twentieth century, local and state government goods and services looked very different from today. Along the way, Americans began outsourcing many public functions that were typically carried out by public servants. Outsourcing inherent government functions ranged from privatization of state correctional systems (Morris, 2007) to contracting for support in executing social programs (Breaux, Duncan, Keller, & Morris, 2002). There are numerous examples of outsourcing public functions, but the underlying reasons most often cited were to increase economic efficiency and responsiveness to constituents (Kakabadse &

Kakabadse, 2001). Public ports were no different. Outsourcing port functions in order to gain efficiency and responsiveness to dynamic markets became the norm (Fawcett, 2007).

Lynn (2010) explains that governance, as something in addition to or beyond government, is “an emerging model of societal direction in which guidance of resource allocation and service delivery is provided by civil society institutions with or without the authorization and influence of government” (p. 2). In the case of ports, this is most evident in the creation of public authorities or similar governing committees. Gerwig (1961) defined a public authority as “a limited legislative agency or instrumentality of corporate form intended to accomplish specific purposes involving long-range financing of certain public facilities without legally or directly impinging upon the credit of the State” (p. 591). Port authorities are governing bodies, in addition to or beyond typical government, created to manage public ports and are given significant autonomy that enables sustainability through fiscal mechanisms. For instance, port authorities are often granted the leeway to float bonds for capital improvements to the assets they are charged with maintaining. Port authorities are therefore, examples of governance in addition to or beyond government.

Governance not government.

Outsourcing government functions to non-governmental actors who are not constrained by red tape is the essence of this category. Networks of actors who can carry out government functions in a more efficient and responsive manner than the traditional civil servant institution are becoming more prevalent in the United States. Kettl (2002) points out that by outsourcing certain functions, non-governmental organizations have become governmentalized. The idea of outsourcing governmental functions occurred during the time that New Public Management (NPM) became popular in the United States. The principal idea of NPM is that the private sector

is better suited to handle important business-like decisions (Osborne & Gaebler, 1993) than the public sector. Likewise, Baltazar and Brooks (2007) state that “NPM proponents attempt to apply commercial private sector principles to government operations” (p. 380). There is evidence that the governmentalization described by Kettl has also occurred in U.S. ports. Fawcett (2007) states that “most of the nation’s seaports share a good portion of their management with the private sector” (p. 232). In line with the tenets of NPM, it is understandable why devolution is occurring in other parts of the world. The U.S. seaport system has been operating fairly well while relying more and more on the private sector to carry out port functions.

U.S. Seaport Governance

A U.S. public seaport authority is a self-regulating enterprise that is an agency of a state or municipal government. We know from Bös (1986) that public enterprises are chartered to operate public assets in a manner that benefits citizens in the region vice merely serving business interests. Furthermore, operating any seaport requires carrying out certain port functions that have been identified by the World Bank (2007) and published in the Port Reform Toolkit. The port functions include:

> Landlord for private entities offering a variety of services; Regulator of economic activity and operations; Regulator of marine safety, security, and environmental control; Planning for future operations and capital investments; Operator of nautical services and facilities; Marketer and promoter of port services and economic development; Cargo handler and storer; and Provider of ancillary activities (p. 80).

The World Bank (2007) explains that the port functions above are carried out by either a public or a private organization in ports across the world, and that many port authorities assume

the landlord role thus maintaining control of the real estate next to the natural asset, (i.e. the water) while outsourcing various port functions. A review of the port functions indicates that some are inherently government, at least in part, such as Regulator of Marine Safety,[15] while others have the flexibility to be outsourced.

Most seaports in the U.S. are landlord ports (Fawcett, 2007) that rely on private actors to carry out many of the port functions. Table 2-3 illustrates Lynn's (2010) categories of governance with the corresponding World Bank (2007) port functions. The purpose of Table 2-3 is to point out that each public seaport in the U.S. is a unique and complex public-private partnership and therefore any definition of governance must encapsulate many, if not all of Lynn's categories. Public seaports have a higher calling than the profit motive and a set of inherent responsibilities that are unmatched by their private counterparts. Any study of port governance that includes public-owned seaports or inland waterway ports, should take these distinguishing characteristics into account.

[15] Regulatory enforcement can be outsourced in some cases, but the inherent responsibility for compliance resides with the government agent.

Table 2-3. *Categories of governance comparison with World Bank port functions*

Lynn's Categories of Governance	Key Attributes	Landlord for private entities offering a variety of services	Regulator of economic activity & operations	Regulator of marine safety, security, & environmental control	Planning for future operations & capital investments	Operator of nautical services & facilities	Marketer & promoter of port services & economic development	Cargo handler and storer	Provider of ancillary activities
Governance meaning ordered rule	Ordered rule of an entity whose purpose is to accomplish a purpose shared by affected actors	X	X	X	X	X	X	X	X
Governance as being synonymous with government	Synonymous with the state and its role in societal guidance and direction	X	X	X	X		X		
Governance meaning good government	Effective governing by and with the authority of duly constituted institutions of the public sector	X	X	X	X	X	X	X	X
Governance as something in addition to, or beyond government	Guidance of resource allocation and service delivery provided by private actors with or without the authorization and influence of		X	X	X	X	X	X	X
Governance as societal direction being replaced by organizations that are not government	Government replaced by decentralized networks, partnerships, and markets not subject to the imposed authority of governments		X	X	X	X	X	X	X

Definition of seaport governance.

A review of Table 2-3 makes clear the business-like attributes required to operate a seaport as well as the public aspects inherent in governance. Seaports are competitive businesses, yet because they are public owned they are beholden to the citizenry for efficient, effective, and transparent operations. Therefore, the following definition is offered that encapsulates the entrepreneurial and governance aspects inherent in operating a U.S. public seaport:

> Public seaport governance requires that the governing body provide ordered rule and strategic direction for all tenants and port users in a manner that is mutually beneficial for all stakeholders. Because of the public-private partnership characteristics inherent in the U.S. seaport governance landscape, this endeavor is carried out through a networked governance arrangement that includes private actors moving towards objectives that are either common or somewhat aligned. Ultimately, the governing body is responsible to the citizenry and higher-level governments for operating the public asset in a manner that benefits the region.

Measuring U.S. Seaport Performance

This section will explain how seaport performance is operationalized for measurement. Currently, no study exists that measures U.S. seaports' performance towards achieving stated missions, nor have the common elements in mission statements been identified. Therefore, it is important to determine the stated mission elements that are commonly held by U.S. public seaports. The common elements were determined at the beginning of this research process in order to guide the literature review which are economic development, environmental stewardship and financial sustainability. Next, an exploration of the economic, environmental, and finance

literature is conducted to develop a set of dependent variables for assessing the impact of U.S. seaports' performance on the common mission elements.

Economic Impacts

Economic development lacks a standard and scholarly definition similar to what is seen with governance. An investigation into the literature reveals a distinct and sometimes misunderstood difference between economic development and growth. Schumpeter (1934) described economic development as a function of innovation and entrepreneurship that would transform an economy into achieving value-added activities designed to boost productivity. This could mean revisions to current institutional structures, new business ventures, and the introduction of new technologies. The ideas that Schumpeter expressed on economic development were founded on the notion that a deeper understanding of economic development would facilitate a higher degree of economic growth.

Economic development is made possible through economic growth. Feldman, Hadjimichael, Lanahan, and Kemeny (2016) state that "economic growth is tied to macroeconomic conditions and a function of market forces, [while] economic development represents the conditions that determine the microeconomic functioning of the economy, affecting both the quality of inputs and the opportunity set for firms" (pp 6-7). Based on this understanding of the difference between growth and development, it is clear that economic development is concerned with quality of life and prosperity while economic growth deals with market forces which are more tangible and easily measured. This study uses variables from the economic growth and development fields to assess the impacts that seaports have on regional economies. Economic impact is therefore, any change in the region's economy found to be attributed to seaport activity.

Gross domestic product.

Gross Domestic Product (GDP) is an indicator of economic health that has been used to measure ports' impacts on host regions' economies (Bergantino, Musso, & Porcelli, 2013; Park & Seo, 2016; Shan, Yu, & Lee, 2014). The U.S. Bureau of Economic Analysis defines real GDP[16] as "the value of the goods and services produced by the nation's economy less the value of the goods and services used up in production, adjusted for price changes" (2016). Equation 2.1 defines the component parts of GDP at the national level. The adjustment for price changes refers to deflating the data, or removing the effects of inflation. Real (deflated) GDP data, as described by the Bureau of Economic Analysis are used in this research to mitigate the need to control for inflation.

$$GDP = C + G + I + NX \tag{2.1}$$

where,

C = all consumer spending in the economy

G = all government spending

I = all consumer investments

NX = the sum of total net exports (exports – imports)

Bergantino et al. (2013) found evidence indicating that as per capita GDP increases, ports become more economically efficient to their regions. Correspondingly, Shan et al. (2014) found

[16] The U.S. Bureau of Economic Analysis (2016) defines real GDP as "a measure used to express real prices, or prices that have been adjusted to account for inflation in order to represent a dollar's purchasing power" (para. 16). Nominal GDP, on the other hand, doesn't account for changes in inflation.

that growth in annual per capita GDP is related to increases in host regions' and neighboring ports' cargo throughput. It is important to understand that the goods coming into a port do not all stay in the port region. However, the service jobs created by the port (directly and indirectly) are captured in GDP and those jobs provide consumers income that will likely be spent in the region. Therefore, changes in GDP can be used as a variable to capture economic growth in a port region.

Measuring growth in an economy using GDP can be misleading if one has not properly controlled for rival hypotheses. For instance, it is conceivable that a population increase can cause an increase in cargo throughput in order to meet the demands of a growing market. Therefore, the analysis should consider rival explanations when measuring a port's impact on regional economic growth.

Employment and wages.

Regional employment rates have also been used to measure ports' economic impacts. Acciaro (2008) found that the port system on the Mediterranean island of Sardinia was responsible for three percent of the island's overall employment, and as much as eight percent in port cities. Similarly, Bottasso, Conti, Ferrari, Merk, and Tei (2013) found that employment rates in host regions are positively related to ports' cargo throughput. Similarly, Bilotkach (2015) found that major U.S. airports experience increases in MSA-level average wages by increasing the number of flights and destinations served, which is comparable to a seaport increasing cargo throughput. Employment and average wages are both indicators of economic development that should be considered when measuring economic impacts.

Other causes of economic development.

Government spending in the region has also been shown to have a causal relationship with GDP in port regions (Park & Seo, 2016; Shan et al., 2014). It seems logical that government spending in states and municipalities can stimulate economic growth which is realized in rising GDP values. The reason for including the cost price index and government spending is to account for as many causes of GDP fluctuations as possible. Remler and Van Ryzin (2015) state that “evidence for causation gains strength when plausible common causes are taken into account” (p. 361), so controlling for a robust set of potential causal factors is a primary concern of the researcher.

Neighboring ports can have an impact on host port economies. Shan et al. (2014) found that seaport regions’ economies in China are affected by neighboring ports within 500 kilometers. Similarly, Bilotkach (2015) found that major U.S. airports serving Metropolitan Statistical Areas (MSA) have economic impacts on neighboring MSA’s economies. The competition for market share in the U.S. is likely to be a contributing factor in U.S. seaport region’s economies and should be included in a control vector. There is no doubt that world ports have the propensity to grow or shrink host and neighboring regions’ economies (Bergantino et al., 2013; Bottasso et al., 2013; Park & Seo, 2016; Shan et al., 2014), and similar evidence in the U.S. is highly likely.

Economic impact construct.

In this research, economic impacts are measured using growth regression models and identifying changes where one can be reasonably certain were caused by the stimulus under study (the seaport). The economic growth model uses annual changes in real per capita GDP as the dependent variable, and the economic development model uses annual changes in average

weekly wages. The primary independent variable for each model is annual cargo throughput and control vectors are used that contain rival causes of economic development in the port region.

Limitations to measuring economic impacts.

Measuring the economic impacts of ports is a difficult endeavor. The sources of impacts on a port region's economy are numerous, as explained above, and spurious findings are a persistent concern. Also, it has been noted that economies are capable of impacting a seaport's cargo throughput (Shan et al., 2014). Therefore, a control vector is used that captures as many rival explanations of economic impacts as possible, and a causality analysis will be used to understand the directionality between cargo throughput and port regions' economies.

Environmental Stewardship

As public entities, ports have an inherent responsibility to protect the environment. This is a large endeavor considering the amount of point sources within a port that can cause pollution. For instance, ships transiting in and out of ports burn diesel fuel for their engines which contributes to air pollution. Likewise, idling trucks waiting for their freight to be loaded or unloaded contribute to the level of harmful emissions in the port region. Under public scrutiny for air quality and traffic congestion, some ports have initiated an off-peak program which reduces the number of idling trucks at the port (Sathaye, Harley, & Madanat, 2010). Also, while ships are sitting pier-side for cargo transfer they might operate diesel generators to maintain electrical power unless cold ironing is compulsory. Cold ironing is a process where ships shut down their engines and rely on shore services (i.e., electricity, water, and steam) so that air pollution is kept to a minimum (Chang & Wang, 2012). Cold ironing is an initiative to reduce emissions, but not all ports have adopted the practice.

Ships are floating industrial environments with many hazardous fluids being transferred on a near-continuous basis (Navy, n.d.). Ships' engines need a constant supply of fuel to operate. Sewage systems must be in operation to support crew sanitation. Lubricants must be pushed to operating machinery to dissipate the heat of friction between moving metal surfaces (i.e., bearings). All of the systems that convey these hazardous fluids are under pressure, and leaks or inadvertent overboard discharges are not uncommon. To prevent hazardous spills from occurring, ports have implemented policy solutions such as prohibiting ships from transferring hazardous liquids between sunset and sunrise, and placement of containment apparatuses around ships in port so that spills can be contained (International Maritime Organization, 2002).

Offloading cargo is also a potential source of contamination. Some vessels carry hazardous material such as liquid bulk petroleum (i.e., tankers) that can cause great harm to a region's ecosystem if a spill occurs (International Maritime Organization, 2002). It is clear that ship operations can cause harm to the environment. Therefore, U.S. ports follow a mix of environmental protection regulations that are delineated in federal, state, or local legislation as well as those adopted by the International Convention for the Prevention of Pollution from Ships (MARPOL) in 1973.

International Maritime Organization.

The International Maritime Organization (IMO) has gone to great lengths to increase awareness of environmental pollution inherent in marine shipping (Griffen, 1994). In 1973, the IMO convened the International Convention for the Prevention of Pollution from Ships to establish a set of protocols for preventing environmental mishaps and reducing pollution. The IMO reconvened the convention in 1978 to amend the 1973 protocols and the resulting pollution abatement guidelines were published as MARPOL 73/78. As technology increased and the world

community learned more about pollution, the MARPOL regulations were further revised through Annexes III through VI. These updates cover the various sources of ship pollution and specify requirements that signatory countries must follow (International Maritime Organization, 2002).

The U.S. was involved in ratification of the conventions and follows MARPOL 73/78 which includes regulations for the prevention of the following sources of pollution: Annex III) harmful substances carried by sea in packaged form; Annex IV) sewage from ships; Annex V) garbage from ships; and Annex VI) air pollution from ships (International Maritime Organization, 2002). A model of port governance should include measures for how well a port espouses good stewardship of the environment.

Difficulties in measuring port-related pollution.

It is difficult to measure the outputs of ports' efforts towards environmental stewardship because of the inability to control for adjacent pollution sources. For instance, combustion engines typically emit the same species of pollutants into the air regardless of each engine's purpose. There are studies that estimate pollutant emission sources (Deniz, Kilic, & Cıvkaroglu, 2010; Dolphin & Melcer, 2008), but the assumptions used in those methods do not lend themselves to causal analysis techniques. Likewise, seaports are located in areas where rivers and tidal influences make it difficult to allocate water pollutants to their actual sources (Ng & Song, 2010).

The literature for air quality is more mature than water quality and national air monitoring data is more widely available, making it the best environmental stewardship variable for analysis. However, the methods of controlling for adjacent sources have not been perfected. Nonetheless, relationships between economic growth and air quality have been discovered (Davis, 2012; Pao & Tsai, 2011; Yang, Yyuan, & Sun, 2012), as well as relationships between

ports' cargo throughput and regional GDP (Park & Seo, 2016; Shan et al., 2014). This study uses local air quality as a surrogate for ports' environmental stewardship while controlling for non-port related transportation sources.

Shipping related air pollution.

In Talley's (2009) book, *Port Economics*, he explains that ports require an infrastructure that facilitates moving goods and passengers into and out of shipping terminals. From the ocean, ships carry goods across waterways between ports. From the hinterlands, cargo arriving or departing the port can do so via, truck, rail, or lighters.[17] Nearly all of these modes of moving cargo have one thing in common – diesel engines are their prime movers for transportation, as well as being used to provide auxiliary (electrical) power while ships are in port (Cooper, 2003). Cargo handling gear used in port facilities are also a source of diesel emissions. According to the U.S. Environmental Protection Agency (EPA) (2016c), there are environmentally friendly machines available to handle cargo within a port such as hybrid or electric stackers, saddle lifts, and cranes, but cargo primarily enters, moves through, and exits a seaport via diesel power.

Diesel engines emit toxic byproducts into the atmosphere through the process of combustion. Complete combustion will yield water (H_2O) and the greenhouse gas, carbon dioxide (CO_2) (Dolphin & Melcer, 2008). Therefore, even under perfect (complete) combustion conditions diesels are harmful to the atmosphere. Incomplete combust, however, is extremely harmful because of the toxic byproducts emitted. According to Krivoshto, Richards, Albertson, and Derlet (2008) these byproducts include Carbon Monoxide (CO), Hydrocarbons (HC),[18]

[17] The U.S. Department of Transportation (2008) glossary of shipping terms defines a lighter as "an open or covered barge towed by a tugboat and used mainly in harbors and inland waterways to carry cargo to/from alongside a vessel" (p. 63).
[18] The EPA (2016d) classifies hydrocarbons as volatile organic compounds which are "any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates and ammonium carbonate, which participates in atmospheric photochemical reactions, except those designated by EPA as having negligible photochemical reactivity."

Nitrogen Oxides (NO_x), Ozone (O_3), Sulfur Oxides (SO_x) and unburned carbon particles that end up as Particulate Matter (PM).[19] The convergence of so many diesel-powered modes of transportation at one geographical area can negatively impact local air quality. All of these pollutants are monitored by the U.S. Environmental Protection Agency (EPA) in large cities and are important outputs to consider when assessing a port's environmental stewardship efforts.

Environmental impact construct.

This research measures seaports' impacts on county-level air quality as a surrogate for environmental stewardship. The environmental impact construct is designed to estimate the effect seaports' cargo transfer operations have on county-level air quality. Annual mean surface level ozone concentrations are used as the dependent variable because of the known relationship between diesel exhaust and the production of surface-level ozone. The EPA (2017a) explains the reaction that occurs between diesel exhaust and the environment on the surface of the Earth:

> ground-level ozone is not emitted directly into the air, but is created by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC)." This happens when pollutants emitted by cars, power plants, industrial boilers, refineries, chemical plants, and other sources chemically react in the presence of sunlight (Bad Ozone, December 7, 2017)

Likewise, Krivoshto et al. (2008) point out that diesel engines have a higher compression ratio than gasoline-burning engines which causes disproportionally higher emission levels of Nitrogen Oxides (NO_x) thus establishing precursor conditions for the formation of surface-level ozone. Due to the preponderance of diesel engines employed in moving cargo inside or near the

[19] The EPA (2016b) is concerned with, and therefore monitors inhalable particulate matter that is equal to or less than 10μm in size (PM_{10}) and the more dangerous particles that are equal to or less than 2.5μm in size ($PM_{2.5}$).

port, changes in surface level ozone concentrations are expected to be associated with changes in seaports' cargo throughput. Essentially, the higher the amount of cargo moving through a seaport, the higher the amount of surface ozone concentrating in the port area.

Limitations to measuring environmental impacts.

There are also limitations in the literature that inhibit a thorough analysis of environmental stewardship. Establishing causality for the origin of air and water pollution is a difficult endeavor. Analyses on suspected origins of air pollution using secondary data have recently begun (Pao & Tsai, 2011; Yang et al., 2012), and similar studies for water pollution are virtually nonexistent. There are source apportionment studies which identify chemical compositions of water pollutants (Mustapha & Nabegu, 2011; Zhang, Guo, Meng, & Wang, 2009), but none were found to have been used to causally tie non-point source pollutants to ports or port users. Although these limitations serve as barriers to modeling ports' environmental impacts, they highlight key areas that are ripe for future research.

Financial Sustainability

Financial sustainability is a term often associated with the wellbeing of private organizations or the fiscal health of public organizations. Like governance and economic development, one standard definition for financial sustainability does not exist in the literature, nor one standard methodology for its measurement. At its core, financial sustainability addresses the ability of an organization to meet its financial obligations in the short and long term but depending on the degree of publicness of the organization the definition could vary. Therefore, it is important that public enterprises consult literature from both the public and the private sectors when deciding on a definition of financial sustainability.

Using ownership as the sole criteria for describing differences between public and private enterprises overlooks the most salient dissimilarities. Bös (1986) points out that it is the "political and economic determinants of public enterprises' activities as compared to the mainly commercial determinants of the activities of private enterprises" (p. 13) that diferentiates public and private organizations. Public ports for instance, might operate in an manner that seems financially inefficient to a private port in order to secure jobs for the region. The overarching focus on the good of the public could serve as an inhibitor of U.S. seaports' ability to maximize profits. Fortunately, the good of the public is considered a primary objective in public seaport management.

Bowman (2011) explains financial capacity (short-term) and sustainability (long-term) as cohort concepts of non-profit financial management and states "the sustainability principle acknowledges short-term resiliency as a precondition for long-term success" (p. 39). From a policy perspective, Burnside (2005) states that when economists use the term fiscal sustainability they are "typically referring to fiscal policies of a government" (p. 11), but with a special emphasis on solvency. Government agencies, like non-profit organizations, should be capable of managing their long-term debts to avoid default and their fiscal policies should support that endeavor. After all, public ports are unique in that they are hybrid organizations exhibiting both private and public-sector characteristics.

One of the more robust definitions of public sector financial sustainability reviewed for this research came from a discussion paper published by New Zealand's Office of the Auditor-General (2013).

> Public sector financial sustainability is the financial capacity of the public sector to meet its current obligations, to withstand shocks, and to maintain service, debt, and commitment levels at reasonable levels relative to both national expectations and likely future income, while maintaining public confidence (p. 8).

This definition captures the short-term (liquidity) and long-term (solvency) components mentioned by Bowman and Burnside and includes the public accountability aspect. Ports in the U.S. should be accountable to their constituents, liquid enough to handle external shocks, and solvent enough to reasonably assure longevity. Therefore, with a minor change the following definition of financial sustainability is used for this research: Public seaport financial sustainability is the financial capacity of the port to meet its current obligations, to withstand shocks, and to maintain service, debt, and commitment levels at reasonable amounts relative to both state and local expectations and likely future income while maintaining public confidence. This definition captures accountability to the public and citizens' expectations for their local port governing boards as well as the short and long-term management of obligations which are necessary to provide cushion during fiscal uncertainty.

Fiscal uncertainty.

The shipping industry is cyclic and prone to external shocks such as geopolitical strife and natural disaster. Stopford (2009) points out that the shipping industry has been cyclical since 1741 with each cycle averaging just over 10 years in duration. This is an indication that ports should be capable of absorbing external shocks and maintaining liquidity during fiscally challenging times. Therefore, U.S. ports should be profit-seeking institutions in order to maintain self-sufficiency during periods of fiscal uncertainty. The notion of operating a port like a

business is in line with the philosophy of NPM (Baltazar & Brooks, 2007; Osborne & Gaebler, 1993), meaning ports should be operated using business principles where the profit motive is of major importance.

At first glance, the profit-seeking motive seems an unorthodox way of running a public-owned resource. However, as economic engines that are intended to benefit the public, seaports should be self-sustaining to ensure that benefits continue to stream over long periods of time. In essence, seaports must be managed like private companies to sustain their existence. Poor management practices can lead to unsustainable seaports which in other countries have resulted in full privatization in order to bail out the failing public asset (Baird & Valentine, 2007). Likewise, ports sometimes rely on governments for financial support (Virginia Joint and Legislative Audit and Review Commissions, 2013). Citizens might take issue with having to dig into state and municipal tax coffers to subsidize a failing port, so it becomes prudent to monitor indicators of fiscal health.

Fiscal health indicators.

Determining a ports financial sustainability can be accomplished using indicators that predict fiscal health. Very little scholarly effort has been placed on determining ports’ financial sustainability, but much effort has been spent on measuring financial sustainability of firms. Private firms use financial ratios to monitor fiscal health. A port, being a self-sustaining economic engine, can make use of the same ratios to monitor its fiscal health. There is a plethora of financial ratios in use, but many of them produce similar results. Choosing the appropriate ratios for measurement requires some insight and experience in financial analysis. Chen and Shimerda (1981) found that some financial ratios can be used to predict bankruptcy, but a

problem of multicollinearity manifests amongst many of the extant ratios. Therefore, a data reduction technique is often needed, such as factor analysis.

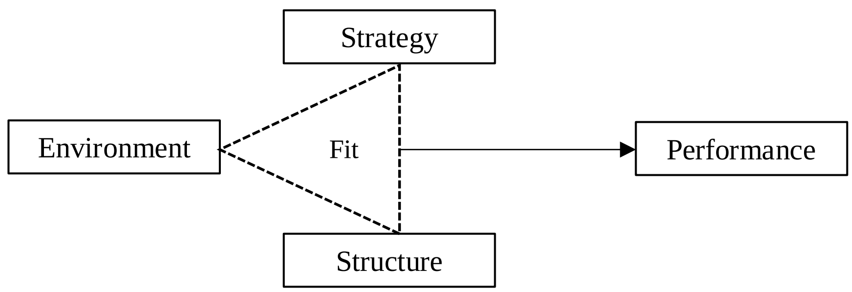
Several classes of financial ratios are available for analysis. Feldman and Libman (2007) indicate that four categories of ratios exist: 1) liquidity, used to measure a firm's ability to meet its short-term obligations; 2) profitability, used to measure a firm's profits relative to its assets; 3) activity (or performance), which is a measure of how efficiently a firm uses its assets; and 4) solvency which is used to determine a firm's ability to repay its long-term debts. Within these categories are a number of ratios that can be used to tease out a firm's operational, financial, and debt performance over time. However, selecting the right mix of ratios for use in analyses is a delicate balance due to the inherent correlations amongst ratios; therefore, the appropriate ratios from the four categories above will be determined after careful analysis of ratio correlations.

Limitations of Existing Studies

There are several studies on port governance in the maritime economics field, but not many offer an explanatory model of port governance, and even fewer describe it from a public administration perspective. However, the performance aspect of port governance can be explained using the matching framework (Baltazar & Brooks, 2007). Baltazar and Brooks (2007) state that port performance is "a function (output) of the match (or fit) among the characteristics of the organization's external operating (or task) environment, strategies, and structures" (p. 384). The matching framework is based on the contingency theory of organizations which posits that an organization's structure is based on how well it fits with its environment (Donaldson, 2001). As the environment changes, the organization's structure and strategies must also change in order to maximize performance. The dependent variable (performance) is measured by cost

efficiency and effectiveness which limits the matching framework to evaluations of the fiscal performance element of port governance. The matching framework is illustrated in Figure 2-1.

Figure 2-1. *The matching framework*



From Baltazar, R., & Brooks, M. R. (2007). Port governance, devolution and the matching framework: A configuration theory approach. In M. R. Brooks & K. Cullinane (Eds.), *Research in Transportation Economics (*Vol. 17, pp. 379-403). Boston: Elsevier.

Thus, the obvious limitation is the lack of a model of port governance that takes into account the many constraints that public seaport directors and governing boards must circumvent in order to provide port services. Bös (1986) points out that public enterprises such as ports are subjected to four constraints that are not necessarily connected to private firms. First, public ports must consider the demand side when making sourcing decisions. Services must continue to flow in a manner that is most beneficial to existing port industries and economically beneficial to the public while considering future needs of the current and prospective industries and the wellbeing of the citizens.

Second, Bös (1986) explains that inefficient production in the private sector is usually not tolerated, but it is often considered an acceptable cost of achieving policy objectives in the public sector. If U.S. seaports are operating in a steward-like manner, the subordination of the profit motive to regional public benefits could give the appearance of inefficient productivity. Third, public enterprises do not have the financial autonomy that private firms enjoy. A private firm can maximize profits as its primary objective, but a public enterprise must operate in a financially responsible manner, only accruing the revenue it needs to operate and using the revenue to reinvest in the port region. A port is a public asset, and, even though capital is needed for modernization of facilities and upgrades to technologies, the wellbeing of its constituents is the primary objective. Fourth, private enterprises are less likely to be impacted by the political environment. For instance, Bös (1986) states that maintaining employment levels in the public sector can be a directive from an elected official, but, in the private sector, this will usually result from "indirect instruments of subsidization, public purchasing, and moral suasion" (p. 18). Developing a comprehensive, explanatory model of U.S. seaport governance that uses extant ideologies from both the economics and public administration fields is possible. It seems evident that, in addition to a seaport's economic performance, achievement of other public objectives also holds significant importance for a port region's citizens. However, the lack of analyses in the relationships between ports' objectives and the nuances of governance remains an obstacle to a holistic understanding of U.S. seaport performance. Understanding governance in a manner that captures both the perspectives of the economic and administrative men is essential in developing a comprehensive model for analyzing U.S. seaport governance.

Chapter Summary

This chapter explained the literature used to formulate the foundation for analyzing U.S. seaports. Public port authorities are stewards of resources that belong to the citizens of the port regions. In order to shepherd public resources into the future, these stewards should exhibit entrepreneurial behavior when focusing on sustainability. In the case of public port authorities, profit seeking behavior and stewardship are not mutually exclusive. These public enterprises rely on the operating perspectives of both Administrative (Simon, 1957) and Economic (Mill, 1836) Men.

Because of the publicness of U.S. seaports and the necessity to be self-sustaining in a capitalist market, an interdisciplinary approach was used to gain an understanding of the seemingly competing objectives of managing public resources and profit-seeking organizations. These notions are also known as public and corporate governance. Furthermore, most seaports in the U.S. are limited operating ports (Fawcett, 2007) comprised of public and private actors that might share decision-making authority instead of leaving it to the sole discretion of government actors. This is a unique operating environment that demands a novel analytical approach in order to gain insight that is transferable from theory to practice. Therefore, variables were developed at the end of the chapter that are intended to measure seaports' performance, in terms of accomplishment of common missions, while using metrics from the competing notions of public and private organizations as bases for measurement. Chapter 3 further develops the measures identified in this chapter and explains a method for answering this dissertation's research questions.

CHAPTER 3:

METHODOLOGY

Chapter 1 provided an introduction to the U.S. public seaport context, described the gap of U.S. seaport analyses in the port governance literature, and provided justification for the importance of this dissertation. Chapter 2 discussed how the U.S. seaport governance context differs from other countries, reviewed stewardship theory and its relevance to this application, compared competing notions of governance to develop a holistic understanding as it relates to public resource management, and put forth a foundation for analyzing U.S. seaport governance. This chapter reviews the research purpose and questions, details the data collection and analysis plan, develops the research design, and describes the methodology. The limitations of each method are discussed in turn.

Research Purpose and Framework

Research Purpose

The purpose of this research is to increase the body of knowledge in port governance by analyzing how U.S. public seaports are governed. The specific objectives of this research are: 1) determine the common mission elements amongst public seaports; 2) examine the relationships between port performance and the common mission elements; and 3) analyze the behavior of U.S. public seaports for steward-like characteristics.

Research Questions

This dissertation addresses three research questions: First, what are the common elements of governance within the mission statements of U.S. public seaports? Second, are the common mission elements within the mission statements of U.S. public seaports reflective of

seaport performance? And lastly, do U.S. public seaports' governing boards exhibit stewardship behavior?

Conceptual Framework

This dissertation puts forth a conceptual framework of U.S. seaport governance derived from the common mission elements identified during the content analysis of seaports' mission statements. Essentially, this research determines the common objectives of U.S. public seaports and measures how well ports accomplish those objectives. The common mission elements among U.S. public seaports were determined to be economic development, environmental stewardship and financial sustainability. If seaports exist to accomplish these missions, evidence of accomplishment will be detectable when analyzing relevant performance metrics across port regions.

Research Design

Research Philosophy

Important aspects to consider in any research project are the fundamental beliefs of the researcher regarding the nature of reality. In essence, a researcher should understand their own beliefs on what reality is, objective or otherwise, and how the truth being sought might be revealed (i.e. methodology). Any knowledge acquired is more robust when phenomena are analyzed through multiple ontologies and epistemological traditions. Each tradition can result in exploration from a unique perspective which facilitates a layered approach to the acquisition of knowledge over time. The research presented here offers a few layers from a realist perspective. According to Riccucci (2010), in the logical positivist tradition "reality is obtainable by empirically testing and *verifying* logically derived hypotheses" (p. 100). Reality, in this school of thought, is defined by a set of universal laws that are assumed to be independent of the

researcher. This independence creates an environment that facilitates analyses which are presumed to be external to and uninhibited by researcher influence (Guba & Lincon, 1989).

Contrary to the realist perspective lies a valid postmodern argument on the nature of the universal laws. Are these laws truly universal? Kuhn (1996) challenged the assumption that humans can truly know universal laws on the grounds that everything humans observe is from their own socially-constructed viewpoint. Therefore, how could such grand and commonly accepted laws exist that describe a true reality? This research rejects this postmodern view of the world for two reasons: 1) scientific successes in the fields of public administration and port governance have been based on commonly accepted methods of inquiry found in the relevant fields of study; and 2) the need to perform a descriptive analysis of U.S. public seaport governance in a manner that lends itself to future comparative analyses of other nations' seaports.

Justification of Research Design

The purpose of this research is to increase the body of knowledge in world port governance by analyzing how seaports in the U.S. are managed. Currently, no study exists that defines how U.S. seaports are administered, nor does any extant research lay out a set of benchmarks encompassing the totality of what citizens can expect from these public assets. This purpose is realized by making use of existing methodologies to define the mission elements that U.S. public seaports hold in common, and assess how the ports accomplish those missions.

In order to determine the salient objectives of U.S. public seaports in the current context, an inductive analysis was used to compare and contrast U.S. seaports' mission statements in an effort to identify commonalities that can be used to generate testable hypotheses. The remainder

of the dissertation makes use of quantitative methods to test hypotheses regarding seaports' common mission elements.

Unit of Analysis

According to Miller (2005), the "unit of analysis identifies the level with which numbers are reported" (p. 55). The unit of analysis for this research is the "public port authority." Referring to Figure 1-1, port authorities are decision-making bodies that govern seaport management. Port directors manage the public assets using the legitimate power and administrative discretion granted by the port authorities' boards of directors to accomplish stated missions. Therefore, this research uses the notion of mission accomplishment to develop a set of metrics that determine if U.S. seaport authorities make good on their common, specified objectives.

Research Approach

This research is an exploratory study into U.S. seaport governance which employed a mixed methods approach, relying primarily on a quantitative design. Stage 1 is a content analysis of U.S. seaports mission statements which determined the operating objectives (elements) commonly held as being important to U.S. public seaports. Stage 2 employs panel data regressions to analyze the relationships between ports' performance (annual cargo throughput) and economic indicators at the MSA level. Stage 3 also uses panel data regressions to study the relationship between port performance and air quality indicators at the county level. Stage 4 employs factor analysis to develop factor variables based on commonalities amongst seaports' financial ratios. The ratios with the strongest parent factor correlations are then used to set benchmarks and explain U.S. seaports' financial sustainability.

Research Methods

This section explains the research methods used to arrive at the study's findings. First, the content analysis conducted at the onset of this research to arrive at the common mission elements is described in detail. Second, the estimation process for the measuring seaports' economic impacts is detailed along with the concerns and mitigations for timeseries data. This process uses panel regressions and a series of tests designed to mitigate the concerns for endogeneity and spuriousness inherent in longitudinal regression models. Third, environmental stewardship is assessed using the same methodology as Stage 2. Fourth, the financial sustainability mission is assessed using factor analysis to identify relevant metrics for gaging financial health and evaluating those metrics to explain mission accomplishment. Lastly, a concise summary of this dissertation's analytical methods will be offered.

Data Collection

This research employs both qualitative and quantitative data to answer the research questions. The qualitative data was collected over the course of calendar year 2016 and contains public seaports' current mission statements for 59 seaports. The quantitative data support analyses of the three common mission elements: economic development, environmental stewardship, and financial sustainability. This data was collected in order to analyze change over time for the period of 2006 through 2015.

The population of interest is all public-owned seaports in the United States. A review of the World Port Source (2016) online database indicates a sample frame of 71 ports matching the seaport definition in Chapter 1.[20] The qualitative data includes mission statements from 59 public

[20] The term "seaport" describes a trade facility located in a coastal area or on a Great Lake where seagoing vessels transfer cargo and passengers between the shore and sea. Seaports are situated along coastlines often enclosed by protected harbors and can be inside of navigable sounds with access to the sea.

seaports and sample selection for each quantitative database was determined by data availability. The economic impact database is a 10-year panel of data for 49 seaports, the environmental impact database is a 10-year panel of data for 50 seaports, and the financial sustainability database includes 10 years of data from 43 seaports.

The data used in this research is described in four different categories: seaport data, economic development data, environmental stewardship data, and financial sustainability data. All data was originally reported in calendar years with the exception of government spending and ports' financial data. These data were converted to calendar year format by determining the monthly averages of each applicable figure and summing the appropriate months to coincide with the calendar year format.[21] Data collection for each category are explained below.

Seaport data.

Seaport data includes cargo throughput in short tons, the geographic location (latitude, longitude, and physical addresses) of each seaport, and published mission statements. The cargo throughput data provides the key indicator of port performance, and neighboring seaport cargo throughput data helps capture the competitive environment between seaports. The latitude and longitude of each seaport are used to calculate distances between ports to control for rival ports' economic impacts in the region. The cargo throughput and location data were downloaded from the U.S. Army Corps of Engineers (USACE) Waterborne Statistics Center (2016).

All U.S. public seaports' mission statements were obtained through an internet search of seaports' websites where the statements were published or located in correspondence residing on the website.[22] The master list of U.S. seaports was downloaded from the World Port Source

[21] Government spending data was reported in the federal fiscal year format (1 October – 30 September) and port annual financial reports ended their fiscal years on the last days of March, April, June, September, and December.
[22] This study assumes that the mission statements published by each port are relevant across the duration of this study (2006 through 2015).

(2016) database which included 106 facilities labeled as seaports. Thirty-five facilities were removed from the master list: eight that did not match the definition of a seaport explained in Chapter 1, due to location and purpose; and 27 small seaports with non-continuous cargo data maintained by the USACE Waterborne Commerce Statistics Center.[23] This analysis yielded 71 continuously operating seaports for the period under study that make up the population of U.S. seaports, and 59 of which had published mission statements (83.1 percent). All U.S. seaports analyzed for this dissertation are described in Appendix A, Table A-2.

Econometric data.

Economic development data was collected at the MSA level from four online databases: GDP and inflation data were downloaded from the U.S. Department of Commerce - Bureau of Economic Analysis (2016); the U.S. Department of Labor - Bureau of Labor Statistics (2016) provided data for analysis of employment and weekly wages; secondary school enrollment data was collected from the U.S. Census Bureau; and federal government spending data was obtained from USAspending.gov (2017). The economic development data accounted for 49 U.S. seaports and their surrounding MSAs.

Environmental data.

Environmental stewardship data was collected at the county level from the EPA’s (2016a) online data repository for annual air quality index summaries and ozone concentrations. The weather data used in the environmental stewardship model was obtained from the National Oceanic and Atmospheric Administration’s (2017) online Climate Data Search Engine. County level unemployment rates were downloaded from the U.S. Bureau of Labor Statistics (2016).[24]

[23] Previous studies have also excluded small ports where cargo throughput was negligible or not available for a meaningful amount of time (Bottasso et al., 2013; Shan et al., 2014).

[24] The land area values reported by the U.S. Census Bureau in 2010 did not change from the values reported in the 2000 census for the counties used in this study.

Data on the presence of large fires (≥100,000 acres) was collected from the National Interagency Fire Center (2017); however, no large fires were reported in the counties or adjacent counties of the ports under study and was therefore discarded. Air quality regulatory periods were identified using historical data collected from the EPA's (2017a) National Ambient Air Quality Standards (NAAQS) historical regulations tables for criteria air pollutants. The environmental sustainability dataset includes 50 of 71 U.S. seaports (68 percent).

Financial data.

All financial data used in this study was obtained directly from each seaport or State Auditor's office. Since the seaports used in this research are public, Comprehensive Annual Financial Reports (CAFR) were made available by nearly every seaport contacted. However, due to differing records retention laws across all of the states in the study, not every seaport could produce sufficient data to cover the entire 10-year period. Additionally, some port authorities' CAFRs covered multiple ports that could not be broken down to component ports. The financial data for this dissertation covers 43 of 71 U.S. seaports (61 percent).

Missing data.

Missing values in longitudinal research come in two forms: within wave and when an entire wave is missing (Young & Johnson, 2015). This research experienced within-wave missing values - two average annual temperature values for the Port of Anacortes, WA (0.4 percent). Due to the small sample of ports being used in the study, this data is not ignorable because missing values lead to omission of ports in a sample that cannot afford to omit any

cases. Therefore, cold deck imputation as described by Hair, Black, Babin, and Anderson (2010) is employed to remedy the missing value problem.[25]

Additionally, air quality data for four counties were not available in a manner that covered the entire longitudinal period. Again, cold deck imputation is used to replace the missing county-level values with MSA-level values. The missing data is further explained in the Measuring Environmental Impacts section.

Content Analysis of Mission Statements

This section describes the process used to reveal the common elements found within U.S. public seaports' mission statements. Mission statements describe what can be expected from an organization (David et al., 2014), and in the case of public port authorities, missions are obligations to the citizenry they serve. This stage of the research makes an inquiry into what U.S. seaports claim as their purposes for existence so that further analyses can be conducted to determine how well seaports accomplish commonly stated missions. This qualitative data analysis is a necessary precursor for the subsequent analyses in this dissertation.

An analysis is conducted on the mission statements of 59 public seaports in order to find commonalities. A method is needed which provides rigor and repeatability to the analysis where the results are reliably derived from within the data. Also, the mission statement data are composed primarily of bullet points and simple sentences describing each seaports' set of missions, but there are some seaports that offer a larger narrative-type description of their missions. This characteristic of the data obfuscates a simple, side-by-side comparison of mission

[25] Cold deck imputation refers to using data from another source (Hair et al., 2010), and in these cases the missing annual average temperature was retrieved from the Weather Underground (2017) historical weather database and the ozone data was retrieved from the EPA's MSA-level database.

statements and calls for a method that is comprehensively sufficient to discover common elements within larger narratives.

Thematic analysis “is a method for systematically identifying, organizing, and offering insight into patterns of meaning (themes) across a data set” (Braun & Clarke, 2012). Once the patterns of meaning are identified, the extraneous information is removed and the relevant themes are further analyzed to determine common mission elements. In this research, the resulting themes of this analysis are the common elements within seaports’ mission statements.

A thematic analysis is typically conducted on larger narratives and in its application here, most of the themes (common elements) being examined are in a form that is concise and direct. This simplifies the search for commonalities in many cases, but not throughout all of the seaports in the database. Therefore, a thematic analysis is conducted as espoused by Braun and Clarke (2012), to reveal the common mission elements whether explicitly stated or offered in a narrative. The following steps are taken to reveal the common mission elements: 1) familiarizing one’s self with the data; 2) generating initial codes; 3) searching for themes; 4) reviewing potential themes; 5) defining and naming themes; and 6) producing the report. The results of the thematic analysis were used to develop the Conceptual Framework of Port Governance illustrated in Figure 1-1.

Researcher bias.

In qualitative research, the investigator acts as the primary research tool, and the research is susceptible to internal biases. Therefore, it is compulsory to identify personal bias prior to conducting qualitative research. The author of this dissertation has a seafaring background and was employed at a public, inland waterway port. The seafaring experience includes 21 years in the U.S. Navy as a surface vessel operator in multiple shipboard positions. Operating naval

vessels is not the same as operating a port authority, but there is a familiarity with port operations that could skew results based on assumptions. Therefore, it became evident that during the content analysis nothing could be assumed. Every result had to be derived from the data through rigorous analytics.

The researcher can exhibit bias stemming from previous employment. This bias is considered because the researcher was employed as a Deputy Director at a public port authority while drafting this dissertation. Although the researcher has experience working in a port authority, not every port is operated in the same manner. Again, the concern is making assumptions based on experience and not rigorous analytics. Therefore, these biases point out the need for an analytical method that will inductively determine the common mission elements within seaports mission statements.

Steps to identify themes.

The sections that follow are the steps taken to arrive at the common mission elements.

1) Data familiarization.

The words used by U.S. seaports to declare mission statements vary from port to port, but the meanings are similar. For example, rather than stating "economic development and growth" as a mission, seaports could use terms like "business development" and "create jobs" or even "economic vitality." Additionally, some U.S. seaports have unique missions which are designed to serve special purposes for their regions such as modernization of waterway infrastructure and multimodal port access. These special missions are important but might not be common amongst all seaports in the United States. Because of the varying terminology, each U.S. seaport's mission statement had to be compared with other seaports to arrive at a standardized list of

missions that can be described as common amongst the seaports in the dataset. Therefore, a data reduction technique was needed to compare and contrast varying mission statements.

2) Generating initial codes.

After becoming familiar with the mission statements, it is necessary to identify initial codes, which are concise representative meanings of the data (Braun & Clarke, 2012). The coding method is an iterative process where seaports' mission statements are analyzed and appropriate chunks of words that best represent the meaning of each port's mission statements are parsed out into temporary categories based on intent or meaning. At this point, the codes revealed serve as a simple means of identifying elements with similar meanings which are parsed into seven initial categories: Economic Development, Public Stewardship, Trade, Environmental Stewardship, Financial Sustainability, Quality of Life, and Recreation. The results of the initial coding process are illustrated in Appendix A, Table A-1.

3) Searching for themes.

After parsing the codes into initial categories or themes, further refinement was conducted to minimize overlap (or drift) between the initial themes. Creswell (2014) defines drift as "a shift in the meaning of the codes during the process of coding" (p. 203). There are many different manners in which seaports' missions can be stated which required multiple iterations and accurate record keeping for each coding session. These records are reviewed prior to each subsequent coding session in an effort to avoid drift in the meanings of the codes.

4) Reviewing potential themes.

Seven themes were initially identified during the coding in Steps 1 and 2, and during Step 3 it became evident that some of the themes exhibited crossover with other themes. For instance, trade is a fundamental purpose of a port and is captured through port performance. Talley (2009)

explains that seaports are the interface between oceangoing vessels and the hinterlands, and trade, which is typically measured using imports and exports, is undertaken to bolster economic development. Additionally, according to Feldman et al. (2016) and Schumpeter (1934), quality of life is an element of economic development. Therefore, the codes that make up the trade and quality of life potential themes are reassigned to economic development.

The public stewardship potential theme also exhibits a large amount of overlap with economic development, yet the connection is not immediately recognizable. The explanatory concept behind this research is stewardship theory which posits that in principal-agent relationships, the interests of both principals and stewards are in alignment (Donaldson & Davis, 1991). In fact, one could posit that public port authorities in the U.S. take on missions intended to benefit the community which makes them stewards of public resources as a central and continually occurring duty. The act of sustainably managing a seaport to bolster a regional economy while protecting the surrounding natural environment is the essence of stewardship. Therefore, the public stewardship theme was collapsed into the economic development theme.

Lastly, the public recreation theme is cited as a mission by seaports located in the Great Lakes and small coastal seaports. Initially, this theme was disregarded. However, after spending 15 months in the field, the importance of recreation for the citizenry became more evident. Not every port is concerned with public recreation, but there could be a sufficient number of ports in the U.S. where a comparative analysis of its efficacy might be beneficial. The prevalence of the theme is insufficient to include as a common mission element in this research, but the mission is clearly relevant to certain seaports and could be considered in future research that includes small coastal and inland waterway ports.

5) Defining and naming themes.

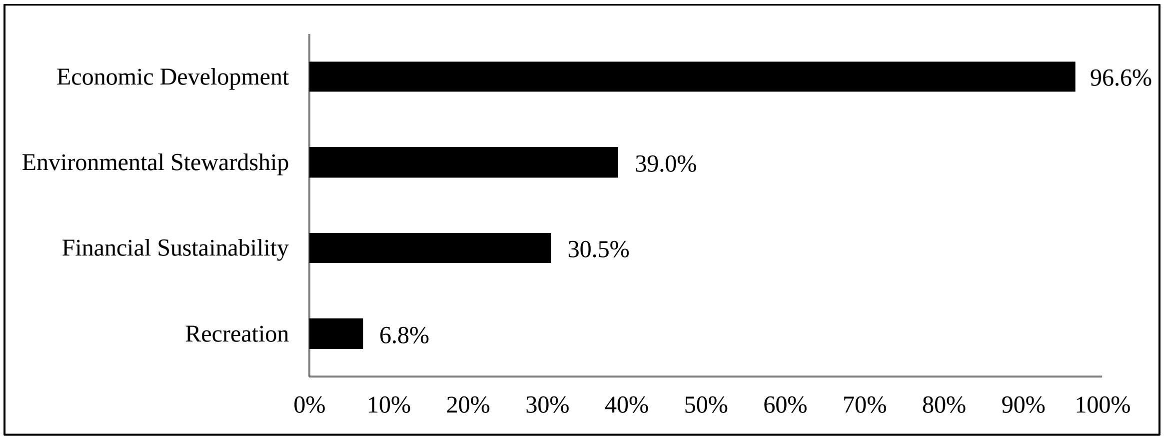
The names of the themes are taken directly from the mission statements' verbiage found to be predominant. For instance, the term "economic development" is used by 17 different seaports when describing the economic mission, and likewise "environmental stewardship" is found eight times. "Financial sustainability" appears one time less than "fiscal responsibility"; however, the former term and the definition developed in Chapter 2 represents a more holistic perspective that encompasses fiscal responsibility.[26] The recreation theme is specifically called out by four port authorities: Erie-Western Pennsylvania Port Authority, Port of Kalama Commission, San Diego Unified Port District, and San Francisco Port Commission.

6) Producing the report.

The common themes found within each seaport's mission statement are reported in Appendix A, Table A-2 which are referred to as the "Common Mission Elements." In summary, the initial coding allowed for the discovery of word chunks having similar meanings which became potential themes. The potential themes were then analyzed routinely for crossover or drift in meaning and, consequently, the number of potential themes was reduced. The final themes that emerged are Economic Development, Environmental Stewardship, Financial Sustainability, and Recreation which are illustrated in Figure 3-1.

[26] Public seaport financial sustainability is the financial capacity of the port to meet its current obligations, to withstand shocks, and to maintain service, debt, and commitment levels at reasonable amounts relative to both state and local expectations and likely future income, while maintaining public confidence.

Figure 3-1. *Prevalence of common mission elements*



Reliability and validity.

This stage of the research is especially concerned with measurement reliability and validity. Gibbs (2007) explains that reliability refers to the consistency of the approach taken by the researchers across different projects. The content analysis of mission statements required an iterative procedure that reliably identified similarities between seaports' mission statements. Additionally, the research should ensure the measures being employed accurately represent the constructs of interest. Remler and Van Ryzen (2015) call this construct validity: "how well the measure represents the true construct of interest" (p. 106). The method used to arrive at the common mission elements must be trustworthy and accurately represent the data. Because of these concerns, certain steps were taken to mitigate threats to reliability and validity which are discussed below.

Reliability.

In an effort to mitigate concerns for reliability, a few methods were used to strengthen the consistency of approach when translating raw data to codes and codes to themes. First, an

existing, consistent, and scholarly accepted process for thematic analysis was applied (Braun & Clarke, 2012) throughout the mission statement analysis. Second, the maintenance of accurate records allowed for a continuous review of previous code meanings and theme derivations to prevent drift in meaning. Lastly, the meanings of codes were derived from the scholarly literature discussed in Chapter 2. This process ensured that the approach to understanding the meanings of codes was consistent and therefore reliable.

Validity.

In an effort to mitigate concerns for validity, this research used the following methods to ensure accuracy of the findings:

1. Rich and thick description of findings is a method for increasing a study's validity (Creswell, 2014; Hays & Singh, 2012). This technique was used to come to an understanding of the meanings of codes. Additionally, relevant scholarly literature was reviewed to establish a backstop for the meanings of mission statements - a procedure which also helped maintain consistency in the process.
2. According to Creswell (2014), prolonged time in the field "lends credibility to the narrative account [because]…. the more experience that a researcher has with participants in their settings, the more accurate or valid will be the findings" (p. 202). After the initial codes were reviewed and potential themes generated, the researcher spent prolonged time in the field as a Deputy Director of a public, inland waterway port authority in the United States. The position held was not at a seaport, but the perspective gained by operating a public port was relevant to the missions of public port authorities in the United States. The time spent in the field enabled a firsthand perspective of the objectives of public

ports which validated the results of the thematic analysis 15 months after they were first generated.

3. Clarifying the bias a researcher brings to a research project is a method of boosting a quantitative study's validity (Creswell, 2014). The bias the researcher brought to this dissertation was clarified prior to data collection and is summarized at the beginning of this chapter. Additionally, reflexive journaling provides a means of identifying how bias might impact the research (Hays & Singh, 2012). Reviews of previous coding sessions and reflexive journal entries were conducted at the beginning of each coding session to identify any possible bias and monitor how it might impact the thematic analysis.

4. Validity was also upheld through the maintenance of strict discipline in data collection, analyses of codes' meanings, and through the maintenance of an auditable trail of the research.

Limitation.

The primary limitation in this stage of the research is the single researcher aspect. Multiple researchers would produce results from multiple perspectives that could be combined in a manner that lends itself to seemingly greater reliability of the findings. However, due to the gap in the literature it is difficult to understand the publicness of America's seaports without becoming participatory in that environment. Therefore, the field experience component of this dissertation was given greater consideration to mitigate the concern for validity of the findings regarding what U.S. seaports claim as their stated purposes for existence.

Measuring Economic Impacts

Measuring the economic impacts ports have on their host regions can be accomplished through a few different approaches. Scholars have used methods to estimate ports' economic

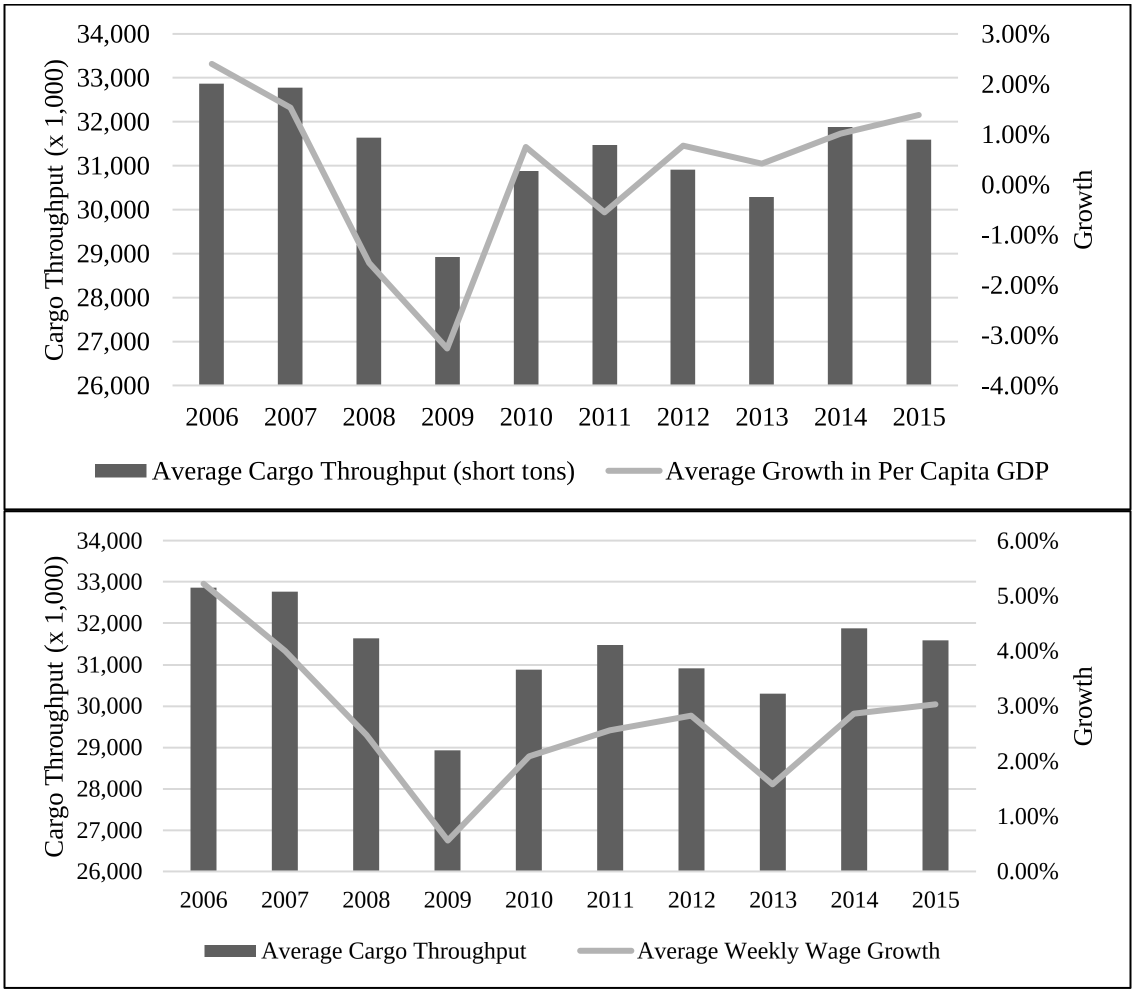
impacts such as the input/output method (Castro & Millán, 1998; Warf & Cox, 1989) and qualitative inquiry (Yochum & Agarwal, 1988). However, recent research has shown a shift towards the use of longitudinal data in panel regressions to monitor changes in economic indicators over time (Park & Seo, 2016; Shan et al., 2014). This dissertation makes use of panel regressions to estimate U.S. seaport's economic impacts on host MSAs over a period of 10 years. Appendix B shows the ports used and their host MSAs.

Figure 3-2 compares average annual cargo throughput with host regions' average economic development and growth exhibited by all MSAs used in this stage of the dissertation. The upper panel of Figure 3-2 illustrates the association between cargo throughput with changes in per capita GDP, an indicator of economic growth ($r = 0.75$, $p < 0.001$). Likewise, the lower panel illustrates the association between average weekly wages, an indicator of economic development, and cargo throughput ($r = 0.93$, $p < 0.001$). These correlations point out a clear and positive association between the amount of cargo moving through seaports (i.e. port performance) and regional economies. Therefore, the following hypotheses will be tested in this stage of the research:

H1: Seaports' cargo throughput has a direct and positive relationship with economic growth in the port region.

H2: Seaports' cargo throughput has a direct and positive relationship with economic development in the port region.

Figure 3-2. *Association between cargo throughput and indicators of economic impacts*



Data and variables.

Data.

A panel of data from 49 seaports and host region MSAs are used to estimate ports' economic impacts between 2006 and 2015. Despite having to omit ports with insufficient data, the ports used in this analysis are geographically representative of the regions where U.S. seaports are typically located. Thirty-seven percent of the ports are located on the West Coast, 27-percent on the Gulf Coast, 24-percent on the East Coast, and 12-percent on the Great Lakes.

Table 3-1 identifies the seaports used in this stage of the research. Appendix B provides an illustration of all seaports used in the quantitative portion of this dissertation.

Table 3-1. *Geographical representation of U.S. seaports used in economic impact analyses*

West Coast (37%)	Gulf Coast (27%)	East Coast (24%)	Great Lakes (12%)
Port of Anacortes, WA	Port Freeport, TX	Port of Jacksonville, FL	Port of Cleveland, OH
Port of Anchorage, AK	Port of Corpus Christie, TX	Port Canaveral, FL	Port of Detroit, MI
Port of Everett, WA	Port of Galveston, TX	Port Everglades, FL	Port of Duluth, MN
Port of Kalama, WA	Port of Gulfport, MS	Port of Albany, NY	Port of Milwaukee, WI
Port of Long Beach, CA	Port of Houston, TX	Port of Baltimore, MD	Port of Monroe, MI
Port of Longview, WA	Port of Mobile, AL	Port of Boston, MA	Port of Toledo, OH
Port of Los Angeles, CA	Port of New Orleans, LA	Port of New York-New Jersey	
Port of Oakland, CA	Port of Panama City, FL	Port of Palm Beach, FL	
Port of Olympia, WA	Port of Pascagoula, MS	Port of Philadelphia, PA	
Port of Portland, OR	Port of Pensacola, FL	Port of Portland, ME	
Port of Redwood City, CA	Port of Port Manatee, FL	Port of Virginia	
Port of Richmond, CA	Port of South Louisiana, LA	Port of Wilmington, DE	
Port of San Diego, CA	Port of Tampa, FL		
Port of San Francisco, CA			
Port of Seattle, WA			
Port of Stockton, CA			
Port of Tacoma, WA			
Port of Vancouver, WA			

Variables.

To estimate whether port activity has an impact on a host MSA's economy, regression models are developed using indicators that measure economic growth and economic development. In this dissertation, economic growth is measured using annual changes in real per

capita GDP (*ΔPCGDP*),[27] and economic development is measured using changes in annual average weekly wages (*ΔWages*). Per capita GDP has been used as the dependent variable in similar studies of port's economic impacts on host region economies (Park & Seo, 2016; Shan et al., 2014). Using annual changes to per capita GDP for port regions in China, Shan et al. (2014) found that cargo throughput has a positive and causal relationship with economic growth. Similarly, Park and Seo (2016) found that cargo throughput Granger causes changes to per capita GDP.

Using per capita GDP to measure economic impacts is also common in studies of airports impacts on host regions. Button and Yuan (2013) found that airfreight transport Granger (1969) causes changes in per capita GDP at the MSA level. This study analyzes the relationship between seaports' cargo throughput and regional economic growth using the methodologies employed by Shan et al. (2014) and Button and Yuan (2013).

The economic development model borrows from Bilotkach (2015), who found that airline passenger traffic volumes are positively related to annual average weekly wages at the MSA level. Bilotkach's (2015) methodology is fundamentally the same used by Shan et al. (2014) and Button and Yuan (2013) with the obvious difference being the substitution of cargo throughput for passenger traffic volumes. Therefore, the aim of this research is to assess the association between seaports' cargo throughput and economic development using changes in average weekly wages (*ΔWages*) as the dependent variable.

The primary independent variable for the models is cargo throughput *(Cargo*) which represents port performance using the amount of cargo moving through each port during a calendar year. In the same manner as Shan et al. (2014) and Park and Seo (2016), the spillover

[27] Real (deflated) per capita GDP is used instead of nominal GDP values in order to control for the effects of inflation.

effects of neighboring ports are controlled for using the combined amount of cargo moving through ports located within 500 kilometers of the host seaport *(NCargo)*.

The control vectors include variables to capture rival explanations of economic growth and development: 1) the influence of government spending is controlled for using the ratio of federal government spending to GDP (*GSpend*); 2) in the economic growth model, the economic convergence effect[28] is controlled for by adding the initial PCGDP value (*t-1*) to the control vector as *iPCGDP* which also accounts for autoregressive behavior in the dependent variable, and, accordingly, the lagged (*t-1*) value of average weekly wages (*iWages*) is used in the economic development model; 3) lastly, the economic impacts of human capital (*HCapital*) are addressed using the MSA-level ratio of the number of people enrolled in secondary education to the total population.[29] All variables used in this stage of the research are explained in Table 3-2.

[28] The convergence effect describes how it is more difficult for larger (better) economies to exhibit growth, than it is for smaller economies (Grossman & Krueger, 1995).

[29] Scholars postulated that economic development occurs through the use of physical capital and human capital (Fisher, 1930; Mincer, 1984). This study estimates the impact of physical capital while controlling for human capital in the same manner as Shan et al. (2014) and Park and Seo (2016).

Table 3-2. *Economic impact variables*

Variable	Description	Units	Source
Changes in Per Capita GDP (ΔPCGDP)	Annual growth in real per capita GDP	Percentage	U.S. Bureau of Economic Analysis
Per Capita GDP (PCGDP)	Annual real per capita GDP	U.S. dollars	U.S. Bureau of Economic Analysis
Changes in Average Weekly Wages (ΔWages)	Annual growth in average weekly wages	Percentage	U.S. Bureau of Labor Statistics
Average Weekly Wages (Wages)	Annual average weekly wages	U.S. dollars	U.S. Bureau of Labor Statistics
Cargo Throughput (Cargo)	Annual amount of cargo moving through a seaport	Short tons	USACE Waterborne Commerce Statistics Center
Neighboring Port's Cargo Throughput (NCargo)	Annual amount of cargo moving through neighboring seaports	Short tons	USACE Waterborne Commerce Statistics Center
Government Spending (GSpend)	Ratio of federal spending to real GDP	Ratio	USASpending.gov, U.S. Bureau of Economic Analysis
Human Capital (HCapital)	Percent of people enrolled in secondary education out of entire population	Ratio	U.S. Census Bureau
Initial PCGDP (iPCGDP)	Initial PCGDP value *(t-1)*	U.S. dollars	U.S. Bureau of Economic Analysis
Initial Average Weekly Wages (iWages)	Initial average weekly wage value *(t-1)*	U.S. dollars	U.S. Bureau of Labor Statistics

Econometric models.

Panel data econometric models are used to analyze the association between port performance and host region economies. Panel data models have a few distinct advantages over other methods of analyzing economic impacts. First, linear panel regressions permit follow-on testing for the direction of causality via the Granger causality test (Granger, 1969). This enables the researcher to assess whether economic development is the cause of increased cargo throughput, and not vice versa. Second, panel models are far more descriptive than cross-sectional models when searching for impacts over time. Third, the regression models permit the

researcher the ability to control for rival hypothesis and estimate the effects of ports' cargo throughput on host regions' economies. The basic panel regression model used in this stage of the research is illustrated as Equation 3.1.

$$Growth_{i,t} = \beta_0 + Cargo_{i,t}^{T}\alpha + Controls_{i,t}^{T}\beta + \eta_{i,t} \tag{3.1}$$

In Equation 3.1 the subscript *i* is the host region index, subscript *t* is the temporal index, superscript *T* is the number of time periods in the index, α and β are the coefficients, and $\eta_{i,t}$ is the residual term. This study assumes the residual term $\eta_{i,t} = \nu_t + \mu_i + \varepsilon_{i,t}$, where ν_t is a time component that captures temporal fixed effects, μ_i is the unobserved fixed effect for each ports' host region, and $\varepsilon_{i,t}$ represents the idiosyncratic error term.

$Growth_{i,t}$ is the dependent variable in Equation 3.1 that represents changes in economic development and economic growth indicators, and β_0 is the constant term. $Cargo_{i,t}$ is the explanatory variable representing port performance and $Controls_{i,t}$ represents the rival explanations of economic development and growth in each host region. Equations 3.2 and 3.3 illustrate the "Baseline" and "Alternate" models used for estimating economic growth and development.

Model (1):
$$\Delta PCGDP_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(NCargo_{i,t}) + \beta_2 \text{Ln}(GSpend_{i,t}) + \beta_3 \text{Ln}(HCapital_{i,t}) + \beta_4 \text{Ln}(iPCGDP_{i,t}) + \eta_{i,t} \tag{3.2}$$

Model (2):
$$\Delta Wages_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(NCargo_{i,t}) + \beta_2 \text{Ln}(GSpend_{i,t}) + \beta_3 \text{Ln}(HCapital_{i,t}) + \beta_4 \text{Ln}(iWages_{i,t}) + \eta_{i,t} \tag{3.3}$$

Using the natural logarithmic forms of variables in econometric models is common amongst economics scholars (Park & Seo, 2016; Shan et al., 2014; Wooldridge, 2016). Shan et al. (2014) report that the logarithmic forms of econometric variables account for a possible non-linear relationship between the dependent and independent variables, as well as ensuring "that the estimated coefficients are robust to the measurement units of the variables" (p. 47).

A note on panel analysis.

Panel data regression models are used in longitudinal research designs to add a level of dimensionality which helps researchers understand differences within and between individual panels. This added dimension was a key factor in developing a model for these analyses because of the ability to estimate U.S. seaports' average contribution to the changes observed in the dependent variables over time. The features that are highly desirable in the estimation process are within group and between group differences. The ability to estimate within individual differences (i.e. fixed effects) is the most attractive panel analysis capability for this dissertation.

There are two main types of panel models in use: fixed and random effects. A third panel model, called mixed-effects, is a combination of both fixed and random effects. These models derive their names from how unobserved differences between panels are treated. Allison (2009), states that "a fixed effects model treats unobserved differences between individuals as a set of fixed parameters that can either be directly estimated or partialed out of the estimating equations…. [whereas in] a random effects model, unobserved differences are treated as random variables with a specified probability distribution" (p.2). Allison (2009) goes on to explain that omitted variables in fixed effects models are allowed to have any kind of relationship with independent variables, and random effects models assume a zero-correlation relationship.

Additionally, fixed effects models allow solely for estimation of within group differences, and random effects models utilize both within and between individual differences.

The economic and environmental impact regressions used in this dissertation are most closely aligned with the fixed effects model for one primary reason: the ability to control for unobserved differences between individuals. The ability to estimate within individual differences permits an analysis of U.S. seaports while controlling for unobservable and time invariant differences between individual seaports. The between individual differences are not estimated in a fixed effects model but removed so that unobservable individual characteristics do not confound the results (Allison, 2009). This allows for a ceteris paribus interpretation, but it should be noted that fixed effects models do not control for individual parameters that change over time. Therefore, the control vector should be robust enough to provide meaningful results by accounting for time variant rival explanations of changes in the response variables.

Limitations.

Panel regression models with time series data pose a few challenging limitations that can lead to spurious findings. First, the presence of unit autoregressive roots in time series data can cause non-stationarity (drift) which, if accepted can lead to a violation of distributional assumptions in regression models (Dickey & Fuller, 1979; Harris & Tzavalis, 1999). This research uses the Harris-Tzavalis test (Harris & Tzavalis, 1999) to identify the presence of unit roots. Second, endogeneity is a constant concern when working with longitudinal models which is largely caused by omitted explanatory variables. The endogeneity threat is addressed through analysis of error terms for heteroscedasticity and cross-sectional dependence. If either are present, estimates are calculated that mitigate model bias.

Third, simultaneity between the dependent and independent variables can lead to spurious findings (Wooldridge, 2002). Once relationships between dependent and independent variables of interest are discovered, directionality of the relationships should be established when possible to support causal inferences. The presence of simultaneity is mitigated using the Granger causality test (1969), as modified by Freeman (1983) to the “more powerful Direct Granger” method (p. 328).

Fourth, model misspecification can lead to biased estimates which raises the potential for spurious findings. Therefore, specifying the most appropriate model for the data is important to help rule out spuriousness in the results. This research addresses this limitation with the Hausman (1978) Specification Test. The Hausman test assesses whether the model used for estimation is appropriate for the data (fixed or random effects).

Fifth, there is a clear issue with omitted variables. Strengthening the models to account for all sources of economic growth and development is not possible with currently available data. Attempts were made to narrow the dataset down to include only the economic impacts on port-related industries, however, data at that level became so granular that the Bureaus of Economic Analysis and Labor Statistics consider some of it confidential. Hence, the data was unobtainable. Because of the omitted variable problem this issue presents, robustness testing is conducted to strengthen the inferences made from the core economic development and growth models (Models 1 and 2).

Lu and White (2014) state that “robustness is necessary for valid causal inference, in that the coefficients of the critical core variables should be insensitive to adding or dropping variables, under appropriate conditions” (p. 195). Nuemayer and Plumper (2017) call this type of

robustness “Leamer” robustness[30] and define it by stating “a baseline model estimate is robust to plausible alternative model specifications if and only if all estimates have the same direction and are all statistically significant” (p. 46). This research uses the Leamer Robustness method to compare models while alternatingly omitting key independent variables which are explained later in this chapter. Core Models 1 and 2 serve as the baseline for the testing. Additionally, Alternate Models are assessed alongside the Core Models where the dependent variables are actual values of the dependent variable in place of percent growth. The alternate models provide a basis for comparison of the core models behavior when omitting variables. Alternate Models 3 and 4 are described in Equations 3.4 and 3.5.

Model (3):

$$PCGDP_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(NCargo_{i,t}) + \beta_2 \text{Ln}(GSpend_{i,t}) + \beta_3 \text{Ln}(HCapital_{i,t}) + \beta_4 \text{Ln}(iPCGDP_{i,t}) + \eta_{i,t} \quad (3.4)$$

Model (4):

$$Wages_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(NCargo_{i,t}) + \beta_2 \text{Ln}(GSpend_{i,t}) + \beta_3 \text{Ln}(HCapital_{i,t}) + \beta_4 \text{Ln}(iWages_{i,t}) + \eta_{i,t} \quad (3.5)$$

Nuemayer and Plumper (2017) are scholars at odds with Leamer Robustness who put forth a method for measuring robustness (ρ) and define it as the degree to which the “probability density function of the robustness test model’s estimate falls within the confidence interval of the baseline model” (p. 37). Once a baseline model is specified, robustness models are estimated by removing key control variables from the baseline model, one at a time, and measuring the degree of robustness for the point estimate of interest. In this research, *Cargo* is the primary independent

[30] According Nuemayer and Plumper (2017), “Edward Leamer was the first to systematically justify robustness testing as a means to tackle model uncertainty without the unrealistic aim of eliminating it” (p. 24).

variable and therefore the point estimate of interest, and all other independent variables are subject to omission except the time-lag used to mitigate autoregressive behavior. The robustness measure, rho (ρ), is on a 0 to 1 scale which identifies what percentage of the robustness model's probability density function of interest lies within the baseline PDF's 95-percent confidence interval. The higher the value of rho, the more robust the point estimate is to shock.This research assesses the robustness of the *Cargo* point estimates in two manners: 1) Leamer robustness is assessed across the Core and Alternate Models, and 2) the degree of robustness (ρ) is measured using the Robustness Models.

In total, 16 models are estimated: The Core Models, 1 and 2 are represented by Equations 3.1 and 3.2, the Alternate Models 3 and 4 represented by Equations 3.4 and 3.5; and the Robustness Models where the independent variables *NCargo*, *GSpend*, and *HCapital* are omitted, alternatingly. Equations 3.6 through 3.17 are the Robustness Models where independent variables are removed to introduce shock to the point estimate of interest (*Cargo*). Leamer robustness and the degrees of robustness for the Core and Alternate Model's *Cargo* variable will be evaluated in this process.

Model (1.a): $$\Delta PCGDP_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(GSpend_{i,t}) + \beta_2 \text{Ln}(HCapital_{i,t}) + \beta_3 \text{Ln}(iPCGDP_{i,t}) + \eta_{i,t} \quad (3.6)$$

Model (1.b): $$\Delta PCGDP_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(NCargo_{i,t}) + \beta_2 \text{Ln}(HCapital_{i,t}) + \beta_3 \text{Ln}(iPCGDP_{i,t}) + \eta_{i,t} \quad (3.7)$$

Model (1.c): $$\Delta PCGDP_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(NCargo_{i,t}) + \beta_2 \text{Ln}(GSpend_{i,t}) + \beta_3 \text{Ln}(iPCGDP_{i,t}) + \eta_{i,t} \quad (3.8)$$

Model (2.a): $$\Delta Wages_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(GSpend_{i,t}) + \beta_2 \text{Ln}(HCapital_{i,t}) + \beta_3 \text{Ln}(iWages_{i,t}) + \eta_{i,t} \quad (3.9)$$

Model (2.b): $$\Delta Wages_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(NCargo_{i,t}) + \beta_2 \text{Ln}(HCapital_{i,t}) + \beta_3 \text{Ln}(iWages_{i,t}) + \eta_{i,t} \quad (3.10)$$

Model (2.c): $\Delta Wages_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(NCargo_{i,t}) + \beta_2 \text{Ln}(GSpend_{i,t}) + \beta_3 \text{Ln}(iWages_{i,t}) + \eta_{i,t}$ (3.11)

Model (3.a): $PCGDP_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(GSpend_{i,t}) + \beta_2 \text{Ln}(HCapital_{i,t}) + \beta_3 \text{Ln}(iPCGDP_{i,t}) + \eta_{i,t}$ (3.12)

Model (3.b): $PCGDP_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(NCargo_{i,t}) + \beta_2 \text{Ln}(HCapital_{i,t}) + \beta_3 \text{Ln}(iPCGDP_{i,t}) + \eta_{i,t}$ (3.13)

Model (3.c): $PCGDP_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(NCargo_{i,t}) + \beta_2 \text{Ln}(GSpend_{i,t}) + \beta_3 \text{Ln}(iPCGDP_{i,t}) + \eta_{i,t}$ (3.14)

Model (4.a): $Wages_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(GSpend_{i,t}) + \beta_2 \text{Ln}(HCapital_{i,t}) + \beta_3 \text{Ln}(iWages_{i,t}) + \eta_{i,t}$ (3.15)

Model (4.b): $Wages_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(NCargo_{i,t}) + \beta_2 \text{Ln}(HCapital_{i,t}) + \beta_3 \text{Ln}(iWages_{i,t}) + \eta_{i,t}$ (3.16)

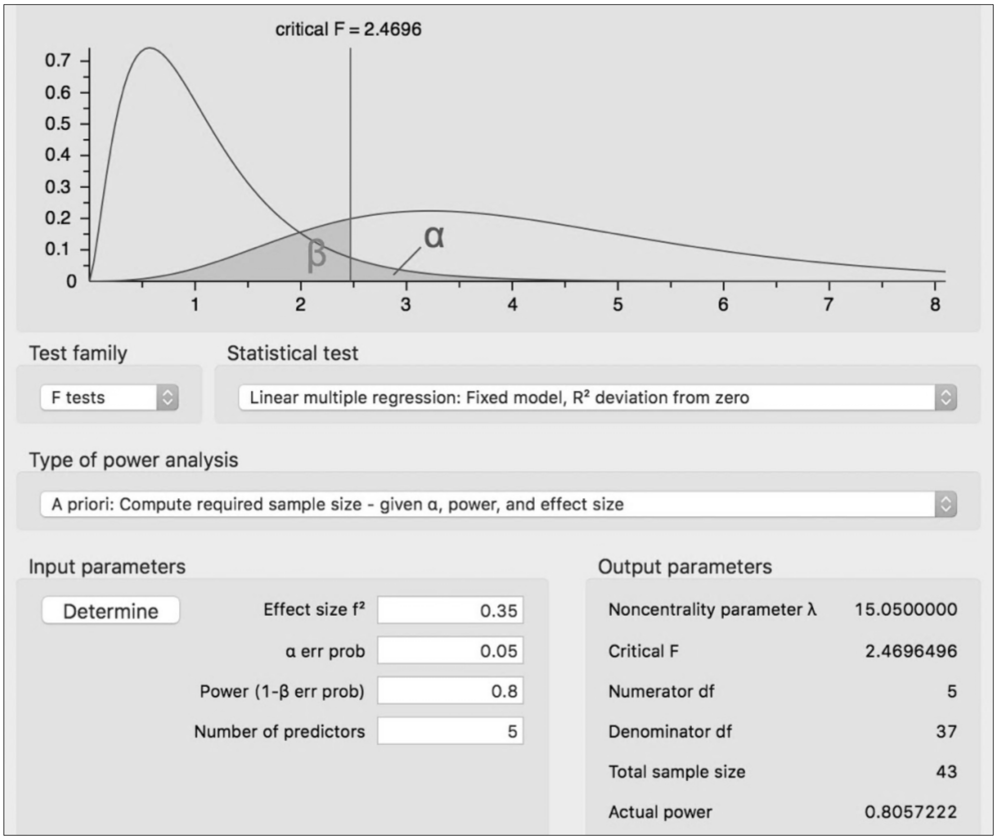
Model (4.c): $Wages_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(NCargo_{i,t}) + \beta_2 \text{Ln}(GSpend_{i,t}) + \beta_3 \text{Ln}(iWages_{i,t}) + \eta_{i,t}$ (3.17)

Lastly, the small sample size in this stage of the research is cause for concern that a Type II error[31] may occur when interpreting the results. This research is a small sample study ($n = 49$), but large enough to employ the panel regression method described in the previous sections. Cohen (1988) suggests that research designs incorporate alpha levels *(α)* of 0.05 with 80 percent power, and he set guidelines for effect sizes *(f^2)* of 0.02 (small), 0.15 (medium), and 0.35 (large). In order to achieve Cohen’s suggested values, care must be taken to select the appropriate sample size that permits detection of a sufficient effect size. Therefore, following the advice of Faul, Erdfelder, Buchner, and Lang (2009), this research uses G*Power (Version 3.1.9.2) to calculate the necessary sample size to detect an effect at an acceptable benchmark ($f^2 \leq 0.35$). Figure 3.3

[31] Hair et al. (2010) state that a Type II Error is “the probability of incorrectly failing to reject the null hypothesis” (p. 3).

illustrates the results of the power analysis using G*Power and the required sample size (n = 43) to attain acceptable α, statistical power, and f^2 benchmarks.

Figure 3-3. *G*Power results of sample size analysis for economic impact models*



Measuring Environmental Impacts

Measuring the environmental impacts ports have on their host regions is a difficult task due to the inability to control for rival hypotheses. There are numerous anthropogenic sources that impact air quality in metropolitan areas. For instance, some U.S. seaports are collocated with

U.S. Navy bases where naval vessels impact air quality through combustion of diesel fuel.[32] This concern is mitigated by the Navy's policy to shut down engines once the vessel is in port (EPA, 2017b), a procedure known as cold ironing. Also, most U.S. seaports are located in large metropolitan areas where industries, commuter traffic, and large populations that rely on energy for heat and electricity further confound the omitted independent variable problem. In the introduction to *Environmental Statistics: Methods and Applications*, Barnett (2005) explains the challenge of attempting to measure variables in an environment where so many things are occurring simultaneously, yet he states that "no matter how awesome [the challenge], it must be faced!" (p.1). In order to move knowledge forward, this dissertation will face the challenge described by Barnett while addressing the omitted variable limitations.

In recent history scholars have begun to tackle the difficulties of controlling for unobserved causes of variance using panel data studies. Davis (2012) uses a mixed modeling approach to estimate the impacts of economic trends on air pollution in California. Additionally, Yang (2012) and Pao (2011) use cointegration and Granger causality testing to understand the impacts and directionality of relationships between air pollution and economic growth in China and BRIC countries (Brazil, Russia, India, and China). Similarly, this dissertation makes use of panel analyses methods to estimate U.S. seaports' associations with local air quality over a 10-year period.

[32] Nearly every U.S. naval vessel relies on the combustion of marine grade diesel fuel for propulsion and electricity (iENCON, 2017) while not connected to shore services. The exceptions to this are nuclear powered submarines and aircraft carriers.

Data and variables.

Data.

A panel of data from 50 seaports and host region counties are used to estimate ports' impacts on local air quality as a surrogate for environmental stewardship between 2006 and 2015. Like with the economic impact models, the seaports used in the environmental stewardship analyses are representative of the regions where U.S. seaports are typically located. Appendix B matches host ports with their relevant counties. Thirty-six percent of the ports are located on the West Coast, 26 percent on the Gulf Coast, 24 percent on the East Coast, and 14 percent on the Great Lakes. Table 3-3 identifies the seaports used in this stage of the research.

Table 3-3. *Geographical seaport representation in environmental stewardship analyses*

West Coast (36%)	Gulf Coast (26%)	East Coast (24%)	Great Lakes (14%)
Port of Anacortes, WA	Port Freeport, TX	Port Canaveral, FL	Port Conneaut, OH
Port of Everett, WA	Port of Corpus Christie, TX	Port Everglades, FL	Port of Ashtabula, OH
Port of Kalama, WA	Port of Galveston, TX	Port of Albany, NY	Port of Cleveland, OH
Port of Long Beach, CA	Port of Gulfport, MS	Port of Baltimore, MD	Port of Detroit, MI
Port of Longview, WA	Port of Houston, TX	Port of Boston, MA	Port of Duluth, MN
Port of Los Angeles, CA	Port of Mobile, AL	Port of Jacksonville, FL	Port of Milwaukee, WI
Port of Oakland, CA	Port of New Orleans, LA	Port of New York-New Jersey	Port of Toledo, OH
Port of Olympia, WA	Port of Panama City, FL	Port of Palm Beach, FL	
Port of Port Angeles, WA	Port of Pascagoula, MS	Port of Philadelphia, PA	
Port of Portland, OR	Port of Pensacola, FL	Port of Portland, ME	
Port of Redwood City, CA	Port of Port Manatee, FL	Port of Virginia	
Port of Richmond, CA	Port of South Louisiana	Port of Wilmington	
Port of San Diego, CA	Port of Tampa, FL		
Port of San Francisco, CA			
Port of Seattle, WA			
Port of Stockton, CA			
Port of Tacoma, WA			
Port of Vancouver, WA			

This stage of the research had to account for missing data. Average annual temperature values for Skagit County, Washington (Port of Anacortes) were not available from the same source. Two annual temperatures totaling 0.4 percent of the host variable's data were missing. In order to retain the port for this analysis, cold deck imputation was used to obtain the missing values. The missing annual temperature values were obtained from the Weather Underground (2017) online historical weather database.

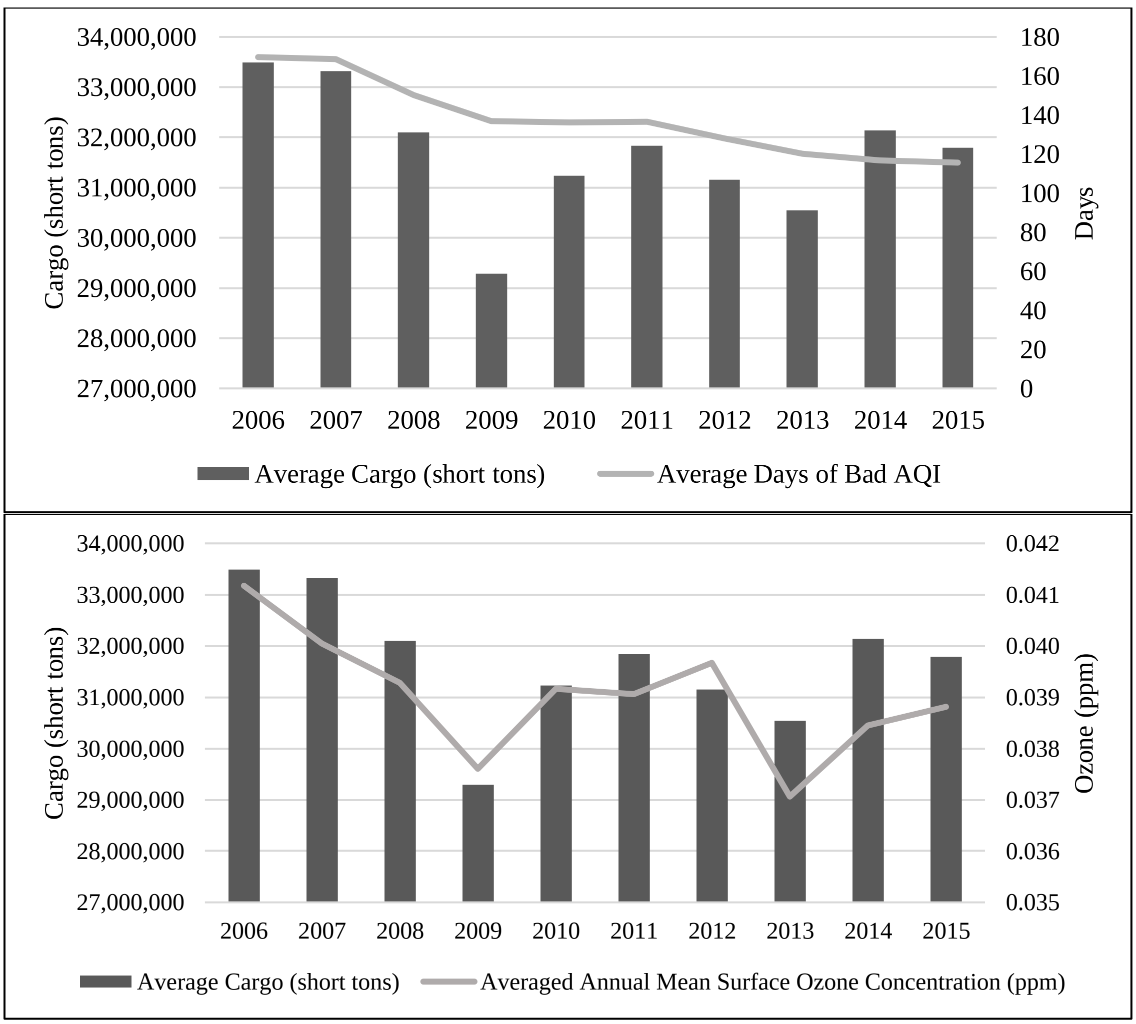
County-level ozone data covering the entire period of study were unavailable for six seaports' totaling 14.0 percent of the host variables' data. The ports include: Port of New York-New Jersey (New York County); Port of Virginia (City of Norfolk); the Port of Everett, Washington (Snohomish County); the Port of Port Angeles Washington; and the Ports of Kalama and Longview in Washington (Cowlitz county). Therefore, using cold deck imputation as described by Hair et al. (2010), MSA-level data was substituted. In the case of the Ports of New York-New Jersey and Virginia, the substitution seems reasonable for geospatial reasons. These ports are comprised of multiple terminals in multiple cities. Therefore, the impacts of cargo moving through the port would not be localized to the areas where the seaports' headquarters are located. Also, the Ports of Kalama and Longview are both located in the same county on the Columbia River which separates Cowlitz County, Washington from Columbia County, Oregon. The impacts to air quality are not expected to be localized to Cowlitz County alone but spread throughout the Portland-Vancouver-Salem, OR-WA MSA where these ports reside.

Trends in air quality.

To illustrate seaports' impacts on host counties' environments, averaged annual data for U.S. seaports' cargo throughput and the number of days that county-level air qualities are considered to be "Bad" are compared in the top panel of Figure 3-4. Air quality index levels are

considered to be good for human health if the index values do not exceed 50 (EPA, 2017a). Figure 3-4 shows a moderate association between the average amount of cargo moving through U.S. seaports and average local air quality ($r = 0.60$, $p < 0.001$) which indicates a need for deeper analysis.

Figure 3-4. *Association between cargo throughput and air quality indicators*



Further investigation is needed because AQI values are collectively comprised of what the EPA (2017a) has termed Criteria Air Pollutants.[33] Criteria pollutants are not monitored standardly across all seaports' host regions, nor are all of the criteria pollutant's byproducts of diesel fuel combustion. However, there is one pollutant indicative of diesel fuel combustion that is standard across a sufficient number of seaports that lends itself to casual analysis: Ozone (O_3).

Diesel engines' high compression ratios cause emission of disproportionally higher levels of Nitrogen Oxides (NO_x) than gasoline engines, which is a precursor condition for the formation of surface-level ozone (Krivoshto et al., 2008). After averaging the mean annual ozone levels and superimposing them onto average cargo throughput, a strong relationship is observed between the amount of cargo moving through seaports and surface-level ozone concentrations ($r = 0.81$, $p < 0.001$). The lower panel in Figure 3-4 indicates a clear trend that should be analyzed to determine if seaport performance has a significant and causal relationship with local surface-level ozone concentrations.

Variables.

The dependent variables used for measuring air quality capture the annual mean levels (O_3Mean) and changes in O_3Mean ($\Delta Ozone$), as well as the annual Fourth Maximum values (*4thMax*) and its annual changes ($\Delta 4thMax$), all at the county level. The primary independent variable is port performance which is expressed as cargo throughput (*Cargo*) in short tons. The control vector borrows from similar studies to account for rival hypotheses. Based on studies from Davis (2012) and Sarzinski (2012), the following independent variables are included in the model: 1) the impacts of varying commuter populations between seaports is accounted for using

[33] The EPA monitors a set of the most common air pollutants: Ozone (O_3), Particulate Matter ($PM_{2.5}$ & PM_{10}), Nitrogen Dioxide (NO_2), and Sulfur Dioxide (SO_2).

county level unemployment rates (*Unemploy*); 2) the influence of meteorological conditions are controlled for using total annual precipitation (*Precip*) in inches, average annual surface temperature (*Temp*) in degrees Fahrenheit, and average annual wind speed (*Wind*) in miles per hour; 3) the previous years' ozone levels (*iOzone* and *i4thMax*) are used to control for autocorrelation in the time series dataset; and 4) federal ozone regulations across the research period are used to account for regulation-driven reductions in surface-level O_3 concentrations (*O_3Reg)*. All variables used in this stage of the research are explained in Table 3-4.

Table 3-4. *Environmental stewardship variables*

Variable	Description	Units	Source
Change in Ozone Mean Concentrations (ΔOzone)	Annual growth in local mean concentrations of ozone	Percentage	U.S. Environmental Protection Agency
Ozone Annual Mean (O_3Mean)	Annual average mean ozone concentration	Parts per million	U.S. Environmental Protection Agency
Change in fourth max value (Δ4thMax)	Annual change in fourth maximum value	Percentage	U.S. Environmental Protection Agency
Fourth max value (4thMax)	Annual fourth highest 8-hour surface ozone concentration	Parts per million	U.S. Environmental Protection Agency
Cargo Throughput (Cargo)	Annual amount of cargo moving through a seaport	Short tons	USACE Waterborne Commerce Statistics Center
Unemployment (Unemploy)	County level unemployment rate	Percentage	U.S. Bureau of Labor Statistics
Precipitation (Precip)	Annual amount of precipitation	Inches	National Oceanic and Atmospheric Administration
Temperature (Temp)	Annual average surface temperature in the port region	Degrees Fahrenheit	National Oceanic and Atmospheric Administration
Wind Speed (Wind)	Annual average wind speed in the port region	Miles per hour	National Oceanic and Atmospheric Administration
Ozone Regulation Period (O_3Reg)	Ozone regulation period	Dummy	U.S. Environmental Protection Agency
Initial Ozone Concentration (iOzone)	Initial annual ozone mean concentration *(t-1)*	Parts per million	U.S. Environmental Protection Agency
Initial fourth maximum value (i4thMax)	Initial annual fourth maximum value *(t-1)*	Parts per million	U.S. Environmental Protection Agency

Environmental models.

This dissertation uses panel models to analyze the association between port performance and host regions' air qualities over a 10-year period. There are four dependent variables in the environmental analysis: annual growth in mean surface ozone concentrations (Equation 3.18); actual annual mean ozone levels check (Equation 3.19); Equation 3.20 measures the changes to the annual fourth maximum value (*ΔOzone*); and Equation 3.21 estimates annual fourth maximum 8-hour surface ozone concentration *(4thMax)*.

The dependent variables were explained earlier in this section, but the right-hand side variables have not been described in detail. Also, even though this methodology has been used in recent literature, this research is a novel approach at exploring the specific relationship between port performance and local air quality. Therefore, attention is given to explaining the regression models stated below.

Model (5): $$\Delta Ozone_{i,t} = \beta_0 + \alpha_1 \mathrm{Ln}(Cargo_{i,t}) + \beta_1 \mathrm{Ln}(Unemploy_{i,t}) + \beta_2 \mathrm{Ln}(Precip_{i,t}) + \beta_3 \mathrm{Ln}(Temp_{i,t}) + \beta_4 \mathrm{Ln}(Wind_{i,t}) + \beta_5 O_3 Reg + \beta_6 \mathrm{Ln}(iO_3\ Mean_{i,t}) + \eta_{i,t} \quad (3.18)$$

Model (6): $$O_3 Mean_{i,t} = \beta_0 + \alpha_1 \mathrm{Ln}(Cargo_{i,t}) + \beta_1 \mathrm{Ln}(Unemploy_{i,t}) + \beta_2 \mathrm{Ln}(Precip_{i,t}) + \beta_3 \mathrm{Ln}(Temp_{i,t}) + \beta_4 \mathrm{Ln}(Wind_{i,t}) + \beta_5 O_3 Reg + \beta_6 Ln(iO_3\ Mean_{i,t}) + \eta_{i,t} \quad (3.19)$$

Model (7): $$\Delta 4thMax_{i,t} = \beta_0 + \alpha_1 \mathrm{Ln}(Cargo_{i,t}) + \beta_1 \mathrm{Ln}(Unemploy_{i,t}) + \beta_2 \mathrm{Ln}(Precip_{i,t}) + \beta_3 \mathrm{Ln}(Temp_{i,t}) + \beta_4 \mathrm{Ln}(Wind_{i,t}) + \beta_5 O_3 Reg + \beta_6 Ln(i4thMax_{i,t}) + \eta_{i,t} \quad (3.20)$$

Model (8): $$4thMax_{i,t} = \beta_0 + \alpha_1 \mathrm{Ln}(Cargo_{i,t}) + \beta_1 \mathrm{Ln}(Unemploy_{i,t}) + \beta_2 \mathrm{Ln}(Precip_{i,t}) + \beta_3 \mathrm{Ln}(Temp_{i,t}) + \beta_4 \mathrm{Ln}(Wind_{i,t}) + \beta_5 O_3 Reg + \beta_6 Ln(i4thMax_{i,t}) + \eta_{i,t} \quad (3.21)$$

The primary independent variable for all models is port performance as explained by cargo throughput *(Cargo)*. The most common mission of U.S. seaports is economic development (and growth), and scholars have found inverse relationships between economic growth and local air quality (Davis, 2012, Pao & Tsai, 2011). Therefore, it follows that the amount of cargo moving through a port will impact local air quality in a manner which is inversely associated with port performance. The higher the amount of cargo moving through a port, the higher the surface-level ozone concentration. The criteria pollutant serving as the dependent variable was selected based on known relationships between ports' prime movers of cargo (i.e. diesel engines) and measurable elements of local air quality. This interdisciplinary approach gives rise to the following hypothesis:

> H3: Seaports' cargo throughput has a direct and positive relationship with changes in the mean surface-level ozone concentrations of host counties.

There can be many sources of excessive surface ozone concentrations in a port's host county that are not associated with port performance. The logic of this control vector is to control for that which can be controlled and describe that which cannot as a limitation. The models' control vectors (Equations 3.18 through 3.21) include counties' unemployment rates (*Unemploy*), meteorological conditions *(Precip, Temp, Wind),* periods where federally regulated reductions in surface ozone levels might have caused a reduction *(O_3Reg)*, and the lagged value of annual mean ozone levels *(iOzone)* to compensate for autoregressive behavior.

Employment levels have been shown to have an inverse and significant relationship with air quality (Davis, 2012). Therefore, county level annual unemployment rates are used as a proxy

for the effects of commuting on air quality. Meteorological conditions are common control variables in air quality studies (Davis, 2012; Jammalamadaka & Lund, 2006; Sarzynski, 2012). Environmental regulatory periods are coded as a dummy variable with a one-year lag to account for federally directed reductions and the time it takes for counties to exhibit compliance. This variable has been handled similarly in the literature (Davis, 2012). The ozone regulatory periods are summarized in Table 3-5. The lagged value *(t-1)* of the annual mean concentration of ozone is used in the event that the dependent variables show signs of serial correlation. Testing for serial correlation in the dependent variable is conducted prior to specifying the final model.

Table 3-5. *History of ozone NAAQS, 1997 – 2015*

Legislation	Averaging Time	Level	Requirement
1997 62 FR 38856 Jul 18, 1997	8 hours	0.08 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
2008 73 FR 16483 Mar 27, 2008	8 hours	0.075 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
2015 80 FR 65292 Oct 26, 2015	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour average concentration, averaged over 3 years

Note: The changes to ozone NAAQS over the duration of study caused the development of one dummy variable for 2008. 2015 is not addressed due to the one-year lag in the time it takes to observe changes in surface-level ozone concentrations.

It has been pointed out in the literature that diesel engines contribute to surface ozone formation so if a relationship is found in this research, it will be valuable but expected. More information is needed to assess achievement of the environmental stewardship mission.

Therefore, the values used by the U.S. EPA to determine if seaports' host counties attain the surface ozone NAAQS are used in Models 7 and 8 to explore seaports' contributions. More specifically, the annual fourth-highest daily maximum 8-hr concentration values are operationalized to assess the following hypothesis:

> H4: Seaports' cargo throughput has a direct and positive relationship with host counties' ability to attain National Ambient Air Quality Standards.

The concern for spurious findings is mitigated through robustness testing. Robustness testing is used to determine how susceptible the relationships of interest (*Cargo* $\rightarrow$ *Dependent Variable*) are to external shocks. As with the economic impact stage, Leamer robustness and the Neumayer and Plümper (2017) method of calculating the degrees of robustness ($\rho(\beta_r)$) are used for each of the environmental Core Models. The robustness models developed to answer hypothesis H3 are described in Equations 3.22 through 3.29.

Model (5a): $$\Delta Ozone_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(Precip_{i,t}) + \beta_2 \text{Ln}(Temp_{i,t}) + \beta_3 \text{Ln}(Wind_{i,t}) + \beta_4 O_3\ Reg + \beta_5 \text{Ln}(iO_3\ Mean_{i,t}) + \eta_{i,t} \quad (3.22)$$

Model (5b): $$\Delta Ozone_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(Unemploy_{i,t}) + \beta_2 \text{Ln}(Temp_{i,t}) + \beta_3 \text{Ln}(Wind_{i,t}) + \beta_4 O_3 Reg + \beta_5 \text{Ln}(iO_3\ Mean_{i,t}) + \eta_{i,t} \quad (3.23)$$

Model (5c): $$\Delta Ozone_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(Unemplpy_{i,t}) + \beta_2 \text{Ln}(Precip_{i,t}) + \beta_3 \text{Ln}(Wind_{i,t}) + \beta_4 O_3 Reg + \beta_5 \text{Ln}(iO_3\ Mean_{i,t}) + \eta_{i,t} \quad (3.24)$$

Model (5d): $$\Delta Ozone_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(Unemploy_{i,t}) + \beta_2 \text{Ln}(Precip_{i,t}) + \beta_3 \text{Ln}(Temp_{i,t}) + \beta_4 O_3 Reg + \beta_5 \text{Ln}(iO_3\ Mean_{i,t}) + \eta_{i,t} \quad (3.25)$$

Model (6a): $$O_3 Mean_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(Precip_{i,t}) + \beta_2 \text{Ln}(Temp_{i,t}) + \beta_3 \text{Ln}(Wind_{i,t}) + \beta_4 O_3\ Reg + \beta_5 \text{Ln}(iO_3\ Mean_{i,t}) + \eta_{i,t} \quad (3.26)$$

Model (6b): $$O_3 Mean_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(Unemploy_{i,t}) + \beta_2 \text{Ln}(Temp_{i,t}) + \beta_3 \text{Ln}(Wind_{i,t}) + \beta_4 O_3 Reg + \beta_5 \text{Ln}(iO_3\ Mean_{i,t}) + \eta_{i,t} \quad (3.27)$$

Model (6c): $$O_3 Mean_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(Unemplpy_{i,t}) + \beta_2 \text{Ln}(Precip_{i,t}) + \beta_3 \text{Ln}(Wind_{i,t}) + \beta_4 O_3 Reg + \beta_5 \text{Ln}(iO_3\ Mean_{i,t}) + \eta_{i,t} \quad (3.28)$$

Model (6d): $$O_3 Mean_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(Unemploy_{i,t}) + \beta_2 \text{Ln}(Precip_{i,t}) + \beta_3 \text{Ln}(Temp_{i,t}) + \beta_4 O_3 Reg + \beta_5 \text{Ln}(iO_3\ Mean_{i,t}) + \eta_{i,t} \quad (3.29)$$

The robustness models developed to answer hypothesis H4 are described in Equations 3.30 through 3.37.

Model (7a): $$\Delta 4thMax_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(Precip_{i,t}) + \beta_2 \text{Ln}(Temp_{i,t}) + \beta_3 \text{Ln}(Wind_{i,t}) + \beta_4 O_3\ Reg + \beta_5 \text{Ln}(i4thMax_{i,t}) + \eta_{i,t} \quad (3.30)$$

Model (7b): $$\Delta 4thMax_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(Unemploy_{i,t}) + \beta_2 \text{Ln}(Temp_{i,t}) + \beta_3 \text{Ln}(Wind_{i,t}) + \beta_4 O_3 Reg + \beta_5 \text{Ln}(i4thMax_{i,t}) + \eta_{i,t} \quad (3.31)$$

Model (7c): $$\Delta 4thMax_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(Unemplpy_{i,t}) + \beta_2 \text{Ln}(Precip_{i,t}) + \beta_3 \text{Ln}(Wind_{i,t}) + \beta_4 O_3 Reg + \beta_5 \text{Ln}(i4thMax_{i,t}) + \eta_{i,t} \quad (3.32)$$

Model (7d): $$\Delta 4thMax_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(Unemploy_{i,t}) + \beta_2 \text{Ln}(Precip_{i,t}) + \beta_3 \text{Ln}(Temp_{i,t}) + \beta_4 O_3 Reg + \beta_5 \text{Ln}(i4thMax_{i,t}) + \eta_{i,t} \quad (3.33)$$

Model (8a): $$4thMax_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(Precip_{i,t}) + \beta_2 \text{Ln}(Temp_{i,t}) + \beta_3 \text{Ln}(Wind_{i,t}) + \beta_4 O_3\ Reg + \beta_5 \text{Ln}(i4thMax_{i,t}) + \eta_{i,t} \quad (3.34)$$

Model (8b): $$4thMax_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(Unemploy_{i,t}) + \beta_2 \text{Ln}(Temp_{i,t}) + \beta_3 \text{Ln}(Wind_{i,t}) + \beta_4 O_3 Reg + \beta_5 \text{Ln}(i4thMax_{i,t}) + \eta_{i,t} \quad (3.35)$$

Model (8c): $$4thMax_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(Unemplpy_{i,t}) + \beta_2 \text{Ln}(Precip_{i,t}) + \beta_3 \text{Ln}(Wind_{i,t}) + \beta_4 O_3 Reg + \beta_5 \text{Ln}(i4thMax_{i,t}) + \eta_{i,t} \quad (3.36)$$

Model (8d): $$4thMax_{i,t} = \beta_0 + \alpha_1 \text{Ln}(Cargo_{i,t}) + \beta_1 \text{Ln}(Unemploy_{i,t}) + \beta_2 \text{Ln}(Precip_{i,t}) + \beta_3 \text{Ln}(Temp_{i,t}) + \beta_4 O_3 Reg + \beta_5 \text{Ln}(i4thMax_{i,t}) + \eta_{i,t} \quad (3.37)$$

There are other causes of NO_x emissions and the subsequent formation of excessive surface ozone concentrations that are not captured in the models' control vectors. However, if it is shown that an association exists between ports' cargo throughput and local ozone concentrations and further demonstrated that the association is unidirectional *(Cargo → ΔOzone)*, knowledge will have progressed pointing out the need for future methods that allow for more precise estimations. This and other limitations are addressed in the following section.

Limitations.

As with the economic development regressions, the environmental stewardship models exhibit similar limitations: 1) the presence of unit autoregressive roots causing drift and subsequent violation of distributional assumptions (Dickey & Fuller, 1979; Harris & Tzavalis, 1999); 2) the presence of endogeneity caused by omitted explanatory variables and simultaneity between the dependent and independent variables (Wooldridge, 2002); 3) model misspecification leading to biased results caused by correlation of error terms with unobserved variables; 4)

omitted variables that account for rival explanations of growth in mean ozone concentrations; and 5) the small sample size.

The presence of unit roots are examined using the Harris-Tzavalis test (Harris & Tzavalis, 1999). All variables containing unit roots that persist after natural log transformations are discarded. The Hausman specification test is used, post estimation, to determine whether a fixed or random effects model is most appropriate for the data. The presence of endogeneity, caused by omitted variable bias, is mitigated by examining error terms for heteroscedasticity and simultaneity by using the Granger causality test (1969) as modified by Freeman (1983) to the "more powerful Direct Granger" method (p. 328). The Granger test has been used in similar research applications involving air quality (Hoffmann, Lee, Ramasamy, & Yeung, 2005; Pao & Tsai, 2011). The misspecification limitation is addressed using the Hausman Specification Test (Hausman, 1978).

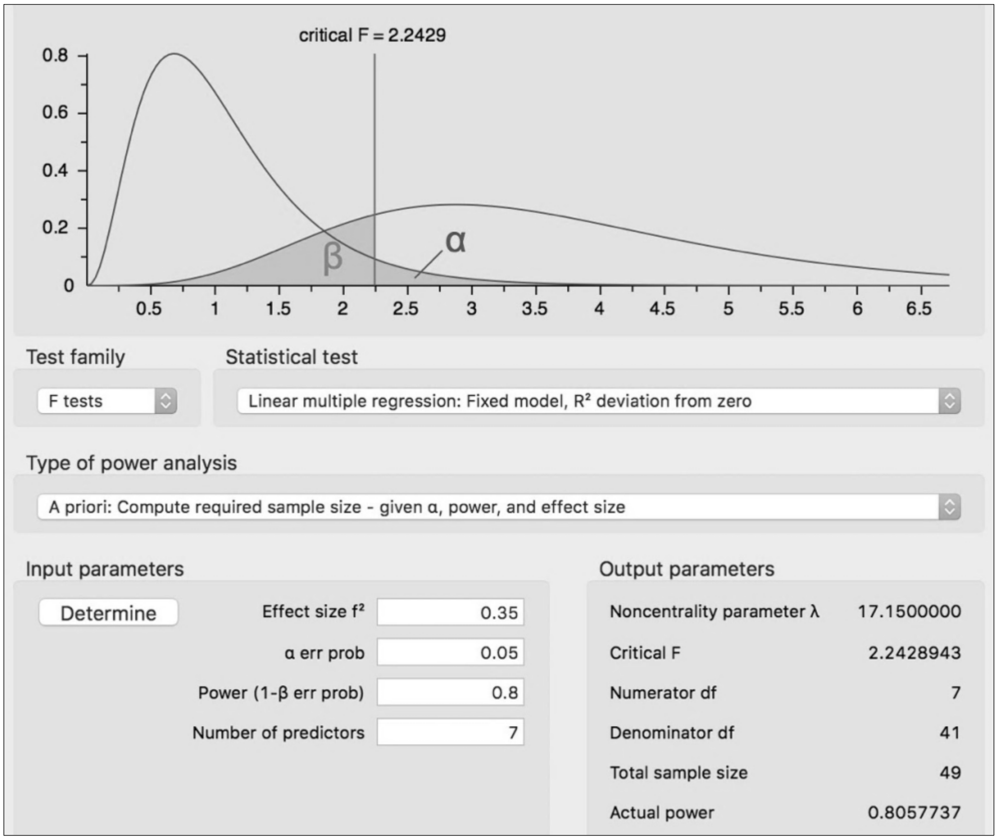
Rival explanations of increased ozone concentrations are a difficult limitation to address. The control vector accounts for that which is controllable, but there are many other sources of elevated mean ozone levels in metropolitan areas. The gasoline-burning commuter and energy-dependent population aspect are accounted for using unemployment rates *(Unemploy)*. Meteorological conditions are accounted for using annual precipitation, and annual average values for temperature and wind speed. Likewise, the effects of tightening NAAQS in the U.S. are accounted for using a dummy variable for ozone regulatory periods. However, the contributions of adjacent industries are not accounted for in the environmental stewardship models.

Because of the omitted variable limitation, the afore mentioned analyses are conducted to mitigate spuriousness and establish directionality. If an association is found between mean local

surface ozone concentrations and ports' cargo throughput that is unidirectional *(Cargo* $\rightarrow$ Δ*Ozone)*, the evidence will indicate the need for further analysis through methodologies that are not yet available or that are currently available in other disciplines that are better suited to estimate the association identified in this research.

Lastly, the sample size for this stage of the research is small ($n = 50$). As with the economic development regressions, this stage uses G*Power with Cohen's (1988) suggested parameters ($\alpha \leq 0.05$, 80-percent power, $f^2 \leq 0.35$) to estimate the relationship between cargo throughput and changes to local ozone concentrations. The number of ports required for this stage of the analysis is calculated and illustrated in Figure 3-5. The sample of seaports used in this stage of the research is sufficient to achieve Cohen's suggested model parameters.

Figure 3-5. *G*Power results of sample size analysis for environmental stewardship models*



Measuring Financial Sustainability

This section describes how U.S. seaports' financial conditions are assessed in order to determine if they achieve the common mission of being financially sustainable. The literature is rife with techniques that can be used to measure a firm's financial condition and, in more recent years, to develop probabilistic models to predict bankruptcy. All of these methods however, have one thing in common: a reliance on financial ratios as normative indicators of past financial conditions. Laurent (1979) uses factor analysis to categorize 45 financial ratios and subsequently uses the ratios that are most highly correlated with parent factors to assess firms' financial wellbeing. Similarly, Chen and Shimerda (1981) use Principal Component Analysis (PCA) as a

data reduction technique in order to find the most efficient ratios for the context of their study and caution that care should be taken to select ratios that do not omit important information.

Therefore, the first step in this stage of the research is to examine the pooled dataset using financial ratios that are indicative of public enterprises' financial conditions. Like Laurent (1979) and Chen and Shimerda (1981), a data reduction technique is used to categorize common ratios and isolate the one ratio that best represents each category (i.e. highest correlation with parent factor). Once the most highly correlated ratios are found for the categories that manifest during factor analysis, benchmarks are established by removing outliers and taking the mean values for each ratio across the 10-year period. The benchmarks permit an assessment of all seaports at each annual data point.

The most efficient and effective ratios used to measure privately held firms may not be as informative when used to measure the financial conditions of public enterprises. In fact, Mead (2002) lauds the development of the Government Accounting Standards Board (GASB) by stating that "accountability in the private sector is concerned with profitability and maximizing the return to stockholders, as well as with providing quality goods and services to customers, [but] accountability in the public sector is much more complex" (p. 52). This complexity can be understood by considering the capital assets of a private firm compared to those of a public enterprise. Private firms have no real obligation to the citizenry to report on the conditions of capital assets and plans for future sustainability, but with public enterprises it becomes compulsory. Further confounding the measurement of U.S. seaports' financial conditions are the competing objectives of profit-seeking (private) firms and public organizations. Therefore, the ratios used in this stage of the research are selected from literature on both public and private organizations.

Data and variables.

Data.

The data used for this stage of the research are drawn from the Comprehensive Annual Financial Reports (CAFR) of 43 public seaports. Unlike the previous methods in this dissertation, data pooled at the seaport level are used to develop common factors from the ratios for categorization purposes which are subsequently analyzed to develop benchmarks. The benchmarks are then compared with seaports' ratio values across the 10-year time period (2006 – 2015) to assess financial condition. This approach mitigates the small sample size concerns that were seen in the previous stages. Additionally, most U.S. seaports report financial data in fiscal years rather than calendar years. Thus, the data was extracted from the CAFRs, converted to calendar year data, and fed into financial ratios to develop the variables used in this stage of the dissertation. Table 3-6 shows the seaports used in this stage of the analysis

Table 3-6. *Geographical representation of U.S. seaports for financial sustainability analysis*

West Coast (44%)	Gulf Coast (23%)	East Coast (21%)	Great Lakes (12%)
Port of Anacortes, WA	Port Freeport, TX	Port Canaveral, FL	Port Conneaut, OH
Port of Anchorage, AK	Port of Corpus Christie, TX	Port Everglades, FL	Port of Cleveland, OH
Port of Everett, WA	Port of Galveston, TX	Port of Boston, MA	Port of Duluth, MN
Port of Grays Harbor, WA	Port of Gulfport, MS	Port of Jacksonville, FL	Port of Monroe, MI
Port of Kalama, WA	Port of Houston, TX	Port of NewYork-New Jersey	Port of Toledo, OH
Port of Long Beach, CA	Port of New Orleans, LA	Port of Palm Beach, FL	
Port of Longview, WA	Port of Panama City, FL	Port of Philadelphia, PA	
Port of Los Angeles, CA	Port of Port Manatee, FL	Port of Virginia	
Port of Oakland, CA	Port of South Louisiana	Port of Wilmington, DE	
Port of Olympia, WA	Port of Tampa, FL		
Port of Port Angeles, WA			
Port of Portland, OR			
Port of Redwood City, CA			
Port of San Diego, CA			
Port of San Francisco, CA			
Port of Seattle, WA			
Port of Stockton, CA			
Port of Tacoma, WA			
Port of Vancouver, WA			

Variables.

In 1999, GASB issued *Statement No. 34. Basic financial statements—and management's discussion and analysis—for state and local government* which standardized financial reporting. Rivenbark, Roenigk, & Allison (2010) made use of GASB 34's standardization requirements to develop a set of financial ratios indicative of public enterprises' financial conditions. There are numerous publications on corporate governance and firm performance claiming to have identified unique methods and ratios, but further investigation reveals that even though the methods may differ, the ratios are similar, if not comprised of the same numerators and denominators. In fact, in many cases the only difference is the ratio's names. This research cuts

through the ubiquity by identifying a set of ratios primarily from three sources: the public enterprise aspect of the research is drawn from Rivenbark et al. (2010), and the profit seeking perspective uses ratios found in *Financial Ratios for Executives* (Rist & Pizzica, 2015) and Bragg's (2012) *Business Ratios and Formulas: A Comprehensive Guide*. The ratios used in this study are explained in Table 3-7. It should be noted that the ratios used in this dissertation do not represent the universe of finacial ratios. They are a set of ratios from different financial dimensions that the researcher has determined from the literature review are well suited to represent public enterpises and match the financial data available for this study. Prior to factor analysis, benchmarks are set for the U.S. seaport industry for each of the ratios in Table 3-7.

Table 3-7. *Ratios used to assess financial sustainability*

Indicator	Reported Dimension	Calculation	Interpretation Criteria	Source	Notes
Accumulated depreciation to fixed assets	Asset utilization	Accumulated depreciation / gross fixed assets	The higher the ratio, the less an organization has invested in fixed asset replacement	Baggs, 2012	Acc. depreciation / capital assets being depreciated
Capital assets condition	Capital	1 – (accumulated depreciation / capital assets being depreciated)	The higher the ratio, the more an organization has invested in its capital assets	Rivenbark et al., 2010	
Cash ratio	Liquidity	Cash + cash equivalents / current liabilities	The higher the ratio, the more capable an organization is at paying off current liabilities	Rist & Pizzica, 2015	
Charge to expense ratio	Self sufficiency	Charges for services / total expenses	≥ 1.0 suggests the organization is self-supporting	Rivenbark et al., 2010.	Operating revenue / operating expenses
Debt ratio	Solvency	Total liabilities / total assets	The higher the ratio, the more an organization's assets are funded by debt	Rist & Pizzica, 2015	
Debt to assets ratio	Solvency	Long term debt / total assets	The higher the ratio, the more reliant an organization is on using debt to finance its assets	Rivenbark et al., 2010	Long term debt = total liabilities - current liabilities
Debt to equity ratio	Solvency	Total liabilities / equity	The higher the ratio, the more reliant an organization is on using debt to finance its assets	Rist & Pizzica, 2015	Equity = total assets- total liabilities
Fixed asset turnover ratio	Performance	Sales / total fixed assets	The higher the ratio, the better an organization is at using its assets to generate revenue	Rist & Pizzica, 2015	Sales = operating revenue
Net assets ratio	Solvency	Unrestricted net assets / total liabilities	The higher the ratio, the more capable an organization is at meeting long term obligations	Rivenbark et al., 2010	
Net profit margin	Profitability	Net income / sales	The higher the ratio, the more profitable the organization	Rist & Pizzica, 2015	Sales = operating revenue
Operating cash flow ratio	Liquidity	Net cash flow from operations / current liabilities	The higher the ratio, the more capable an organization is at paying off current liabilities	Laurent, 1979	

Table 3-7 Continued

Indicator	Reported Dimension	Calculation	Interpretation Criteria	Source	Notes
Percent change in net assets	Financial performance	Change in net assets / initial net assets	A positive change indicates an increase in the organization's financial position	Rivenbark et al., 2010.	
Quick ratio	Liquidity	Current assets / current liabilities	The higher the ratio, the more capable an organization is at meeting short term obligations	Rivenbark et al., 2010	
Return on assets	Profitability	Net income / total assets	The higher the ratio, the more efficient an organization is at generating revenue from its assets	Rist & Pizzica, 2015	Net income = change in net assets
Return on net assets	Profitability	Net income / fixed assets + working capital	The higher the ratio, the more efficient an organization is at using its assets to generate revenue	Rist & Pizzica, 2015	Working capital = current assets - current liabilities
Total asset turnover	Performance	Sales / total assets	The higher the ratio, the more capable an organization is at generating sales per dollar of assets	Rist & Pizzica, 2015	Sales = operating revenue

Factor analysis.

In order to assess seaports' financial sustainability, factor analysis is conducted to parse out financial dimensions based on Rist and Pizzica's (2015) explanations of ratio categories (i.e. dimensionality). The categories likely to manifest from this analysis are liquidity, solvency, performance, and profitability. These categories are useful in measuring financial sustainability based on the definition stated in Chapter 2:

> Public seaport financial sustainability is the financial capacity of the port to meet its current obligations, to withstand shocks, and to maintain service, debt, and commitment levels at reasonable amounts relative to both state and local expectations and likely future income, while maintaining public confidence.

The four dimensions of financial sustainability are assessed as follows: 1) the liquidity dimension is used to capture ports' abilities to meet current obligations (within one year); 2) the solvency dimension covers how well seaports handle debt and equity in order to meet future obligations; 3) the profitability dimension is used in conjunction with liquidity to determine how well seaports can withstand financial shocks, and 4) the performance dimension is used to measure how well seaports use their assets to maintain service and commitment levels. Assessment of additional dimensions that manifest during the study are discussed as necessary, based on the results of the factor analysis. The maintenance of public confidence is not directly measured in this dissertation.

Factor analysis is performed on the variables listed in Table 3-7 as a means of categorizing the ratios for the context of this study and determining the one best ratio to represent

each financial dimension. The ratios used are intended to cover a range of financial dimensions that each contribute to seaports' financial sustainability. It should be noted that there is no standard set of ratios assigned to dimensions in the literature. The goal here is to use ratios from the extant literature and categorize the ratios into dimensions based on the results of the factor analysis. However, in some cases it is expected that the most representative ratio for each dimension will not be specific enough to answer its parent hypothesis. In that case other ratios defined in Table 3-8 will be used for hypothesis testing.

One could reasonably argue that factor analysis is unnecessary if the financial ratios used to answer hypotheses are not the "one-best" ratio determined through factor analysis. The rationale for using factor analysis is simple. The only way to know if the "one-best" set of ratios will fully answer the hypotheses is to conduct factor analysis. More importantly, these results are not only used to answer hypotheses, but they paint a more complete picture of seaports' financial conditions that will be used to determine if seaports exhibit steward-like behavior. Lastly, the factor analysis informs future studies on the most representative ratios for measuring industry-specific financial dimensions.

Financial sustainability hypothesis testing.

After the factor analysis is conducted the following hypotheses are assessed:

H5: U.S. seaports exhibit sufficient liquidity to meet current obligations.

H6: U.S. seaports exhibit sufficient solvency to meet long term obligations.

H7: U.S. seaports exhibit sufficient profitability to withstand financial shocks.

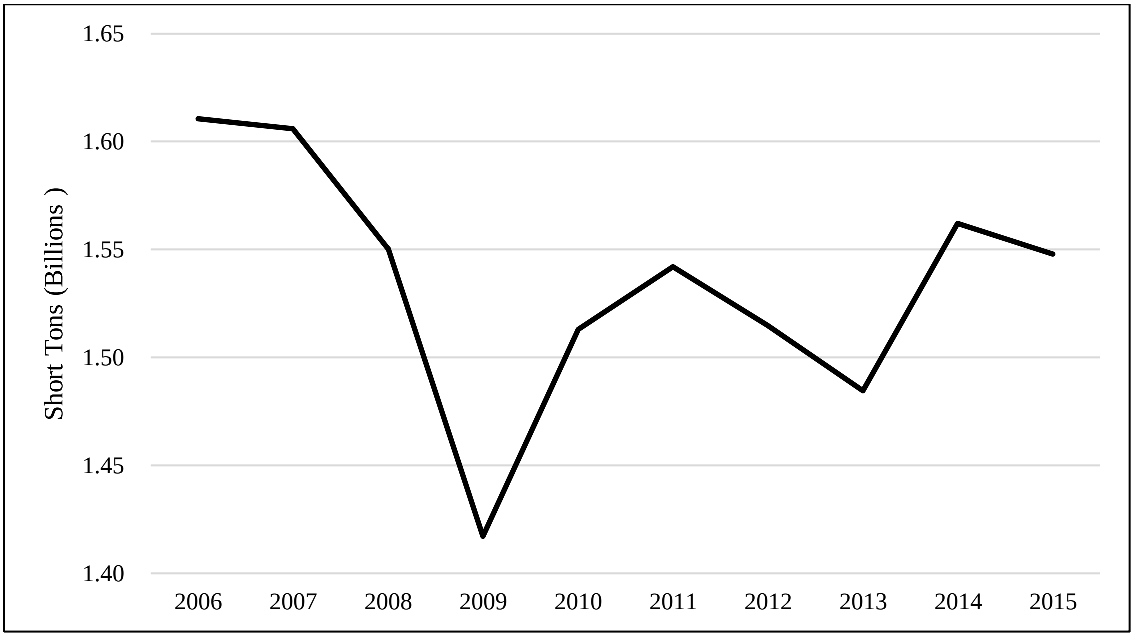
H8: U.S. seaports exhibit sufficient performance to maintain service and commitment levels.

The liquidity hypothesis (H5) is assessed using current assets and current liabilities. According to Rist and Pizzica (2015) liquidity is the ability to pay off short term debts, and the quick ratio divides current assets by current liabilities (debts) to explain how many times a seaport can pay off its short-term obligations with currently available resources. Hypothesis H5 will be accepted if the majority of seaports operated over the 10-year study period with current assets exceeding current liabilities.

Feldman and Libman (2007) point out that solvency ratios “measure a firm’s ability to repay its debt obligations” (p. 260). If U.S. seaports were capable of paying long-term obligations over the period of this study, evidence will exist in the financial reports. Specifically, if total assets are greater than total liabilities for the majority of U.S. seaports across the timespan of this study, the solvency hypothesis (H6) will be accepted.

The profitability hypothesis (H7) is assessed over a period where a known financial shock occurred – the Global Financial Crisis of 2008. During the period of this study, the annual sums of cargo throughput shown in Figure 3-6 indicate a decrease after 2008 that does not approach recovery levels until 2014.

Figure 3-6. *Annual sums of cargo throughput for seaports used in this analysis*



The profitability hypothesis (H7) states that U.S. seaports demonstrate sufficient profitability to withstand financial shocks. If seaports are profitable enough to withstand financial shocks they will have maintained liquidity and positive profitability during the shock introduced by the Global Financial Crisis of 2008. Not only should seaports be liquid enough to withstand the initial shock that was introduced in 2008 and continued to decline in 2009, but they should also be profitable enough to show a positive change in net position once the effects of the shock on cargo throughput began to diminish in 2010, or before. Therefore, in order to accept the profitability hypothesis there must be evidence that the majority of seaports were able to maintain liquidity and profitability between 2007 and 2014 despite the influence of the shock.

The financial performance dimension covers seaports' abilities to use their assets to earn a profit (Rist and Pizzica, 2015) and their history of growth in net position (Rivenbark et al.,

2010). Seaports are capital intensive organizations that rely on fixed assets to generate revenue and as such, they must constantly concern themselves with the status of their assets. This status includes how efficient the seaport uses its assets to earn revenue, how much service life remains in the fixed assets, and how effective the seaport is at growing its fixed assets in order to keep up with increasing demands. Therefore, in order to accept the performance hypothesis (H8), evidence must exist across the period of the study which indicates that the majority of seaports demonstrated efficient use of assets in earning revenue and proper management of fixed assets to support sustained growth into the future.

Limitations.

There are two limitations that impact this stage of the dissertation: the set of financial ratios used, and the lack of industry specific benchmarks. The financial ratios used in this analysis were chosen based on their compatibility with public enterprises. There are numerous ratios available but not all are compatible with public organizations' financial reporting requirements in accordance with GASB Statement 34. An example of ratios that are not conducive to the purpose of this stage of the dissertation are those that deal with company stock prices. Therefore, relevant ratios were chosen to address this dissertation's purpose with the understanding that further research is needed in this area.

Financial ratio benchmarks are not available for the seaport industry. There are no set values for each of the ratios that could serve as technical underpinnings for evaluating whether seaports are liquid, solvent, high performing, and profitable. Also, the ratios in Table 3-7 are not industry-specific, but they are unambiguous which is sufficient to conduct the present analysis.

This study establishes benchmarks and illustrates where seaports lie with regard to the benchmarks of the most representative ratios for each financial dimension.[34]

Chapter Summary

This chapter explained the qualitative and quantitative methods used to answer the research questions in four stages. First, a content analysis was used to determine what U.S. seaports claim as common mission elements. Second, fixed effects models are explained which are used to estimate seaports' economic impacts on their host regions. Third, and similar to Stage 2, fixed effects models are employed to estimate seaports' impacts to host regions' annual mean surface ozone concentrations. Lastly, the assessment of U.S. seaport's financial sustainability is explained by using financial ratios that are most highly correlated with parent factor variables. The factor variables are made up of ratios that fall into at least four categories: liquidity, performance, profitability, and solvency. Together, these methods are used to answer the first two research questions so that the third question can be addressed in the following chapter.

1) What are the common elements of governance within the mission statements of U.S. public seaports?
2) Are the common mission elements within the mission statements of U.S. public seaports reflective of seaport performance?
3) Do U.S. public seaports' governing boards exhibit stewardship behavior?

[34] The financial ratios calculations available in the literature are non-standard amongst authors which introduces ambiguity. Therefore, the financial ratios in Table 3-7 specify the exact numerators and denominators for the ratios used in this analysis which should be employed if this study is replicated.

Table 3-8. *Chapter 3 key terms*

Name	Definition
Endogeneity	According to Remler and Van Ryzen (2015) "A phenomenon that occurs when the independent variable is caused by variables or processes that also affect the dependent variable— or by the dependent variable itself" (p. 559)
Panel data	According to Remler and Van Ryzen (2015) panel data are "repeated measures of the same variables for the same individuals over time" (p. 340).
Parts per million (ppm)	A unit used to measure Ozone and numerous other chemical concentrations.
Reliability	According to Remler and Van Ryzen (2015) "Measurement reliability refers to the consistency of a measure— and it is directly related to the concept of random error or noise" (p. 118).
Robustness	Defined by Neumayer and Plümper (2017) as the degree "to which an estimate using a plausible alternative model specification supports the baseline model's estimated effect of interest" (p. 4).
Short tons	A unit of weight used as a standard for measuring cargo in the maritime industry which is equal to 2,000 lbs.
Simultaneity	The notion that both causation and reverse causation are occurring at the same time (Remler & Van Ryzen, 2015).
Validity	According to Remler and Van Ryzen (2015) the validity of a measure refers to "How well a measure represents the construct of interest" (p 571).

CHAPTER 4:

ANALYSIS AND RESULTS

Chapter 3 explained the thematic analysis used to determine common mission elements amongst U.S. seaports (Stage 1), introduced the methods used for Stages 2 through 4, the data collection effort, and the limitations associated with each method. This chapter will summarize the thematic analysis, further explain the data through summary statistics, and describe the results of the methods used in Stages 2 through 4. The findings are discussed in the same order as the research method presented in Chapter 3. The results of Stages 2 through 4 are reported as each hypothesis is tested, and a deeper interpretation of the findings is explained after Stage 4.

Stage One - Thematic Analysis

A content analysis was conducted on seaports' mission statements in order to gain an understanding of what they claim as their purposes for existence. This was a necessary first step so that the common mission elements could be identified and operationalized to measure how effective seaports are at accomplishing stated missions. The most prevalent common mission elements are economic development (97-percent), environmental stewardship (39-percent), and financial sustainability (31-percent). The seaports used in this dissertation are public organizations, and, therefore, have inherent responsibilities to the citizens in their host regions. The methods that follow represent the set of analytic tools used to understand the impacts that seaports have on host regions. The following sections are broken down by each stage of the research.

Stage Two – Economic Impacts

The results of the analyses used to test the economic impact hypotheses are explained in this section. Seaports are suspected of impacting host regions' economies through growth and

development. Therefore, variables from the growth and development literature have been operationalized to examine the following hypotheses:

H1: Seaports' cargo throughput has a direct and positive relationship with economic growth in the port region.

H2: Seaports' cargo throughput has a direct and positive relationship with economic development in the port region.

The Core Models 1 and 2, represented by Equations 3.2 and 3.3, were conceptualized in Chapter 3 in order to test hypotheses H1 and H2. Model 1 estimates U.S. seaports' economic growth impact on host regions at the MSA level, using annual change in per capita GDP (*ΔPCGDP*) as the dependent variable. Model 2 uses average annual growth in weekly wages (*ΔWages*) as the dependent variable to estimate U.S. seaports' impact to the economic development of host regions at the MSA level. The primary independent variable in both models is port performance, expressed as cargo throughput (*Cargo*) in short tons.

The Alternate Models 3 and 4 (Equations 3.4 and 3.5) use actual values of *PCGDP* and *Wages* as the dependent variables in place of percent growth. These models are estimated to provide a basis of comparison during robustness testing. Similar treatment has been observed in the literature (Shan et al., 2014) where the authors buttress robustness claims based on no appreciable changes between the growth models' and actual value models' coefficients and significance levels.

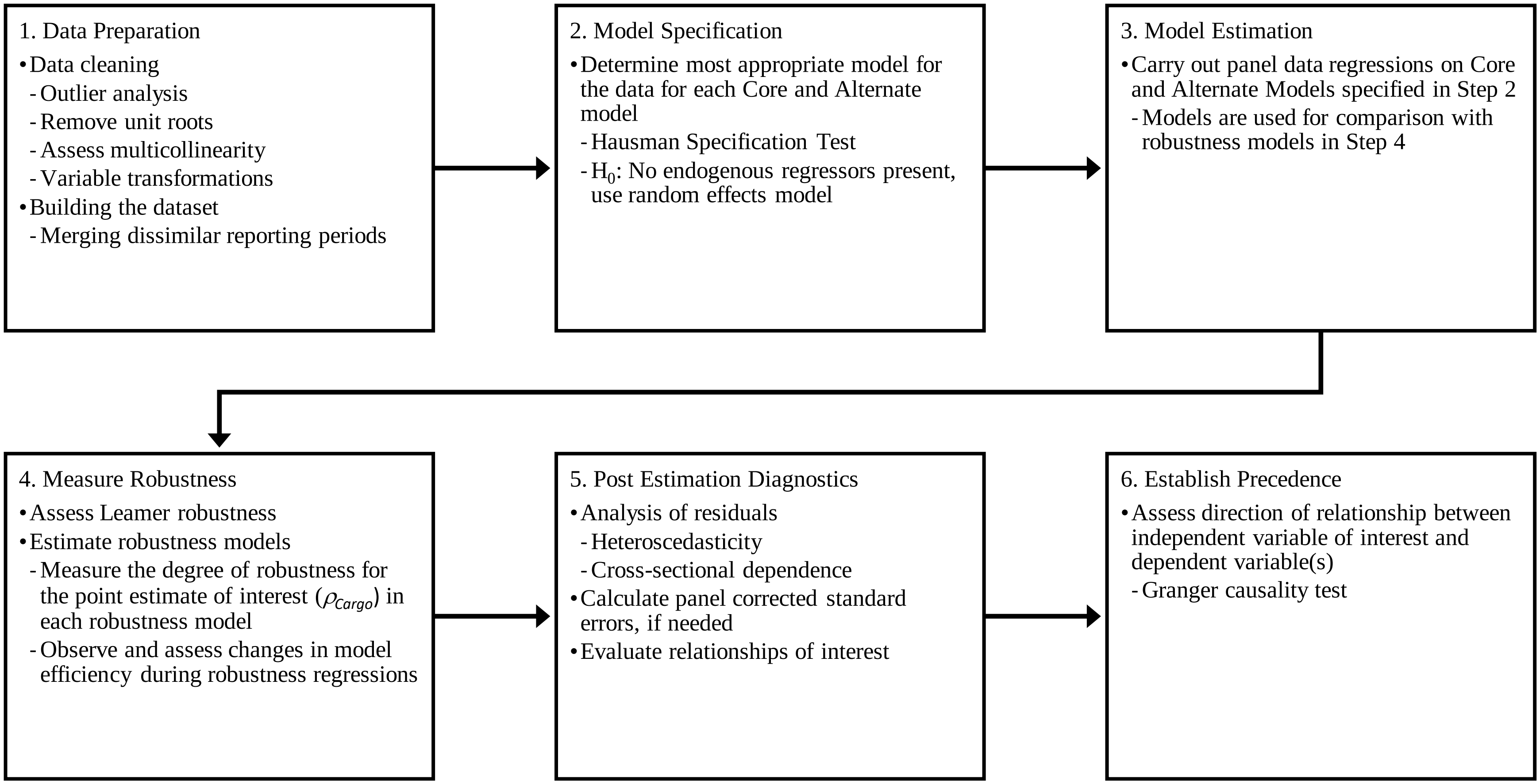
The last set of models estimated in this stage are used to determine the degree of robustness (ρ_{Cargo}) for each of the robustness models. The degrees of robustness are calculated using the method developed by Neumayer and Plümper, (2017) explained in Chapter 3. This amount of testing could be perceived as excessive. However, one must keep in mind that panel data models are prone to endogeneity. Therefore, the rationale for using alternate models and robustness testing is to provide a layered approach to assessing whether seaports' cargo throughput has an impact on host regions' economies. This approach adds more layers of scrutiny to the overall findings. All statistical testing in this dissertation is conducted using Stata (StataCorp, 2015) version 14.2.

Empirical Inquiry

This section explains the logic and steps used to empirically test the economic impact hypotheses. Hypotheses H1 and H2 state what conditions must be true in order to reject the null hypothesis. First, there must be a relationship between the independent variable cargo throughput (*Cargo*) and the dependent variables *ΔPCGD*P and *ΔWages*. Estimating these relationships is challenging due to the many unobservable causes of change and the potential for bias in the panel models caused by endogeneity. Also, there must be reliable evidence that the *Cargo* variable precedes the models' dependent variables (i.e. causality). Establishing variable precedence requires more than an intuitive approach in this research because it is reasonable to argue that both port performance (*Cargo*) and economic conditions could cause changes in one another. Therefore, the task at hand is to estimate the relationship between cargo throughput and the dependent variables using methods designed to handle the challenges inherent in longitudinal data, and, if found to be significant, establish variable precedence.

The test method for the economic impact hypotheses is designed to mitigate the concerns inherent in longitudinal studies. The analytical method is broken down into the six steps and summarized in Figure 4-1. First, the data is prepared for the analysis. In this step, the data is reviewed for irregularities that violate OLS assumptions, datasets are merged together across common reporting periods, and independent variables are transformed to the natural log form to account for possible nonlinear relationships. Second, testing is conducted to determine the most appropriate model for the data, fixed or random effects. Third, the Core and Alternate Models (1 through 4) are estimated and used to compare with the Robustness Models in Step 4.

Figure 4-1. *Panel model development and analysis process*



Fourth, the Robustness Models are estimated, Leamer robustness is assessed, and the degrees of robustness are calculated for the *Cargo* point estimates. This evaluation is carried out by omitting key variables from the Core and Alternate Models to introduce shocks to the independent variable of interest (*Cargo*), and measuring the degree of robustness (ρ_{Cargo}) for each model. Evaluating the differences between point estimates is conducted by measuring how much of the Probability Density Function (PDF) of the robustness model's estimate falls within the confidence interval of the baseline estimate in the Core and Alternate Models. Leamer Robustness is dichotomous, but measuring the degree of robustness is continuous and reported on a 0 to 1 scale. Neumayer and Plümper (2017) describe the advantages of continuous robustness: "A continuous concept of robustness reflects the fact that robustness comes in degrees and not as a dichotomy. Higher values of ρ represent a higher degree of robustness and lower values represent a lower degree of robustness" (p. 44).

If robustness exists, the Alternate and Robustness models are no longer needed so the analysis shifts focus to the Core Models. Step 5 is a set of post-estimation tests employed to mitigate spuriousness in the findings. The tests in this step examine the residuals of a properly specified Core Model to determine if the standard errors are reliable or biased. The presence of heteroscedasticity and cross panel dependence in the residuals indicate that the standard error estimates are unreliable and should not be used. If the estimates are found to be biased, panel corrected standard errors are estimated, and the models are reviewed to determine if a significant relationship still exists. Step 5 provides the first piece of information needed to accept or reject the economic impact hypotheses. The final piece of information needed to evaluate the economic impact hypotheses is variable precedence. Therefore, a Granger causality test is performed in Step 6 to establish precedence between *Cargo* and the Core Models' dependent variables.

Step 1: Data preparation.

The descriptive statistics in Table 4-1 show a sizable amount of dispersion amongst means in some of the variables. For instance, the dependent variables *ΔPCGDP* and *ΔWages* have large standard deviations compared to the means. The independent variables *Cargo*, *NCargo*, and *GSpend* also have large standard deviations. These dispersion properties are indicative of seaports that operate on different levels of performance and located in economies of varying sizes. Although these phenomena have no impact on answering this dissertation's research questions, future research on port performance should consider the impacts of seaports across a range of performance levels and economies.

Table 4-1. *Descriptive statistics: Economic impact variables*

	Description	Unit	Mean	Median	Std. Dev.
Dependent Variables					
ΔPCGDP	Annual growth in real per capita GDP	Percent	0.29	0.65	3.62
PCGDP	Annual real per capita GDP	U.S Dollars (x10^3)	52.85	53.33	14.98
ΔWages	Annual growth in average weekly wages	Percent	2.72	2.56	2.00
Wages	Average weekly wage value	U.S. Dollars	955.69	893.00	230.02
Independent Variables					
Cargo	Annual amount of cargo moving through a seaport	Short Tons (x10^6)	31.32	13.73	49.77
NCargo	Annual amount of cargo moving through neighboring seaports	Short Tons (x10^6)	233.06	120.73	231.21
GSpend	Ratio of federal spending to real GDP	Ratio (x10^3)	12.04	2.48	50.78
HCapital	Percent of people enrolled in secondary education out of entire population	Percent	6.85	6.85	1.27
iPCGDP	Initial PCGDP value *(t-1)*	U.S Dollars (x10^3)	52.66	52.92	14.68
iWages	Initial average weekly wage value *(t-1)*	U.S Dollars	930.31	871.00	222.29

The presence of unit roots indicates non-stationarity in time-series variables which if left unchecked, can lead to spurious findings. Therefore, unit root testing is conducted using the univariate method designed by Harris and Tzavalis (1999) prior to regression analyses. The unit root test is carried out in Stata using the “xtunitroot” command with the “ht” option. The results of the Harris-Tzavalis tests are shown in Table 4-2.

Table 4-2. *Unit root tests of economic impact variables*

	Dependent Variables				Independent Variables					
	ΔPCGDP	*ΔWages*	*PCGDP*	*Wages*	*Cargo*	*NCargo*	*GSpend*	*HCapital*	*iPCGDP*	*iWages*
ρ_u	0.007	0.040	0.629	0.998	0.572	0.452	0.493	0.359	0.642	0.867
p-value	<0.001	<0.001	0.0065	1.000	<0.001	<0.001	<0.001	<0.001	0.015	0.999

All independent variables represented in the natural log form.
H_0: $\rho_u = 1$ (indicating the presence of a unit root)

The results of the Harris-Tzavalis unit root tests indicate that the null hypothesis of a unit root is strongly rejected in the economic growth variables. However, the large autocorrelation coefficients (ρ_u) and lack of significance for *Wages* and *iWages* indicate the presence of unit roots. Several transformations were attempted to remedy the unit roots, but none were successful. The variable *iWages* is important to Models 2 and 4 because of its lagged nature (*t*–1) which is recommended (Wooldridge, 2002) in order to counter autoregressive behavior in time series dependent variables. Likewise, the variable *Wages* is the dependent variable for Model 4 which is the economic development Core Model. As a result of these challenges, any estimates made from Models 2 and 4 will be unreliable. Therefore, the economic development regression models and robustness checks are discarded. The economic growth models are free from unit roots and will be used to estimate seaports' economic impacts. The economic development hypothesis (H2) will be left to future research.

Prior to specifying the economic growth models, the absence of perfect multicollinearity is verified by reviewing correlation coefficients. The correlations illustrated in Table 4-3 indicate that human capital (*HCapital*) and initial per capita GDP (*iPCGDP*) variables have a moderate correlation. Since the correlation observed is moderate and is not associated with the dependent or key independent variables, variable omission is not necessary.

Table 4-3. *Correlation coefficients for economic impact independent variables*

	Ln(*Cargo*)	Ln(*NCargo*)	Ln(*GSpend*)	Ln(*HCapital*)	Ln(*iPCGDP*)
Ln(*Cargo*)	1.000				
Ln(*NCargo*)	0.180	1.000			
Ln(*GSpend*)	0.006	0.161	1.000		
Ln(*HCapital*)	-0.018	-0.173	0.123	1.000	
Ln(*iPCGDP*)	0.253	-0.061	0.117	0.490	1.000

Step 2: Model specification.

Testing is conducted using the Hausman (1978) specification test to verify which type of model best suits the data – fixed or random effects. The Hausman test determines if correlations exist between unique error terms and predictor variables. The null hypothesis for the test is that no correlations exist between panels' unique error terms which would indicate greater compatibility with a random effects model. In fixed effects models, the panel's unique error terms can be correlated with predictor variables which is the specific model to be used in the event the test exhibits sufficient significance to reject the null hypothesis. The Hausman specification tests for Models 1 and 3 reject the null hypotheses, indicating greater compatibility with fixed effects regression models (Model 1: $\chi^2 = 229.09$, $p < 0.001$; Model 3: $\chi^2 = 208.35$, $p < 0.001$).

Step 3: Model estimation.

The economic growth models are estimated in Stata 14.2 (StataCorp, 2015) using the "xtreg" command with the fixed effects option invoked. Model 1 is the Core Model under study and Model 3 is the Alternate Model. Table 4-4 shows the results of the regressions on Models 1 and 3.

Table 4-4. *Regression results of economic growth models*

	(1)	(3)
Ln(*Cargo*)	0.0156*	767.49†
	(0.0075)	(402.28)
Ln(*NCargo*)	0.1213***	5205.39***
	(0.0194)	(1047.87)
Ln(*GSpend*)	-0.0054***	-294.49***
	(0.0011)	(59.97)
Ln(*HCapital*)	0.0050	79.70
	(0.0178)	(956.91)
Ln(*iPCGDP*)	-0.3724***	28438.48***
	(0.0287)	(1544.77)
Constant	1.5516**	-363219.80***
	(0.4457)	(24021.12)
R^2 (within)	0.331	0.510
F	43.17	90.81
Dep. Variable	*ΔPCGDP*	*PCGDP*

Standard errors in parentheses.
N = 49; 490 Observations, 49 Seaports, 10 Time Periods
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, † $p = 0.057$

Interpretation of regressions

The results of Model 1 in Table 4-4 show a significant and positive relationship between growth in per capita GDP and cargo throughput as well as neighboring ports' cargo throughput. In fact, neighboring ports' cargo throughput has a stronger and more significant relationship than host ports' individual cargo throughput which is similar to what has been reported in the literature (Shan et al., 2014). In Model 3, the relationship between *PCGDP* and *Cargo* is significant above the $p < 0.05$ level ($p = 0.057$). Even though this level of significance is greater than the traditional 95-percent cutoff, Model 3 remains useful for the overall robustness assessment of Model 1. Models 1 and 3 achieved 96 and 97 percent power, respectively.

Step 4: Measuring robustness.

Robustness checks are used in this research which involve the omission and replacement of key variables in order to assess the structural validity of the baseline models under shock conditions. This research conducts robustness testing by adding and removing independent variables that were discovered to have an observable impact on regional economies during the literature review. The lagged value of the dependent variables will remain in place in each of the models to counter autoregressive behavior.

Robustness is assessed in two manners: Evaluating Leamer robustness and measuring the degree of robustness for the point estimates of interest. Nuemayer and Plümper (2017) define Leamer robustness by stating that "a baseline model estimate is robust to plausible alternative model specifications if and only if all estimates have the same direction and are all statistically significant" (pp. 45-46). Therefore, Core Model 1 and Alternate Model 3 will be analyzed alongside their relevant Robustness Models to determine if Leamer robustness exists.

Lu and White (2014) and Neumayer and Plümper (2017) argue that evaluating robustness as having the same sign and similar coefficient sizes (i.e. Leamer robustness) provides insufficient evidence for declaring the presence of robustness. Although each method offers an acceptable procedure for making robustness claims, the latter work puts forth a technique that is sufficiently rigorous to support robustness claims in this application. Neumayer and Plümper (2017) specifically define "the degree of robustness ρ (rho) as the share or percentage of the probability density function of the robustness test model that falls within the 95-percent confidence interval of the probability density function of the baseline model" (p. 37). The authors' corresponding method to measure robustness is a non-statistical technique that compares the differences between PDFs through the use of integral calculus. The comparison

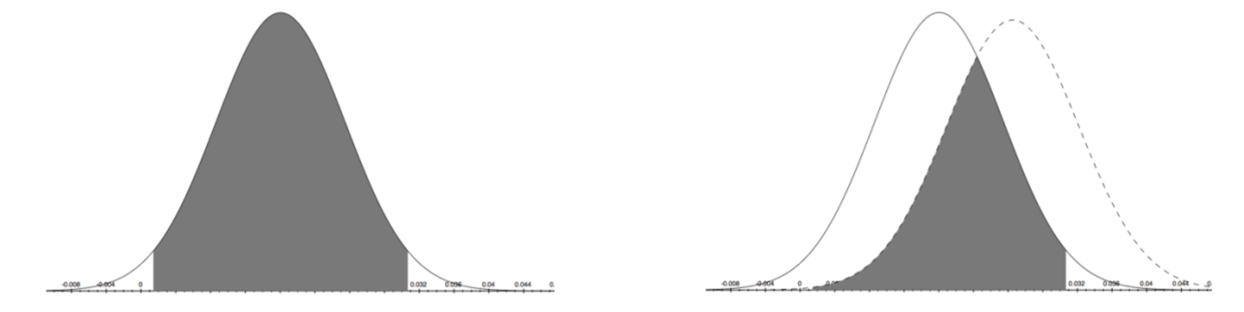
permits measurement of how much of the robustness estimate's PDF occupies the same space as the parent estimate's PDF, which is typically bounded on both sides to make up the 95-percent confidence interval.

The PDF of any random continuous variable x is explained in Equation 4.1. Calculating Equation 4.1 provides the probability that the value of a point estimate lies within the PDF's upper and lower bounds where the subtext b signifies baseline model, β represents the point estimate of interest, and σ is the standard error of the estimate.

$$P(X_b; \beta_b, \sigma_b) = \frac{1}{\sigma_b\sqrt{2\pi}} e^{-\frac{(X_b-\beta_b)^2}{2(\sigma_b)^2}} \tag{4.1}$$

For a graphic example, consider the probability density function of a point estimate with a 95-percent confidence interval. The left panel of Figure 4-2 illustrates the familiar picture of a PDF where the shaded area represents the area under the curve that falls within the 95-percent confidence band. The right panel of Figure 4.2 illustrates a baseline model estimate alongside a corresponding robustness model estimate, and the shaded area represents the overlap between the baseline PDF's 95-percent confidence band and the robustness estimates' PDF.

Figure 4-2. *Illustration of Neumayer and Plümper's degree of robustness measurement*



PDF with 95% Confidence Bounds

Baseline (—) and Robustness (--) PDF Overlap

Graphic created by author.

The shaded area in the right panel is what Neumayer and Plümper (2017) refer to as the "degree of robustness ρ (rho)" (p. 37) which they propose measuring using the definition in Equation 4.2. This equation serves as a tool for quantifying the degree of robustness for the point estimate of interest, $\rho(\beta_r)$ which in this research is the *Cargo* variable.

$$\rho(\beta_r) \equiv \frac{1}{\sigma_r \sqrt{2\pi}} \int_{\beta_b - C\sigma_b}^{\beta_b + C\sigma_b} \left(e^{-\frac{(X_r-\beta_r)^2}{C\sigma_r^2}} \right) dx \tag{4.2}$$

In Equation 4.2, the subtexts b and r signify baseline and robustness model, respectively. The β symbol represents the point estimate of interest, σ is the standard error of the estimate, and $C\sigma_b$ makes up the margin of error around the point estimate of the baseline model. The probability function explained in Equation 4.2 permits measurement of how much space the robustness estimate's PDF occupies within the 95-percent confidence band of the baseline estimate's PDF. Therefore, the area under the robustness estimates' PDF curve that lies within

the upper and lower confidence bounds of the baseline estimate is the degree of robustness, ρ*(Cargo),* which is reported on a 0 to 1 scale. Neumayer and Plümper (2017) also offer criteria to assist in characterizing robustness based on standard error behavior:

> In our definition of robustness, the consequences of efficiency for the degree of robustness depends on the location of the robustness test model's point estimate. If it is far from the baseline model's point estimate, small standard errors of the robustness test signal non-robustness, not robustness. Larger standard errors signal greater robustness but never high degrees of robustness. If the robustness test point estimate is close to the baseline model's point estimate, robustness test models that lack efficiency (that come with fairly large standard errors) are not informative: these estimates do not signal non-robustness unless the size of standard errors substantially exceeds the size of the baseline model estimate's standard error (pp. 47-48).

Table 4-5 illustrates the Core Model (1) alongside the Robustness Models (1.a through 1.c) using growth in per capita GDP (Δ*PCDGP*) as the dependent variable.

Table 4-5. *Core model 1 robustness - ΔPCDGP*

	(1)		(1.a)		(1.b)		(1.c)	
	Coef. (Std.Err)	*p*	Coef. (Std.Err)	*p*	Coef. (Std.Err)	*p*	Coef. (Std.Err)	*p*
Ln(*Cargo*)	0.0156 (0.0075)	0.037	0.0245 (0.0076)	0.001	0.0197 (0.0076)	0.010	0.0153 (0.0073)	0.038
Ln(*NCargo*)	0.1213 (0.0101)	0.000			0.1148 (0.0199)	0.000	0.1204 (0.0191)	0.000
Ln(*GSpend*)	-0.0054 (0.0011)	0.000	-0.0049 (0.0012)	0.000			-0.0054 (0.0011)	0.000
Ln(*HCapital*)	0.0050 (0.0178)	0.781	-0.0138 (0.0182)	0.450	0.0026 (0.0182)	0.887		
Ln(*iPCGDP*)	-0.3724 (0.0287)	0.000	-0.3522 (0.0297)	0.000	-0.3556 (0.0292)	0.000	-0.3725 (0.0286)	0.000
Constant	1.5516 (0.4457)	0.001	3.4182 (0.3447)	0.000	1.3778 (0.4555)	0.003	1.5613 (0.4438)	0.000
ρ_{Cargo}	Baseline		0.530		0.779		0.936	
R^2 (within)	0.334		0.271		0.295		0.331	
F	43.17		40.67		45.75		54.06	

Standard errors in parentheses
No. Observations: 490, No. Seaports: 49
Dependent Variable: *ΔPCDGP*

Table 4-6 illustrates the Robustness Model estimates alongside the Alternate Model (3), where the actual value of *PCGDP* is used in place of *ΔPCGDP* as the dependent variable. The robustness calculations for this dissertation are included as Appendix D.

Table 4-6. *Alternate model 3 robustness – PCGDP*

	(3)		(3.a)		(3.b)		(3.c)	
	Coef. (Std.Err)	*p*	Coef. (Std.Err)	*p*	Coef. (Std.Err)	*p*	Coef. (Std.Err)	*p*
Ln(*Cargo*)	767.49 (402.28)	0.057	1149.94 (405.44)	0.005	988.26 (410.20)	0.016	762.32 (397.00)	0.055
Ln(*NCargo*)	5205.39 (1047.87)	0.000			4847.82 (1071.37)	0.000	5190.65 (1030.40)	0.000
Ln(*GSpend*)	-294.49 (59.97)	0.000	-273.74 (61.43)	0.000			-294.35 (59.88)	0.000
Ln(*HCapital*)	79.70 (956.91)	0.934	-725.16 (968.40)	0.454	-49.04 (981.52)	0.960		
Ln(*iPCGDP*)	28438.48 (1544.77)	0.000	29307.83 (1575.98)	0.000	29358.80 (1573.39)	0.000	28437.63 (1539.62)	0.000
Constant	-363219.80 (0.4457)	0.000	-283109.10 (18297.44)	0.000	-372719.90 (24568.12)	0.000	-363064.60 (23921.53)	0.000
ρ_{Cargo}	Baseline		0.530		0.779		0.936	
R^2 (within)	0.334		0.271		0.295		0.331	
F	43.17		40.67		45.75		54.06	

Standard errors in parentheses
No. Observations: 490, No. Seaports: 49
Dependent Variable: *PCDGP*

Interpretation of robustness

Robustness testing was used to assess the relationships between cargo throughput and per capita GDP when subjected to shocks. According to Nuemayer and Plümper (2017), a baseline model estimate exhibits Leamer robustness “if and only if all [robustness] estimates have the same direction and are all statistically significant” (p. 46). Tables 4-5 and 4-6 demonstrate Leamer robustness for the *Cargo* variables’ point estimates across all models. The *HCapital* variable does not have a significant relationship with the dependent variable in any of the models and is therefore not considered. All significant variables in the Core Model maintain significance and signs throughout the robustness regressions.

Additionally, the robustness regressions on the Alternate Model (3) in Table 4-6 show decreased significance for the *Cargo* variable which began at $p = 0.057$ in the baseline estimate.

The *p*-value for the *Cargo* estimate in Model 3.c is 0.055 which is also above the traditional value of $p \leq 0.05$. Models 3 and 3.a through 3.c are used solely as comparative tools to assist in assessing the stability of Core Model (1). Because no inferences will be made from the Alternative Model (3), and significance levels are just slightly over the traditional cutoff, these models are retained for further analyses. In the event biased estimates are discovered in the core models, nonparametric standard errors will be calculated.

Next, the degrees of robustness for the point estimate of interest ρ_{Cargo} are calculated and reported in Tables 4-5 and 4-6 (see Appendix D for calculations). In Table 4-5, the ρ_{Cargo} value is at its lowest (0.53) when *NCargo* is omitted and rises to 78 and 94 percent in models 1.b and 1.c, respectively. The Alternate Model's (3) robustness regressions display remarkably similar behavior to the Core Model robustness regressions thus providing further evidence in favor of robustness. The ρ_{Cargo} values for Models 1.a and 3.a however, deserve some discussion.

In this application, the continuous measurement of robustness calculates how much area a robustness estimate's PDF lies within the 95-percent confidence interval of the baseline estimate's PDF. In the worst case, 53 percent of the robustness estimate's PDF lies within the baseline estimate's PDF. It is important to note that the "a" models experience the largest shock by the removal of the *NCargo* variable. In this research, and the study conducted by Shan et al. (2014), neighboring ports' cargo outpaces host port cargo by a large margin. Therefore, when *NCargo* is removed from the baseline regressions, the *Cargo* estimate assumes more of the variance, thus increasing the coefficient and significance level.

The standard errors also behave in a manner indicative Nuemayer and Plümper's (2017), robustness. As the *Cargo* estimates' coefficients increase and move further away from the baseline estimate, the standard errors increase. When the robustness models' coefficients

decrease, the standard errors also decrease. This behavior coupled with the ρ_{Cargo} values indicate sufficient robustness to begin the next stage of the research.

Step 5: Post estimation diagnostics.

In this step post estimation diagnostics are carried out on the residuals of Model 1 to determine if the OLS assumption of homoscedasticity is violated and to assess the presence of cross-sectional dependence amongst the panels. When heteroscedasticity and cross-sectional dependence are present, fixed effects estimates yield imprecise standard errors and *t*-scores which might lead to misinterpretation of observed relationships (Allison, 2009; Wooldridge, 2002). If heteroscedasticity and cross-sectional dependence exists in the models, panel corrected standard errors should be calculated.

The Wald test is employed to assess group-wise homoscedasticity using the Stata package designed by Baum (2000).[35] This package examines the null hypothesis of homoscedasticity which is needed to satisfy the OLS assumption defined by Hair et al. (2010) as "dependent variables exhibit equal levels of variance across the range of predictor variables" (p. 74). When the error terms exhibit unequal variance on the dependent variable, estimates remain unbiased but standard errors become biased (Hair et al., 2010). This research rejects the null hypothesis ($\chi^2 = 2454.42$, $p < 0.001$) indicating the presence of biased standard errors.

Cross sectional dependence is evaluated using the Pesaran (2004) test for cross-sectional independence in panel-data models. Like heteroscedasticity, the presence of cross-sectional dependence in the panels contributes to biased standard errors while the estimates remain consistent (De Hoyos & Sarafidis, 2006). In this research the Pesaran test is carried out in Stata

[35] The xttest3 Stata command uses a program developed by Baum (2000) to conduct the Wald Test for heteroscedasticity across panel data.

14.2 (StataCorp, 2015) using the "xtcsd" command.[36] This research rejects the null hypothesis of cross-sectional independence in the residuals ($\chi^2 = 18.24$, $p < 0.001$) indicating bias in the standard errors. Because the residuals exhibit cross-sectional dependence and heteroscedasticity, an alternative method is needed to estimate the standard errors and *t*-scores (Elhorst, 2003).

Driscoll and Kraay (1998) developed a nonparametric method for estimating fixed effect models' standard errors when parametric estimates are biased. Their method uses an orthogonal transformation to develop a nonparametric covariance matrix estimator which is robust to the presence of heteroscedasticity and cross-sectional dependence. Similar treatments of econometric panel data models can be found in the literature (Arezki, Ramey, & Sheng, 2017; Elhorst, 2003; Iqbal, Mehmood, & Nisar, 2015). This research determines the Driscoll-Kraay standard errors for Core Model 1 using the "xtscc" Stata command developed by Hoechle (2006). The parametric and nonparametric estimations for Model 1 are compared in Table 4-7.

[36] The xtcsd command uses a program developed by De Hoyos and Sarafidis (2006) to conduct the Pesaran test for cross-sectional independence across panel data.

Table 4-7. *Parametric and nonparametric estimates – Model 1*

	Model 1: ΔPCGDP		
		Parametric	Nonparametric
	Coefficient	*t*	*t*
Ln(*Cargo*)	0.0156	2.09 (0.0075)	2.16 (0.0064)
Ln(*NCargo*)	0.1213	6.25 (0.0194)	2.90 (0.0418)
Ln(*GSpend*)	-0.0054	-4.84 (0.0011)	-6.61 (0.0080)
Ln(*HCapital*)	0.0050	0.28 (0.0178)	0.15 (0.0332)
Ln(*iPCGDP*)	-0.3724	-12.99 (0.0287)	-7.30 (0.0287)
Constant	1.5516	3.48 (0.4457)	3.63 (0.4274)
F		43.17	56.68
R^2 (within)	0.331		

Standard errors (in parentheses). Critical value of *t* = 2.015
N = 49; 490 Observations, 49 Seaports, 10 Time Periods

Table 4-7 shows that the *Cargo* estimate's *t*-value increases between parametric and nonparametric methods while the standard error shows a decrease. The Driscoll and Kraay (1998) method demonstrates that the relationship between *Cargo* and *ΔPCGDP* is more significant than what the parametric estimation revealed. Model 1 also shows a decrease in the *t*-value for *NCargo* while the standard errors increase. The *NCargo* variable remains significant in the nonparametric method. The results up to this point demonstrate with confidence that a significant relationship exists between *ΔPCGDP* and *Cargo* that is not spurious. Therefore, variable precedence can be assessed in Step 6.

At this point in the analysis a concern manifests for the legitimacy of the degrees of robustness calculated based on biased standard errors. However, some of that concern is

mitigated by observing that the non-parametric standard error for the *Cargo* variable (Table 4-7) decreased from the parametric value. Any changes in model efficiency are likely to affect the significance level of the relationship between *Cargo* and the dependent variable. Therefore, the degrees of robustness for each robustness regression on the Core Model (1) are recalculated using non-parametric standard errors. The revised degrees of robustness (ρ'_{Cargo}) are shown in Table 4-8.

Table 4-8. *Comparison of Model 1 robustness using non- and parametric standard errors*

					95% Confidence Interval		Robustness	
Model	Omitted Variable	*Cargo* Coef.	Std. Err.	*t*	Lower Limit	Upper Limit	ρ'_{Cargo}	ρ_{Cargo}
1	None	0.0156222	0.0063695	2.45	0.0028154	0.0284289	Baseline	Baseline
1.a	*NCargo*	0.0245335	0.0123189	1.99	-0.0002354	0.0493024	0.513	0.530
1.b	*GSpend*	0.0196613	0.0063950	3.07	0.0068034	0.0325193	0.725	0.779
1.c	*HCapital*	0.0153009	0.0044791	3.42	0.0062951	0.0243067	0.826	0.936

The comparison of robustness measurements (ρ_{Cargo} and ρ'_{Cargo}) in Table 4-8 reveal small differences between the degrees of robustness in Models 1.a and 1.b. However, Model 1.c, shows a difference of more than 10 percent. It is also important to point out that the omitted variable (*HCapital*) in Model 1.c was not significant in any of the models.

The *Cargo* variable is subjected to the largest shock when *NCargo* is omitted in Model 1.a. The PDF and standard errors for the non-parametric *Cargo* estimate in Model 1.a. reveal behavior that is indicative of robustness (Neumayer & Plümper, 2017). The *Cargo* coefficient experiences the largest deviation from the baseline while the standard errors expand thus

increasing the geometry of the PDF. Robustness testing on Model 1 using non-parametric standard errors indicates no remarkable difference from the calculations using parametric standard errors and finds that the *Cargo* point estimate is robust to plausible alternate model specifications.

Step 6: Granger causality.

The regressions leading up to this step indicate that the amount of cargo moving through a seaport has a significant relationship with changes in host regions' per capita GDP. However, because there are numerous sources in regional economies that could stimulate change in per capita GDP, the nature of the relationship remains unclear. More evidence is needed to describe the directionality of the relationship between the two variables and rule out simultaneity.

The Granger (1969) causality test is employed, as modified by Freeman (1983), to determine if the associations between *Cargo* and *ΔPCGDP* are unidirectional or bidirectional. The Granger test was developed to determine if a particular time series is useful for predicting another time series which is tantamount to identifying precedence between the two variables. In this application, it is possible that regional economies could drive cargo throughput and; if that is the case, no directional inference can be made between the association observed in the regression of Model 1. Hence, if *ΔPCGDP* is useful in predicting *Cargo*, it can be said that economic growth "Granger causes" changes in seaports' cargo throughput.[37]

Freeman (1983) developed a direct version of the Granger causality test which has been used in similar applications to analyze the direction of relationships between econometric variables (Park & Seo, 2016; Shan et al., 2014). This modified Granger test regresses one

[37] It should be noted that the Granger causality test does not provide absolute evidence of causation. The test helps to understand precedence between variables.

variable (*Cargo*) on the lagged values of itself and the variable of interest which is *ΔPCGDP*. Subsequently, the *F*-test is employed to examine the null hypothesis that the coefficient values of $\Delta PCDGP_{i,t}$ are in fact not statistically different from zero. Equation 4.3 describes the Granger causality test as modified by Freeman (1983).

$$Cargo_{i,t} = \alpha_1 Cargo_{i,t-1} + \cdots + \alpha_5 Cargo_{i,t-5} + \beta_1 \Delta PCGDP_{i,t-1} + \cdots + \beta_5 \Delta PCGDP_{i,t-5} + \upsilon_t + \mu_i + \epsilon_{i,t} \quad (4.3)$$

In Equation 4.3, $Cargo_{i,t}$ is the dependent variable which is also found on the righthand side of the equation for periods *t*-1 through *t*-5, along with the same periods' values for $\Delta PCDGP_{i,t}$. The time component (ν_t) captures temporal fixed effects, μ_i is the unobserved fixed effect for each ports' host region, and $\varepsilon_{i,t}$ represents the idiosyncratic error term. In order to infer that $\Delta PCDGP_{i,t}$ does not "Granger cause" *Cargo,* the coefficients β_1 through β_5, should not be statistically different from zero, hence the null hypothesis $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$. Table 4-9 illustrates the results of the modified Granger causality tests using fixed effects models.

Table 4-9. *Economic growth Granger causality test results*

	Coef.	Std Err.	*p*-value
Granger Test			
$Ln(Cargo_{i,t-1})$	0.397	-0.069	< 0.000
$Ln(Cargo_{i,t-2})$	0.006	0.072	0.940
$Ln(Cargo_{i,t-3})$	-0.089	-0.065	0.171
$Ln(Cargo_{i,t-4})$	0.073	-0.066	0.265
$Ln(Cargo_{i,t-5})$	-0.073	-0.098	0.112
$\Delta PCDGP_{i,t-1}$	0.394	-0.069	0.482
$\Delta PCDGP_{i,t-2}$	0.002	0.071	0.783
$\Delta PCDGP_{i,t-3}$	-0.080	-0.064	0.229
$\Delta PCDGP_{i,t-4}$	0.078	-0.065	0.888
$\Delta PCDGP_{i,t-5}$	-0.114	-0.062	0.454
Constant	11.594	0.182	< 0.000
F Test			
F statistic	0.590		
p-value	0.709		

F Test null hypothesis: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$

The results reported in Table 4-9 indicate that Ln($Cargo_{i,t-1}$) is the only variable that is statistically different from zero. Additionally, the *F*-test on the null hypothesis $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$ indicates that none of the β values are statistically different from zero. Thus, it can be inferred that *Cargo* Granger causes $\Delta PCDGP$, indicating the absence of simultaneity.

Summary and interpretation of Economic Impact Analysis

This section discusses the analysis and results of seaports' impacts on regional economies. Realizing the threats to accurately estimating seaports' economic impacts with longitudinal data, Steps 1 through 6 were developed as a series of mitigating efforts designed to buttress any inferences made from these results. The unit root test, developed by Harris and Tzavalis (1999), is a univariate technique used to assess the presence of unit roots which can

cause researchers to misinterpret results, thereby contributing to Type I and II errors. Hence, it is important to deal with non-stationarity in variables before adding them to a model. The economic growth models were free of unit roots as illustrated in Table 4-2, but the economic development models were not. Several transformations were attempted to rid the variables of unit roots, but none were successful. As a result, the economic development models were discarded and hypothesis H2 was not tested.

Next, the Hausman specification test was employed to analyze predictor variables and residuals for correlations (i.e. endogeneity). The Hausman test results indicated that the residuals are correlated with the regressors, suggesting that a fixed effects model is more appropriate for the data. Therefore, each of the regressions estimated in Stage 2 used fixed effects models.

The results of the baseline models in Table 4-4 indicate a significant relationship between *Cargo* and *ΔPCDGP* at the $p < 0.05$ level, and *PCGDP* at the $p = 0.057$ level.[38] The relationships are weak in both models when compared to the *NCargo* variables ($p < 0.001$) which have coefficients that are nearly eight times greater than host seaports' impacts seen in the *Cargo* variables. Even though the results here are similar to what is seen in the literature (Shan et al., 2014), the results in Table 4-4 are not considered reliable until further analysis was conducted to identify the potential for biased estimates in Steps 4 and 5.

Two methods of robustness testing were used: Leamer robustness and measuring the degrees of robustness (ρ_{Cargo}) through a series of robustness model estimations. The robustness models allowed for key independent variables to be omitted thereby introducing shock to the point estimates of interest ($Cargo_{i,t}$). Probability density functions were graphed at each

[38] Model 3 is used as a comparative tool only for the relationship of interest in Model 1. No inferences are made from Model 3 in this dissertation.

robustness regression and compared to the relevant baseline model's PDF to determine the difference between the geography of the two functions. The results of the robustness testing on Models 1 and 3 are illustrated in Tables 4-5 and 4-6, respectively, which show that the *Cargo* variable maintains a significant relationship throughout the range of the growth model regressions.

Additionally, the ρ_{Cargo} value indicates how robust the relationship is on a scale of 0 to 1. The least robust measurements taken from Models 1.a and 3.a, where *NCargo* was omitted, were 0.530 and 0.533, respectively. Although no benchmark for the degree of robustness has been established in the literature, the zero-to-one scale of the measure allows one to gauge robustness and make informed decisions about the quality of the observed relationships in the baseline models. This research finds that the relationship between *Cargo* and $\Delta PCDGP$ is robust to plausible, alternative model specifications.

After fixed effects models were estimated and relevant robustness checks completed, post-estimation diagnostics discovered that the estimates produced by Model 1 was potentially unreliable due to non-standard residual behavior. Therefore, the method developed by Driscoll and Kraay (1998) was used to calculate panel corrected standard errors which are reported in Table 4-7. The Driscoll and Kraay standard errors were then used to verify that the relationships of interest maintain significance when estimated using the nonparametric method.

The testing illustrated in Table 4-7 revealed that the *Cargo* variable estimates were in fact significant using both parametric and nonparametric estimation methods for Model 1. Additionally, Model 1 shows standard errors decreasing for the *Cargo* and *GSpend* variables and increasing for *NCargo*. The bias observed in the parametric estimates is not surprising. Driscoll and Kraay (1998) have shown that relatively weak cases of cross-sectional dependence and

endogeneity can cause standard error estimates to be largely biased. Nonetheless, this research finds that a significant relationship exists between the amount of cargo moving through seaports and the host regions' growth in per capita GDP. Before step five could be completed, it became apparent that the degrees of robustness were calculated using biased standard errors. In order to verify that the models are robust, non-parametric standard errors were used verify that the cargo variable maintained robustness throughout the Core Model's robustness regressions (see table 4-8).

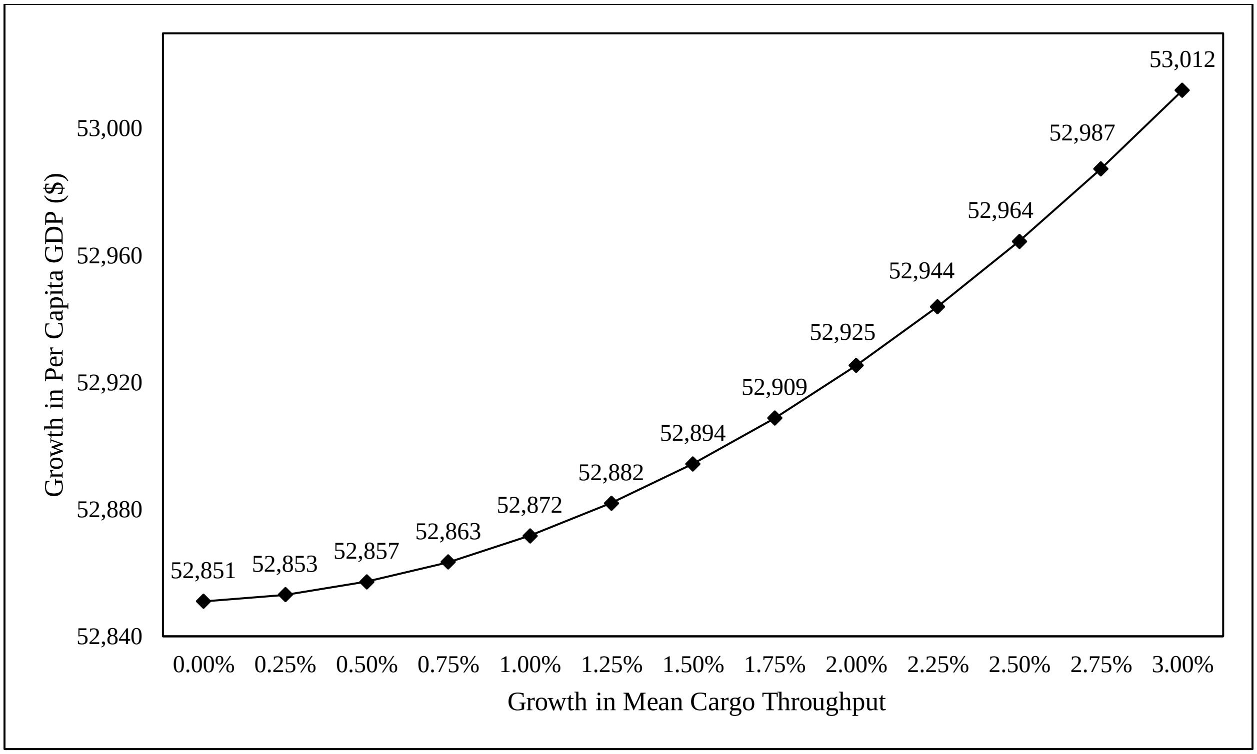
The last piece of information needed to test hypothesis H1 was directionality. The Granger causality test was used to rule out simultaneity between the dependent variable (*ΔPCGDP*) and the independent variable of interest (*Cargo*). The granger causality test results are shown in Table 4-9 which indicate that the relationship between *Cargo* and *ΔPCGDP* is one-directional: *ΔPCGDP* does not "Granger cause" *Cargo*.

Economic impact of seaports' cargo throughput.

In addition to providing evidence for rejecting the economic growth null hypothesis (H1), the analysis also provides useful information for understanding the impact of U.S. seaports on regional economies. The Stage 2 analysis revealed that the relationship between cargo throughput and economic growth is significant and growth in per capita GDP does not Granger cause cargo throughput. Furthermore, the robustness checks and post estimation testing reinforced the evidence from Model 1 that a one-way, significant relationship exists between *Cargo* and growth in per capita GDP. The coefficient estimated for *Cargo* in Model 1 can be used for a ceteris paribus interpretation of seaports economic impact: For every one percent increase in cargo moving through a U.S. public seaport, the growth in MSA-level per capita GDP can be expected to increase by 0.0156 percent. The economic growth impact is further

extrapolated in Figure 4.3, with all controls held constant, to illustrate the projected impacts of increased cargo (*x* axis) on per capita GDP.

Figure 4-3. *Annual average economic growth curve of U.S. seaports*



The projections in Figure 4-3 originate with the dataset's annual mean cargo throughput value (31,323,238 short tons) at zero percent increase on the horizontal axis and the corresponding mean per capita GDP value of $52,851. As the mean value of cargo throughput increases by one percent, per capita GDP increases by 0.0156 percent. Therefore, if cargo throughput were increased by 2.5 percent from its mean level, per capita GDP would increase from the mean by 0.039 percent to $52,964. Based on these estimates, the per capita GDP for an

MSA with a population of 1.7 million would see an annual increase of $124,100,000 into the economy.

Stage Three – Environmental Impacts

The results of the analysis used to test the environmental impact hypotheses are explained in this section. Seaports are suspected of impacting host regions' air quality through hazardous emissions from diesel-powered cargo handling equipment converging upon one location (ships, trains, trucks, tugboats, container handling equipment, etc.). In this research, annual surface-level ozone concentrations are used as a surrogate to assess environmental stewardship. Because of the number of diesel-powered combustion engines used to move goods through each port, a relationship between port performance and local air quality is suspected. Therefore, surface-level ozone data has been operationalized to examine the following hypotheses:

H3: Seaports' cargo throughput has a direct and positive relationship with changes in the mean surface-level ozone concentrations of host counties.

H4: Seaports' cargo throughput has a direct and positive relationship with host counties' ability to attain National Ambient Air Quality Standards.

Models 5 through 8, represented by Equations 3.18 through 3.37, were conceptualized in order to test hypotheses H3 and H4. Core environmental Models 5 and 7 use changes in surface-level ozone concentrations ($\Delta Ozone$) and changes in the Fourth Maximum value ($\Delta 4thMax$) of surface ozone concentration as dependent variables, respectively. Alternate Models 6 and 8 use actual values of the surface-level ozone concentrations (O_3Mean) and Fourth Max value

(*4thMax)* as the dependent variables, respectively. The Alternate Models serve as a basis of comparison for the Core Models when subjected to robustness testing, in the same manner as Stage 2 where the critical independent variables *Unemploy*, *Precip, Temp,* and *Wind* are omitted, alternatingly. The independent variable of interest in both models is port performance, expressed as cargo throughput (*Cargo*) in short tons. All statistical testing in this stage is conducted using Stata (StataCorp, 2015) version 14.2.

Empirical Inquiry

This section explains the logic and steps used to empirically test the environmental impact hypotheses. The environmental hypotheses are tested using the regression models described in Chapter 3. Hypotheses H3 is aimed at understanding the relationship between the county-level annual mean surface ozone concentration and the amount of cargo moving through a seaport. Hypothesis H4 is used to assess what impacts seaports' have on host counties ability to attain surface ozone NAAQS. In both hypotheses there must be a defendable and statistically significant relationship between cargo throughput (*Cargo*) and the dependent variables (*ΔOzone* and *Δ4thmax*). Estimating these relationships are challenging due to the unobservable causes of change in the dependent variables and the inherent potential for endogeneity in longitudinal models. Also, there must be reliable evidence that the *Cargo* variable precedes the models' dependent variables (i.e. causality). Therefore, the analytical process used in Stage 2 of this dissertation is also appropriate for this stage (see Figure 4-1).

First, the data is prepared for the analysis by conducting univariate testing to identify violations of OLS assumptions and causes of endogenous behavior. Second, data are analyzed to determine the most appropriate model, fixed or random effects. Third, Models 5, 6, 7, and 8 are estimated to set a baseline for robustness testing. Fourth, a series of regressions are carried out on

the baseline models to evaluate the robustness of the point estimate of interest (*Cargo*). Step 5 is a set of post-estimation tests employed to mitigate spuriousness in the findings. Lastly, Step 6 employs a Granger causality test to inspect for simultaneity which is the final piece of information needed to evaluate the environmental impact hypotheses.

Step 1: Data preparation.

The descriptive statistics in Table 4-10 show a large amount of dispersion in *Cargo, Precip,* and *ΔOzone*. As was seen in Stage 2, *Cargo*'s large standard deviation is indicative of seaports that operate on different levels of performance. The *Precip* variable indicates approximately 36 inches of variance around the mean value which is also expected to impact surface-level ozone concentrations. The *ΔOzone* variable's dispersion is also large, showing a standard deviation of 8.2 percent compared to the mean and median of 0.19 and -0.36 percent, respectively. Additionally, *ΔOzone* is positively skewed indicating some counties with large annual changes in surface ozone concentrations.

Table 4-10. *Descriptive statistics: Environmental impact variables*

Variable	Description	Unit	Mean	Median	Std. Dev.
ΔOzone	Change in ozone mean concentrations	Percent	0.19	-0.36	8.20
O_3Mean	Ozone annual mean	Parts per million	0.038	0.039	0.006
Δ4thMax	Annual change in fourth maximum value	Percent	-0.010	-0.006	0.103
4thMax	Annual fourth highest 8-hour surface ozone concentration	Parts per million	0.067	0.067	0.010
Cargo	Annual cargo throughput	Short tons ($x10^6$)	31.32	13.73	49.77
Unemploy	Unemployment	Percent	7.06	6.90	2.83
Precip	Precipitation	Inches	39.84	41.46	17.61
Temp	Annual average surface temperature	°F	59.71	57.50	9.44
Wind	Wind speed	mph	7.52	7.40	1.58
O_3Reg	Ozone regulation period (*t*-1)	Dummy	0.10	0.00	0.30
iOzone	Initial ozone concentration	Parts per million	0.039	0.039	0.007
i4thMax	Initial annual fourth maximum value *(t-1)*	Parts per million	0.069	0.068	0.011

Prior to regression analyses unit root testing is conducted using the method designed by Harris and Tzavalis (1999). The unit root test is carried out in Stata 14.2 (StataCorp, 2015) using the “xtunitroot” command with the “ht” option invoked. The results of the Harris-Tzavalis tests are shown in Table 4-11.

Table 4-11. *Unit root tests of environmental impact variables*

	Dependent Variables				*Independent Variables*					
	ΔOzone	*O_3Mean*	*Δ4thMax*	*4thMax*	*Cargo*	*Unemploy*	*Precip*	*Temp*	*iO_3Mean*	*i4thMax*
ρ_u	-0.4835	0.0565	-0.4606	0.1892	0.4784	0.6430	-0.1748	0.2308	0.0065	0.1995
p	<0.001	<0.001	<0.001	<0.001	<0.001	0.0154	<0.001	<0.001	<0.001	<0.001

All independent variables represented in the natural log form.
H_0: ρ_u = 1 (indicating the presence of a unit root)

The results of the Harris-Tzavalis unit root tests indicate the absence of unit roots in all environmental variables. The autocorrelation coefficients (ρ_u) do not approach a value of 1.0 and therefore, the null hypothesis is rejected in each variable. These data are free from unit roots and therefore suitable to continue the analysis.

Prior to testing the environmental models, the absence of perfect multicollinearity is verified by reviewing correlation coefficients. The correlations illustrated in Table 4-12 indicate that *Unemploy*, *iO₃Mean,* and *i4thMax* variables have a moderate correlation. Since the correlation observed is moderate and is not associated with the relationship between *Cargo* and the dependent variables, variable omission is not necessary. Also, the correlation between *iO₃Mean* and *i4thMax* is not concerning because the two variables will not be used in the same model.

Table 4-12. *Correlation coefficients for environmental impact independent variables*

	Ln(*Cargo*)	Ln(*Unemploy*)	Ln(*Precip*)	Ln(*Temp*)	*O₃Reg*	Ln(*iO₃Mean*)	Ln(*i4thMax*)
Ln(*Cargo*)	1.000						
Ln(*Unemploy*)	-0.015	1.000					
Ln(*Precip*)	0.111	-0.044	1.000				
Ln(*Temp*)	0.215	0.078	0.074	1.000			
O₃Reg	-0.031	0.110	0.010	-0.021	1.00		
Ln(*iO₃Mean*)	0.124	0.572	0.220	0.121	0.00	1.000	
Ln(*i4thMax*)	0.315	0.154	0.180	0.237	0.02	0.739	1.000

Step 2: Model specification.

Testing is conducted to ascertain whether the data is better suited for a fixed or random effects model using the Hausman (1978) specification test. The null hypothesis for the Hausman

test is that no correlations exist between panels' predictor variables and unique error terms. Rejecting the null hypothesis denotes that the data has greater compatibility with a fixed effects model. The Hausman specification test for Models 5 and 6 reject the null hypothesis indicating greater compatibility with fixed effects regression models (Model 5: $\chi^2 = 439.90$, $p < 0.001$; Model 6: $\chi^2 = 382.45$, $p < 0.001$). The Hausman tests for the data used in Models 7 and 8 also reject the null hypothesis (Model 7: $\chi^2 = 228.66$, $p < 0.001$; Model 8: $\chi^2 = 310.38$, $p < 0.001$). Therefore, fixed effects models are used for all regressions in this stage of the dissertation.

Step 3: Model estimation.

The environmental models are estimated in Stata 14.2 (StataCorp, 2015) using the "xtreg" command with the fixed effects option. The regression results of Models 5 and 6 are shown in Table 4-13. There is a significant and positive relationship between *Cargo* and the dependent variables: $\Delta Ozone$ and O_3Mean. The wind speed variable (*Wind*) was removed due to poor model performance.[39] Further interpretation is offered below.

[39] The regressions of Models 5 and 6 without the *Wind* variable exhibit better global *F* scores and shows no change in the 'within R-squared' values.

Table 4-13. *Regression results of environmental models*

	(5)	(6)	(7)	(8)
Ln(*Cargo*)	0.0303*	0.0013*	0.0353†	0.0025†
	(0.0154)	(0.000)	(0.0203)	(0.0014)
Ln(*Unemploy*)	-0.0308**	-0.0011**	-0.0473**	-0.0030**
	(0.0101)	(0.0004)	(0.0136)	(0.0009)
Ln(*Precip*)	-0.0187†	-0.0008*	0.0080	0.0001
	(0.0097)	(0.0004)	(0.0126)	(0.0009)
Ln(*Temp*)	0.7927***	0.0292***	0.8134***	0.0551***
	(0.1188)	(0.0046)	(0.1559)	(0.0105)
O_3Reg	-0.0090	-0.0006	0.0152	0.0009
	(0.0097)	(0.0004)	(0.0127)	(0.0009)
Ln(iO_3Mean)	-0.9992***	-0.0015		
	(0.0462)	(0.0018)		
Ln(*i4thMax*)			-0.8075***	0.0139***
			(0.0404)	(0.0027)
Constant	-6.8737***	-0.0925***	-6.0248***	-0.1553***
	(0.5938)	(0.0230)	(0.7564)	(0.0504)
R^2 (within)	0.533	0.176	0.492	0.183
F	84.33	15.84	71.52	16.52
Dep. Variable	*ΔOzone*	O_3Mean	*Δ4thMax*	*4thMax*

Standard errors (in parentheses).
N = 50; 500 Observations, 50 Seaports, 10 Time Periods
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, † $p < 0.10$

Interpretation of regressions

This interpretation is preliminary for the purpose of determining if the data can go forward to the next step. A more descriptive interpretation of the findings will be offered once the models are subjected to the entire analytical process. The results of Models 5 and 6 in Table 4.13 show significant and positive relationships between the dependent variables, *ΔOzone* and O_3Mean, and the primary independent variable *Cargo*. Additionally, the *Unemploy* and *Temp* variables are significant and in the expected directions. The precipitation variable in Model 5 is over the traditional cutoff ($p \leq 0.05$), but since it is not the point estimate of interest (*Cargo*) and it is only slightly higher than the cutoff, the variable is retained. Additionally, post estimation

power analysis revealed that Model 5 achieved 99-percent and Model 6 achieved 61-percent. Model 6 is the alternate model used for robustness testing of Core Model 5 from which no inferences will be made. Therefore, Model 6 is retained for comparative purposes in the remaining steps.

The results of Models 7 and 8 indicate that no significant relationship exists between *Cargo* and the dependent variables with individual *p*-values of 0.107 and 0.082, respectively. The *Unemploy* and *Temp* variables show at least moderate and strong significance, respectively, and are in the expected directions. Post estimation power analysis revealed that Model 7 achieved 99-percent and Model 8 achieved 63-percent. Even though the *Cargo* variable is not significant at the $p \leq 0.05$ level in Models 7 and 8, the models are retained for robustness testing and post estimation diagnostics. If the post estimation testing determines that the models suffer from endogeneity, nonparametric standard errors are calculated and the levels of significance reassessed.

Step 4: Measuring robustness.

This step assess the robustness of the *Cargo* point estimates in Core Models 5 and 7. Leamer robustness is evaluated using the definition offered by Nuemayer and Plümper (2017). Briefly, if all variables in the model remain significant and in the same direction throughout the robustness regressions, Leamer robustness exists.

Next, the degrees of robustness for the point estimates of interest are calculated (ρ_{Cargo}) and compared across the Core and Alternate Models. The robustness calculations are included in Appendix D. Table 4-14 illustrates the results of robustness testing of Core Model 5.

Table 4-14. *Core model 5 robustness - ΔOzone*

	(5)		(5.a)		(5.b)		(5.c)	
	Coef. (Std.Err)	*p*	Coef. (Std.Err)	*p*	Coef. (Std.Err)	*p*	Coef. (Std.Err)	*p*
Ln(*Cargo*)	0.0303 (0.0154)	0.049	0.0424 (0.0150)	0.005	0.0305 (0.0154)	0.049	0.0271 (0.0161)	0.093
Ln(*Unemploy*)	-0.0308 (0.0101)	0.003			-0.0323 (0.0101)	0.001	-0.0362 (0.0106)	0.001
Ln(*Precip*)	-0.0187 (0.0004)	0.053	-0.0211 (0.0097)	0.030			-0.0192 (0.0101)	0.58
Ln(*Temp*)	0.7927 (0.1188)	0.000	0.8220 (0.1194)	0.000	0.7946 (0.1191)	0.000		
O_3Reg	-0.0090 (0.0096)	0.348	-0.0177 (0.0092)	0.055	-0.0088 (0.0096)	0.359	-0.0166 (0.0099)	0.096
Ln(O_3Mean)	-0.9992 (0.0019)	0.410	-0.9769 (0.0461)	0.200	-0.9876 (0.0460)	0.000	-0.9659 (0.0482)	0.000
Constant	-6.8737 (0.5938)	0.000	-7.1631 (0.5915)	0.000	-6.9101 (0.5954)	0.000	-3.4686 (0.3186)	0.000
ρ_{Cargo}	Baseline		0.661		0.946		0.954	
R^2 (within)	0.533		0.523		0.529		0.486	
F	84.33		97.54		99.82		84.05	

Standard errors (in parentheses)
No. Observations: 500, No. Seaports: 50
Dependent Variable: *ΔOzone*

Table 4-14 reveals that Leamer Robustness exists across Models 5.a and 5.b. The *Cargo* variable in Model 5.c however, does not achieve significance at the $p \leq 0.05$ level. This concern will be further addressed in Step 5 when the models are assessed for endogeneity and cross-panel dependence. It is important to note that the coefficient of the omitted variable (*Temp*) is more than 20 times larger than the *Cargo* coefficient in the baseline regression (Model 5). Hence, it is not surprising to see the *p*-value for *Cargo* rise to 0.093 once *Temp* is removed, therefore further scrutiny is prudent before claiming non-robustness on the baseline *Cargo* point estimate.

Additionally, the O_3Reg variable shows nonuniform behavior across the Core Model 5 robustness regressions. Although the ozone regulatory variable is not the estimate of interest, the

behavior of this variable indicates that federal regulatory policies may not be effective at reducing hazardous emissions. This could be an area for future research.

The measures of robustness (ρ_{Cargo}) in Table 4-14 indicate that the probability density functions of the point estimate of interest (*Cargo*) occupies 66 percent of the baseline estimate's PDF, in the worst case (see Appendix D for calculations). This is an indication that the robustness point estimates do not fall far from the baseline when subjected to the shocks of variable omission. Additionally, the behavior of the standard errors across Models 5.a through 5.c provide further evidence of robustness. Specifically, the standard errors for the *Cargo* point estimate in the robustness models show signs of shrinking and swelling to compensate for the changes in variance. This behavior is indicative of robustness according to Nuemayer and Plümper (2017). The graphical and mathematical representations in Appendix D illustrate the behavior of the point estimates and standard errors. The evidence presented in Table 4-14 indicates that the *Cargo* point estimate in Core Model 5 is robust to plausible model specifications.

Table 4-15 illustrates the results of robustness testing on the Alternate Model (6), where the actual values of annual average surface ozone concentrations (O_3Mean) are used in place of percent growth.

Table 4-15. *Alternate model 6 robustness – O_3Mean*

	(6)		(6.a)		(6.b)		(6.c)	
	Coef. (Std.Err)	*p*	Coef. (Std.Err)	*p*	Coef. (Std.Err)	*p*	Coef. (Std.Err)	*p*
Ln(*Cargo*)	0.0013 (0.0006)	0.030	0.0017 (0.0006)	0.003	0.0013 (0.0006)	0.030	0.0012 0.0006	0.059
Ln(*Unemploy*)	-0.0011 (0.0004)	0.005			-0.0012 (0.0004)	0.003	-0.0013 (0.0004)	0.001
Ln(*Precip*)	-0.0008 (0.0004)	0.040	-0.0009 (0.0004)	0.023			-0.0008 (0.0004)	0.043
Ln(*Temp*)	0.0293 (0.0046)	0.000	0.0303 (0.0046)	0.000	0.0294 (0.0046)	0.000		
O_3Reg	-0.0006 (0.0132)	0.127	-0.0009 (0.0004)	0.014	-0.0006 (0.0004)	0.133	0.0009 (0.0004)	0.028
Ln(O_3Mean)	-0.0015 (0.0019)	0.410	0.0023 (0.0018)	0.200	-0.0020 (0.0018)	0.273	-0.0027 (0.0019)	0.146
Constant	-0.0926 (0.0230)	0.000	-0.1030 (0.0229)	0.000	-0.0940 (0.0230)	0.000	0.0333 (0.0123)	0.007
ρ_{Cargo}	Baseline		0.679		0.945		0.877	
R^2 (within)	0.176		0.161		0.168		0.101	
F	15.84		17.12		18.03		9.990	

Standard errors (in parentheses)
No. Observations: 500, No. Seaports: 50
Dependent Variable: O_3Mean

In Table 4-15, Alternate Model 6 reveals similar behavior to Core Model 5. First, Leamer robustness cannot be claimed across Models 6.a through 6.c due to the O_3Reg variable teetering in and out of significance at the $p \leq 0.05$ level. Core Model 5 exhibited similar behavior. Second, measures of robustness (ρ_{Cargo}) show comparable values to the Model 5 counterparts in Table 4-14. Third, the *Cargo* coefficients of Models 6.a through 6.c only realized sizable changes from the baseline in Model 6.a and the behavior of the standard errors is indicative of robustness (see Appendix D for calculations with more significant digits). Table 4-15 provides more evidence that the relationship of interest in Model 5 is genuine. Therefore, the evidence presented in Tables 4-14 and 4-15 indicates that the *Cargo* point estimate in Core Model 5 is robust to plausible model specifications.

Table 4-16 illustrates the results of robustness testing on the Core Model (7), where the changes in the annual fourth maximum value (*Δ4thMax*) is the dependent variable.

Table 4-16. *Core model 7 robustness – Δ4thMax*

	(7)		(7.a)		(7.b)		(7.c)	
	Coef. (Std.Err)	*p*	Coef. (Std.Err)	*p*	Coef. (Std.Err)	*p*	Coef. (Std.Err)	*p*
Ln(*Cargo*)	0.0353 (0.0203)	0.083	0.0523 (0.0200)	0.009	0.0351 (0.0203)	0.085	0.0327 0.0209	0.119
Ln(*Unemploy*)	-0.0473 (0.0136)	0.001			-0.0464 (0.0135)	0.001	-0.0538 (0.0140)	0.000
Ln(*Precip*)	0.0080 (0.0126)	0.527	0.0034 (0.0132)	0.789			0.0065 (0.0130)	0.618
Ln(*Temp*)	0.8134 (0.1560)	0.000	0.8631 (0.1572)	0.000	0.8111 (0.1558)	0.000		
O_3Reg	0.0152 (0.0132)	0.458	-0.0013 (0.0122)	0.917	0.0150 (0.0127)	0.239	0.0079 (0.0130)	0.544
Ln(*i4thMax*)	-0.8075 (0.0404)	0.000	-0.7727 (0.0397)	0.000	-0.8070 (0.0404)	0.000	-0.8030 (0.0416)	0.000
Constant	-6.0248 (0.7464)	0.000	-6.4755 (0.7440)	0.000	-5.9837 (0.7430)	0.000	-2.6356 (0.3781)	0.000
ρ_{Cargo}	Baseline		0.647		0.947		0.902	
R^2 (within)	0.450		0.478		0.491		0.417	
F	60.43		81.40		85.86		63.71	

Standard errors in parentheses
No. Observations: 500, No. Seaports: 50
Dependent Variable: *Δ4thMax*

The regressions in Table 4-16 indicate that the *Cargo* estimate teeters in and out of significance at the $p \leq 0.05$ level. This behavior is not indicative of Leamer robustness. As the *Cargo* variable estimate's coefficient increases in Model 7.a, the standard errors decrease slightly. In Model 7.b the Cargo estimate is virtually unchanged, but as the Cargo estimate decreases below the baseline estimate in model 7.c, the standard error becomes larger. The

calculations and graphical comparisons of probability density functions in Appendix D illustrate the robustness of the point estimates and standard errors.

Table 4-17 illustrates the results of robustness testing on the Alternate Model (8), where the actual values of the fourth highest maximum ozone concentration value (*4thMax*) are used in place of percent growth.

Table 4-17. *Alternate model 8 robustness – 4thMax*

	(8)		(8.a)		(8.b)		(8.c)	
	Coef. (Std.Err)	*p*	Coef. (Std.Err)	*p*	Coef. (Std.Err)	*p*	Coef. (Std.Err)	*p*
Ln(*Cargo*)	0.0025 (0.0014)	0.073	0.0036 (0.0014)	0.009	0.0025 (0.0014)	0.073	0.0023 (0.0014)	0.106
Ln(*Unemploy*)	-0.0030 (0.0009)	0.001			-0.0030 (0.0009)	0.001	-0.0035 (0.0009)	0.000
Ln(*Precip*)	0.0001 (0.0009)	0.911	-0.0002 (0.0009)	0.815			-0.0001 (0.0009)	0.993
Ln(*Temp*)	0.0551 (0.0105)	0.000	0.0583 (0.0106)	0.000	0.0551 (0.0105)	0.000		
O_3Reg	0.0009 (0.0009)	0.304	-0.0001 (0.0008)	0.988	0.0001 (0.0008)	0.305	0.0004 (0.0009)	0.659
Ln(*i4thMax*)	0.0139 (0.0027)	0.000	0.0161 (0.0027)	0.000	0.0139 (0.0027)	0.000	0.0142 (0.0028)	0.000
Constant	-0.1553 (0.0504)	0.002	-0.1842 (0.0502)	0.000	-0.1548 (0.0502)	0.002	0.0744 (0.0256)	0.004
ρ_{Cargo}	Baseline		0.661		0.956		0.875	
R^2 (within)	0.191		0.162		0.183		0.132	
F	17.48		17.26		19.87		13.54	

Standard errors in parentheses
No. Observations: 500, No. Seaports: 50
Dependent Variable: Δ*4thMax*

In Table 4-17, The *Cargo* variable reveals similar behavior to the robustness regressions of Core Model 7 (see table 4-16). Leamer robustness does not exist primarily due to the *Cargo*

variable teetering in and out of significance at the $p \leq 0.05$ level. The behavior of Model 8 robustness regressions and measures of robustness (ρ_{Cargo}) indicate similar behavior to the Core Model 7 counterparts. The largest shocks to *Cargo* come from omitting *Unemp* and *Temp* causing changes in the *Cargo* coefficients of at least 40 percent. During these shocks the standard errors behaved in a manner conducive with Nuemayer and Plümper's (2017) description of robustness. Based on this interpretation, the behavior of the standard errors and the robustness values of Models 7.a through 7.c indicate that the relationship between *Cargo* and *Δ4thMax* is robust per the method described by Nuemayer and Plümper (2017). Core Model 7 is able to proceed into Step 5 and Alternate Model 8 is retired after serving its comparative purpose.

Interpretation of robustness

Robustness testing was used to assess the relationship between cargo throughput and county-level surface ozone concentrations when subjected to shocks. First, Leamer robustness is assessed using Nuemayer and Plümper's (2017) definition: "a baseline model estimate is robust to plausible alternative model specifications if and only if all estimates have the same direction and are all statistically significant" (p. 46). Leamer robustness was not demonstrated in all of the robustness regressions. However, Nuemayer and Plümper (2017) contend that their method for measuring the degree of robustness "is independent of the level of statistical significance of the effects in either baseline or robustness test models…. [and] is incompatible with Leamer robustness and that useful definitions of robustness must refer to stability in estimated effect sizes or effect strengths" (p. 46). Even though some social scientists may prefer the use of an accepted statistical significance level as a backstop, the mechanics of the Nuemayer and Plümper (2017) method make clear that significance is not the most important criteria in this technique.

The degrees of robustness for the point estimate of interest $\rho_{(Cargo)}$ are calculated and reported in Tables 4-14 through 4-17 (see Appendix D for calculations). The levels of robustness for the Core Models (5 and 7) indicate that the PDF for the point estimates of interest occupy at least 65 percent of their baseline estimate's PDF. Additionally, the Core Models standard errors behave in a manner that is indicative of robustness according to Nuemayer and Plümper (2017). The Alternate Models (6 and 8) exhibit similar behavior as the Core Models which lends credence to the relationship between *Cargo* and the dependent variables, *ΔOzone* and *Δ4thMax*. As a result of the Step 4 testing, Core Models 5 and 7 are carried forward to Step 5 and Alternate Models 6 and 8 are retired.

Step 5: Post estimation diagnostics.

In this step, postestimation diagnostics are carried out on the residuals of the Core Models (5 and 7) to determine if the OLS assumption of homoscedasticity is violated, and to assess the presence of cross-sectional dependence amongst the panels. If heteroscedasticity and cross-sectional dependence are present, standard errors are considered biased and panel corrected standard errors are computed. The Wald test is employed for group-wise heteroscedasticity using the Stata package designed by Baum (2000),[40] which examines the null hypothesis of homoscedasticity. This research rejects the null hypothesis in Model 5 ($\chi^2 = 479.45$, $p < 0.001$), and Model 7 ($\chi^2 = 307.55$, $p < 0.001$) indicating that the residuals are heteroscedastic.

Cross sectional dependence is evaluated using the Pesaran (2004) test for panel data models. The Pesaran test is carried out in Stata 14.2 using the "xtcsd" command from the package developed by De Hoyos and Sarafidis (2006). Like heteroscedasticity, the presence of

[40] The xttest3 Stata command uses a program developed by Baum (2000) to conduct the Wald Test for heteroscedasticity across panel data.

cross-sectional dependence in the panels contributes to biased estimates. This research rejects the null hypothesis of cross sectional independence in the residuals of Model 5 ($\chi^2 = 16.47$, $p < 0.001$) and Model 7 ($\chi^2 = 30.01$, $p < 0.001$), indicating the presence of potentially biased estimates. Because the residuals of the models exhibit cross-sectional dependence and heteroscedasticity, the Driscoll and Kraay (1998) non-parametric method for estimating standard errors is employed and compared with the baseline (parametric) standard errors. Table 4-18 compares parametric and nonparametric standard errors for Model 5.

Table 4-18. *Parametric and nonparametric estimates – Model 5*

	Model 5: ΔOzone		
		Parametric	Nonparametric
	Coefficient	*t*	*t*
Ln(*Cargo*)	0.030	1.97 (0.015)	5.34 (0.006)
Ln(*Unemploy*)	-0.031	-3.04 (0.010)	-1.28 (0.024)
Ln(*Precip*)	-0.019	-1.94 (0.010)	-1.05 (0.018)
Ln(*Temp*)	0.793	6.68 (0.119)	19.90 (0.040)
O_3Reg	-0.009	-0.94 (0.010)	-1.01 (0.009)
Ln(iO_3Mean)	-0.999	-21.62 (0.046)	-6.43 (0.155)
R^2 (within)	0.533		
F	84.33		

Standard errors (in parentheses). Critical value of $t = 2.015$.
$N = 50$; 500 Observations, 50 Seaports, 10 Time Periods

The comparison of standard errors in Table 4-18 reveals a few interesting characteristics. First, the relationship between *Cargo* and *ΔOzone* is highly significant in the nonparametric estimate, as opposed to the weak significance in the parametric estimate. The relationship between *Cargo* and *Unemploy* is not significant (p = 0.207) in the nonparametric model and the relationship between *Temp* and *ΔOzone* is also very highly significant. Second, the standard errors around *Cargo* and *Temp* decrease indicating greater efficiency over the parametric estimates while the *Unemploy* variable becomes less efficient. The regressions can be interpreted using the revised, nonparametric standard errors. Table 4-19 compares parametric and nonparametric standard errors for Model 7.

Table 4-19. *Parametric and nonparametric estimates – Model 7*

	Model 7: Δ4thMax		
		Parametric	Nonparametric
	Coefficient	*t*	*t*
Ln(*Cargo*)	0.035	1.74 (0.020)	2.02 (0.018)
Ln(*Unemploy*)	-0.047	-3.47 (0.014)	-1.18 (0.040)
Ln(*Precip*)	0.008	0.63 (0.013)	0.50 (0.016)
Ln(*Temp*)	0.813	5.22 (0.160)	3.08 (0.264)
O_3Reg	0.015	1.20 (0.013)	0.84 (0.018)
Ln(*i4thMax*)	-0.808	-19.97 (0.040)	-7.70 (0.105)
R^2 (within)	0.492		
F	79.52		

Standard errors (in parentheses)
N = 50; 500 Observations, 50 Seaports, 10 Time Periods

The comparison of standard errors in Table 4-19 reveals greater significance between *Cargo* and *Δ4thMax* using the nonparametric estimate than what is seen in the parametric estimate. Unlike Model 5, the relationship between *Temp* and *Δ4thMax* is less significant when calculated using the nonparametric method. This is understandable since Model 5 uses changes in annual mean surface ozone concentrations as the dependent variable and Model 7 uses changes in the fourth maximum 8 hour concentration value attained for the calendar year. Nonetheless, the estimates of interest (*Cargo*) in Models 5 and 7 are significant at the $p \leq 0.05$ level when calculated using the Driscoll and Kraay (1998) nonparametric method.

Because the biased standard errors were discovered after robustness testing, it is prudent to recalculate the degrees robustness for the Core Models using nonparametric standard errors before claiming robustness. The degrees of robustness for each robustness regression on the Core Model (5) are recalculated using non-parametric standard errors. The revised degrees of robustness (ρ'_{Cargo}) are shown in Table 4-20.

Table 4-20. *Robustness using non- and parametric standard errors*

Model	Omitted Variable	*Cargo* Coef.	Driscoll & Kraay Std. Err.	*t*	95% Confidence Interval Lower Limit	95% Confidence Interval Upper Limit	Robustness ρ'_{Cargo}	Robustness ρ_{Cargo}
5	None	0.030	0.006	1.97	0.018870	0.041664	Baseline	Baseline
5.a	*Unemploy*	0.042	0.014	3.06	0.014588	0.070299	0.394	0.661
5.b	*Precip*	0.031	0.006	5.01	0.018255	0.042688	0.920	0.946
5.c	*Temp*	0.027	0.005	5.01	0.016224	0.037938	0.747	0.954
7	None	0.035	0.018	2.02	0.000205	0.070477	Baseline	Baseline
7.a	*Unemploy*	0.052	0.014	3.89	0.025275	0.079382	0.551	0.647
7.b	*Precip*	0.035	0.017	2.02	0.000095	0.0701015	0.951	0.947
7.c	*Temp*	0.033	0.018	1.79	-0.004005	0.0693664	0.897	0.903

The comparison of robustness measurements in table 4-20 reveal some noteworthy differences between ρ_{Cargo} and ρ'_{Cargo}. First, in Models 5.a through 5.c the ρ'_{Cargo} value is lower than the calculations with parametric estimates. Models 5.a and 5.c show the largest differences in robustness between the parametric measurement (ρ_{Cargo}) and ρ'_{Cargo}. The standard errors in Model 5.a also show a significant increase above the baseline (Model 5) indicating behavior that is robust to plausible alternative model specification (see Nuemayer & Plümper, 2017). Graphic representations of each robustness calculation are provided in Appendix D.

The behavior of Models 5.b and 7.b are unremarkable because the point estimates and standard errors are nearly unchanged from the baseline. However, Model 5.c shows a decrease of greater than 20 percent in ρ'_{Cargo} over ρ_{Cargo}. In this case, the *Cargo* estimate became slightly smaller than the baseline, and the standard errors remain decrease slightly. This behavior is in line with Nuemayer and Plümper's (2017) description of standard errors' behavior when point estimates exhibit robustness. In summary, the post estimation testing and calculation of

nonparametric standard errors accomplished in this step demonstrated significant relationships between *Cargo* and surface ozone mean concentration levels and the ability to attain current ozone NAAQS. The last piece of information needed to address the environmental hypotheses is directionality which is assessed in Step 6.

Step 6: Granger causality.

The regressions leading up to this step indicate that the amount of cargo moving through a seaport has a significant relationship with changes in local ozone concentrations and NAAQS attainment. However, in order to strengthen any causal inference made concerning the relationship, more evidence is needed that demonstrates variable precedence. The Granger (1969) causality test is employed, as modified by Freeman (1983), to establish variable precedence between *Cargo* and the dependent variables of Models 5 and 7. If the Granger test finds that *Cargo* precedes *ΔOzone,* it can be said that cargo throughput "Granger causes" changes in surface ozone concentrations. Likewise, the Granger test will also establish precedence between *Cargo* and *Δ4thMax*. Equations 4.4 and 4.5 are estimated in fixed effects regression models to establish variable precedence.

$$Cargo_{i,t} = \alpha_1 Cargo_{i,t-1} + \alpha_2 Cargo_{i,t-2} + \beta_1 \Delta Ozone_{i,t-1} + \beta_2 \Delta Ozone_{i,t-2} + \upsilon_t + \mu_i + \epsilon_{i,t} \quad (4.4)$$

$$Cargo_{i,t} = \alpha_1 Cargo_{i,t-1} + \alpha_2 Cargo_{i,t-2} + \beta_1 \Delta 4thMax_{i,t-1} + \beta_2 \Delta 4thMax_{i,t-2} + \upsilon_t + \mu_i + \epsilon_{i,t} \quad (4.5)$$

In Equations 4.4 and 4.5, $Cargo_{i,t}$ is the dependent variable which is also found on the righthand side of the equation for periods *t*-1 through *t*-2, along with the same periods' values for *ΔOzone* and *Δ4thMax*. The time component (υ_t) captures temporal fixed effects, μ_i is the

unobserved fixed effect for each ports' host region, and $\varepsilon_{i,t}$ represents the idiosyncratic error term. In order to infer that *Cargo* "Granger causes" *ΔOzone*, the coefficients (β_1 and β_2), should not be statistically different from zero (H_0: $\beta_1 = \beta_2 = 0$). Additionally, there is no expectation that surface ozone molecules linger in any location for long periods of time after emission. Therefore, the Granger causality test method is limited to a lag of two years. The information in Table 4-21 illustrates the results of the Granger causality test between *Cargo* and *ΔOzone*.

Table 4-21. *Granger causality test results - ΔOzone*

	Coef.	Std Err.	*p*-value
Granger Test			
$Ln(Cargo_{i,t-1})$	0.426	0.052	< 0.000
$Ln(Cargo_{i,t-2})$	-0.050	0.050	0.325
$\Delta Ozone_{i,t-1}$	-0.030	0.118	0.801
$\Delta Ozone_{,t-2}$	-0.010	0.114	0.931
Constant	10.128	0.182	< 0.000
F Test			
F statistic	18.79		
p-value	< 0.000		

F test null hypothesis: $\beta_1 = \beta_2 = 0$

The Granger causality test results in Table 4-21 indicates the absence of simultaneity. Specifically, the only variable useful in predicting future values of *Cargo* is the previous years' cargo throughput ($Cargo_{i,t-1}$). Therefore, it can be inferred that changes in *ΔOzone* do not Granger cause changes in *Cargo* which mitigates the concern for simultaneity in Model 5. Table 4-22 illustrates the results of the Granger causality test between *Cargo* and *Δ4thMax*.

Table 4-22. *Granger causality test results - Δ4thMax*

	Coef.	Std Err.	*p*-value
Granger Test			
$Ln(Cargo_{i,t-1})$	0.425	0.052	< 0.000
$Ln(Cargo_{i,t-2})$	-0.049	0.050	0.327
$\Delta Ozone_{i,t-1}$	0.028	0.091	0.758
$\Delta Ozone_{,t-2}$	0.008	0.090	0.929
Constant	10.151	0.888	< 0.000
F Test			
F statistic	18.80		
p-value	< 0.000		

F test null hypothesis: $\beta_1 = \beta_2 = 0$

The results in Table 4-22 indicate that the only variable useful in predicting future values of *Cargo*, is $Cargo_{i,t-1}$. No other variables show significant relationships with the dependent variable. This test indicates that *Cargo* Granger causes *Δ4thMax* thus mitigating the concern for simultaneity in Model 7. This stage of the research determines that the relationship between *Cargo* and the dependent variables is one-directional; Cargo Granger causes *ΔOzone* and *Δ4thMax*.

Summary and Interpretation of Environmental Impact Analysis

Steps 1 through 6 were used as a series of mitigating efforts designed to buttress inferences made from these results. Step 1 cleaned and prepared the data for analysis in a manner that mitigated concerns for any characteristics that contribute to model bias or Type I and II errors.

In Step 2, the Hausman (1978) specification test was employed to analyze predictor variables and residuals for correlations (i.e. endogeneity). The Hausman test results indicated

that the residuals are correlated with the regressors suggesting that a fixed effects model is more appropriate for the data. Hence, each of the regressions estimated in this stage of the dissertation used fixed effects models. The regressions are reported for Models 5 and 6 in Table 4-13.

The results of the regressions in Table 4-13 indicate the presence of significant relationships between the independent variable of interest, *Cargo*, and the dependent variables ($p < 0.05$). The results in Table 4-13 are not considered conclusive until further analysis is conducted to identify the potential for biased estimates.

Robustness regressions were used to analyze the point estimates of interest when subjected to shocks. This research was unable to declare Leamer robustness across Models 5 through 8. However, probability density functions were graphed at each robustness regression and compared to the relevant baseline model's PDF to determine the difference between the geography of the two functions. Step 4 resulted in a determination of robustness for the relationships between the amount of cargo moving through a seaport and county-level ozone concentrations. The results of the robustness checks of Models 5 through 8 are illustrated in Tables 4-14 and 4-17.

After fixed effects models were estimated and relevant robustness checks completed, post-estimation diagnostics discovered that the estimates produced by Models 5 and 7 were potentially unreliable due to non-standard residual behavior. Therefore, the method developed by Driscoll and Kraay (1998) was used to calculate panel corrected standard errors which are reported in Tables 4-18 and 4-19. The Driscoll and Kraay standard errors were then used to verify that the relationships of interest maintained significance when estimated using the nonparametric method. The nonparametric estimations illustrated in Tables 4-18 and 4-19 reveal that the *Cargo* variable estimates are significant at the $p \leq 0.05$ level.

The Granger causality test was used to analyze the presence simultaneity between the dependent variables of Models 5 and 7 and *Cargo*. The Granger causality tests are shown in Tables 4-21 and 4-22 which show relationships between *Cargo* and the dependent variables of Models 5 and 7 is one-directional. Hence, a one-directional relationship exists between *Cargo* and county-level ozone concentrations signifying rejection of the null hypothesis (H3). Additionally, the testing of hypothesis H4 reveals that U.S. seaports have a significant and one-directional relationship between *Cargo* and *Δ4thMax*.

Environmental impact of seaports' cargo throughput.

Further analysis is conducted in order to address the second research question: Are the common mission elements within the mission statements of U.S. public seaports reflective of seaport performance? The relationships found between *Cargo* and surface ozone concentrations are not informative enough to answer the research question because it does not reveal information concerning recorded exposure levels or regulatory compliance. This is because the surface ozone mean values are averaged across a 24-hour period and not isolated to the period that coincides with the routine flow of cargo through a seaport during a normal workday. Also, the ozone regulatory threshold is not based on mean concentrations but is the annual fourth-highest daily maximum 8-hour concentration which is averaged over 3 years (EPA, 2017a). Table 4-23 illustrates the county-level fourth-highest daily maximum 8-hour concentration for each seaport across all years of this study.

Table 4-23. *Annual fourth-highest 8-hour concentration values – County level*

		Surface Ozone Fourth Maximum 8-hour Concentration Legislated Thresholds (ppm)									
		|--------- 0.080 ---------|		-- 0.075					--------------------------------------|0.070		
		Surface Ozone Fourth Highest 8-hour Concentration Maximum Values (ppm)									
County	Seaport	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Alameda, CA	Port of Oakland, CA	0.071	0.049	0.062	0.065	0.050	0.056	0.052	0.055	0.064	0.064
Albany, NY	Port of Albany, NY	0.066	0.075	0.077	0.064	0.073	0.065	0.073	0.064	0.061	0.063
Ashtabula, OH	Port Conneaut, OH	0.086	0.092	0.075	0.075	0.083	0.077	0.079	0.070	0.069	0.070
Ashtabula, OH	Port of Ashtabula, OH	0.086	0.092	0.075	0.075	0.083	0.077	0.079	0.070	0.069	0.070
Baltimore, MD	Port of Baltimore, MD	0.086	0.078	0.083	0.070	0.081	0.086	0.083	0.068	0.068	0.074
Bay, FL	Port of Panama City, FL	0.077	0.077	0.075	0.065	0.072	0.070	0.066	0.063	0.066	0.061
Brazoria, X	Port Freeport, TX	0.087	0.079	0.076	0.084	0.082	0.084	0.081	0.079	0.066	0.078
Brevard, FL	Port Canaveral, FL	0.076	0.068	0.068	0.063	0.064	0.066	0.065	0.063	0.061	0.059
Broward, FL	Port Everglades, FL	0.071	0.061	0.062	0.058	0.060	0.057	0.061	0.057	0.061	0.057
Clallam, WA	Port of Port Angeles, WA	0.051	0.051	0.056	0.059	0.054	0.054	0.051	0.051	0.055	0.051
Clark, WA	Port of Vancouver, WA	0.066	0.060	0.060	0.062	0.054	0.055	0.059	0.052	0.057	0.065
Contra Costa, CA	Port of Richmond, CA	0.072	0.065	0.070	0.062	0.067	0.066	0.064	0.059	0.066	0.068
Cowlitz, WA	Port of Kalama, WA	0.068	0.057	0.060	0.063	0.056	0.056	0.060	0.053	0.056	0.061
Cowlitz, WA	Port of Longview, WA	0.068	0.057	0.060	0.063	0.056	0.056	0.060	0.053	0.056	0.061
Cumberland, ME	Port of Portland, ME	0.066	0.083	0.065	0.065	0.066	0.065	0.066	0.067	0.065	0.061
Cuyahoga, OH	Port of Cleveland, OH	0.074	0.081	0.079	0.061	0.073	0.074	0.081	0.064	0.064	0.067
Duval, FL	Port of Jacksonville, FL	0.077	0.078	0.068	0.058	0.067	0.069	0.058	0.057	0.064	0.058
Escambia, FL	Port of Pensacola, FL	0.082	0.079	0.074	0.071	0.073	0.072	0.070	0.065	0.070	0.062
Galveston, TX	Port of Galveston, TX	0.082	0.069	0.069	0.076	0.080	0.079	0.081	0.064	0.071	0.084
Harris, TX	Port of Houston, TX	0.091	0.079	0.074	0.078	0.078	0.081	0.080	0.074	0.064	0.081
Harrison, MS	Port of Gulfport, MS	0.084	0.081	0.078	0.079	0.073	0.074	0.073	0.062	0.073	0.067
Hillsborough, FL	Port of Tampa, FL	0.077	0.081	0.074	0.070	0.070	0.074	0.069	0.066	0.067	0.067
Jackson, MS	Port of Pascagoula, MS	0.082	0.078	0.076	0.073	0.073	0.072	0.074	0.066	0.075	0.065
John the Baptist, LA	Port of South Louisiana	0.081	0.082	0.071	0.077	0.073	0.076	0.077	0.064	0.068	0.067
King, WA	Port of Seattle, WA	0.065	0.057	0.058	0.063	0.057	0.052	0.058	0.052	0.056	0.064
Los Angeles, CA	Port of Long Beach, CA	0.087	0.082	0.082	0.084	0.071	0.075	0.076	0.073	0.079	0.080

Table 4-23 Continued

		Surface Ozone Fourth Maximum 8-hour Concentration Legislated Thresholds (ppm)									
		|--------- 0.080 ---------|--------------------------------------- 0.075 ---------------------------------------|0.070									
		Surface Ozone Fourth Highest 8-hour Concentration Maximum Values (ppm)									
County	Seaport	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Los Angeles, CA	Port of Los Angeles, CA	0.087	0.082	0.082	0.084	0.071	0.075	0.076	0.073	0.079	0.080
Lucas, OH	Port of Toledo, OH	0.073	0.078	0.072	0.068	0.066	0.068	0.080	0.065	0.066	0.063
Manatee, FL	Port of Port Manatee, FL	0.077	0.073	0.073	0.053	0.066	0.068	0.062	0.064	0.062	0.062
Milwaukee, WI	Port of Milwaukee, WI	0.070	0.076	0.064	0.068	0.074	0.070	0.088	0.065	0.066	0.066
Mobile, AL	Port of Mobile, AL	0.083	0.079	0.073	0.070	0.076	0.071	0.070	0.061	0.069	0.062
Multnomah, OR	Port of Portland, OR	0.064	0.056	0.060	0.061	0.054	0.057	0.060	0.053	0.055	0.057
New Castle, on	Port of Wilmington	0.080	0.081	0.079	0.068	0.080	0.079	0.080	0.065	0.069	0.069
New York, NY	Port of N. York - N. Jersey	0.083	0.082	0.080	0.071	0.077	0.080	0.077	0.069	0.067	0.072
Norfolk, VA	Port of Virginia	0.075	0.077	0.077	0.071	0.075	0.075	0.071	0.066	0.061	0.062
Nueces, TX	Port of Corpus Christie, TX	0.070	0.069	0.072	0.066	0.073	0.076	0.067	0.066	0.066	0.064
Orleans, LA	Port of New Orleans, LA	0.078	0.080	0.071	0.070	0.072	0.070	0.070	0.064	0.068	0.066
Palm Beach, FL	Port of Palm Beach, FL	0.070	0.067	0.065	0.064	0.065	0.061	0.064	0.061	0.065	0.059
Philadelphia, PA	Port of Philadelphia, PA	0.077	0.083	0.075	0.066	0.083	0.082	0.078	0.055	0.066	0.071
Pierce, WA	Port of Tacoma, WA	0.069	0.062	0.058	0.059	0.055	0.053	0.060	0.054	0.060	0.063
Saint Louis, MN	Port of Duluth, MN	0.060	0.062	0.058	0.056	0.059	0.053	0.059	0.055	0.055	0.056
San Diego, CA	Port of San Diego, CA	0.071	0.071	0.074	0.066	0.065	0.063	0.061	0.057	0.067	0.066
San Francisco, CA	Port of San Francisco, CA	0.044	0.047	0.049	0.048	0.046	0.048	0.047	0.043	0.052	0.050
San Joaquin, CA	Port of Stockton, CA	0.088	0.077	0.081	0.075	0.073	0.073	0.079	0.069	0.076	0.073
San Mateo, CA	Port of Redwood City, CA	0.051	0.052	0.058	0.059	0.056	0.053	0.050	0.056	0.064	0.059
Skagit, WA	Port of Anacortes, WA	0.051	0.047	0.048	0.037	0.062	0.038	0.047	0.045	0.045	0.048
Snohomish, WA	Port of Everett, WA	0.065	0.057	0.058	0.063	0.057	0.052	0.058	0.052	0.056	0.064
Suffolk, MA	Port of Boston, MA	0.074	0.072	0.067	0.069	0.067	0.063	0.065	0.065	0.057	0.056
Thurston, WA	Port of Olympia, WA	0.068	0.054	0.060	0.060	0.054	0.054	0.061	0.050	0.056	0.058
Wayne, MI	Port of Detroit, MI	0.070	0.086	0.072	0.068	0.074	0.080	0.080	0.066	0.069	0.067
U.S. Seaport Average		0.074	0.072	0.070	0.067	0.066	0.066	0.066	0.064	0.063	0.062

Table 4-23 reveals many counties with levels that fall above the current thresholds. In March of 2008 the surface ozone NAAQS dropped from 0.080 ppm to 0.075 ppm, and in October of 2015 the threshold dropped to its present value of 0.070 ppm (see Table 3-5). The regulation calls for averaging the Fourth Maximum 8-hour concentration values over a period of three continuous years to arrive at a final value for comparison with the current ozone NAAQS.

A review of U.S. seaport host counties' average Fourth Max values for surface ozone (Table 4-23, bottom line) reveals that the emission levels are decreasing, but whether that has anything to do with seaports remains unknown and could be the focus of future research. Individually however, this dissertation discovered that seaports are at least one of the industries responsible for host county ozone emissions and NAAQS attainment. Table 4-23 indicates counties in violation of federally mandated air quality standards but tying those violations to any one industry or source is difficult and not the intent of this research. Instead, this research puts forth evidence of a relationship between county-level surface ozone and seaports' cargo throughput that is more than anecdotal and reviews the attainment of surface ozone NAAQS in seaports' host counties. This stage of the research discovered a one-directional, significant relationship between *Cargo* and changes in annual surface ozone concentrations and Fourth Max values of 8-hour surface ozone concentrations. Seaports are indeed stakeholders in the host county surface ozone levels. Therefore, this research finds that the surface ozone concentrations in U.S. counties hosting seaports are reflective of U.S. seaport performance and the evidence in Table 4-23 indicate a need for environmental mitigations.

Stage Four – Financial Sustainability

This section explains the analysis and results used to determine if U.S. seaports exhibit financial sustainability. The uniqueness of being a public enterprise comes with the expectation

that the public resource will be managed in a manner that benefits the citizens in the region. Hence, the port must exhibit the qualities stated in the definition of financial sustainability developed in Chapter 2:

> Public seaport financial sustainability is the financial capacity of the port to meet its current obligations, to withstand shocks, and to maintain service, debt, and commitment levels at reasonable amounts relative to both state and local expectations and likely future income while maintaining public confidence.

The following hypotheses are used to determine if U.S seaports exhibited financial sustainability over the period of the study:

H5: U.S. seaports exhibit sufficient liquidity to meet current obligations.

H6: U.S. seaports exhibit sufficient solvency to meet long term obligations.

H7: U.S. seaports exhibit sufficient profitability to withstand financial shocks.

H8: U.S. seaports exhibit sufficient performance to maintain service and commitment levels.

Empirical Inquiry

This stage of the research evaluates financial sustainability using data from seaports' Comprehensive Annual Financial Reports (CAFR). In order to conduct the assessment however,

the data is reduced using factor analysis to summarize the dimensions in as few variables as possible. After analyzing all financial dimensions that manifest from factor analysis, financial benchmarks are established using the ratio variables with the strongest correlations to parent factors. The literature review guided the selection of financial ratios that are well-suited for this analysis,[41] which are reduced in number through factor analysis to find the best suited ratios to represent the financial dimensions of U.S. seaports.

External statistical benchmarking is a process where organizations compare themselves with similar establishments to understand how their own performance measures up to that of their competitors. Poister (2003) points out that the primary concerns with these kinds of comparisons should be the reliability of the data and the possibility for unfair comparisons based on variations in operating characteristics. The concern for reliability of the data is mitigated by using data from financial reports because there is a legal expectation that public sector finances are reported accurately and in a standardized format per the Governmental Accounting Standards Board's (1999) *Statement 34*.

Comparisons with industry means is an effective management tool, but it is possible that benchmarks could be unfair to some ports based on operating characteristics, geographical locations, and sizes of markets served. Therefore, the benchmarks defined in this research are explanatory of all U.S. public seaports regardless seaport operating characteristics. Hence, the benchmarking procedure removes the outliers that are evident in Table 4-24 and arrives at mean value that is representative of the data. This analysis is conducted in three steps: 1) Data

[41] "Well-suited financial ratios" refers to ratios that can be derived from the financial reporting required by the Governmental Accounting Standards Board's (1999) *Statement No. 34. Basic financial statements—and management's discussion and analysis—for state and local governments*.

preparation, 2) Factor analysis; and 3) Ratio benchmarking and assessment of financial sustainability hypotheses.

Step 1: Data preparation

The data for this study represents 43 U.S. public seaports across 10 years from 2006 through 2015. These seaports represent 61 percent of the sampling frame and 57 percent of the waterborne commerce movements in the United States for the period under analysis. The data is pooled for the purpose of benchmarking but otherwise operationalized as financial ratios and used to describe seaports' financial condition over the study's time period. Additionally, as described in Chapter 3, the financial data was converted from fiscal to calendar year data so that this stage of the research covered the same time period as the previous two stages. The descriptive statistics for the ratio variables are shown in table 4-24.

Table 4-24. *Descriptive statistics: Financial sustainability variables*

Ratio Variable	Median	Mean	Std. Dev.	Min	Max
Acc. depreciation to fixed assets	0.443	0.443	0.110	0.139	0.881
Capital assets condition	0.557	0.556	0.110	0.119	0.861
Cash ratio	1.224	2.181	3.311	0.008	36.989
Charge to expense	1.207	1.327	0.574	-0.150	4.835
Debt ratio	0.298	0.319	0.162	0.004	0.690
Debt to assets	0.240	0.265	0.151	0.000	0.648
Debt to equity	0.429	0.578	0.477	0.004	2.225
Fixed asset turnover	0.161	0.171	0.088	0.022	0.560
Net assets	0.267	0.762	2.211	-0.657	32.319
Net profit margin	0.239	0.469	1.198	-7.605	10.799
Operating cash flow	0.654	0.868	1.513	-4.359	22.228
Percent change in net assets	0.044	0.054	0.101	-0.339	0.815
Quick ratio	3.277	4.622	4.969	0.320	39.657
Return on assets	0.030	0.037	0.056	-0.321	0.410
Return on net assets	0.034	0.047	0.082	-0.337	0.805
Total asset turnover	0.110	0.122	0.061	0.020	0.392

N = 430

The data in Table 4-24 show extreme maximum values in four ratios: *Cash ratio, Net assets*, *Operating cash flow,* and the *Quick ratio*. Because of the extreme values, the data for all financial variables was reviewed for errors occurring during the calendar year conversion process and are validated as accurate. Therefore, the values remain and the benchmarks are set using an appropriate outlier removal process in Step 3. At the end of this step, all data is prepared for factor analysis.

Step 2: Factor analysis

Prior to conducting factor analysis, correlations between the ratio variables are reviewed as shown in Table 4-25.

Table 4-25. *Correlations between financial ratio variables*

	Acc. Dep. to fixed assets	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed asset turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total asset turnover*
Acc. dep. to fixed assets	1.000															
Capital assets condition	-1.000	1.000														
Cash	-0.098	0.099	1.000													
Charge to expense	-0.110	0.111	0.293	1.000												
Debt	0.008	-0.008	-0.410	0.048	1.000											
Debt to asset	-0.050	0.051	-0.359	0.084	0.979	1.000										
Debt to equity	-0.044	0.043	-0.335	0.072	0.959	0.946	1.000									
Fixed asset turnover	0.150	-0.151	0.097	0.020	0.066	0.038	0.043	1.000								
Net assets	-0.115	0.116	0.805	0.194	-0.393	-0.367	-0.279	0.050	1.000							
Net profit margin	-0.042	0.041	-0.032	-0.117	-0.173	-0.205	-0.141	-0.239	0.071	1.000						
Operating cash flow	-0.086	0.087	0.646	0.332	-0.218	-0.171	-0.140	0.141	0.701	-0.120	1.000					
Pct. change in net assets	-0.038	0.038	0.003	-0.032	-0.097	-0.127	-0.073	-0.126	0.094	0.717	-0.027	1.000				
Quick	-0.153	0.154	0.822	0.234	-0.464	-0.394	-0.380	0.069	0.706	-0.083	0.639	-0.047	1.000			
Return on assets	-0.080	0.080	0.090	0.039	-0.173	-0.196	-0.139	-0.085	0.155	0.769	0.014	0.807	0.016	1.000		
Return on net assets	0.014	-0.014	0.032	-0.013	-0.155	-0.225	-0.126	-0.054	0.105	0.719	-0.018	0.707	-0.036	0.852	1.000	
Total asset turnover	0.124	-0.124	-0.029	-0.017	0.108	0.104	0.085	0.888	-0.055	-0.270	0.110	-0.113	-0.076	-0.111	-0.158	1.000

The *Capital assets condition* and *Accumulated depreciation* variables in Table 4-25 show poor correlation with all other variables and are removed. Next, the Kaiser-Meyer Olkin (KMO) test is conducted on the remaining 14 variables to determine if the data is suitable for factor analysis. According to Hair et al. (2010), the data is considered acceptable for PCA if the KMO value is greater than 0.500. The KMO value indicates that the factor variable data is suitable for PCA (0.710, $p < 0.001$).

Four factors emerge from factor analysis with PROMAX rotation on 13 of the original 16 ratio variables. *Charge to expense* failed to load on any component with an eigen value greater than 1.0 and was therefore removed (revised KMO = 0.713, $p < 0.001$). Table 4-26 illustrates the results of the analysis conducted using Stata 14.2 (StataCorp, 2015).

Table 4-26. *PROMAX rotated factor loadings*

	Factor 1	Factor 2	Factor 3	Factor 4	Communality
Cash	0.015	0.918	-0.005	0.040	0.823
Debt	0.970	-0.067	0.000	0.015	0.990
Debt to assets	0.974	-0.026	0.025	-0.027	0.986
Debt to equity	0.981	0.057	-0.029	0.003	0.942
Fixed asset turnover	0.032	0.077	0.022	0.949	0.887
Net assets	-0.035	0.864	-0.004	-0.012	0.797
Net profit margin	-0.032	-0.013	0.719	-0.068	0.714
Operating cash flow	0.021	0.682	0.018	-0.001	0.629
Pct. change in net assets	0.034	0.020	0.831	0.031	0.721
Quick	-0.061	0.823	0.001	-0.038	0.796
Return on assets	0.010	0.044	0.995	0.036	0.890
Return on net assets	-0.020	-0.056	0.950	-0.020	0.829
Total asset turnover	-0.040	-0.081	-0.019	0.925	0.894
Eigenvalue	4.240	3.103	1.793	1.554	
Variance explained	0.327	0.323	0.303	0.181	
Financial dimension	Solvency	Liquidity	Profitability	Performance	

N = 430

Table 4-26 shows that the ratios loaded on components from the solvency, liquidity, profitability, and performance dimensions as described by Rist & Pizzica (2015). Also, according to Hair et al. (2010), the variables with highest correlations to the parent factors are the ratios that are best suited to represent the construct. Table 4-27 shows the ratio correlations with each factor.

Table 4-27. *Ratio correlations with parent factors*

Ratio	Liquidity	Solvency	Profitability	Performance
Cash	0.941			
Net assets	0.907			
Quick	0.906			
Operating cash flow	0.772			
Debt		0.996		
Debt to equity		0.989		
Debt to assets		0.970		
Return on assets			0.970	
Return on net assets			0.904	
Pct. change in net assets			0.873	
Net profit margin			0.858	
Total asset turnover				0.972
Fixed asset turnover				0.970

The correlations in Table 4-27 illustrate which ratios are best suited to represent the parent factor (dimension): the *Cash* ratio is best suited to explain liquidity; the *Debt* ratio represents solvency; the *Return on assets* ratio best represents profitability; and the *Total asset turnover* ratio is best suited to represent the performance dimension.

Step 3: Benchmarking and assessment of financial sustainability hypotheses

The goal at this point in the analysis is to establish financial benchmarks that can be used to compare U.S. seaports' individual financial sustainability measures with one another. Because the data contains extreme values that are in fact actual, an outlier identification process is used that is based on absolute deviation (Hampel, 1974) making it less sensitive to the presence of the extreme values. Once outliers are removed, the industry benchmarks are determined from the means of the remaining data.

Outlier detection.

The technique employed for outlier detection is the Median Absolute Deviation (MAD) method made popular by Hampel (1974). The MAD method is a simple outlier detection procedure that requires the researcher to calculate the absolute deviations from the median for each case in each ratio, called MAD values. The medians are then determined for the MAD values in each variable which serve as the central tendency measure from which outliers are removed that are more than three absolute deviations away from the median. This method is described in detail by Leys, Ley, Klein, Bernard, and Licata (2013). The resulting benchmarks in Table 4-28 are derived from the mean values of the data after outliers are removed.

Table 4-28. *Financial sustainability benchmark data*

Ratio Variable	Mean	Std. Dev.	*N*
Acc. depreciation to fixed assets	0.443	0.109	429
Cash[1]	1.408	1.289	394
Debt[2]	0.319	0.162	430
Debt to assets	0.265	0.151	430
Debt to equity	0.528	0.405	415
Fixed asset turnover	0.171	0.086	429
Net assets	0.280	0.310	383
Net profit margin	0.264	0.262	394
Operating cash flow	0.685	0.632	405
Percent change in net assets	0.045	0.048	406
Quick	3.613	2.491	405
Return on assets[3]	0.031	0.029	408
Return on net assets	0.036	0.032	406
Total asset turnover[4]	0.120	0.059	428

Notes: 1. Liquidity benchmark. 2. Solvency benchmark. 3. Profitability benchmark. 4. Performance benchmark.

Benchmarks are established in Table 4-28 from the means of the ratio variables, after outlier removal. The following sections will describe the financial dimensions of all U.S. seaports used in this study, and analyze each financial hypothesis using the benchmarks in Table 4-28.

Hypothesis H5: Liquidity

According to Rist and Pizzica (2015), liquidity ratios measure a company's capability to cover short-term debt, otherwise known as current obligations. The liquidity hypothesis (H5) states that U.S. seaports exhibit sufficient liquidity to meet current obligations. If seaports are capable of covering current obligations, it is noticeable in the financial reports. Specifically, cash and equivalents should be greater than the current liabilities for the reporting period. The *Cash* ratio serves as the benchmark for this test and if seaports are liquid, the ratio should not be less than 1.0. The benchmark for the seaport industry is 1.408 and the industry average is 2.181 which demonstrates that on average U.S. seaports can meet current obligations more than two times. Table 4-29 illustrates the percent of time between 2006 and 2015 that seaports were liquid.

Table 4-29. *Percent of time U.S. seaports exhibited liquidity (2006 -2015)*

Seaport	Time Liquid (%)	Seaport	Time Liquid (%)
Port Canaveral	0	Port of NY-NJ	100
Port Conneaut	0	Port of Oakland	100
Port Everglades	100	Port of Olympia	10
Port Freeport	100	Port of Palm Beach	0
Port of Anacortes	100	Port of Panama City	20
Port of Anchorage	90	Port of Philadelphia	100
Port of Boston	100	Port of Port Angeles	70
Port of Cleveland	100	Port of Port Manatee	0
Port of Corpus Christie	100	Port of Portland, OR	10
Port of Duluth	100	Port of Redwood City	80
Port of Everett	0	Port of San Diego	0
Port of Galveston	30	Port of San Francisco	40
Port of Grays Harbor	10	Port of Seattle	10
Port of Gulfport	100	Port of South Louisiana	10
Port of Houston	100	Port of Stockton	20
Port of Jacksonville	100	Port of Tacoma	10
Port of Kalama	100	Port of Tampa	10
Port of Long Beach	100	Port of Toledo	20
Port of Longview	0	Port of Vancouver	30
Port of Los Angeles	100	Port of Virginia	100
Port of Monroe	100	Port of Wilmington	0
Port of New Orleans	100		

The results in Table 4-29 show that U.S. public seaports were liquid an average of 55 percent of the study's time period. The average liquidity value for all seaports across all years is 2.181 which indicates that on average, seaports have sufficient cash and cash equivalents to pay off current liabilities. Interestingly, some of the non-liquid seaports are small, and several seaports do not exhibit liquidity during any of the calendar years. Although this level of liquidity is unremarkable and indicates non-liquidity in eight seaports across the study's time period, U.S. seaports exhibit sufficient liquidity to cover current obligations across the period of the study.

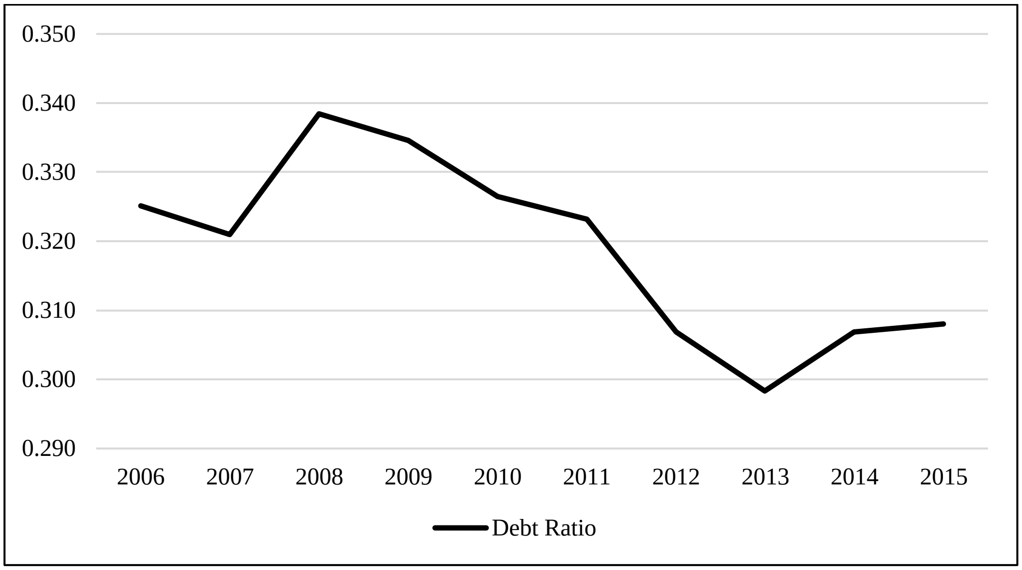
Therefore, the null hypothesis for liquidity (H4) is rejected. All financial ratios used in this research are calculated in Appendix E.

Hypothesis H6: Solvency

The solvency hypothesis states that U.S. seaports exhibit sufficient solvency to meet long term obligations. In order to make improvements to infrastructure, seaports need large amounts of capital. Some of the capital is borrowed from lenders which causes the long-term financial obligations. In order to borrow money, there must be useful life in the seaport's assets to use as leverage which is measured by the *Debt* ratio.

The industry benchmark for *Debt* is 0.319 (std. dev. = 0.162, *n* = 430) which also serves as the industry's mean value. The size of the standard deviation indicates that the amount of leverage between U.S. seaports varies through a sizable range. The *Debt* ratio divides total liabilities by total assets which gives an indication of how much of each seaport is financed by lenders. The higher the *Debt* ratio, the less leverage a seaport has which could be an indication of future insolvency. The industry mean shows that on average U.S seaports maintained 68-percent leverage across the study's time period. With the standard deviation considered (16.2 percent) in a worst-case scenario, seaports averaged 52-percent leverage for the period of the study. Figure 4-4 illustrates the changes to leverage over the study's time period.

Figure 4-4. *Debt ratio: U.S. seaports 2006 - 2015*



The trend in Figure 4-4 reveals an increasing trend in leverage since 2006. The *Debt* ratio divides total liabilities by total assets which provides an indication of how much of a seaport's assets are financed by lenders. The higher the ratio, the higher the percentage of assets financed by debt. The downward trend in Figure 4-4 is an indication that seaports are becoming less reliant on lenders to support operations, thus more solvent.

Hypothesis H7: Profitability

The profitability hypothesis (H7) states that U.S. seaports exhibit sufficient profitability to withstand financial shocks. In order to demonstrate seaports' ability to withstand financial shocks, the majority of seaports must be liquid which was demonstrated earlier in this stage, and profitable across the impacts and aftermath of the shock (2008 through 2014). The benchmark for the profitability dimension is the *Return on assets* ratio which divides net income by total assets. The industry benchmark established by this research is 0.031 with a standard deviation of

0.029. The industry mean for *Return on assets* is 0.037 (s.d. = 0.056). This indicates a somewhat large range around the 3-percent average profit margin. Figure 4-5 illustrates U.S. seaports' average profit margin overlaid on the cargo tonnage for the years under study.

Figure 4-5. *U.S. seaports' average return on assets*

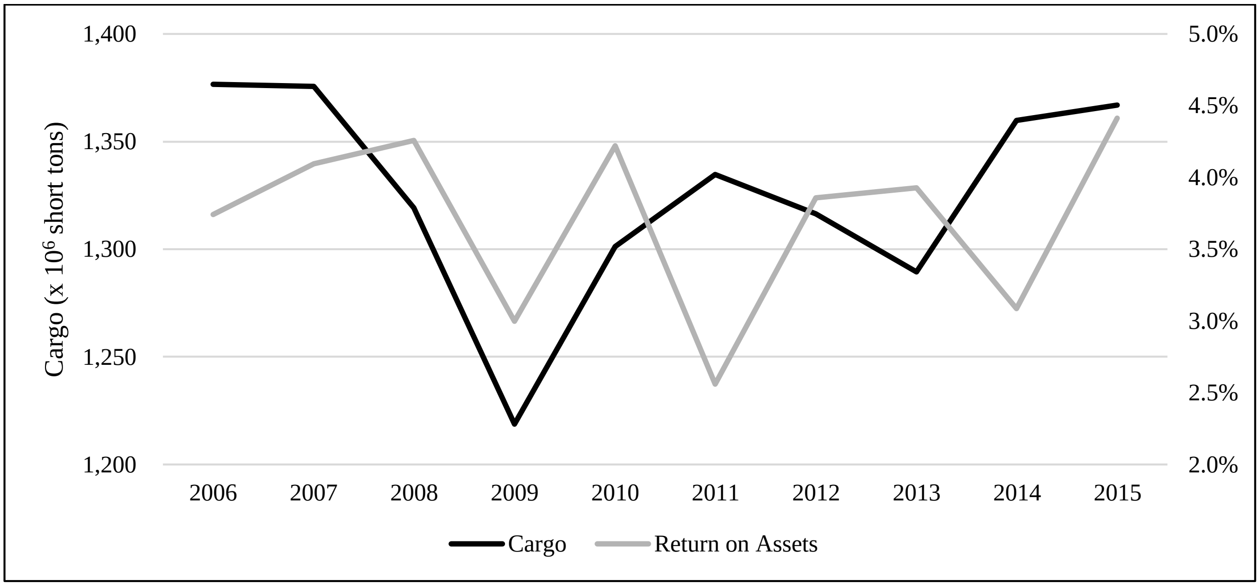


Figure 4-5 illustrates the trends of average seaport cargo throughput and *Return on* assets over the time period of this study. It should be noted that the amount of cargo moving through seaports is used as a proxy for average performance over time. Seaports profits are impacted largely by cargo throughput but also through other pricing mechanisms such as tenant-specific tariff agreements, for handling varying types of cargos.

Profits trend closely with the amount of cargo moving through U.S seaports with the exception of calendar year 2011. Also, the shock caused by the global financial crisis in 2009 is

evident as well as seaports' ability to withstand the perturbation while maintaining service levels in the following years which is corroborated with the liquidity hypothesis (H5) testing. Therefore, the only piece of information left to consider before rejecting the null hypothesis is determining, on average, how often seaports are profitable and unprofitable. Table 4-30 demonstrates the percent of time each seaport's annual operating revenues were greater than expenses.

Table 4-30. *Percent of time U.S. seaports exhibited profitability (2006 -2015)*

Seaport	Time Profitable (%)	Seaport	Time Profitable (%)
Port Canaveral	100	Port of NY-NJ	0
Port Conneaut	10	Port of Oakland	100
Port Everglades	100	Port of Olympia	80
Port Freeport	100	Port of Palm Beach	100
Port of Anacortes	90	Port of Panama City	80
Port of Anchorage	60	Port of Philadelphia	0
Port of Boston	100	Port of Port Angeles	80
Port of Cleveland	0	Port of Port Manatee	100
Port of Corpus Christie	90	Port of Portland, OR	40
Port of Duluth	100	Port of Redwood City	100
Port of Everett	60	Port of San Diego	100
Port of Galveston	100	Port of San Francisco	100
Port of Grays Harbor	10	Port of Seattle	100
Port of Gulfport	20	Port of South Louisiana	90
Port of Houston	80	Port of Stockton	100
Port of Jacksonville	100	Port of Tacoma	100
Port of Kalama	100	Port of Tampa	100
Port of Long Beach	100	Port of Toledo	100
Port of Longview	80	Port of Vancouver	100
Port of Los Angeles	100	Port of Virginia	90
Port of Monroe	0	Port of Wilmington	100
Port of New Orleans	100		

The data in Table 4-30 make clear that the majority of seaports were profitable over the period of the study. On average, seaports revenues outweighed expenditures 78 percent of the time. Therefore, this research rejects the null hypothesis. U.S. public seaports exhibited profitability over the time period of this study.

Hypothesis H8: Performance

The performance hypothesis states that U.S. seaports exhibit sufficient asset performance to maintain service and commitment levels. This hypothesis assesses the ability of U.S. seaports to manage and maintain property, plant and equipment so that it can be employed to earn revenue. Seaports are asset-intensive organizations that rely on capable infrastructure for safe and profitable operations. Also, assets depreciate over time and without an infusion of capital, the service life of the assets can depreciate to nothing leaving a seaport less capable of earning revenue and with less leverage to replace the spent assets. It is important to maintain property, plant, and equipment to support sustained growth into the future.

The *Total assets turnover* ratio divides operating revenue by total assets to express how effective seaports are at employing their assets to generate income. This research finds that on average U.S seaports generate 12.2 cents for every U.S. Dollar invested across the time period of this study. The average annual performance values are trending in the upward direction which began at 0.12 and rose to 0.13 by the end of 2015. The focus now shifts to understanding how much capacity remains in seaports fixed assets that can be used to earn revenue in future years.

The *Accumulated depreciation to fixed assets* ratio (see Table 3-7) divides the gross value of fixed assets being depreciated, by the accumulated depreciation to arrive at the amount of useful assets remaining (see Table 4-27). If seaports are maintaining fixed assets in a manner that

supports earning revenue into the future, it will be evident in the financial reports. Table 4-31 illustrates fixed assets for each seaport over the time period of the study.

Table 4-31. *U.S. public seaports' Accumulated depreciation to fixed assets* (2006 – 2015)

Seaport	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Port Canaveral	0.37	0.39	0.39	0.41	0.44	0.44	0.40	0.42	0.42	0.37
Port Conneaut	0.51	0.51	0.55	0.58	0.62	0.63	0.59	0.63	0.67	0.71
Port Everglades	0.53	0.53	0.56	0.60	0.57	0.52	0.52	0.51	0.53	0.56
Port Freeport	0.30	0.31	0.32	0.32	0.34	0.34	0.36	0.32	0.30	0.29
Port of Anacortes	0.50	0.47	0.45	0.46	0.47	0.46	0.45	0.46	0.49	0.52
Port of Anchorage	0.53	0.55	0.55	0.57	0.61	0.59	0.61	0.37	0.38	0.40
Port of Boston	0.37	0.36	0.38	0.41	0.43	0.44	0.47	0.49	0.50	0.50
Port of Cleveland	0.31	0.34	0.37	0.40	0.42	0.42	0.38	0.40	0.44	0.44
Port of Corpus Christie	0.47	0.50	0.43	0.46	0.38	0.41	0.51	0.50	0.52	0.51
Port of Duluth	0.44	0.44	0.42	0.43	0.44	0.46	0.46	0.47	0.47	0.48
Port of Everett	0.42	0.35	0.36	0.33	0.35	0.35	0.36	0.34	0.36	0.35
Port of Galveston	0.45	0.45	0.44	0.44	0.46	0.44	0.42	0.43	0.45	0.47
Port of Grays Harbor	0.61	0.61	0.63	0.64	0.61	0.55	0.56	0.53	0.54	0.55
Port of Gulfport	0.28	0.27	0.25	0.23	0.21	0.22	0.23	0.23	0.21	0.19
Port of Houston	0.56	0.43	0.38	0.40	0.37	0.39	0.42	0.42	0.43	0.43
Port of Jacksonville	0.47	0.48	0.50	0.42	0.41	0.44	0.45	0.47	0.50	0.50
Port of Kalama	0.29	0.26	0.26	0.29	0.33	0.32	0.35	0.39	0.32	0.14
Port of Long Beach	0.44	0.47	0.48	0.50	0.53	0.56	0.57	0.58	0.52	0.48
Port of Longview	0.40	0.42	0.42	0.45	0.46	0.46	0.48	0.47	0.46	0.47
Port of Los Angeles	0.39	0.40	0.43	0.45	0.47	0.47	0.45	0.44	0.46	0.45
Port of Monroe	0.52	0.58	0.63	0.66	0.69	0.71	0.73	0.75	0.73	0.67
Port of New Orleans	0.40	0.39	0.39	0.41	0.43	0.45	0.44	0.44	0.45	0.46
Port of NY-NJ	0.43	0.45	0.44	0.44	0.45	0.44	0.46	0.46	0.39	0.38
Port of Oakland	0.33	0.33	0.33	0.34	0.37	0.40	0.43	0.46	0.48	0.49
Port of Olympia	0.47	0.44	0.34	0.44	0.42	0.44	0.41	0.41	0.37	0.37
Port of Palm Beach	0.29	0.28	0.30	0.33	0.36	0.39	0.41	0.44	0.47	0.50
Port of Panama City	0.33	0.33	0.30	0.31	0.33	0.36	0.39	0.40	0.40	0.40
Port of Philadelphia	0.48	0.50	0.53	0.56	0.55	0.43	0.34	0.37	0.39	0.40
Port of Port Angeles	0.61	0.62	0.53	0.54	0.56	0.54	0.53	0.55	0.56	0.56
Port of Port Manatee	0.46	0.42	0.42	0.43	0.44	0.46	0.49	0.52	0.51	0.53
Port of Portland, OR	0.64	0.64	0.64	0.64	0.64	0.65	0.66	0.67	0.68	0.68
Port of Redwood City	0.51	0.52	0.54	0.55	0.55	0.53	0.51	0.53	0.57	0.48
Port of San Diego	0.43	0.44	0.44	0.45	0.45	0.46	0.46	0.46	0.47	0.47

Table 4-31 Continued

Seaport	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Port of San Francisco	0.41	0.41	0.42	0.52	0.62	0.63	0.64	0.56	0.49	0.50
Port of Seattle	0.27	0.29	0.28	0.29	0.32	0.34	0.34	0.36	0.37	0.38
Port of South Louisiana	0.18	0.19	0.21	0.23	0.23	0.24	0.24	0.23	0.22	0.23
Port of Stockton	0.51	0.51	0.48	0.46	0.48	0.49	0.51	0.48	0.45	0.44
Port of Tacoma	0.39	0.41	0.44	0.44	0.48	0.50	0.50	0.53	0.55	0.56
Port of Tampa	0.25	0.26	0.28	0.31	0.32	0.33	0.35	0.37	0.37	0.39
Port of Toledo	0.58	0.58	0.58	0.60	0.59	0.57	0.55	0.55	0.57	0.55
Port of Vancouver	0.41	0.44	0.47	0.45	0.45	0.46	0.44	0.46	0.42	0.88
Port of Virginia	0.37	0.35	0.36	0.35	0.37	0.39	0.40	0.42	0.46	0.48
Port of Wilmington	0.20	0.21	0.24	0.27	0.29	0.30	0.32	0.34	0.35	0.37
Average	*0.42*	*0.42*	*0.42*	*0.44*	*0.45*	*0.45*	*0.46*	*0.46*	*0.48*	*0.47*

The *Accumulated depreciation to fixed assets* ratio values in Table 4-31 indicates that on average 44.7 percent of fixed assets remain that can be used as leverage each year. However, the standard deviation indicates that some seaports have less fixed assets remaining. From the 430 values listed in Table 4-31, 214 are below the benchmark (0.443). Deeper analysis indicates that four seaports have less than 30 percent of their assets remaining in 2015, while on average 47 percent of U.S. seaports' fixed assets remain viable for earning revenue and serving as leverage to finance future improvements. In fact, changes to fixed assets can be observed in Table 4-31 when looking across all successive year's values. Increases in the *Accumulated depreciation to fixed assets* values signify additions to, or improvements in existing fixed assets.

Although this analysis identifies some ports with low percentages of fixed assets remaining in 2015, the bulk of U.S. seaports have healthy levels of fixed assets remaining. Also, and on average, seaports appear to shepherd their fixed assets in a manner that earns current revenue while responsibly managing the remaining assets' service lives. Therefore, the null hypothesis is rejected. U.S. public seaports exhibit sufficient asset performance to maintain service and commitment levels.

Summary and Interpretation of Financial Sustainability Analysis

This section summarizes the analysis and reviews the results of the financial sustainability hypothesis testing. In Step 1, data was reviewed to gain an understanding of the distributions for each ratio. Data summarization was accomplished in Step 2 using factor analysis with PROMAX rotation which resulted in four components with acceptable Eigenvalues (> 1.0). The four ratios with the highest factor loading for each financial dimension were determined: liquidity uses the *Cash* ratio; solvency uses *Debt* ratio; Performance uses the *Total assets turnover* ratio and is augmented by the *Accumulated depreciation to fixed assets* ratio; and profitability is best measured using the *Return on assets* ratio. In Step 3, the parent benchmarks are determined for all ratios used in the factor analysis which are called upon to asses U.S. seaports financial sustainability.

The financial sustainability analysis allowed for acceptance of hypotheses H5 through H8 suggesting that seaports are operated in a financially sustainable manner. However, in order to fully understand how well U.S. seaports steward their financial resources, a closer look at seaports' financial health is required. Using the benchmarks and the factor variables from the factor analysis, the financial status for each dimension across the study's timeframe are illustrated in Figure 4-6.

Figure 4-6. *U.S. seaports' average financial dimensions (2006 – 2015)*

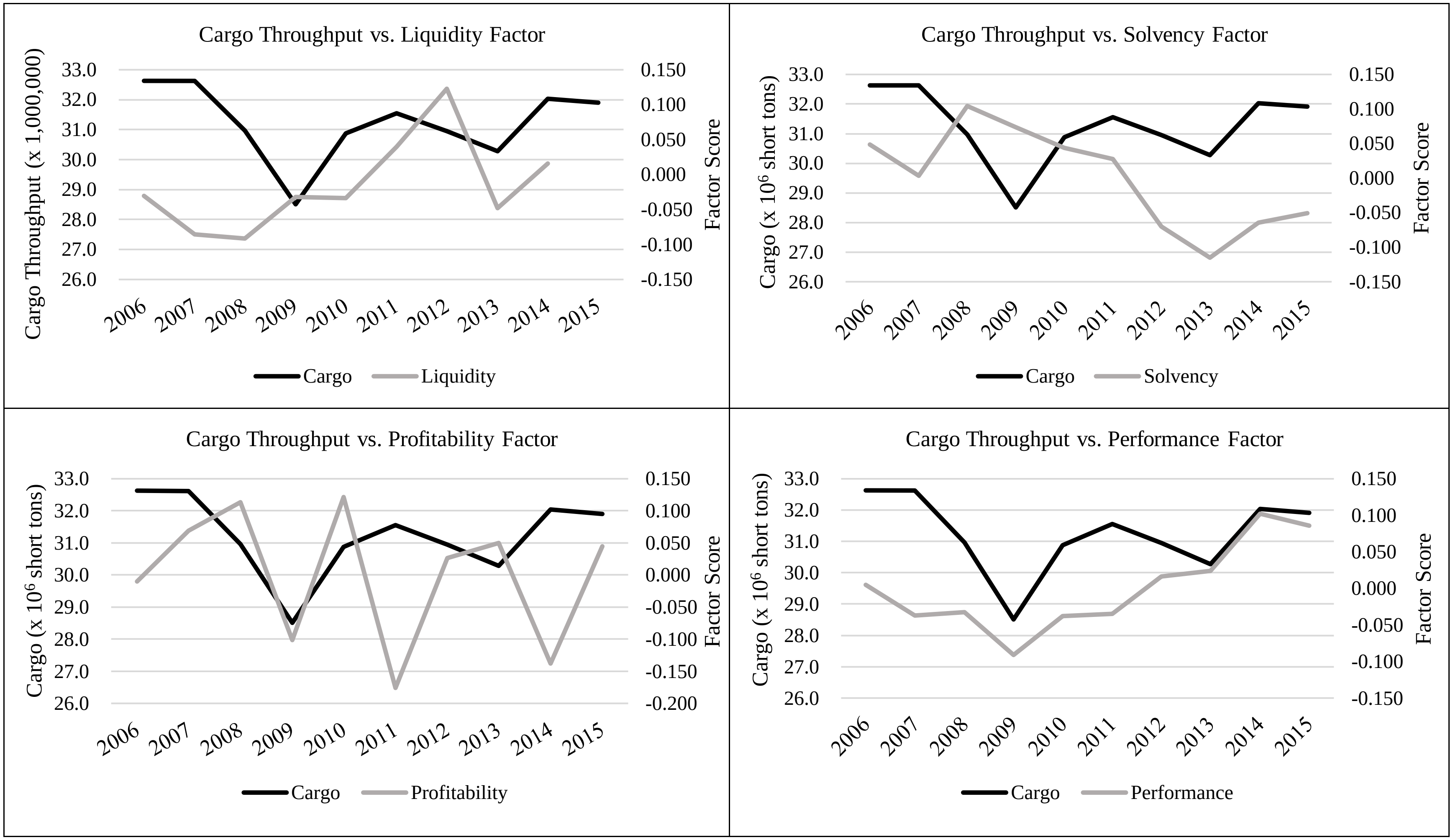


Figure 4-6 is developed from the factor variables for the purpose of making an overall assessment of financial sustainability. The benchmarks contain important industry-specific information from a single perspective that were used for hypothesis testing. The factor variables contain important information from multiple perspectives (ratio variables) that are otherwise omitted when using the single ratio benchmarks. Therefore, the data in Figure 4-6 is assessed to answer the second research question: are the common mission elements within the mission statements of U.S. public seaports reflective of seaport performance?

The graph in the upper left panel of Figures 4-6 indicate that liquidity trends closely with *Cargo* and shows signs of recovery after the decreases in *Cargo* during 2009 and 2013. The behavior of liquidity is in the expected direction and shows signs of higher levels of liquidity towards the end of the study. The solvency graph in the upper right panel of Figure 4-6 shows a decreasing trend beginning in 2006 and carrying forward to the end of the study. This is an indication that U.S. seaports are becoming more solvent and less reliant on lenders to finance seaport infrastructure.

The profitability graph in Figure 4-6 shows an interesting set of perturbations that trend with cargo throughput until 2011. The last five years of this study indicates that seaports are profitable on average but, the perturbations reveal a phenomenon that deserves more attention from future research. The trend in profit is in the downward direction which is likely related to the decreasing trend in cargo throughput.

The graph in the lower right panel of Figure 4-6 shows that on average seaport's performance tracks closely with cargo throughput. This graph provides evidence that seaports are capable of using their assets to generate revenue and the upward trend indicates improvement from the beginning of the study.

The data reviewed for this stage of the dissertation revealed the financial condition of U.S. seaports. Seaports are public resources that benefit each and every citizen in this country. The general financial condition of the nation's seaports is less than stellar, but not to a point of extremis. Understanding how much of U.S. seaports' assets remain and the plan to renew the resources should be a priority for future research. The job of managing a seaport is not similar to other public management positions and requires that port authorities steward seaports' assets in a responsible manner that supports sustained operations well into the future. In general, U.S. seaports demonstrate financial sustainability over the time period of this study.

Discussion of Stewardship Behavior

According to Davis et al. (1997) a "steward protects and maximizes shareholders' wealth through firm performance, because, by so doing, the steward's utility functions are maximized" (p. 25). Maximizing wealth in this case is synonymous with completing stated missions intended to benefit the public. In the case of public seaports, the steward is the port authority and the citizenry in the surrounding region make up the principal. This research determined the common mission elements in the mission statements of U.S. public seaports using content analysis and investigated the resulting elements to determine if they are reflective of seaport performance. A discussion of how each mission element relates to stewardship theory follows.

Economic development is the most prevalent common mission element amongst the seaports used in this research, and the analysis in Stage 2 finds that U.S. public seaports are operating in a manner where they are making a positive impact to host regions' economies. If there were no economic benefits to operating a seaport, the positive relationship between seaports' cargo throughput and growth in per capita GDP would not exist. This research does not attempt to quantify how well each seaport carries out the economic development mission, but it

does provide evidence supporting a positive relationship which is in line with maximizing the utility of the principal.

The environmental stewardship testing in Stage 3 indicates that county-level air quality is impacted by seaports' cargo throughput. Surface ozone levels in excess of the National Ambient Air Quality Standards are related to seaports' cargo throughput. On the surface, the Stage 3 results indicate that U.S. public seaports are not stewarding the natural environment with regard to local air quality. However, no analyses were performed in this dissertation that measures the mitigating actions of each seaport. Therefore, the only claim that can be made is that on average, negative impacts to local air quality occur as a result of cargo moving through the seaport. More research is needed to determine how effective seaports are at mitigating negative impacts to air quality and the natural environment.

U.S. public seaports' financial sustainability was measured across four dimensions: liquidity, solvency, performance and profitability. As a public enterprise, seaports are expected to earn a profit and be self-sufficient (Bös, 1986). Although there are seaports in this research that perform poorly across one or more of the dimensions, on average U.S. seaports make good on the financial sustainability mission. Financial self-sufficiency indicates that the management of the public asset is sufficient to avoid using funds from higher-level governments to finance unsustainable seaports which is in line with maximizing a principal's utility. Therefore, on average U.S. seaports' financial condition is reflective of stewardship qualities.

The distinguishing features of stewardship theory listed in Table 2-2 were not assessed in this research, but U.S. seaport authorities offer a viable environment for such analyses. Davis et al. (1997) describe the psychological factors as motivation, identification, and use of power, and the situational factors as management philosophy and the working culture fostered by the

steward. This study looks at U.S. seaport governance from a high-level perspective placing the Port Authority as the principal with no regard for each actors' steward-like characteristics. Future research in stewardship theory could explore the presence of the distinguishing factors within individual port authority actors to further understand the impacts on organizational culture and performance.

Chapter Summary

This chapter reported the results of the analyses used to arrive at the findings. This section will summarize the results of the hypothesis testing and answer the research questions developed in Chapter 1.

1) What are the common elements of governance within the mission statements of U.S. public seaports?
2) Are the common mission elements within the mission statements of U.S. public seaports reflective of seaport performance?
3) Do U.S. public seaport governing boards exhibit stewardship behavior?

The first research question was answered in Chapter 3 during the content analysis of U.S. public seaports' mission statements. The predominant mission statements were economic development, environmental stewardship, financial sustainability, and recreation. Recreation was omitted due to its low prevalence in this dataset, but it could be recognized as a mission for smaller seaports and inland waterway ports.

The second research question asks whether the common mission elements within the mission statements of U.S. public seaports are reflective of seaport performance. The answers to this question are discussed by mission area. Hypothesis testing in Stage 2 indicates a positive and

significant relationship between seaports' cargo throughput and MSA-level economic growth. The economic development hypothesis was not tested due persistent unit roots in the data. The results of Stage 2 indicate that on average, for every 1-percent increase in cargo throughput, there is a 0.0156-percent increase in per capita GDP in the host MSA. Therefore, the economic development mission is indicative of port performance.

The environmental stewardship hypothesis tested whether seaports' cargo throughput has a direct and positive relationship with changes in the mean surface-level ozone concentrations of host counties. This analysis discovered that the cargo moving through U.S. seaports has a direct relationship with changes in county-level annual fourth-highest daily maximum 8-hour average ozone concentration.

Stage 4 tested hypotheses H5 through H8 to understand the financial condition of U.S. public seaports. This analysis used commonly accepted ratios in scholarly literature that define financial dimensions. The testing revealed concerns for U.S. seaports' current posture to replace fixed assets as they approach the end of their service lives. However, the study also determined that seaports are being operated in a financially responsible manner, which takes into consideration the materiel condition of seaports' assets.

The last research question is only answerable after hypothesis testing has been completed: Do U.S. public seaport governing boards exhibit stewardship behavior? Across the mission elements one can see that on average the cargo moving through a seaport is responsible for economic growth. This is the most called out mission element in the content analysis. Nearly all U.S. seaports claim to exist for the purpose of positively impacting the local economy, and Stage 2 of this research finds that seaports make good on that mission.

Stage 2 examined seaports' impacts on local air quality, specifically surface ozone concentrations. This research finds that seaports' cargo throughput has a positive relationship with surface level ozone concentrations at the county level. Determining the degree of the impacts on surface ozone concentrations is difficult and not the focus of this research. The relationship discovered between *Cargo* and county-level surface ozone concentrations is justification for future research to further characterize the strength of the relationship.

At present, there are no quick and affordable remedies for mitigating the harmful emissions caused by diesel engines while maintaining cargo operations at a level that sustains local economies. However, future research into the policy-driven and technological solutions that could help to curtail harmful emissions is needed, at least until new technology arrives. Some ports on the west coast of the United States have introduced mechanisms that are designed to curtail harmful emissions (EPA, 2017b; Giuliano & O'Brien, 2007), which could serve as a prototype for mitigations that might be used by other seaports. Based on the data assessed here however, seaports' host counties are trending towards a cleaner environment, but it remains unclear if seaports actions are the cause of the decreasing trend or simply technological solutions being driven by policy or innovation.

Stage 3 enabled a description of the average financial condition of U.S. seaports. The financial dimensions liquidity, solvency, profitability, and performance were assessed and found to be in fair condition and operating in line with public stewardship characteristics. Some seaports have troubling showing steward-like qualities in one or more dimensions, but on average U.S seaports are financially sustainable.

Based on the evidence this dissertation revealed, U.S seaports make good on economic growth, understand the harm that cargo operations cause the environment and are making strides

to mitigate harmful emissions, and seaports operate their assets in a financially sustainable manner. Stewardship Theory deviates from Agency Theory in that the Agent's incentives are in line with the principal (Davis et al, 1997). Opportunistic behavior is not conducive with managing a public resource and this research shows that seaports are operating in a responsible manner through accomplishment of stated missions. Therefore, the third research question is answered in the affirmative: based on the evidence found by this dissertation, U.S. public seaports exhibit stewardship behavior. Although Stewardship Theory was used as an explanatory framework in this research, U.S. public seaports could serve as an ideal environment for testing stewardship theory in the future.

This chapter has addressed all hypotheses and answered the research questions. Chapter 5 will discuss the research conclusion and implications to practitioners and scholars. Additionally, it will discuss the limitations to this study and how they relate to the findings. This dissertation will conclude with a summary of the opportunities for future research and the researcher's closing remarks in Chapter 5.

CHAPTER 5:

CONCLUSIONS

This chapter summarizes the results found in Chapter 4 and discusses the theoretical and practitioner implications of the findings. Next, the study's limitations are reviewed and areas for future research are discussed. The chapter finishes with the researcher's closing remarks.

Study Conclusions

This dissertation investigated the common mission elements found in U.S. seaports' mission statements, conceptualized a framework of port governance (see Figure 1-1) and used that framework to explore how well seaports make good on their stated objectives. This study finds evidence that on average, seaports are responsible for positive economic growth in host MSAs, contribute to county-level surface ozone concentrations, and on average U.S. seaports are operated in a financially sustainable manner. The relationship between cargo throughput and indicators of economic development were not assessed due to persistent unit roots in the data.

The explanatory framework used in this research is stewardship theory (Davis et al., 1997) which posits that stewards, unlike agents are incentivized by higher order needs that are often in line with the principal's desires. Seaports are public assets and based on the mission statement analysis the assets exist to benefit citizens residing in port regions (i.e. principals). Stewardship theory was not tested in this research, but U.S. public seaports could serve as a testbed for future research in the theory.

The analytical methods in this research distilled the research questions into hypotheses that were assessed using qualitative and quantitative methods. The methods used in this dissertation are not unique, but one is recent - Neumayer and Plümper's (2017) method for measuring the degrees of robustness. Also, the manner in which these methods were arranged to

arrive at the results is somewhat novel (see Figure 4-1). Using real-world data from events that occur as a matter of routine in any culture or community brings with it a fair amount of noise that has to be negotiated to make progress in understanding the world around us. This research took up the challenge of identifying relationships with real-world data fraught with the potential for biased estimates. The painstaking task of developing a research method to explore a social phenomenon was fruitful in this endeavor.

Continuing this work is important to understanding how U.S. seaports behave when challenged with external forces that jeopardize local communities' qualities of life and the natural environments. As such, several implications were discovered that could impact scholars and practitioners which are discussed further in the next two sections. Also, during the testing and the review of results, several characteristics came to light that warrant further exploration. These areas are discussed in the Future Research section later in this chapter.

Theoretical Implications

Port Governance

During the literature review it became apparent that the scholarly field of port governance seems to have grounded itself in the exploration of operating efficiencies. Moving more cargo through a port while expending less resources is no doubt a worthwhile endeavor. Maritime economists have been leading the charge in exploring operating characteristics and the results have been fruitful (Acosta et al., 2011; Brooks & Cullinane, 2007; Brooks & Pallis, 2008; Talley, 2007). However, very little attention has been focused on the local externalities of seaports from a public service perspective. U.S. seaports are primarily public and public administration scholars need to step up and take ownership of this emerging niche field. One cannot expect the maritime economists that currently populate the port governance field to explore public

administration characteristics. If the scholars of public administration do not take ownership of this emerging field, public seaport governance will be defined by other disciplines that may or may not pay homage to the notions of democratic governance that are salient in the field (Behn, 2001; Bevir, 2009; Kettl, 2002; Lynn, 2010).

The categories of governance described by Lynn (2010)[42] in Table 2-3 are largely indicative of how U.S. public seaports operate. Most U.S. seaports are landlord ports (Fawcett, 2007) and must provide government services and ordered rule to regulate tenant industries on the seaport. Also, U.S. port authorities are government agencies that are in addition to, or beyond the typical idea of a government providing services and ordered rule over a state or municipality. The mission statements point out that these public assets exist for purposes that benefit the citizens. Therefore, it makes sense that the field of public administration explore the various governance mechanisms employed by U.S. port authorities and develop an understanding of the many schemes in use with regard to each port function. Establishing a body of knowledge for U.S. public seaport governance can benefit practitioners in terms of best practices.

Stewardship Theory

In stewardship theory, Davis et al. (1997) point out that stewards have higher order needs that are in line with the needs and desires of the principal which in this case is the citizenry. These higher order needs that are in line with the principal's needs are what mitigate the Agency Problem defined by Jensen and Meckling (1976) as a conflict of interest between principals and agents. The assumption behind Stewardship Theory is that the agency problem does not exist (Davis et al., 1997). Thus, the steward does not need to be incentivized to act in the principal's

[42] In 2010, Laurence Lynn summarized several scholars' meanings of governance into five distinct categories: 1) governance meaning ordered rule; 2) governance as being synonymous with government; 3) governance meaning good government; 4) governance as something in addition to, or beyond government; and 5) governance as societal direction being replaced by organizations that are not government.

best interests. This seems logical for the manner in which a public-owned seaport operates and is the reason Stewardship Theory was chosen as an explanatory framework.

A premise behind Stewardship Theory is that the steward has higher order, intrinsic needs that are in line with the principal's desires. Therefore, it seems reasonable that if stewardship characteristics as defined by Davis et al. (1997) exist in seaport operators, they might manifest through organizational performance. Using seaports, or public authorities in general to further explore Stewardship Theory could benefit the available body of knowledge.

Practitioner Implications

This research begins to fill a knowledge gap in the existing port governance literature. The implications that this research brings to practitioners are explained for each common mission element in the following sections.

Economic Growth

The relationship discovered between economic growth and cargo throughput make clear the importance of seaports to host regions' economies. Seaports have an impact on quality of life factors that impact everyday citizens. These findings show that increased amounts of cargo in general, can lead to economic growth. Most port authorities probably realize this, but accurately estimating each seaport's economic impacts remains a valuable endeavor.

Understanding a specific seaports' impacts to its host region's economy is valuable for planning purposes and developing seaport expansion strategies. Also, understanding how external impacts to the world shipping and commodities markets impact host region's economies is extremely valuable to port directors and port authorities. The maritime transport industry is complex and susceptible to many influences while U.S. public seaports' profit margins are relatively small. Public seaport operators could benefit from developing economic models

similar to the ones used in this research, but tailored to the individual seaport. Understanding the shipping market's impacts on individual ports will remove some of the guess-work and better position U.S. seaports for inherent market fluctuations.

Environmental Stewardship

The environmental impacts discovered in this research are not groundbreaking. The knowledge of how diesel engines contribute to surface ozone formation has been known for quite some time and has recently been addressed by scholars (Krivoshto et al., 2008; Fabian & Dameris, 2014) and the EPA (2016c, 2017b). The relationship that this research discovered between cargo throughput and the ability for counties to attain surface ozone air quality standards implicates new stakeholders (the seaports) in the daunting task of keeping the natural environment safe for humans, plants, and animals.

This study shows that the average surface ozone concentrations in host seaport counties has been decreasing over time, but one cannot avoid the fact that several seaports' host counties are in violation of surface ozone NAAQS (see Table 4-23). With knowledge of the relationships discovered in this research between cargo throughput and surface ozone concentrations, the need for further safeguards are clear. Seaports in the U.S. can and should do more to protect air quality.

This research explored environmental impacts using one airborne chemical compound as a surrogate. There are more airborne compounds that can and should be used in future research. Krivoshto (2008) states that there are many byproducts of diesel exhaust, "including (1) carbon monoxide and carbon dioxide; (2) nitrogen oxides; (3) sulfur oxides; (4) hydrocarbons; (5) unburned carbon particles (soot); and (6) water" (p. 56). Krivoshto (2008) goes on to state that "exhaust from diesel engines is considered to contribute to more than 50% of ambient particulate

matter greatly contributing to overall air pollution" (p. 56). These compounds can be tested in many seaports' counties, but data availability for specific pollutants across all U.S. seaports is an issue. Environmental stewardship testing can also use other pollution media for analyses such as water, sound, and aesthetics.

The methods used to investigate relationships between pollutants and possible causes are an impediment to progress. Without costly resources it is difficult to attribute pollutants to their sources. The methods used in Stage 3 were developed to mitigate spuriousness in the findings which is sufficient for this application. Large municipalities however, will have rival polluting industries and methods for determining seaports' contributions to the total pollutant levels recorded in seaport regions are not available. If pollutants' sources cannot be positively identified, no single agency can be held accountable for their contribution to the pollution.

Financial Sustainability

The results of the financial sustainability analysis indicate a range of operating levels between public seaports. Using ratios enabled a comparison of seaports' financials in the industry while each ratio value remained relative to the seaport it describes. Generally speaking, the financial status of U.S public seaports is healthy. However, there are a few seaports that are operating in an unhealthy financial condition. Appendix E illustrates all financial ratios for all seaports used in the Stage 4 analysis, and across all years.

Understanding industry benchmarks such as the ones used in this research (see Table 4-28) could benefit seaport operators when making strategic operating decisions. These findings however, are not only of interest to seaport operators. The federal government's Maritime Administration (MARAD) might also find the financials telling of the nation's current maritime capabilities as well as helping to mitigate future insolvency and asset replacement issues.

Likewise, understanding the materiel condition of U.S. seaports' assets is paramount to sustainable growth. Asset utilization should be on the minds of port authority board members and federal government officials alike if the nation is to achieve sustainable growth in its maritime transport capabilities.

The ratios used in this research were constructed to assess the financial dimensions prevalent in the literature: liquidity, solvency, performance, and profitability. There are many financial ratios in scholarly publications, so care must be used in defining the exact calculation of each ratio employed. The ratios in Table 3-7 are defined in a manner where this study can be accurately repeated. There is no claim that the ratios used in this research are the best-suited ratios for the U.S. seaport industry.

Study Limitations

This research began as an inductive analysis into what U.S. public seaports commonly claim as missions which became deductive through the use of quantitative methods to explore mission accomplishment. Each analytical method used was impacted by limitations which are reviewed here again, so that the reader can consider these results through the proper perspective.

The content analysis was limited by a single researcher reviewing the results. In order to mitigate this concern, the results of the content analysis and coding were reviewed on separate occasions with the use of reflective note taking at each session. Additionally, the researcher served a leadership role at a public inland waterway port where there was exposure to seaports and national waterway issues as part of working groups chartered to investigate issues that impact multiple ports. The time spent in the public inland waterway port position added another layer of scrutiny to the findings, but it is also reasonable to believe that bias could have been

introduced. Therefore, the previous employment history must be factored into the interpretation of these results.

The economic and environmental impact analyses, Stages 2 and 3 respectively, were impacted by several limitations due to the nature of the data used. This research employs time-series models to understand the impacts of cargo throughput on the local economy and natural environment. Time series data bring with it a set of concerns for spurious regressions which in this research include persistent unit roots, endogeneity caused by heteroscedasticity and cross-sectional dependence, and simultaneity. These concerns were mitigated through the use of statistical techniques designed to discover the potential for biased estimates and establish directionality (see Figure 4-1). In Step 5 of Stages 2 and 3, the results of the Core Models produced biased standards errors triggering the calculation of nonparametric standard errors.

Also, the degrees of robustness were calculated to better understand how the point estimate of interest (*Cargo*) behaved when subjected to the shocks of variable omission. This research used parametric and nonparametric standard errors to compare the degrees of robustness (ρ_{Cargo}) as a final mitigation of the biased estimate problem. The results indicated that the relationship of interest in the Core Models of Stages 2 and 3 were robust to plausible, alternate model specifications.

The financial sustainability analysis in Stage 4 was impacted by two limitations. First, the set of financial ratios used were not the universe of ratios and these results are only as good as the data input limitations. There are numerous financial ratios claiming to be sufficiently complex for describing financial dimensions. This research drew financial ratios from three sources that are compatible with public and private sector finances: the public enterprise aspect of the research is drawn from Rivenbark et al. (2010), and the profit seeking perspective uses

ratios found in *Financial Ratios for Executives* (Rist & Pizzica, 2015) and Bragg's (2012) *Business Ratios and Formulas: A Comprehensive Guide* (see table 3-7). It is understandable that different ratios might produce different results. Therefore, the explanation provided of the financial dimensions in Chapter 4 is based on factor variables, not single ratio perspectives.

Also, the industry benchmarks for the financial ratios were not available and had to be produced during this dissertation. Having a set of industry benchmarks would have provided an independently developed basis for comparison. Unfortunately, the independent aspect is not available. Therefore, benchmarks were set using the Median Absolute Deviation (MAD) method designed by Hampel (1974).

Lastly, each stage of this dissertation was burdened with small sample sizes. The content analysis results in Stage 1 are based on a sample size of 59 seaports from a sample frame of 71, the economic development analysis employed 49 seaports (69 percent), the environmental stewardship analysis in Stage 3 was based on a sample size of 50 seaport (70 percent) , and the financial sustainability analysis employed 43 seaports (61 percent). The sample sizes were deemed sufficient for the methods used and the Core Models' power calculations revealed acceptable levels (> 0.80). The issue then became the ability to generalize findings across all U.S. public seaports. The financial sustainability results are the most impacted because of the amount of seaports' financials available for the research.

Future Research

This study posits relationships between public seaport performance and indicators of economic growth and air quality over a 10-year period and analyzes industry-level financial conditions over the same period. Throughout this dissertation process, several opportunities presented themselves where future research could be focused in a manner that is beneficial to

further advance knowledge in U.S. public seaport governance. The areas identified for future research are discussed below.

Economic Development

The economic development hypothesis (H2) was not tested in this research. Economic development is suspected of having a relationship with seaport performance, but this research failed to test for the relationship due to persistent unit roots in the data. Future research should focus on explaining the relationship between seaport performance and indicators of economic development over time. According to Blakely and Leigh (2010), true economic development should preserve and increase the standard of living for all citizens in the region. Therefore, these indicators should include quality of life factors that create wealth in the port region and are measurable over long periods of time.

Environmental Impacts

Source attribution in pollution studies is not an easy task when the pollution medium is water and air. Controlling for omitted variables is less than ideal in statistical models and introduces an angle from which the model's credibility can be questioned. The impacts of this gap in scholarly knowledge are evident and need to be filled. Not having the methods available that can aid port authorities and local governments in understanding the harm that seaport operations are causing as a matter of routine, sends a message that the environment is not all that important. This research demonstrates that U.S. public seaports have the potential to harm the environment using one pollutant in one pollution medium. Indeed, there are many pollutants that can be studied in air, aesthetics, noise, and water. New methods of source attribution need to be employed in port environmental studies to identify and characterize causal relationships harmful to the environment.

Additionally, during the environmental impact testing the environmental policy variable (*O_3Reg*) indicated intermittent significance across the robustness models. The purpose of this research was not to assess the effectiveness of the National Ambient Air Quality Standard policy for surface ozone concentrations, but the behavior of the *O_3Reg* variable indicates potential for ineffectiveness. Exploring the effectiveness of NAAQS at county-levels across different states, or the Nation as a whole, could be revealing of air quality policies' effectiveness across different sets of polluting industries.

Financial impacts of market fluctuations

The impacts of market fluctuations such as that seen in the Global Financial Crisis of 2008 are perfect opportunities to explore the comprehensiveness of the global maritime transport system. Economists have been tracking seaport indicators for many years and offering industry outlooks that capture financial disturbances caused by a myriad of reasons. Stopford (2009) describes the many influences that impact industry profitability for stakeholders in the supply chains. The impacts to seaports include issues such as the need for infrastructure modernization to berth and handle new and evolving vessel designs, commodity shortages, geopolitical strife, natural disaster or anything that interrupts the routine flow of cargo. U.S. public seaports need cargo to earn profits. They are not line items on any state or local government's budget. U.S. public seaports are self-sufficient, but where do we educate the practitioners on financial management when the scholars do not have a comprehensive understanding of holistic port governance? Current public budgeting curriculums should pay homage to the entrepreneurial aspects of public seaport management. This niche practitioner area is in desperate need of educational materials to advance knowledge in public seaport financial management.

Seaport Comparisons

This research explains seaport governance in the United States' context so that the results can be compared with other seaports across the world. This dissertation is a first in understanding the totality of what port governance in the U.S. entails. There are no doubt differences between the ports used in this dataset and seaports across the world which can be drawn upon to compare and contrasts the efficiency levels of port functions based on governance characteristics. This opportunity is ripe for research and understanding how policies can help or hinder U.S. seaports is a worthwhile endeavor.

Stewardship Theory

The last area discussed with potential for future research is the explanatory framework used in this dissertation – Stewardship Theory. This theory is based on the innate and steward-like characteristics of the agent (read as steward) in a principal-agent relationship (Davis et al., 1997). These characteristics were highlighted in Table 2-2 as psychological and situational factors. The assumption made here is that seaport operators adopt the steward-like characteristics with regard to stewarding public resources rather than agent-like characteristics such as control oriented, high power-distance and in search of extrinsic rewards. It seems logical that the psychological and situational factors innate to the port director or governing board members could permeate a culture and somehow impact seaport performance. Therefore, it seems logical to test Stewardship Theory in a Public Seaport environment.

Closing Remarks

This research identified a relationship between seaports' annual cargo throughput (*Cargo*) and economic growth, and between *Cargo* and county level air quality. The study also shined a light on the financial condition of the U.S. public seaport industry from 2006 to 2015.

This research is the first of its kind in the U.S. to inductively determine what public seaports claim as their missions and to assess whether or not they accomplish stated missions.

The desire for an inquiry into seaports came about by an early curiosity into how a local public seaport impacts its host region, especially since it claims publicness. The literature review truly began in 2009 while completing a master's degree in public administration. It became immediately evident that the public aspect of seaports is underrepresented in scholarly literature. The use of the term "Port Governance" in the current literature seldom describes democratic governance. It is time for scholars of public administration to establish roots in this niche discipline and allow them to grow while keeping in mind that the study of seaports is an interdisciplinary venture crossing the lines of public service, economics, and engineering, in the least.

Nothing in these findings rings through as a groundbreaking discovery. The relationships discovered here have been found by other researchers. The novelty of this approach however, is that these relationships are operationalized in a manner that explains how well public seaports accomplish commonly stated missions and impacts to host regions. This research cataloged the meaning of public seaport governance in the United States. Now, it is time to start focusing on individual U.S. seaports for the purpose of comparing and contrasting. The methods used in this dissertation can be adapted to single seaports using monthly or quarterly data to alleviate the small sample size issue. The field of port governance needs to understand public seaport governance before we can educate practitioners.

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APPENDIX A:

CONTENT ANALYSES

This appendix presents the data used in the content analysis of U.S. seaports' mission statements. Table A-1 illustrates the codes organized by potential themes. The potential themes were subsequently reduced to Economic Development, Environmental Sustainability, Financial sustainability and Recreation which are illustrated in Table A-2.

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Table A-1. *U.S. seaports' mission statement coding and potential themes*

Potential Themes	Codes		
Economic Development	Best facilities (1)	Economic opportunities (2)	Optimal performance (1)
	Business development (5)	Economic prosperity (4)	Partnership (2)
	Business opportunities (1)	Economic vitality (4)	Principal hub (1)
	Business support (1)	Economic wellbeing (1)	Promote local agriculture (1)
	Capital improvement (1)	Efficient handling of cargo (1)	Promote manufacturing (1)
	Capital investments (1)	Efficient operations (3)	Prosperity (1)
	Collaboration with Stakeholders (1)	Efficient transportation (1)	Protect/enhance current industries (1)
	Commercial opportunities (1)	Efficient workforce (1)	Public-private partnership (2)
	Create additional tax base (1)	Enhance economy (2)	Regional economic benefit (1)
	Customer focus (1)	Enhancing industrial base (1)	Regional growth and development (1)
	Customer oriented (1)	Expansion (2)	Regional prosperity (1)
	Customer relations (1)	Exports (1)	Specialized cargo (1)
	Customer requirements (1)	Future growth (1)	Stimulate commerce (1)
	Customer service (5)	Generate and expand economic activity (1)	Stimulate private investments (1)
	Developing deep water fishing facilities (1)	Industrial development (4)	Supply chain optimization (1)
	Distribution hub (1)	Industrial opportunities (1)	Sustainable growth (1)
	Economic benefit (4)	Industry growth (1)	Sustainable operations (1)
	Economic catalyst (1)	Industry support (1)	Tourism (1)
	Economic development (17)	Job creation (1)	Waterfront development (1)
	Economic engine (2)	Jobs (11)	Workforce development (1)
	Economic goals (1)	Meet customer needs (1)	
	Economic growth (8)	Needs and desires (1)	

Potential Themes	Codes		
Public Stewardship	Asset stewardship (2)	Leadership (1)	Regional stewardship (1)
	Collaboration with customers (1)	Legislative advocate (1)	Safe and efficient (1)
	Community (2)	Local community (1)	Safe and secure facilities (1)
	Community benefit (1)	Maintain property (1)	Safety (3)
	Community engagement (2)	Manage and develop resources (1)	Security (2)
	Community members (1)	Manage facilities (1)	Sound business practices (1)
	Community relations (2)	Meet infrastructure needs (1)	Sound financial practices (1)
	Community wellbeing (1)	Next generation (1)	Stewardship (3)
	Cooperative development (1)	Port sustainment (2)	Support sustainability (1)
	Cooperative waterway development (1)	Prudent management of assets (1)	Sustainability (1)
	Ethics (2)	Public safety (1)	Sustainable development (1)
	Asset stewardship (2)	Public service (1)	Sustainable infrastructure (1)
	Collaboration with customers (1)	Public stewardship (1)	Sustainable stewardship (1)
	Community (2)	Public trust (1)	Transparency (2)
Trade	Advance trade (1)	Maximize trade (1)	Multi-modal (3)
	Commerce (4)	Move the world (1)	Promote trade (1)
	Competitive environment (1)	Moving cargo (1)	Provide access to global markets (1)
	Enhance trade (1)	Moving freight (1)	Trade (5)
	Facilitate commerce (1)	Moving goods (7)	Waterborne commerce (2)
	Maximize commerce (1)	Moving people (4)	
Environmental Stewardship	Environmental protection (2)	Environmentally responsible (2)	Resource protection (1)
	Environmental responsibility (2)	Improve environment (1)	Responsible manner (environmental) (1)
	Environmental stewardship (8)	Preserve environment (1)	Sound environmental practices (1)
	Environmental sustainability (2)	Protection of marine and coastal resources (1)	
	Environmentally friendly (1)	Reduce environmental footprint (1)	

Potential Themes	Codes		
Financial Sustainability	Financial sustainability (2)	Long-term financial viability (1)	Self-sufficient (2)
	Financially health (1)	Maximize assets (1)	Self-supporting (1)
	Financing services (1)	Profit (1)	Self-sustaining (1)
	Fiscal responsibility (3)	Profitable (1)	
	Growth of assets (1)	Selective investments (1)	
Quality of Life	Quality of life (5)	Social benefit (1)	
	Quality of place (1)	Social responsibility (2)	
Recreation	Enhance public access to waterways (1)	Recreation (1)	
	Public recreation (1)	Recreation opportunities (2)	

Table A-2 presents the final results of the content analysis of U.S. public seaport authority's mission statement (*n* = 59) alongside the themes, or common mission elements conveyed by each. The Public Stewardship, Quality of Life, and Trade themes were reallocated to Economic Development which is the most prevalent common mission element amongst the seaports in the dataset. In order of prevalence amongst seaports, Environmental Stewardship, Financial Sustainability, and Recreation make up the remaining common mission elements

Table A-2. *U.S. seaports' mission statements content analysis final report*

Port Authority	Themes Conveyed	Mission Statements	Source
Ashtabula City Port Authority	Economic Development	The mission of the Ashtabula County Port Authority is to implement economic development initiatives that will strengthen and diversify the economy of Ashtabula County and throughout Northeast Ohio.	http://www.acpaohio.org/about.html
Board of Commissioners of the Port of New Orleans	Financial Sustainability	To be a proactive, customer-oriented, financially healthy service organization whose primary purpose is to maximize the flow of foreign and domestic waterborne trade and commerce with relevant markets by providing, directly or through third parties, highly productive facilities, equipment and support services to meet the specialized needs of shippers and ship operators.	http://www.portno.com/about
Board of Trustees of the Galveston Wharves	Economic Development Financial Sustainability	Manage the assets and resources under its stewardship for optimum economic benefit for the City of Galveston and the surrounding region. It is the intent of the Wharves to set its fees, leases and other charges at a level to recover the cost of its activities including renewal and replacement of its facilities and equipment. The Wharves rates are not expected to increase significantly next year.	http://www.portofgalveston.com/documentcenter/view/1503
Broward County Board of County Commissioners	Economic Development Environmental Stewardship	Mission Statement: As a premier gateway and powerhouse for international trade, travel and investment, Broward County's Port Everglades leverages its world-class South Florida facilities and innovative leadership to drive the region's economic vitality and provide unparalleled levels of service, safety, environmental stewardship and community engagement.	http://www.porteverglades.net/about-us/
Brown County Harbor Commission	Economic Development	Creating long-term relationships by consistently delivering value; helping customers to become high-performance businesses by understanding their business needs; establishing realistic expectations and meeting commitments.	https://static1.squarespace.com/static/56ec0372859fd0e272858772/t/574db2e1c6fc08d3dba6ac4c/1464709859021/Strategic+Plan+2015.pdf
Brownsville Navigation District	Economic Development Financial Sustainability	It is the mission of the Port of Brownsville (Brownsville Navigation District) to be a leader in business development by providing state of the art infrastructure expansion, developing economic opportunities, providing the best transportation facilities possible, and exhibiting high standards of public administration with the ultimate goal being to improve quality of life and create employment opportunities, gain the public's trust and confidence in order to increase growth development, and establish the port as a world class port.	http://www.portofbrownsville.com/our-vision/

Port Authority	Themes Conveyed	Mission Statements	Source
Calhoun County Port Authority	Economic Development Environmental Stewardship Financial Sustainability	The mission of the Calhoun Port Authority is to serve as a regional economic development catalyst while protecting and enhancing its existing industrial base and simultaneously working to diversify its international maritime cargo business. The Port Authority's goals include (1) fiscal responsibility, (2) excellent customer service, (3) protection of the region's marine and coastal resources and (4) serving as a positive and proactive force for economic growth.	http://www.calhounport.com/about/mission.php
Canaveral Port Authority	Economic Development	With every decision, the Port Authority as a key economic engine for Brevard County, keeps in focus its primary mission to serve as the Central Florida maritime gateway for the import and export of consumer goods which creates jobs and business opportunities for the local community.	https://www.portcanaveral.com/About
City of Los Angeles, Harbor Department	Economic Development Environmental Stewardship	Our Mission We deliver value to our customers by providing superior infrastructure and promoting efficient operations that grow our port as North America’s preferred gateway. Our Vision We are America’s Port® - the nation’s #1 container port and the global model for sustainability, security, and social responsibility.	https://www.portoflosangeles.org/pdf/Strategic-Plan-2012-17.pdf
Cleveland-Cuyahoga County Port Authority	Economic Development Environmental Stewardship	The Port fosters job creation and economic vitality in Greater Cleveland. Our maritime services and assets add value and result in a competitive advantage for regional firms competing globally. The Port tackles challenges tied directly to jobs, quality of place, and environmental sustainability through innovative development financing services and selective public investments in critical harbor projects.	http://www.portofcleveland.com/about-the-port/mission-and-strategic-plan/
Coos Bay Board of Commissioners	Economic Development	The main role of most port districts is to facilitate and promote the economic development and growth of their region and of Oregon. This is likewise for the Port of Coos Bay, whose mission is to promote sustainable development throughout the Southwest Oregon region, state and nation. This is pursued through private-public partnership economic development projects, capital improvement projects, and promoting regional industry growth to the nation. The largest city on Oregon's south coast, Coos Bay is in a unique position as a multi-modal connection point by sea, by rail, by air and by road. The Port of Coos Bay's role is to advocate for and develop the infrastructure of the area through business development, capital improvement, and public-private partnerships in order to further the economic growth of the region. It comes down to allowing our farmers, our loggers, our fishermen and other constituents the ability to transport their products throughout the state, nation and world.	http://www.portofcoosbay.com/about-the-port

Port Authority	Themes Conveyed	Mission Statements	Source
Diamond State Port Corporation	Economic Development	Mission Statement: To contribute to Delaware's economic vitality by sustaining and promoting the Port of Wilmington as a competitive and viable full service, multi-modal operation by providing for the efficient, economical, and safe handling of cargo.	http://www.portofwilmington.com
Duluth Seaway Port Authority	Economic Development	Like port authorities and harbor commissions worldwide, the DSPA mission is to generate domestic and international trade, advance regional industrial development, and advocate for maritime industry interests in legislative initiatives.	http://www.duluthport.com/authority.php
Erie-Western Pennsylvania Port Authority	Economic Development Recreation	To promote industrial, commercial and recreational opportunities	http://www.porterie.org/wp-content/uploads/2011/09/EP-Jefferson-Port-Authority.jpg
Georgia Ports Authority	Economic Development Environmental Stewardship	To develop, maintain, and operate ocean and inland river ports within Georgia; foster international trade and new industry for state and local communities; promote Georgia's agricultural, industrial, and natural resources; and maintain the natural quality of the environment.	http://www.dot.ga.gov/AboutGeorgia/Board/Presentations/GPA.pdf
Greater Lafourche Port Commission	Economic Development Environmental Stewardship	The Greater Lafourche Port Commission, a political subdivision of the state of Louisiana, facilitates the economic growth of the communities in which it operates by maximizing the flow of trade and commerce. We do this to grow our economy and preserve our environment and heritage.	http://portfourchon.com/about-glpc/
Hawaii Department of Transportation	Economic Development	To provide a safe, efficient, accessible, and inter-modal transportation system that ensures the mobility of people and goods, and enhances and/or preserves economic prosperity and the quality of life.	http://hidot.hawaii.gov/about-us/
Hillsborough County Port District	Economic Development Environmental Stewardship Financial Sustainability	Port Tampa Bay will be recognized as a leader in the maritime industry. Port Tampa Bay will have a customer driven, strategic business focus in working with stakeholders to develop and manage marine terminals and supporting infrastructure for the benefit of the regional economy. The Port Tampa Bay will employ sound financial, business and environmental management practices in fulfilling its mission.	https://www.tampaport.com/About-Port-Tampa-Bay/About-Port-Tampa-Bay

Port Authority	Themes Conveyed	Mission Statements	Source
Illinois International Port District	Economic Development Environmental Stewardship	The Illinois International Port District is committed to developing and maintaining a world-class port that operates as a modern, strategically driven facility. The Illinois International Port District is focused on generating and expanding economic activity and employment for the benefit of the City of Chicago and State of Illinois. The Illinois International Port District is committed to doing so in an environmentally responsible way and improving awareness, understanding and engagement with the surrounding communities	http://www.iipd.com
Jackson County Port Authority Board of Commissioners	Economic Development Financial Sustainability	The mission of the Jackson County Port Authority is to acquire, develop and manage assets as necessary to build and sustain a world-class, multi-use industrial port; and to encourage and support industrial and private industry in Jackson County.	http://www.portofpascagoula.com/port-authority.html
Jacksonville Port Authority	Economic Development	VISION Northeast Florida will be a principal hub of the nation’s global logistics, trade and transportation network MISSION Creating jobs and opportunity by offering the most competitive environment for the movement of cargo and people	https://www.jaxport.com/overview
Long Beach Board of Harbor Commissioners	Economic Development Environmental Stewardship Financial Sustainability	Vision: The Port of Long Beach is a world leader in goods movement, environmental stewardship, and economic development. Mission: Facilitate the efficient and sustainable flow of commerce by providing world leading port infrastructure and operations. Goals: - Environmental Stewardship - Safety & Security - Community, Business & Government Relations - Sustainable Infrastructure & Supply Chain Optimization - Business Development - Financial Strength - Organizational Development	http://polb.com/about/plan.asp

Port Authority	Themes Conveyed	Mission Statements	Source
Lorain Port Authority	Economic Development	To promote waterborne commerce, to provide economic development opportunities within the City of Lorain, and to enhance public access to our waterways.	http://www.lorainportauthority.com/overview/
Manatee County Port Authority	Economic Development Environmental Stewardship Financial Sustainability	The mission of Port Manatee is to be a powerful catalyst of countywide economic growth and hub of trade-related activity, by developing diversified and competitive deepwater shipping facilities and conducting maritime-related activities in a profitable and environmentally responsible manner.	http://www.portmanatee.com/About-Us
Maryland Port Administration	Economic Development	The Mission Statement of the Maryland Department of Transportation Port Administration is to stimulate the flow of waterborne commerce through the ports in the State of Maryland in a manner that provides economic benefit to the citizens of the state.	http://mpa.maryland.gov/Pages/about-us.aspx
Massachusetts Port Authority	Economic Development	A world class organization of people moving people and goods – and connecting Massachusetts and New England to the world – safely and securely and with a commitment to our neighboring communities.	https://www.massport.com/about-massport/about-massport/mission/
Miami Dade County	Environmental Stewardship Financial Sustainability	The Port of Miami's mission is to operate and further develop the world's leading cruise port and the largest container port in the State of Florida; to maximize its assets and strengthen its advantage for future growth; promote international trade and commerce as a vital link between North and South America and a growing global trade; support sustainability and operate in an environmentally responsible manner.	http://www.miamidade.gov/portmiami/master-plan.asp
Mississippi State Port Authority at Gulfport	Economic Development Financial Sustainability	Our mission is to be a profitable, self-sufficient Port providing world-class maritime terminal service to present and future customers and to facilitate the economic growth of Mississippi through the promotion of international trade. - See more at: http://shipmspa.com/commission-staff/#sthash.6LAnwKWn.dpuf	http://shipmspa.com/commission-staff/#sthash.6LAnwKWn.dpbs
Monroe Port Commission	Economic Development Environmental Stewardship	To provide a functional industrial and economic base to the Community of Monroe and the State of Michigan by developing and encouraging development within the established boundaries of the Port of Monroe pursuant to sound policies protecting the environment and the health and welfare of the Community.	http://www.portofmonroe.com/General/Aboutus.aspx

Port Authority	Themes Conveyed	Mission Statements	Source
Municipality of Anchorage, AK	Economic Development	Vision: To provide a modern, safe and efficient Port which stimulates economic development and the movement of goods into and out of Alaska. Mission: To expand and maintain existing property, facilities and equipment to meet growth in established marine trade, to encourage natural resource exports, and to create employment opportunities by attracting new industry and new cargo movement. To support and assist increases in cargo movement that will aid and stimulate domestic and international business activities throughout the Railbelt and other areas of the State serviced by the Port.	http://www.portofanc.com/about-us/mission-vision/
New Hampshire Division of Ports and Harbors/PEASE Development Authority	Economic Development	Pursuant to the New Hampshire State Statute, RSA 12-G:43, I(a), the Division of Ports and Harbors (DPH), of the Pease Development Authority, shall "plan for the maintenance and development of the ports, harbors, and navigable tidal rivers of the State of New Hampshire from the head of navigation to the seaward limits within the jurisdiction of the state, in order to foster and stimulate commerce and the shipment of freight through the state's ports and as an agency of the state, to assist shipping and commercial and industrial interests that may depend on the sea for transport of products."	http://www.peasedev.org/pease-portsharbors.html
North Carolina State Ports Authority	Economic Development Environmental Stewardship Financial Sustainability	The mission of the North Carolina State Ports Authority is to enhance the economy of the State of North Carolina. The Ports Authority will be managed like a business focused on the requirements of our customers. North Carolina's Ports will be recognized for our self-sustaining operations, environmental stewardship, highly efficient workforce, satisfied customers, and modern, well-maintained facilities and equipment.	http://ncports.com/about-the-ports/mission/
Ocean Highway and Port Authority	Economic Development	The Port Authority serves the principal public purpose to encourage economic development in Nassau County. One way it has fulfilled this responsibility has been by renovating the deepwater port facilities to meet the maritime shipping needs of this growing region. In so doing, the Port Authority gives appropriate consideration to the impacts upon and relationships with surrounding communities, the economic goals of the State and region and the regulatory requirements of numerous governmental agencies.	http://www.portoffernandina.org/port-authority-organization--powers
Ogdensburg Bridge and Port Authority	Economic Development Environmental Stewardship	While remaining self-sustaining, the Authority creates sound economic business development through the promotion of buildings, river, road, rail, and air transportation. This is accomplished by providing exceptional customer service, safe and secure facilities, responsible environmental stewardship, and focused professionalism.	http://www.ogdensport.com/accountability/mission_statement/

Port Authority	Themes Conveyed	Mission Statements	Source
Oxnard Harbor District Commission	Economic Development Financial Sustainability	Vision: To operate as a self-supporting Port that enforces the principles of sound public stewardship maximizing the potential of maritime-related commerce and regional economic benefit. Mission: To be the preferred Port for specialized cargo and provide the maximum possible economic and social bene ts to our community and Industries served.	http://www.portofhueneme.org/wp-content/uploads/2015/06/Port_of_Hueneme_2020_Strategic_Plan_FINAL.pdf
Philadelphia Regional Port Authority	Economic Development	The Philadelphia Regional Port Authority, an independent agency of the Commonwealth of Pennsylvania, has as its primary mission the enhancement of water-borne trade and commerce. PRPA was created by an act of the Pennsylvania legislature in 1989. As an organization committed to economic development and job creation, the Authority seeks to generate activity that will maximize port-related employment and revenues by promoting the use of the Philadelphia regional port system by Pennsylvania based industries. It is also committed to working in a cooperative spirit with other Delaware River port and City agencies to realize the potential of the regional port system. Port cargoes and the activity they generate are responsible for thousands of direct and indirect jobs in the Philadelphia area and throughout Pennsylvania.	http://www.philaport.com/about/
Port Authority of New York and New Jersey	Economic Development	Meet the critical transportation infrastructure needs of the bi-state region's people, businesses, and visitors by providing the highest-quality and most efficient transportation and port commerce facilities and services to move people and goods within the region, provide access to the nation and the world and promote the region’s economic development.	http://www.panynj.gov/pdf/SpecialPanelReporttotheGovernors.pdf

Port Authority	Themes Conveyed	Mission Statements	Source
Port of Anacortes Commission	Economic Development Financial Sustainability	Mission Statement In partnership with public agencies and private business, develop and manage facilities and services which stimulate private job creation and commerce, while protecting the quality of life, needs and desires of area residents. The following tenets are basic to accomplishing this mission: Be a responsible steward of the public resources, and operate in a manner which maintains a high level of public understanding and confidence in the Port's activities. Operate as a primarily self-supporting public enterprise, which will maintain the financial strength necessary to fulfill our mission on a continuing basis. Operate in a manner that avoids displacement of private business activity. Establish and maintain sound and ethical management practices in all relations with the Port's customers, employees and the community at large. Give priority to the fostering of economic developments, which, directly or indirectly, lead to the creation, and maintenance of family wage jobs. Concentrate on developments for which the Port is uniquely qualified, primarily marine related activities, transportation, and environmental clean-ups. Economically or socially justify all new capital projects. Provide services and facilities that do not require continuing subsidy. Quality of life means an appropriate balance among economic, social, and environmental elements. Mission Statement	https://www.portofanacortes.com/about/about-us
Port of Astoria Commissioners	Economic Development Environmental Stewardship	The Port of Astoria seeks to generate economic growth and prosperity in a safe and environmentally responsible manner for its citizens through creation of family wage jobs and prudent management of its assets.	http://www.portofastoria.com/About_the_Port_of_Astoria.aspx
Port of Bremerton Commission	Economic Development	In partnership with public agencies and private business, develop and manage facilities and services which stimulate private job creation and commerce, while protecting the quality of life, needs and desires of area residents.	http://www.portofbremerton.org/about/about-us

Port Authority	Themes Conveyed	Mission Statements	Source
Port of Corpus Christi Authority	Economic Development Environmental Stewardship Financial Sustainability	It is the mission of the Port of Corpus Christi Authority to serve as a regional economic development catalyst while protecting and enhancing its existing industrial base and simultaneously working to diversify its international maritime cargo business. In pursuit of this mission, the Authority shall be guided by the following basic principles: - The Port Authority shall conduct its affairs in a positive, open, and cooperative manner; - The Port Authority shall operate in a fiscally responsible manner; - The Port Authority shall be a positive and proactive force in the protection of the region's marine and water related resources; - The Port Authority shall be committed to serving its customers – present and future.	http://portofcc.com/wp-content/uploads/PortofCorpusChristi-StrategicPlan-small.pdf
Port of Everett Board of Commissioners	Economic Development Environmental Stewardship	Vision We are valued for operating in a sustainable manner that improves the community, environment and economy. Mission The Port of Everett is an Economic Development Enterprise carrying out the public's trust to manage and develop resources, transportation facilities and supporting infrastructure to enable community opportunity. Core Values We exemplify the highest ethical standards We honor our commitments to our community We are high-performers that value the privilege of public service We embrace the richness of a diverse community We are responsible stewards of community resources and the environment We are mutually dependent and supportive of our partners	http://www.portofeverett.com/your-port/about-us/vision-mission-core-values
Port of Grays Harbor Commission	Economic Development	Our Mission: To best utilize our resources to facilitate, enhance and stimulate international trade, economic development and tourism for the betterment of the region.	http://www.portofgraysharbor.com/about/history/index.php

Port Authority	Themes Conveyed	Mission Statements	Source
Port of Houston Authority	Economic Development	Mission Statement: "To move the world and drive regional prosperity" Vision Statement: "America's distribution hub for the next generation" This bold, ambitious statement envisages a future state with the following characteristics: - A leading national (as opposed to regional), multi-modal hub for imports and exports § A leader in efficiency, service and innovation - Increased market share, increased capacity and improved freight mobility - A focus on preparing for the "next generation", which embraces: Development of an engaged workforce to serve the Port's future needs Encouragement of diversity, both in the business base and in organizational talent Anticipation of, and provision for future market needs Long-term stewardship of the assets	http://porthouston.com/portweb/about-us/mission-and-vision/
Port of Kalama Commission	Economic Development Environmental Stewardship Recreation	To induce capital investment in an environmentally responsible manner to create jobs and to enhance public recreational opportunities	http://portofkalama.com/about-the-port-of-kalama/commissioners/
port of Newport Commission	Economic Development	Build and maintain waterfront facilities, and promote/support projects and programs in cooperation with other community organizations and businesses that will retain and create new jobs and increase community economic development."	http://www.portofnewport.com/general/mission-statement.php
Port of Oakland Board Commissioners	Economic Development Financial Sustainability	The Port of Oakland delivers the highest value to our customers and community through sustainable stewardship and growth of our assets, optimal performance of our people, and focus on our aviation, maritime, and real estate businesses.	http://www.portofoakland.com/wp-content/uploads/2016/03/strategicPlan2011-2015.pdf
Port of Oswego Authority	Economic Development Environmental Stewardship	The mission of the Port of Oswego Authority is to serve as an economic catalyst in the Central New York Development Council District Region by providing diversified and efficient transportation services and conducting operations in a manner that promotes regional growth and development while being mindful of our responsibility to serve as a steward of the environment.	http://www.portoswego.com/about-us
Port of Palm Beach District	Economic Development	to promote waterborne commerce in the region	http://www.portofpalmbeach.com/DocumentCenter/View/102

Port Authority	Themes Conveyed	Mission Statements	Source
Port of Portland Commission	Economic Development	Charged with promoting the region's aviation, maritime and commercial and industrial interests, the Port's mission is to enhance the region's economy and quality of life by providing efficient cargo and air passenger access to national and global markets. While the mission describes what the Port does, the vision is an aspirational statement of what the Port wants to become over the next five to 10 years. Supporting its mission, the Port's vision is to be a prominent, innovative economic development engine while stewarding the region's community and environmental best interests.	https://www.portofportland.com/PDFPOP/StrategicPlan_0111.pdf
Port of Seattle Commission	Economic Development Environmental Stewardship	The mission of the Port of Seattle is to create good jobs here by advancing trade and commerce, promoting manufacturing and maritime growth, and stimulating economic development. Our vision is to add 100,000 jobs through economic growth led by the Port, for a total of 300,000 port-related jobs in the region, while reducing our environmental footprint. We are committed to creating opportunity for all, stewarding our environment responsibly, partnering with surrounding communities, promoting social responsibility, conducting ourselves transparently, and holding ourselves accountable.	http://www.portseattle.org/About/Pages/default.aspx

Port Authority	Themes Conveyed	Mission Statements	Source
Port of Tacoma Commission	Economic Development Environmental Stewardship Financial Sustainability	Our mission Deliver prosperity by connecting customers, cargo and community with the world. Core values Integrity Being ethically unyielding and honest; inspiring trust by saying what we mean and matching our behaviors to our words; acting in the public interest and in a manner to maintain public confidence. Customer focus Creating long-term relationships by consistently delivering value; helping customers to become high-performance businesses by understanding their business needs; establishing realistic expectations and meeting commitments. Teamwork Focusing on the success of the entire organization; fully utilizing our collective skills, knowledge and experiences to achieve our goals; encouraging diversity, respect and full participation; being effective collaborators with a broad range of partners in the region; having fun together. Courage Facing challenges with fortitude; setting aside fears and standing by personal principles; extending beyond personal comfort zones to achieve goals; taking responsibility for actions. Competitive spirit Pursuing our goals with energy, drive and the desire to exceed expectations; going the extra mile for our customers and to differentiate ourselves in the market; demonstrating passion and dedication to our mission; constantly improving quality, timeliness and value of our work. Sustainability Focusing on long-term financial viability; valuing the economic well-being of our neighbors; doing business in a way that improves our environment.	http://www.portoftacoma.com/about/organization
Quonset Development Corporation	Economic Development	The QDC is a real estate development and management company responsible for developing and managing the Quonset Business Park in accordance with the QDC Master Land Use and Development Plan and in the best interests of the citizens of Rhode Island in order to attract and retain successful businesses that provide diversified jobs. In broad terms, QDC's development goals are as follows: Create jobs. Stimulate private sector investment. Create additional tax base.	http://www.quonset.com/about-qdc/

Port Authority	Themes Conveyed	Mission Statements	Source
San Diego Unified Port District	Economic Development Environmental Stewardship Recreation	Vision: To foster a world-class Port through excellence in public service. Mission: The San Diego Unified Port District will protect the Tidelands Trust resources by providing economic vitality and community benefit through a balanced approach to maritime industry, tourism, water and land recreation, environmental stewardship and public safety.	https://www.portofsandiego.org/about-us.html
San Francisco Port Commission	Economic Development Environmental Stewardship Financial Sustainability Recreation	Mission: The Port of San Francisco manages the waterfront as the gateway to a world-class city and advances environmentally and financially sustainable maritime, recreational, and economic opportunities to serve the City, Bay Area region, and California Vision: Deliver vibrant and diverse waterfront experiences that enrich the City and San Francisco Bay	http://sfport.com/sites/default/files/StrategicPlan_8-5-16.pdf
South Carolina State Ports Authority	Economic Development	The South Carolina Ports Authority (SCPA) promotes, develops and facilitates waterborne commerce to meet the current and future needs of its customers, and for the economic benefit of the citizens and businesses of South Carolina. The SCPA fulfills this mission by delivering cost competitive facilities and services, collaborating with customers and stakeholders, and sustaining its financial self-sufficiency.	http://www.scspa.com/about/mission-and-leadership/
The Vancouver Port Authority	Economic Development	VISION A premier port that is globally recognized and well capitalized with state-of-the-industry facilities, infrastructure and service providing accountable economic benefit. MISSION The port's mission is to provide economic benefit to our community through leadership, stewardship and partnership in marine, industrial and waterfront development.	http://www.portvanusa.com/about/strategic-plan/
Toledo-Lucas County Port Authority	Economic Development	The mission of the Toledo-Lucas County Port Authority is to develop expertise and assets that drive and grow the region's transportation and logistics infrastructure and its economic prosperity for all.	http://www.toledoport.org/about/about-the-port/
Virginia Port Authority	Economic Development Financial Sustainability	THE PORT OF VIRGINIA MISSION Guided by our company values, The Port of Virginia will achieve our shared vision of operational excellence, fiscal responsibility, and sustainable growth. Above all, we will remain responsible members of the communities we serve, a valuable resource to our customers, an excellent place to work, and an economic engine for the region.	http://www.portofvirginia.com/about/our-mission-and-values/

APPENDIX B:

SEAPORTS USED IN QUANTITATIVE ANALYSES

Seaport (port of)	City, State	County	Governing Authority	Metropolitan Statistical Area	Economic	Environmental	Financial
Port Canaveral	Port Canaveral, FL	Brevard	Canaveral Port Authority	Palm Bay-Melbourne-Titusville, FL	x	x	x
Port Conneaut	Conneaut, OH	Ashtabula	Conneaut Port Authority	Ashtabula Micropolitan Statistical Area		x	x
Port Everglades	Port Everglades, FL	Broward	Broward County Port Commission	Miami-Fort Lauderdale-West Palm Beach, FL	x	x	x
Port Freeport	Freeport, TX	Brazoria	Port Freeport Commission	Houston-The Woodlands-Sugar Land, TX	x	x	x
Albany	Albany, NY	Albany	City of Albany, NY	Albany-Schenectady-Troy, NY	x	x	
Anacortes	Anacortes, WA	Skagit	City of Anacortes, WA	Mount Vernon-Anacortes, WA	x	x	x
Anchorage	Anchorage, AK	Anchorage	Municipality of Anchorage, AK	Anchorage, AK	x		x
Ashtabula	Ashtabula, OH	Ashtabula	Port Authority of Ashtabula of County	Ashtabula Micropolitan Statistical Area		x	
Baltimore	Baltimore, MD	Baltimore	Maryland Port Commission	Baltimore-Columbia-Towson, MD	x	x	
Boston	Boston, MA	Suffolk	Massachusetts Port Authority	Boston-Cambridge-Newton, MA-NH	x	x	x
Cleveland	Cleveland, OH	Cuyahoga	Cleveland-Cuyahoga County Port Authority	Cleveland-Elyria, OH	x	x	x
Corpus Christie	Corpus Christi, TX	Nueces	Port of Corpus Christie Authority of Nueces County, Texas	Corpus Christi, TX	x	x	x
Detroit	Detroit, MI	Wayne	Detroit/Wayne County Port Authority	Detroit-Warren-Dearborn, MI	x	x	
Duluth	Duluth, MN	Saint Louis	Duluth Seaway Port Authority	Duluth, MN-WI	x	x	x
Everett	Everett, WA	Snohomish	Everett Port Commission	Seattle-Tacoma-Bellevue, WA	x	x	x
Galveston	Galveston, TX	Galveston	The Board of Trustees of the Galveston Wharves	Houston-The Woodlands-Sugar Land, TX	x	x	x

Seaport (port of)	City, State	County	Governing Authority	Metropolitan Statistical Area	Economic	Environmental	Financial
Grays Harbor	Grays Harbor, WA	Grays Harbor	Grays Harbor Port Commission	Aberdeen, WA Micropolitan Statistical Area			x
Gulfport	Gulfport, MS	Harrison	Mississippi State Port Authority	Gulfport-Biloxi-Pascagoula, MS	x	x	x
Houston	Houston, TX	Harris	Port of Houston Authority	Houston-The Woodlands-Sugar Land, TX	x	x	x
Kalama	Kalama, WA	Cowlitz	Kalama Port Commission	Longview, WA	x	x	x
Jacksonville	Jacksonville, FL	Duval	Jacksonville Port Authority	Jacksonville, FL	x	x	x
Long Beach	Long Beach, CA	Los Angeles	City of Long Beach, CA	Los Angeles-Long Beach-Anaheim, CA	x	x	x
Longview	Longview, WA	Cowlitz	Port of Longview Commission	Longview, WA	x	x	x
Los Angeles	Los Angeles, CA	Los Angeles	City of Los Angeles, CA	Los Angeles-Long Beach-Anaheim, CA	x	x	x
Milwaukee	Milwaukee, WI	Milwaukee	City of Milwaukee, WI	Milwaukee-Waukesha-West Allis, WI	x	x	
Mobile	Mobile, AL	Mobile	Alabama State Port Authority	Mobile, AL	x	x	
Monroe	Monroe, MI	Monroe	City of Monroe, MI	Monroe, MI	x		x
New Orleans	New Orleans, LA	Orleans	Port of New Orleans Commission	New Orleans-Metairie, LA	x	x	x
New York-New Jersey	New York-New Jersey	Multiple	Port Authority of New York-New Jersey	New York-Newark-Jersey City, NY-NJ-PA	x	x	x
Oakland	Oakland, CA	Alameda	City of Oakland, CA	San Francisco-Oakland-Hayward, CA	x	x	x
Olympia	Olympia, WA	Thurston	Port of Olympia Commission	Olympia-Tumwater, WA	x	x	x
Palm Beach	Palm Beach, FL	Palm Beach	Port of Palm Beach District Commission	Miami-Fort Lauderdale-West Palm Beach, FL	x	x	x
Panama City	Panama City, FL	Bay	Panama City Port Authority	Panama City, FL	x	x	x
Pascagoula	Pascagoula, MS	Jackson	Jackson County Port Authority	Gulfport-Biloxi-Pascagoula, MS	x	x	
Pensacola	Pensacola, FL	Escambia	City of Pensacola, FL	Pensacola-Ferry Pass-Brent, FL	x	x	

Seaport (port of)	City, State	County	Governing Authority	Metropolitan Statistical Area	Economic	Environmental	Financial
Philadelphia	Philadelphia, PA	Philadelphia	Philadelphia Regional Port Authority	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	x	x	x
Port Angeles	Port Angeles, WA	Clallam	Port Angeles Port Commission	Port Angeles, WA (Micropolitan Statistical Area)		x	x
Port Manatee	Port Manatee, FL	Manatee	Manatee County Port Authority	North Port-Sarasota-Bradenton, FL	x	x	x
Portland, ME	Portland, ME	Cumberland	City of Portland, ME	Portland-South Portland, ME	x	x	
Portland, OR	Portland, OR	Multnomah	Port of Portland Commission	Portland-Vancouver-Hillsboro, OR-WA	x	x	x
Redwood City	Redwood City, CA	San Mateo	Port of Redwood City Commission	San Francisco-Oakland-Hayward, CA	x	x	x
Richmond	Richmond, CA	Contra Costa	City of Richmond, CA	San Francisco-Oakland-Hayward, CA	x	x	
San Diego	San Diego, CA	San Diego	Unified San Diego Port District	San Diego-Carlsbad, CA	x	x	x
San Francisco	San Francisco, CA	San Francisco	City of San Francisco Port Commission	San Francisco-Oakland-Hayward, CA	x	x	x
Seattle	Seattle, WA	King	Port of Seattle Commission	Seattle-Tacoma-Bellevue, WA	x	x	x
South Louisiana	LaPlace, LA	St. John the Baptist	South Louisiana Port Commission	New Orleans-Metairie, LA	x	x	x
Stockton	Stockton, CA	San Joaquin	Port of Stockton Commission	Stockton-Lodi, CA	x	x	x
Tacoma	Tacoma, WA	Pierce	Port of Tacoma Commission	Seattle-Tacoma-Bellevue, WA	x	x	x
Tampa	Tampa, FL	Hillsborough	Tampa Port Authority	Tampa-St. Petersburg-Clearwater, FL	x	x	x
Toledo	Toledo, OH	Lucas	Toledo-Lucas County Port Authority	Toledo, OH	x	x	x
Vancouver	Vancouver, WA	Clark	Port of Vancouver Commission	Portland-Vancouver-Hillsboro, OR-WA	x	x	x
Virginia	Virginia	Multiple	Virginia Port Authority	Virginia Beach-Norfolk-Newport News, VA-NC	x	x	x
Wilmington	Wilmington, DE	New Castle	Diamond State Port Corporation	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	x	x	x

APPENDIX C:

DESCRIPTIVE STATISTICS BY SEAPORT

Appendix C contains the descriptive statistics for the data used in this dissertation as the port level. Tables C-1 and C-2 illustrate the economic development data in Stage 2, C-3 and C-4 show the environmental stewardship data, and C-5 through C-8 displays the financial ratio data.

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C-1. *Stage 2 – Economic impact dependent variables*

Seaport (port of)	*ΔPCGDP* (%)			*ΔWages* (%)			*PCGDP* ($ x 10^3)			*Wages* ($)		
	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
Albany, NY	0.58	0.54	1.31	2.87	2.72	0.95	49.3	49	1.2	892	892	67.3
Anacortes, WA	-3.87	-2.27	8.17	3.24	3.48	1.61	38.9	38.7	4.5	730	722	59.4
Anchorage, AK	0.62	0.63	4.18	2.97	3.01	1.22	68.4	67.8	2.9	1702	1,704	135.4
Baltimore, MD	0.71	0.77	1.05	2.62	2.64	1.13	56	55.9	1.2	979	982	66.5
Boston, MA	0.8	1.4	1.96	2.94	3.25	1.87	72.2	72.3	1.6	1230	1,221	90.8
Canaveral, FL	-0.86	-0.29	2.51	1.9	2.02	1.49	33.1	33	1.9	833	846	36.2
Cleveland, OH	0.47	0.49	2.52	2.29	2.77	1.32	53.7	53.8	1.5	877	872	56.5
Corp. Christie, TX	2.07	1.79	4.02	3.28	4.18	2.75	42.6	42	2.6	779	762	65.3
Detroit, MI	0	1.29	4.8	1.84	1.92	1.89	48.7	49.4	2.6	984	977	51.1
Duluth, MN	0.53	-0.45	4.93	2.65	2.92	1.43	38.5	38.5	2	729	724	53
Everett, WA	1.09	1.43	2.62	3.55	3.53	1.36	73	73.6	2	1,108	1,098	104.6
Everglades, FL	-0.44	1.11	3.67	2.25	1.75	1.31	46.8	45.9	2.8	880	874	46.3
Freeport, TX	1.21	1.77	2.77	3.33	3.77	2.45	66.7	66.2	2.5	1119	1,105	95.7
Galveston, TX	1.21	1.77	2.77	3.33	3.77	2.45	66.7	66.2	2.5	1,119	1,105	95.7
Gulfport, MS	0.14	-0.48	5.39	2.83	1.18	3.96	40.1	40.7	2.1	720	698	51.3
Houston, TX	1.21	1.77	2.77	3.33	3.77	2.45	66.7	66.2	2.5	1,119	1,105	95.7
Jacksonville, FL	-1.29	-0.4	3.01	2.11	2.14	1.5	43.3	41.8	3	834	828	43
Kalama, WA	-0.1	0.26	2.79	2.93	2.97	1.78	31.7	31.9	1	773	761	63.5
Long Beach, CA	0.82	1.38	2.78	2.4	2.72	1.75	60.3	60.2	1.7	1,030	1,030	60.5
Longview, WA	-0.1	0.26	2.79	2.93	2.97	1.78	31.7	31.9	1	773	761	63.5
Los Angeles, CA	0.82	1.38	2.78	2.4	2.72	1.75	60.3	60.2	1.7	1,030	1,030	60.5
Manatee, FL	-1.8	-1.53	3.3	2.04	1.87	1.53	34.5	33	3.1	728	725	33.5
Milwaukee, WI	0.5	0.72	1.65	2.28	2.63	1.31	56.6	56.6	1	885	884	49.7
Mobile, AL	0.67	0.27	1.7	2.94	2.32	2.12	39.4	39.3	0.3	781	790	56.1
Monroe, MI	-0.49	-0.24	4.46	1.63	2.08	1.53	27.1	27.3	1.4	827	818	35.3
N. York - N. Jersey	0.7	1.11	1.95	2.4	2.19	3.29	67.8	67.9	1.4	1,295	1,294	64.3
New Orleans, LA	0.09	-0.9	8.98	2.96	2.02	4.03	57.9	57.2	4.9	887	894	42.5
Oakland, CA	0.69	1.43	2.82	3.45	3.5	2.5	77.8	77.6	2.4	1,356	1,308	135.9

Seaport (port of)	*ΔPCGDP* (%) Mean	Median	Std. Dev.	*ΔWages* (%) Mean	Median	Std. Dev.	*PCGDP* ($ x 10^3) Mean	Median	Std. Dev.	*Wages* ($) Mean	Median	Std. Dev.
Olympia, WA	-0.53	-0.11	2.13	2.59	2.45	1.47	36.3	35.8	1.6	817	821	50.2
Palm Beach, FL	-0.44	1.11	3.67	2.25	1.75	1.31	46.8	45.9	2.8	880	874	46.3
Panama City, FL	-0.94	-0.19	2.52	1.69	1.62	1.69	37.4	37.6	2	681	685	24.9
Pascagoula, MS	0.14	-0.48	5.39	2.83	1.18	3.96	40.1	40.7	2.1	720	698	51.3
Pensacola, FL	-0.8	-0.45	2.48	2.17	2.15	1.5	31.2	30.9	1.4	698	698	36.3
Philadelphia, PA	0.67	0.91	0.9	2.48	2.34	1.27	58.5	58.2	1.1	1,038	1,033	63.4
Portland, ME	0.06	-0.52	1.26	2.51	2.61	1.05	49.1	49.1	0.4	795	794	52.4
Portland, OR	2.3	3.18	4.41	2.88	3.19	1.18	60.6	60.7	3.3	925	917	72.9
Redwood City, CA	0.69	1.43	2.82	3.45	3.5	2.5	77.8	77.6	2.4	1,356	1,308	135.9
Richmond, CA	0.69	1.43	2.82	3.45	3.5	2.5	77.8	77.6	2.4	1,356	1,308	135.9
San Diego, CA	0.08	0.99	2.14	2.86	3.06	1.18	58.8	59.2	1.7	997	993	77.4
San Francisco, CA	0.69	1.43	2.82	3.45	3.5	2.5	77.8	77.6	2.4	1,356	1,308	135.9
Seattle, WA	1.09	1.43	2.62	3.55	3.53	1.36	73	73.6	2	1,108	1,098	104.6
South Louisiana	0.09	-0.9	8.98	2.96	2.02	4.03	58.1	57.4	4.8	887	894	42.5
Stockton, CA	-0.6	-0.37	2.19	2.18	1.75	1.56	30.2	29.6	1.2	769	774	37.7
Tacoma, WA	1.09	1.43	2.62	3.55	3.53	1.36	73	73.6	2	1,108	1,098	104.6
Tampa, FL	-0.67	0.08	2.49	2.56	2.42	1.06	40.7	40	1.9	818	821	53.9
Toledo, OH	1.06	0.87	3.22	2.17	2.39	1.57	45.1	44.7	2.3	780	772	43.4
Vancouver, WA	2.3	3.18	4.41	2.88	3.19	1.18	60.6	60.7	3.3	925	917	72.9
Virginia	0.52	0.2	1.41	2.67	2.63	1.27	48.8	48.8	0.4	782	782	52.8
Wilmington, DE	0.67	0.91	0.9	2.48	2.34	1.27	58.5	58.2	1.1	1,038	1,033	63.4

C-2. *Stage 2 – Economic impact independent variables*

	Cargo (Short tons x 10^6)			*NCargo* (Short tons x 10^6)			*GSpend* (Ratio)			*HCapital* (%)			*iPCGDP* ($)			*iWages* ($)		
Seaport (port of)	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.
Albany, NY	8.09	7.54	1.7	324.80	313.10	41.5	140.00	44.60	233.2	8.43	8.54	0.5	48977	48867	905	866.90	873.50	68.2
Anacortes, WA	11.30	10.95	2.1	108.10	108.80	6.2	1.40	1.20	0.8	4.25	4.34	0.7	40856	42090	6615	707.70	714.00	60.3
Anchorage, AK	2.79	2.81	0.4	36.40	35.60	4.8	8.80	9.00	4.4	7.58	7.65	0.5	68012	67805	3340	1652.80	1676.50	135.3
Baltimore, MD	39.70	40.44	4.3	326.50	315.50	24.0	14.80	10.80	14.4	8.17	8.18	0.4	55610	55512	1065	954.20	958.50	69.5
Boston, MA	19.05	18.75	2.2	326.50	315.50	24.0	8.70	6.30	9.2	8.83	8.92	0.5	71615	71843	1672	1194.90	1188.50	89.2
Canaveral, FL	3.20	3.25	0.6	149.80	145.20	13.5	16.70	8.50	21.6	6.32	6.30	0.5	33440	33841	1898	817.60	835.50	41.9
Cleveland, OH	11.65	11.51	2.4	127.70	124.90	14.3	2.50	2.90	1.4	6.62	6.47	0.3	53422	53718	1293	857.20	846.50	56.7
Corp. Christie, TX	76.36	76.47	6.2	496.70	502.90	19.2	5.50	2.40	8.2	5.76	5.81	0.5	41815	41808	2528	754.60	746.50	70.4
Detroit, MI	13.46	13.35	2.1	144.50	140.80	16.0	2.20	1.70	1.9	7.00	7.01	0.4	48763	49424	2628	966.00	958.50	45.3
Duluth, MN	38.26	36.54	5.9	39.50	40.30	4.3	4.00	1.80	6.1	7.30	7.20	0.4	38318	38110	1946	710.20	704.00	52.2
Everett, WA	1.73	1.56	0.6	117.70	119.40	7.1	4.90	4.60	4.1	6.76	6.83	0.4	72219	72827	2158	1071.00	1064.00	107.0
Everglades, FL	22.02	21.68	1.6	71.20	67.70	8.8	1.40	1.50	0.8	7.09	7.29	0.6	47022	45876	2965	860.50	861.50	46.8
Freeport, TX	25.42	24.99	4.3	845.70	846.30	46.2	2.90	2.30	2.8	6.14	6.20	0.5	65947	65048	2341	1084.00	1073.00	103.6
Galveston, TX	11.05	10.53	1.6	992.60	994.10	47.4	2.90	2.30	2.8	6.14	6.20	0.5	65947	65048	2341	1084.00	1073.00	103.6
Gulfport, MS	1.96	1.99	0.2	699.10	695.40	34.8	47.30	3.60	79.3	6.22	6.20	0.9	40129	40664	2106	700.80	696.00	53.6
Houston, TX	226.94	228.19	11.1	644.20	645.80	34.3	2.90	2.30	2.8	6.14	6.20	0.5	65947	65048	2341	1084.00	1073.00	103.6
Jacksonville, FL	18.49	17.63	2.3	127.30	122.70	11.6	3.80	1.60	4.1	6.65	6.77	0.8	43861	42018	3202	817.20	813.50	45.5
Kalama, WA	11.22	11.12	1.4	110.00	110.90	7.9	1.10	1.10	0.7	4.78	4.76	0.8	31742	31928	1028	751.00	746.50	63.1
Long Beach, CA	80.38	80.24	4.5	65.00	64.40	3.4	2.80	2.20	2.7	8.48	8.68	0.4	59848	59389	1563	1006.50	1004.25	60.0
Longview, WA	8.56	6.85	3.7	112.70	111.00	9.4	1.10	1.10	0.7	4.78	4.76	0.8	31742	31928	1028	751.00	746.50	63.1
Los Angeles, CA	61.80	61.42	2.9	83.60	83.30	5.0	2.80	2.20	2.7	8.48	8.68	0.4	59848	59389	1563	1006.50	1004.25	60.0
Manatee, FL	3.04	3.09	0.7	95.50	91.90	10.3	1.60	1.00	1.5	4.18	4.08	0.3	35170	33346	3435	714.05	711.25	34.1

Seaport (port of)	*Cargo* (Short tons x 10^6)			*NCargo* (Short tons x 10^6)			*GSpend* (Ratio)			*HCapital* (%)			*iPCGDP* ($)			*iWages* ($)		
	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.
Milwaukee, WI	3.10	3.05	0.6	138.00	136.50	12.5	8.00	7.70	3.0	7.26	7.31	0.6	56278	56581	823	865.80	863.50	51.8
Mobile, AL	58.72	57.15	5.2	529.40	529.70	25.2	13.50	3.90	22.2	6.15	6.08	0.4	39119	39185	633	759.20	763.50	63.5
Monroe, MI	2.00	2.28	0.7	76.50	75.10	6.8	0.90	0.40	1.1	5.79	5.54	0.8	27230	27425	1582	814.10	807.50	33.4
N. York - N. Jersey	139.96	139.19	13.0	685.50	687.30	29.2	1.00	0.90	0.8	7.28	7.26	0.1	67340	67460	1330	1265.60	1279.00	76.3
New Orleans, LA	77.24	77.03	5.7	685.50	687.30	29.2	15.80	15.80	11.3	5.85	5.86	0.3	58066	57362	4796	863.70	877.50	63.1
Oakland, CA	18.04	18.15	0.9	31.20	30.70	2.5	3.60	4.10	2.0	8.23	8.21	0.4	77253	77063	2073	1310.50	1271.00	128.1
Olympia, WA	1.24	1.20	0.3	120.00	121.40	7.8	115.90	38.70	184.1	6.68	6.49	0.6	36531	36434	1644	796.50	810.50	53.9
Palm Beach, FL	2.34	2.33	0.4	90.80	86.80	9.9	1.40	1.50	0.8	7.09	7.29	0.6	47022	45876	2965	860.50	861.50	46.8
Panama City, FL	2.67	2.63	0.4	216.30	211.00	16.1	8.00	4.00	9.5	5.30	5.16	0.7	37805	38292	1947	669.40	677.00	27.9
Pascagoula, MS	33.79	34.49	3.9	554.30	553.20	29.9	47.30	3.60	79.3	6.22	6.20	0.9	40129	40664	2106	700.80	696.00	53.6
Pensacola, FL	0.91	0.87	0.2	530.90	527.60	25.7	9.00	4.30	11.1	7.22	7.43	0.5	31484	31070	1479	683.60	688.00	36.5
Philadelphia, PA	29.55	31.19	6.4	350.10	342.50	21.6	2.50	3.30	1.6	7.49	7.41	0.4	58121	58026	912	1013.10	1013.00	67.2
Portland, ME	16.68	15.67	6.2	197.10	192.70	19.1	3.10	1.60	2.6	5.99	5.97	0.3	49048	49018	439	775.80	777.50	51.8
Portland, OR	25.37	25.51	3.3	95.90	97.30	5.3	2.50	3.20	1.4	6.71	6.67	0.5	59365	60204	4659	898.70	888.50	70.3
Redwood City, CA	1.36	1.18	0.5	95.90	97.30	5.3	3.60	4.10	2.0	8.23	8.21	0.4	77253	77063	2073	1310.50	1271.00	128.1
Richmond, CA	25.14	25.18	1.7	22.60	22.40	1.7	3.60	4.10	2.0	8.23	8.21	0.4	77253	77063	2073	1310.50	1271.00	128.1
San Diego, CA	1.69	1.43	0.7	143.70	142.70	6.3	8.50	3.90	10.3	9.00	8.93	0.4	58749	59192	1662	969.80	961.50	78.8
San Francisco, CA	1.51	1.59	0.5	47.70	47.10	2.1	3.60	4.10	2.0	8.23	8.21	0.4	77253	77063	2073	1310.50	1271.00	128.1
Seattle, WA	25.00	25.39	2.6	96.30	97.60	6.5	4.90	4.60	4.1	6.76	6.83	0.4	72219	72827	2158	1071.00	1064.00	107.0
South Louisiana	239.10	237.42	17.2	110.00	110.90	7.9	15.80	15.80	11.3	5.85	5.86	0.3	58198	57362	4667	863.70	877.50	63.1
Stockton, CA	3.01	3.25	1.0	46.20	45.80	1.7	1.50	0.90	1.5	6.57	6.55	0.4	30396	29626	1376	752.60	761.50	40.5
Tacoma, WA	24.54	24.53	1.8	96.70	98.30	6.2	4.90	4.60	4.1	6.76	6.83	0.4	72219	72827	2158	1071.00	1064.00	107.0
Tampa, FL	36.84	35.04	5.6	96.10	94.40	5.7	3.70	2.00	3.8	6.31	6.38	0.6	40949	39951	2110	798.10	804.50	57.0
Toledo, OH	10.44	10.84	1.2	138.20	135.40	15.9	1.20	0.90	1.2	8.98	8.64	0.8	44636	44614	1662	763.70	762.00	43.7

	Cargo (Short tons x 10^6)			*NCargo* (Short tons x 10^6)			*GSpend* (Ratio)			*HCapital* (%)			*iPCGDP* ($)			*iWages* ($)		
Seaport (port of)	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.
Vancouver, WA	7.67	8.01	1.3	113.60	115.20	7.1	2.50	3.20	1.4	6.71	6.67	0.5	59365	60204	4659	898.70	888.50	70.3
Virginia	44.87	45.41	6.4	113.60	115.20	7.1	20.80	8.50	27.2	7.36	7.64	0.8	48507	48702	577	762.20	767.50	55.7
Wilmington, DE	5.55	5.37	1.3	379.00	369.60	27.6	2.50	3.30	1.6	7.49	7.41	0.4	58121	58026	912	1013.10	1013.00	67.2

C-3. *Stage 3 – Environmental impact dependent and primary independent variables*

	ΔOzone (%)			*O_3Mean* (ppm)			*Cargo* (Short tons x 10^6)		
Seaport (port of)	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.
Albany, NY	-0.58	-3.84	8.1	0.041	0.041	0.002	8.09	7.54	1.7
Anacortes, WA	1.91	-0.29	12	0.027	0.027	0.003	11.3	10.95	2.1
Ashtabula, OH	-1.14	-2.11	6.2	0.046	0.047	0.002	5.21	4.89	1.2
Baltimore, MD	0.12	-1.3	8.8	0.047	0.048	0.002	39.7	40.44	4.3
Boston, MA	-1.52	-0.8	4.7	0.038	0.039	0.002	19.05	18.75	2.2
Canaveral, FL	-0.7	-1.94	6.9	0.04	0.039	0.003	3.2	3.25	0.6
Cleveland, OH	0.15	-0.47	12.7	0.042	0.041	0.003	11.65	11.51	2.4
Conneaut, OH	-1.14	-2.11	6.2	0.046	0.047	0.002	4.61	4.66	1.1
Corpus Christie, TX	-0.06	-0.4	3.9	0.035	0.035	0.001	76.36	76.47	6.2
Detroit, MI	0.1	-1.67	8.4	0.044	0.044	0.002	13.46	13.35	2.1
Duluth, MN	-0.72	-1.03	4.7	0.036	0.036	0.002	38.26	36.54	5.9
Everett, WA	3	7.33	11.4	0.033	0.033	0.003	1.73	1.56	0.6
Galveston, TX	-0.04	-0.1	4.7	0.038	0.039	0.001	11.05	10.53	1.6
Gulfport, MS	-1.68	-2.42	4.6	0.045	0.045	0.002	1.96	1.99	0.2
Houston, TX	-1.41	-2.56	4.4	0.036	0.036	0.002	226.94	228.19	11.1
Jacksonville, FL	-0.43	-1.83	10.3	0.041	0.042	0.004	18.49	17.63	2.3
Kalama, WA	0.83	4.55	9.2	0.022	0.022	0.001	11.22	11.12	1.4
Long Beach, CA	1.43	1.9	3.4	0.043	0.043	0.002	80.38	80.24	4.5
Longview, WA	0.83	4.55	9.2	0.022	0.022	0.001	8.56	6.85	3.7
Los Angeles, CA	1.43	1.9	3.4	0.043	0.043	0.002	61.8	61.42	2.9
Milwaukee, WI	-0.76	-2.92	8	0.04	0.04	0.002	3.1	3.05	0.6
Mobile, AL	-1.48	-3.54	7.8	0.042	0.042	0.003	58.72	57.15	5.2
New Orleans, LA	0.05	-0.46	7.2	0.039	0.039	0.002	77.24	77.03	5.7

Seaport (port of)	*ΔOzone* (%)			*O₃Mean* (ppm)			*Cargo* (Short tons x 10^6)		
	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.
Oakland, CA	2.2	3.75	10.9	0.032	0.031	0.002	18.04	18.15	0.9
Palm Beach, FL	1.96	-2.14	17.4	0.036	0.036	0.003	2.34	2.33	0.4
Panama City, FL	-2.71	-4.7	5.7	0.043	0.042	0.004	2.67	2.63	0.4
Pascagoula, MS	-1.53	-1.39	5.5	0.044	0.045	0.002	33.79	34.49	3.9
Pensacola, FL	-2.24	-5.98	6.3	0.044	0.044	0.004	0.91	0.87	0.2
Philadelphia, PA	0.19	-0.28	8.9	0.042	0.043	0.002	29.55	31.19	6.4
Port Angeles, WA	0.63	0.31	6.5	0.033	0.033	0.001	0.95	0.76	0.4
Port Everglades, FL	0	-3.06	8.8	0.033	0.033	0.002	22.02	21.68	1.6
Port Freeport, TX	-1.27	-2.49	5.7	0.038	0.038	0.002	25.42	24.99	4.3
Port Manatee, FL	-0.47	-1.35	15.7	0.039	0.038	0.005	3.04	3.09	0.7
Port of NY-NJ	-0.23	-1.38	5.9	0.042	0.042	0.002	139.96	139.19	13
Port of Olympia	1.91	4.39	10	0.035	0.035	0.002	1.24	1.2	0.3
Portland, ME	-0.15	-1.4	6	0.039	0.038	0.002	16.68	15.67	6.2
Portland, OR	3.13	4.75	10.9	0.034	0.033	0.002	25.37	25.51	3.3
Redwood City, CA	1.02	1.02	5.3	0.03	0.03	0.001	1.36	1.18	0.5
Richmond, CA	1.1	0.26	6.1	0.035	0.035	0.001	25.14	25.18	1.7
San Diego, CA	0.49	-0.61	7.5	0.042	0.042	0.003	1.69	1.43	0.7
San Francisco, CA	0.28	0.6	5.8	0.028	0.028	0.001	1.51	1.59	0.5
Seattle, WA	3	7.33	11.4	0.033	0.033	0.003	25	25.39	2.6
South Louisiana	-1.44	-2.25	6.2	0.04	0.04	0.003	239.1	237.42	17.2
Stockton, CA	2.06	0.61	7.6	0.04	0.04	0.002	3.01	3.25	1.0
Tacoma, WA	3.16	8.33	12.7	0.036	0.036	0.003	24.54	24.53	1.8
Tampa, FL	-0.7	-0.77	4.9	0.042	0.041	0.002	36.84	35.04	5.6
Toledo, OH	-1.15	0.18	6.8	0.042	0.042	0.002	10.44	10.84	1.2
Vancouver, WA	2.58	5.38	10.8	0.035	0.036	0.003	7.67	8.01	1.3

Seaport (port of)	*ΔOzone* (%)			O_3*Mean* (ppm)			*Cargo* (Short tons x 10^6)		
	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.
Virginia	-0.42	-0.28	12.3	0.045	0.046	0.004	44.87	45.41	6.4
Wilmington, DE	-0.04	0.85	7.9	0.045	0.045	0.003	5.55	5.37	1.3

C-4. *Stage 3 – Environmental impact independent variables*

	Unemploy (%)			*Precip* (in)			*Wind* (mph)			*iOzone* (ppm)		
Seaport (port of)	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.
Albany, NY	5.56	5.45	1.3	43.16	42.83	5.3	7.20	7.00	0.4	0.04	0.04	0.002
Anacortes, WA	8.09	7.90	2.1	14.89	12.78	6.6	4.99	5.00	0.5	0.03	0.03	0.002
Ashtabula, OH	9.12	8.70	2.6	42.21	42.24	10.6	7.05	6.96	0.3	0.05	0.05	0.002
Baltimore, MD	6.09	6.50	1.7	46.30	44.24	7.4	6.46	6.30	0.8	0.05	0.05	0.002
Boston, MA	5.94	5.80	1.2	44.98	44.41	7.1	10.68	10.60	0.4	0.04	0.04	0.002
Canaveral, FL	7.76	7.65	2.8	45.94	46.20	7.9	6.95	6.90	0.2	0.04	0.04	0.002
Cleveland, OH	6.71	6.55	1.3	43.41	41.68	8.4	9.38	9.50	0.4	0.04	0.04	0.003
Conneaut, OH	9.12	8.70	2.6	42.21	42.24	10.6	7.03	6.90	0.4	0.05	0.05	0.002
Corpus Christie, TX	5.89	5.60	1.4	29.69	28.71	11.3	11.49	11.30	0.7	0.04	0.04	0.001
Detroit, MI	11.01	10.55	3.1	35.54	34.09	5.8	8.40	8.40	0.2	0.04	0.04	0.002
Duluth, MN	6.40	6.15	1.4	30.34	30.60	3.2	9.60	9.50	0.5	0.04	0.04	0.002
Everett, WA	6.48	5.45	2.6	34.26	32.72	5.6	6.81	6.80	0.5	0.03	0.03	0.002
Galveston, TX	6.64	6.20	1.7	52.48	52.23	14.7	7.52	7.50	0.4	0.04	0.04	0.001
Gulfport, MS	7.45	7.65	1.6	68.68	66.86	10.0	8.50	8.50	0.5	0.05	0.05	0.002
Houston, TX	5.98	5.50	1.5	52.48	52.23	14.7	7.52	7.50	0.4	0.04	0.04	0.002
Jacksonville, FL	7.50	7.10	2.7	48.07	47.00	8.4	6.47	6.30	0.6	0.04	0.04	0.004
Kalama, WA	0.08	0.08	0.0	37.40	38.63	8.1	6.81	6.70	0.7	0.02	0.02	0.001
Long Beach, CA	8.93	9.00	2.9	9.37	8.03	6.2	4.66	4.60	0.2	0.04	0.04	0.002
Longview, WA	0.07	0.07	0.0	37.40	38.63	8.1	6.81	6.70	0.7	0.02	0.02	0.001
Los Angeles, CA	8.93	9.00	2.9	9.37	8.03	6.2	4.66	4.60	0.2	0.04	0.04	0.002
Milwaukee, WI	7.56	7.65	1.8	35.44	34.47	4.5	9.07	8.90	0.3	0.04	0.04	0.002
Mobile, AL	7.98	8.15	2.8	56.93	59.97	13.2	6.82	6.70	0.2	0.04	0.04	0.003
New Orleans, LA	7.21	7.26	1.1	60.20	54.70	10.5	7.96	8.10	0.3	0.04	0.04	0.002

Seaport (port of)	*Unemploy* (%) Mean	Med.	Std. Dev.	*Precip* (in) Mean	Med.	Std. Dev.	*Wind* (mph) Mean	Med.	Std. Dev.	*iOzone* (ppm) Mean	Med.	Std. Dev.
Oakland, CA	7.30	6.70	2.5	15.63	15.37	6.6	7.96	7.90	0.3	0.03	0.03	0.002
Palm Beach, FL	7.32	6.95	2.6	59.34	59.17	8.8	9.10	9.20	0.3	0.04	0.04	0.003
Panama City, FL	6.99	6.80	2.6	49.51	50.06	9.8	6.31	6.50	0.4	0.04	0.04	0.004
Pascagoula, MS	8.05	8.15	1.6	59.66	59.57	10.4	4.73	4.72	0.4	0.05	0.05	0.002
Pensacola, FL	7.07	6.85	2.4	66.00	64.83	14.4	7.61	7.60	0.3	0.05	0.05	0.004
Philadelphia, PA	8.68	8.90	2.0	47.86	47.33	8.2	8.98	8.90	0.4	0.04	0.04	0.002
Port Angeles, WA	8.93	9.05	1.7	25.22	23.58	9.8	5.24	5.10	0.3	0.03	0.03	0.001
Port Everglades, FL	6.68	6.35	2.4	54.99	54.59	10.4	9.11	9.05	0.5	0.03	0.03	0.002
Port Freeport, TX	6.16	5.60	1.6	40.61	39.22	11.6	6.64	6.55	0.6	0.04	0.04	0.002
Port Manatee, FL	7.30	6.95	3.0	42.19	42.58	7.5	7.91	7.80	0.3	0.04	0.04	0.005
Port of NY-NJ	6.48	6.80	1.8	48.26	48.39	9.4	9.36	9.30	0.5	0.04	0.04	0.002
Port of Olympia	6.97	7.05	1.6	41.27	42.92	11.5	5.65	5.80	0.4	0.04	0.04	0.002
Portland, ME	4.90	4.75	1.3	53.02	53.53	6.5	7.32	7.40	0.3	0.04	0.04	0.002
Portland, OR	6.96	6.35	2.0	37.40	38.63	8.1	6.81	6.70	0.7	0.03	0.03	0.002
Redwood City, CA	5.58	5.10	1.9	15.83	16.62	6.5	9.99	9.95	0.4	0.03	0.03	0.001
Richmond, CA	7.41	6.85	2.5	13.64	13.82	5.3	6.91	6.70	0.4	0.04	0.03	0.001
San Diego, CA	7.36	7.10	2.5	8.25	7.22	3.5	5.49	5.40	0.3	0.04	0.04	0.002
San Francisco, CA	5.97	5.40	2.0	15.83	16.62	6.5	9.99	9.95	0.4	0.03	0.03	0.001
Seattle, WA	5.60	4.85	2.1	41.44	41.93	6.8	7.50	7.60	0.4	0.03	0.03	0.002
South Louisiana	8.26	8.43	1.8	60.20	54.70	10.5	7.96	8.10	0.3	0.04	0.04	0.002
Stockton, CA	11.96	11.40	3.4	11.15	10.30	4.2	7.04	7.20	0.3	0.04	0.04	0.002
Tacoma, WA	7.84	7.70	2.0	41.44	41.93	6.8	7.50	7.60	0.4	0.04	0.03	0.003
Tampa, FL	7.02	6.55	2.6	51.19	52.88	7.8	6.44	6.40	0.3	0.04	0.04	0.002
Toledo, OH	8.38	8.25	2.3	38.16	36.93	5.8	7.87	7.80	0.2	0.04	0.04	0.002
Vancouver, WA	8.94	8.00	2.8	37.40	38.63	8.1	6.81	6.70	0.7	0.04	0.04	0.002

	Unemploy (%)			*Precip* (in)			*Wind* (mph)			*iOzone* (ppm)		
Seaport (port of)	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.
Virginia	6.59	6.70	1.7	48.92	49.72	7.6	8.74	8.70	0.3	0.05	0.05	0.004
Wilmington, DE	5.98	6.00	1.8	46.88	48.57	6.1	8.34	8.50	0.4	0.05	0.05	0.003

C-5. *Stage 4 – Financial sustainability ratio variables (A through C)*

	Acc. dep. to fixed assets			*Capital asset condition*			*Cash*			*Charge to expense*		
Seaport (port of)	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.
Anacortes, WA	5.56	5.45	1.3	43.16	42.83	5.3	7.20	7.00	0.4	0.04	0.04	0.002
Anchorage, AK	8.09	7.90	2.1	14.89	12.78	6.6	4.99	5.00	0.5	0.03	0.03	0.002
Boston, MA	9.12	8.70	2.6	42.21	42.24	10.6	7.05	6.96	0.3	0.05	0.05	0.002
Cleveland, OH	6.09	6.50	1.7	46.30	44.24	7.4	6.46	6.30	0.8	0.05	0.05	0.002
Conneaut, OH	5.94	5.80	1.2	44.98	44.41	7.1	10.68	10.60	0.4	0.04	0.04	0.002
Corpus Christi, TX	7.76	7.65	2.8	45.94	46.20	7.9	6.95	6.90	0.2	0.04	0.04	0.002
Duluth, MN	6.71	6.55	1.3	43.41	41.68	8.4	9.38	9.50	0.4	0.04	0.04	0.003
Everett, WA	9.12	8.70	2.6	42.21	42.24	10.6	7.03	6.90	0.4	0.05	0.05	0.002
Freeport, TX	5.89	5.60	1.4	29.69	28.71	11.3	11.49	11.30	0.7	0.04	0.04	0.001
Galveston, TX	11.01	10.55	3.1	35.54	34.09	5.8	8.40	8.40	0.2	0.04	0.04	0.002
Grays Harbor, WA	6.40	6.15	1.4	30.34	30.60	3.2	9.60	9.50	0.5	0.04	0.04	0.002
Gulfport, MS	6.48	5.45	2.6	34.26	32.72	5.6	6.81	6.80	0.5	0.03	0.03	0.002
Houston, TX	6.64	6.20	1.7	52.48	52.23	14.7	7.52	7.50	0.4	0.04	0.04	0.001
Jacksonville, FL	7.45	7.65	1.6	68.68	66.86	10.0	8.50	8.50	0.5	0.05	0.05	0.002
Kalama, WA	5.98	5.50	1.5	52.48	52.23	14.7	7.52	7.50	0.4	0.04	0.04	0.002
Long Beach, CA	7.50	7.10	2.7	48.07	47.00	8.4	6.47	6.30	0.6	0.04	0.04	0.004
Longview, WA	0.08	0.08	0.0	37.40	38.63	8.1	6.81	6.70	0.7	0.02	0.02	0.001
Los Angeles, CA	8.93	9.00	2.9	9.37	8.03	6.2	4.66	4.60	0.2	0.04	0.04	0.002
Monroe, MI	0.07	0.07	0.0	37.40	38.63	8.1	6.81	6.70	0.7	0.02	0.02	0.001
N. York - N. Jersey	8.93	9.00	2.9	9.37	8.03	6.2	4.66	4.60	0.2	0.04	0.04	0.002
New Orleans, LA	7.56	7.65	1.8	35.44	34.47	4.5	9.07	8.90	0.3	0.04	0.04	0.002
Oakland, CA	7.98	8.15	2.8	56.93	59.97	13.2	6.82	6.70	0.2	0.04	0.04	0.003
Olympia, WA	7.21	7.26	1.1	60.20	54.70	10.5	7.96	8.10	0.3	0.04	0.04	0.002

	Acc. dep. to fixed assets			*Capital asset condition*			*Cash*			*Charge to expense*		
Seaport (port of)	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.
Palm Beach, FL	7.30	6.70	2.5	15.63	15.37	6.6	7.96	7.90	0.3	0.03	0.03	0.002
Panama City, FL	7.32	6.95	2.6	59.34	59.17	8.8	9.10	9.20	0.3	0.04	0.04	0.003
Philadelphia, PA	6.99	6.80	2.6	49.51	50.06	9.8	6.31	6.50	0.4	0.04	0.04	0.004
Port Angeles, WA	8.05	8.15	1.6	59.66	59.57	10.4	4.73	4.72	0.4	0.05	0.05	0.002
Port Canaveral, FL	7.07	6.85	2.4	66.00	64.83	14.4	7.61	7.60	0.3	0.05	0.05	0.004
Port Everglades, FL	8.68	8.90	2.0	47.86	47.33	8.2	8.98	8.90	0.4	0.04	0.04	0.002
Port Manatee, FL	8.93	9.05	1.7	25.22	23.58	9.8	5.24	5.10	0.3	0.03	0.03	0.001
Portland, OR	6.68	6.35	2.4	54.99	54.59	10.4	9.11	9.05	0.5	0.03	0.03	0.002
Redwood City, CA	6.16	5.60	1.6	40.61	39.22	11.6	6.64	6.55	0.6	0.04	0.04	0.002
San Diego, CA	7.30	6.95	3.0	42.19	42.58	7.5	7.91	7.80	0.3	0.04	0.04	0.005
San Francisco, CA	6.48	6.80	1.8	48.26	48.39	9.4	9.36	9.30	0.5	0.04	0.04	0.002
Seattle, WA	6.97	7.05	1.6	41.27	42.92	11.5	5.65	5.80	0.4	0.04	0.04	0.002
South Louisiana	4.90	4.75	1.3	53.02	53.53	6.5	7.32	7.40	0.3	0.04	0.04	0.002
Stockton, CA	6.96	6.35	2.0	37.40	38.63	8.1	6.81	6.70	0.7	0.03	0.03	0.002
Tacoma, WA	5.58	5.10	1.9	15.83	16.62	6.5	9.99	9.95	0.4	0.03	0.03	0.001
Tampa, FL	7.41	6.85	2.5	13.64	13.82	5.3	6.91	6.70	0.4	0.04	0.03	0.001
Toledo, OH	7.36	7.10	2.5	8.25	7.22	3.5	5.49	5.40	0.3	0.04	0.04	0.002
Vancouver, WA	5.97	5.40	2.0	15.83	16.62	6.5	9.99	9.95	0.4	0.03	0.03	0.001
Virginia	5.60	4.85	2.1	41.44	41.93	6.8	7.50	7.60	0.4	0.03	0.03	0.002
Wilmington, DE	8.26	8.43	1.8	60.20	54.70	10.5	7.96	8.10	0.3	0.04	0.04	0.002

C-6. *Stage 4 – Financial sustainability ratio variables (D through F)*

	Debt			*Debt to asset*			*Debt to equity*			*Fixed Asset Turnover*		
Seaport (port of)	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.
Anacortes, WA	0.42	0.42	0.09	0.30	0.29	0.06	0.77	0.72	0.30	0.35	0.35	0.07
Anchorage, AK	0.16	0.18	0.09	0.07	0.00	0.11	0.20	0.22	0.11	0.14	0.17	0.05
Boston, MA	0.54	0.53	0.02	0.45	0.44	0.03	1.17	1.11	0.11	0.21	0.21	0.01
Cleveland, OH	0.26	0.27	0.04	0.20	0.20	0.03	0.36	0.37	0.07	0.16	0.12	0.08
Conneaut, OH	0.20	0.19	0.07	0.13	0.13	0.07	0.26	0.23	0.11	0.28	0.28	0.04
Corpus Christi, TX	0.10	0.09	0.05	0.08	0.07	0.05	0.12	0.10	0.07	0.22	0.21	0.05
Duluth, MN	0.09	0.09	0.02	0.07	0.07	0.02	0.10	0.10	0.03	0.18	0.17	0.02
Everett, WA	0.20	0.21	0.04	0.17	0.17	0.04	0.26	0.26	0.07	0.19	0.18	0.03
Freeport, TX	0.23	0.25	0.06	0.17	0.18	0.06	0.31	0.33	0.10	0.08	0.08	0.01
Galveston, TX	0.43	0.45	0.09	0.36	0.38	0.07	0.79	0.81	0.28	0.23	0.22	0.03
Grays Harbor, WA	0.19	0.18	0.03	0.15	0.13	0.04	0.23	0.22	0.05	0.21	0.21	0.06
Gulfport, MS	0.12	0.11	0.04	0.09	0.08	0.05	0.14	0.13	0.06	0.07	0.07	0.02
Houston, TX	0.43	0.43	0.04	0.37	0.39	0.07	0.78	0.77	0.12	0.16	0.17	0.02
Jacksonville, FL	0.51	0.55	0.10	0.45	0.49	0.09	1.10	1.22	0.32	0.09	0.09	0.01
Kalama, WA	0.06	0.06	0.03	0.04	0.03	0.03	0.06	0.06	0.03	0.22	0.23	0.06
Long Beach, CA	0.29	0.27	0.06	0.24	0.23	0.06	0.41	0.37	0.12	0.13	0.14	0.03
Longview, WA	0.31	0.33	0.04	0.26	0.28	0.04	0.46	0.49	0.08	0.30	0.30	0.05
Los Angeles, CA	0.31	0.31	0.02	0.25	0.26	0.02	0.45	0.45	0.03	0.13	0.13	0.02
Monroe, MI	0.27	0.26	0.06	0.18	0.20	0.05	0.39	0.36	0.11	0.03	0.03	0.01
N. York - N. Jersey	0.64	0.65	0.02	0.55	0.55	0.03	1.76	1.82	0.14	0.18	0.17	0.03
New Orleans, LA	0.22	0.23	0.01	0.19	0.20	0.01	0.28	0.29	0.02	0.08	0.08	0.01
Oakland, CA	0.64	0.65	0.03	0.59	0.60	0.04	1.81	1.87	0.26	0.13	0.13	0.01
Olympia, WA	0.34	0.34	0.04	0.29	0.29	0.03	0.53	0.51	0.09	0.09	0.09	0.02

Seaport (port of)	*Debt*			*Debt to asset*			*Debt to equity*			*Fixed Asset Turnover*		
	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.
Palm Beach, FL	0.34	0.35	0.03	0.30	0.32	0.04	0.52	0.55	0.06	0.11	0.11	0.02
Panama City, FL	0.15	0.15	0.02	0.14	0.14	0.02	0.18	0.18	0.03	0.16	0.16	0.02
Philadelphia, PA	0.28	0.21	0.19	0.21	0.13	0.16	0.50	0.28	0.47	0.04	0.03	0.02
Port Angeles, WA	0.18	0.18	0.02	0.14	0.14	0.02	0.22	0.22	0.03	0.15	0.15	0.03
Port Canaveral, FL	0.33	0.31	0.05	0.28	0.27	0.04	0.51	0.46	0.13	0.20	0.20	0.03
Port Everglades, FL	0.37	0.37	0.04	0.30	0.31	0.03	0.58	0.60	0.10	0.23	0.23	0.02
Port Manatee, FL	0.39	0.40	0.03	0.34	0.33	0.03	0.65	0.68	0.09	0.09	0.09	0.02
Portland, OR	0.35	0.35	0.02	0.30	0.30	0.01	0.54	0.53	0.04	0.23	0.22	0.05
Redwood City, CA	0.32	0.31	0.05	0.26	0.25	0.06	0.47	0.45	0.12	0.25	0.24	0.08
San Diego, CA	0.23	0.22	0.02	0.18	0.18	0.02	0.30	0.28	0.04	0.28	0.27	0.02
San Francisco, CA	0.24	0.25	0.09	0.18	0.19	0.08	0.33	0.34	0.17	0.23	0.23	0.02
Seattle, WA	0.57	0.57	0.03	0.50	0.50	0.02	1.31	1.31	0.16	0.09	0.09	0.01
South Louisiana	0.30	0.36	0.17	0.27	0.33	0.16	0.51	0.63	0.34	0.14	0.13	0.02
Stockton, CA	0.42	0.46	0.08	0.35	0.38	0.08	0.75	0.85	0.22	0.28	0.28	0.03
Tacoma, WA	0.63	0.65	0.05	0.56	0.58	0.06	1.77	1.83	0.31	0.12	0.11	0.02
Tampa, FL	0.26	0.26	0.05	0.23	0.24	0.05	0.36	0.36	0.09	0.09	0.09	0.01
Toledo, OH	0.19	0.20	0.04	0.15	0.16	0.04	0.23	0.25	0.06	0.06	0.06	0.01
Vancouver, WA	0.41	0.41	0.09	0.36	0.37	0.08	0.73	0.70	0.30	0.13	0.12	0.04
Virginia	0.58	0.58	0.01	0.51	0.51	0.01	1.39	1.39	0.03	0.37	0.36	0.09
Wilmington, DE	0.20	0.19	0.04	0.17	0.16	0.04	0.26	0.24	0.07	0.23	0.22	0.03

C-7. *Stage 4 – Financial sustainability ratio variables (N through P)*

	Net assets			*Net profit margin*			*Operating cash flow*			*Pct. change in net assets*		
Seaport (port of)	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.
Anacortes, WA	0.12	0.14	0.20	0.25	0.32	0.38	0.34	0.30	0.29	0.02	0.04	0.14
Anchorage, AK	4.48	0.35	10.22	0.45	0.48	2.77	3.36	0.14	7.28	0.05	0.17	0.18
Boston, MA	0.07	0.07	0.01	0.13	0.13	0.03	0.63	0.63	0.09	0.04	0.21	0.01
Cleveland, OH	0.61	0.61	0.13	0.34	0.31	0.34	-0.24	-0.24	0.39	0.03	0.12	0.04
Conneaut, OH	-0.11	-0.13	0.30	-0.04	-0.09	0.17	0.89	0.89	0.45	-0.02	0.28	0.06
Corpus Christi, TX	2.44	1.10	2.51	0.47	0.33	0.64	2.35	1.96	1.33	0.10	0.21	0.14
Duluth, MN	3.17	3.27	0.88	0.36	0.36	0.17	3.71	3.51	2.38	0.05	0.17	0.03
Everett, WA	0.31	0.26	0.22	0.15	0.10	0.18	0.80	0.78	0.32	0.01	0.18	0.03
Freeport, TX	0.88	0.65	0.51	0.59	0.50	0.29	1.08	0.51	1.57	0.05	0.08	0.02
Galveston, TX	0.20	0.21	0.08	0.34	0.35	0.30	0.61	0.68	0.27	0.10	0.22	0.09
Grays Harbor, WA	0.54	0.50	0.22	0.31	0.12	0.65	0.40	0.41	0.61	0.11	0.21	0.25
Gulfport, MS	2.89	2.91	0.58	2.08	2.14	1.13	0.12	-0.02	0.48	0.11	0.07	0.05
Houston, TX	0.33	0.31	0.08	0.22	0.24	0.10	1.09	1.25	0.69	0.05	0.17	0.03
Jacksonville, FL	0.07	0.06	0.04	0.21	0.19	0.19	0.62	0.61	0.23	0.02	0.09	0.04
Kalama, WA	8.05	7.20	4.17	0.89	0.52	1.29	2.89	2.94	1.02	0.11	0.23	0.18
Long Beach, CA	0.50	0.55	0.17	0.53	0.43	0.22	1.36	1.34	0.32	0.07	0.14	0.02
Longview, WA	0.43	0.43	0.08	0.13	0.14	0.07	0.86	0.64	0.59	0.05	0.30	0.03
Los Angeles, CA	0.25	0.24	0.10	0.29	0.29	0.07	0.98	0.99	0.15	0.04	0.13	0.02
Monroe, MI	-0.49	-0.57	0.17	0.82	0.91	3.87	-1.01	-0.59	1.36	0.06	0.03	0.16
N. York - N. Jersey	0.11	0.11	0.03	0.23	0.24	0.08	0.44	0.51	0.26	0.08	0.17	0.04
New Orleans, LA	0.34	0.36	0.11	0.30	0.24	0.29	0.42	0.45	0.16	0.02	0.08	0.03
Oakland, CA	0.02	0.02	0.02	0.58	0.14	1.06	1.55	1.21	0.67	0.04	0.13	0.04
Olympia, WA	0.16	0.15	0.17	0.35	0.54	0.66	0.12	0.21	0.32	0.06	0.09	0.08

Seaport (port of)	Net assets Mean	Net assets Med.	Net assets Std. Dev.	Net profit margin Mean	Net profit margin Med.	Net profit margin Std. Dev.	Operating cash flow Mean	Operating cash flow Med.	Operating cash flow Std. Dev.	Pct. change in net assets Mean	Pct. change in net assets Med.	Pct. change in net assets Std. Dev.
Palm Beach, FL	0.16	0.16	0.02	0.21	0.19	0.27	0.97	1.04	0.21	0.02	0.11	0.06
Panama City, FL	0.45	0.47	0.18	0.35	0.30	0.16	0.71	0.36	1.02	0.06	0.16	0.03
Philadelphia, PA	0.01	0.00	0.04	4.86	3.98	3.33	-0.44	-0.48	0.25	0.32	0.03	0.25
Port Angeles, WA	1.49	1.56	0.21	0.36	0.23	0.47	0.34	0.50	0.57	0.04	0.15	0.06
Port Canaveral, FL	0.29	0.34	0.13	0.28	0.31	0.10	1.52	1.57	0.43	0.07	0.20	0.03
Port Everglades, FL	0.64	0.62	0.12	0.20	0.19	0.06	1.01	0.91	0.40	0.05	0.23	0.01
Port Manatee, FL	0.07	0.05	0.11	0.28	0.20	0.26	0.80	0.51	0.71	0.04	0.09	0.04
Portland, OR	0.30	0.32	0.07	0.07	0.05	0.10	0.11	0.05	0.26	0.01	0.22	0.03
Redwood City, CA	0.83	0.85	0.29	0.46	0.50	0.12	1.38	1.38	0.39	0.02	0.24	0.11
San Diego, CA	0.49	0.51	0.24	0.06	0.04	0.12	0.86	0.89	0.20	0.01	0.27	0.04
San Francisco, CA	0.54	0.35	0.40	0.19	0.20	0.09	0.83	0.75	0.39	0.03	0.23	0.05
Seattle, WA	0.11	0.11	0.03	0.24	0.23	0.14	0.55	0.56	0.12	0.04	0.09	0.03
South Louisiana	0.67	0.50	0.61	0.43	0.37	0.38	0.69	0.66	0.35	0.02	0.13	0.14
Stockton, CA	0.06	0.04	0.05	0.19	0.12	0.24	0.65	0.63	0.20	0.08	0.28	0.10
Tacoma, WA	0.16	0.16	0.08	0.09	0.16	0.15	0.64	0.62	0.23	0.02	0.11	0.03
Tampa, FL	0.34	0.34	0.14	0.52	0.52	0.11	1.16	1.15	0.18	0.05	0.09	0.01
Toledo, OH	0.43	0.38	0.11	0.64	0.50	0.75	0.41	0.43	0.25	0.04	0.06	0.05
Vancouver, WA	0.12	0.09	0.15	0.52	0.47	0.53	0.79	0.94	1.17	0.09	0.12	0.09
Virginia	0.13	0.12	0.05	0.03	0.02	0.08	0.39	0.35	0.14	0.04	0.36	0.06
Wilmington, DE	0.10	0.10	0.03	0.20	0.17	0.19	0.59	0.65	0.15	0.05	0.22	0.05

C-8. *Stage 4 – Financial sustainability ratio variables (Q through T)*

	Quick			*Return on assets*			*Return on net assets*			*Total asset turnover*		
Seaport (port of)	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.
Anacortes, WA	2.29	2.28	0.95	0.03	0.05	0.06	0.06	0.08	0.12	0.17	0.15	0.04
Anchorage, AK	12.13	5.86	14.84	0.02	0.04	0.14	0.19	0.07	0.36	0.06	0.05	0.02
Boston, MA	1.55	1.51	0.25	0.02	0.02	0.01	0.02	0.03	0.01	0.16	0.16	0.01
Cleveland, OH	4.67	3.48	2.63	0.03	0.03	0.03	0.03	0.03	0.03	0.10	0.08	0.05
Conneaut, OH	1.25	1.28	0.65	-0.01	-0.03	0.04	-0.01	-0.03	0.04	0.25	0.25	0.03
Corpus Christi, TX	7.98	5.20	5.78	0.07	0.05	0.09	0.07	0.05	0.09	0.16	0.16	0.02
Duluth, MN	17.02	18.37	7.41	0.04	0.05	0.02	0.05	0.05	0.03	0.12	0.11	0.02
Everett, WA	3.70	3.67	0.99	0.01	0.01	0.02	0.03	0.01	0.03	0.10	0.09	0.02
Freeport, TX	4.12	3.72	1.02	0.04	0.03	0.02	0.04	0.03	0.02	0.06	0.06	0.00
Galveston, TX	4.14	4.07	0.97	0.05	0.05	0.04	0.06	0.06	0.05	0.15	0.14	0.02
Grays Harbor, WA	4.37	4.56	0.58	0.06	0.02	0.12	0.06	0.02	0.12	0.17	0.17	0.05
Gulfport, MS	9.66	9.85	4.37	0.09	0.09	0.04	0.10	0.10	0.04	0.05	0.05	0.01
Houston, TX	4.53	4.73	2.34	0.03	0.03	0.01	0.03	0.03	0.02	0.12	0.13	0.01
Jacksonville, FL	1.37	1.26	0.41	0.02	0.02	0.01	0.02	0.02	0.02	0.08	0.08	0.01
Kalama, WA	20.10	20.93	5.25	0.09	0.07	0.11	0.09	0.07	0.11	0.10	0.10	0.02
Long Beach, CA	3.95	3.79	1.28	0.05	0.05	0.02	0.05	0.05	0.02	0.09	0.09	0.01
Longview, WA	2.72	2.94	0.89	0.03	0.04	0.02	0.04	0.04	0.02	0.25	0.25	0.04
Los Angeles, CA	2.59	2.72	0.48	0.03	0.03	0.01	0.03	0.03	0.01	0.11	0.11	0.01
Monroe, MI	1.79	1.00	2.03	0.02	0.03	0.09	0.04	0.04	0.11	0.03	0.03	0.00
N. York - N. Jersey	1.28	1.20	0.25	0.03	0.03	0.01	0.04	0.04	0.02	0.12	0.12	0.01
New Orleans, LA	4.87	5.06	1.35	0.02	0.02	0.02	0.02	0.02	0.02	0.07	0.06	0.01
Oakland, CA	2.12	2.18	0.63	0.07	0.02	0.13	0.08	0.02	0.14	0.11	0.11	0.01
Olympia, WA	2.69	2.74	1.03	0.03	0.04	0.05	0.03	0.05	0.05	0.08	0.08	0.01

	Quick			*Return on assets*			*Return on net assets*			*Total asset turnover*		
Seaport (port of)	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.	Mean	Med.	Std. Dev.
Palm Beach, FL	4.28	4.58	0.96	0.02	0.02	0.03	0.02	0.02	0.03	0.10	0.09	0.01
Panama City, FL	6.68	7.14	3.17	0.05	0.04	0.02	0.05	0.04	0.02	0.14	0.14	0.01
Philadelphia, PA	0.56	0.49	0.18	0.14	0.12	0.09	0.18	0.13	0.13	0.03	0.03	0.01
Port Angeles, WA	4.02	4.04	1.35	0.04	0.03	0.04	0.04	0.03	0.05	0.11	0.11	0.02
Port Canaveral, FL	3.60	3.50	1.90	0.05	0.05	0.02	0.05	0.05	0.02	0.16	0.16	0.02
Port Everglades, FL	3.85	3.53	1.09	0.03	0.03	0.01	0.04	0.03	0.01	0.16	0.16	0.01
Port Manatee, FL	3.10	2.07	2.24	0.02	0.02	0.02	0.02	0.02	0.02	0.08	0.08	0.01
Portland, OR	6.10	6.00	0.63	0.01	0.01	0.01	0.01	0.01	0.02	0.11	0.11	0.02
Redwood City, CA	8.80	9.14	3.25	0.06	0.06	0.02	0.07	0.06	0.02	0.13	0.13	0.02
San Diego, CA	4.89	5.16	1.01	0.01	0.01	0.02	0.01	0.01	0.03	0.20	0.20	0.01
San Francisco, CA	5.96	6.27	1.73	0.03	0.03	0.02	0.03	0.03	0.02	0.16	0.17	0.01
Seattle, WA	0.93	0.89	0.20	0.02	0.02	0.01	0.02	0.02	0.01	0.08	0.08	0.01
South Louisiana	5.73	5.40	2.74	0.04	0.03	0.04	0.05	0.05	0.04	0.09	0.09	0.02
Stockton, CA	1.28	1.20	0.33	0.04	0.02	0.05	0.05	0.03	0.06	0.22	0.21	0.02
Tacoma, WA	2.07	2.23	0.79	0.01	0.02	0.01	0.01	0.02	0.01	0.09	0.10	0.01
Tampa, FL	5.74	5.83	1.26	0.04	0.04	0.01	0.04	0.04	0.01	0.07	0.07	0.00
Toledo, OH	2.96	2.91	0.56	0.03	0.02	0.03	0.04	0.03	0.04	0.05	0.05	0.01
Vancouver, WA	3.82	2.24	3.07	0.05	0.05	0.05	0.06	0.05	0.05	0.11	0.10	0.04
Virginia	2.30	2.29	0.49	0.01	0.01	0.02	0.01	0.01	0.03	0.28	0.26	0.06
Wilmington, DE	1.21	1.16	0.26	0.03	0.03	0.03	0.04	0.04	0.04	0.17	0.17	0.01

APPENDIX D:

ROBUSTNESS CALCULATIONS

This appendix illustrates the calculations used to determine the degrees of robustness of the *Cargo* variable during robustness checks. These calculations are conducted using the mathematical definition in Equation 4.2 to calculate what percentage of each robustness model's PDF falls within its baseline estimate's 95-percent confidence interval.

$$\rho(Cargo) \equiv \frac{1}{\sigma_r\sqrt{2\pi}}\int_{\beta_b - C\sigma_b}^{\beta_b + C\sigma_b}\left(e^{-\frac{(X_r-\beta_r)^2}{C\sigma_r^2}}\right)dx \tag{4.2}$$

In Equation 4.2, the subtexts *b* and *r* signify baseline and robustness models, respectively, β represents the point estimate of interest, σ is the standard error of the estimate, and $C\sigma_b$ describes the margin of error around the point estimate (β) of the baseline model. Using the definition above, ρ*(Cargo)* is found by calculating the area under the robustness curve that falls within the 95-percent confidence interval of the baseline curve. The following figures and tables illustrate how ρ*(Cargo)* was calculated.

LIST OF ROBUSTNESS MODELS

Page

Model 1.a ρ_{Cargo} Measurement – *NCargo* Variable Omitted

Figure D-1. *Model 1.a Cargo variable degree of robustness*

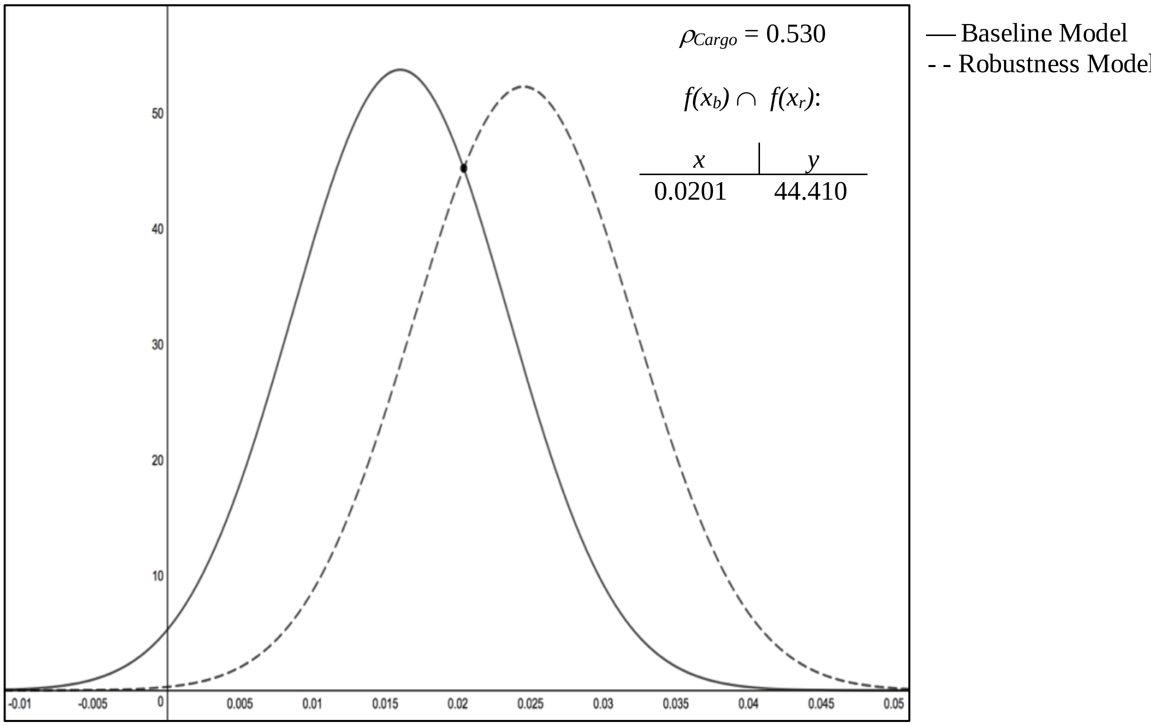


Table D-1. *Model 1.a degree of robustness calculation*

	Cargo Coefficient	Parametric Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0156	0.0075	0.0010	0.0303
Robustness Model	0.0245	0.0076	0.0095	0.0395

$$\rho_{Cargo} = \int_{0.0201}^{0.0303} \left(\frac{1}{0.0075\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0156)^2}{2(0.0075)^2}}\right) dx + \int_{0.0010}^{0.0201} \left(\frac{1}{0.0076\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0245)^2}{2(0.0076)^2}}\right) dx$$

$$\rho_{Cargo_b} = \int_{0.0201}^{0.0303} \left(\frac{1}{0.0075\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0156)^2}{2(0.0075)^2}}\right) dx = 0.2493$$

$$\rho_{Cargo_r} = \int_{0.0014463}^{0.02042} \left(\frac{1}{0.0076376\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0245335)^2}{2(0.0076376)^2}}\right) dx = 0.2803$$

$\rho_{Cargo} =$ 0.2493 + 0.2803 = 0.5296

Model 1.b ρ_{Cargo} Measurement – *GSpend* Variable Omitted

Figure D-2. *Model 1.b Cargo variable degree of robustness*

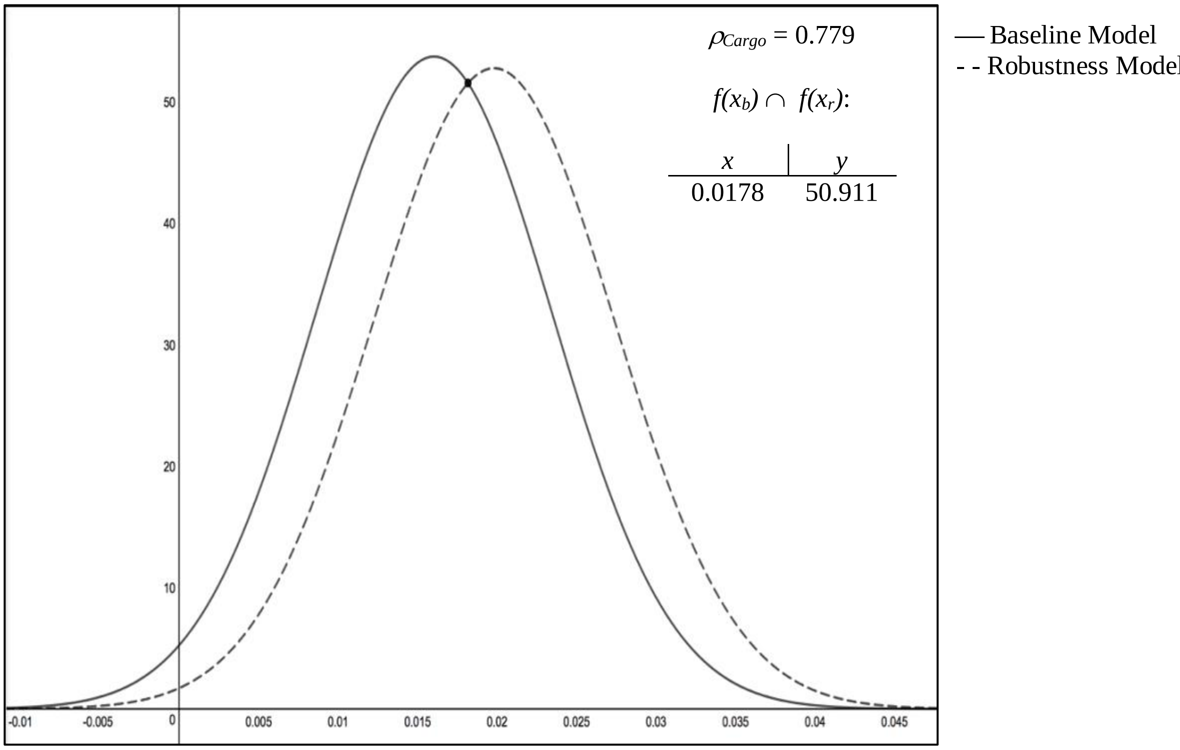


Table D-2. *Model 1.b degree of robustness calculation*

	Cargo Coefficient	Parametric Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0156	0.0075	0.0010	0.0303
Robustness Model	0.0153	0.0074	0.0008	0.0298

$$\rho_{Cargo} = \int_{0.0178}^{0.0303} \left(\frac{1}{0.0075\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0156)^2}{2(0.0075)^2}}\right) dx + \int_{0.0010}^{0.0178} \left(\frac{1}{0.0074\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0153)^2}{2(0.0074)^2}}\right) dx$$

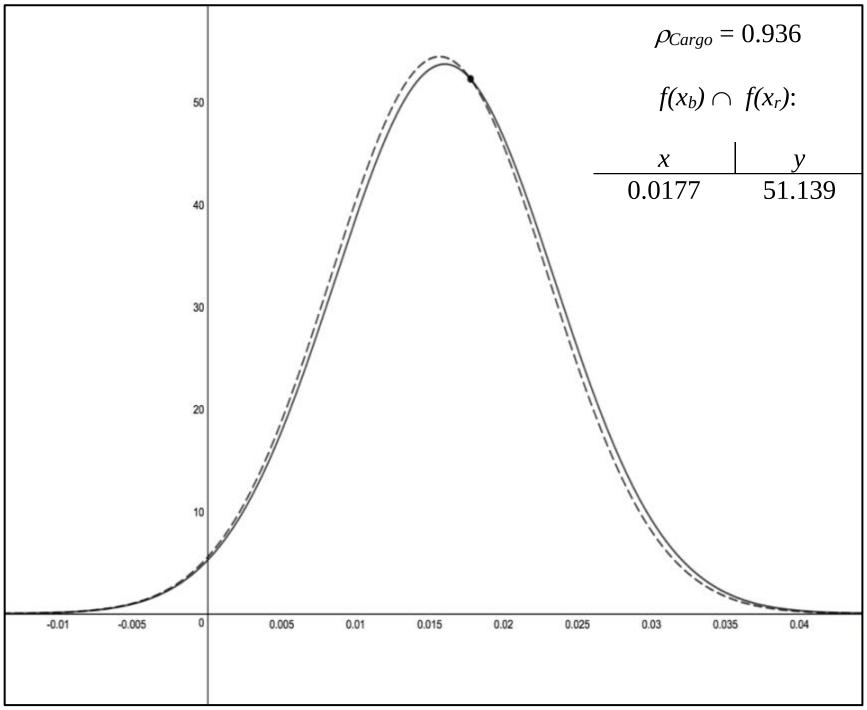
$$\rho_{Cargo_b} = \int_{0.0178}^{0.0303} \left(\frac{1}{0.0075\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0156)^2}{2(0.0075)^2}}\right) dx = 0.3846$$

$$\rho_{Cargo_r} = \int_{0.0010}^{0.0178} \left(\frac{1}{0.0076\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0197)^2}{2(0.0076)^2}}\right) dx = 0.3944$$

$$\rho_{Cargo} = 0.3846 + 0.3944 = 0.7790$$

Model 1.c ρ_{Cargo} Measurement – *HCapital* Variable Omitted

Figure D-3. *Model 1.c Cargo variable degree of robustness*



— Baseline Model
- - Robustness Model

Table D-3. *Model 1.c degree of robustness calculation*

	Cargo Coefficient	Parametric Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0156	0.0075	0.0010	0.0303
Robustness Model	0.0197	0.0076	0.0095	0.0395

$$\rho_{Cargo} = \int_{0.0010}^{0.0177} \left(\frac{1}{0.0075\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0156)^2}{2(0.0075)^2}}\right) dx + \int_{0.0177}^{0.0303} \left(\frac{1}{0.0074\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0156923)^2}{2(0.0074)^2}}\right) dx$$

$$\rho_{Cargo_b} = \int_{0.0010}^{0.0177} \left(\frac{1}{0.0075\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0156)^2}{2(0.0075)^2}}\right) dx = 0.5845$$

$$\rho_{Cargo_r} = \int_{0.0177}^{0.0303} \left(\frac{1}{0.0074\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0156923)^2}{2(0.0074)^2}}\right) dx = 0.3515$$

$$\rho_{Cargo} = 0.5845 + 0.3515 = 0.9360$$

Model 1.a ρ'_{Cargo} Measurement – *NCargo* Variable Omitted

Figure D-4. *Model 1.a Cargo variable degree of robustness*

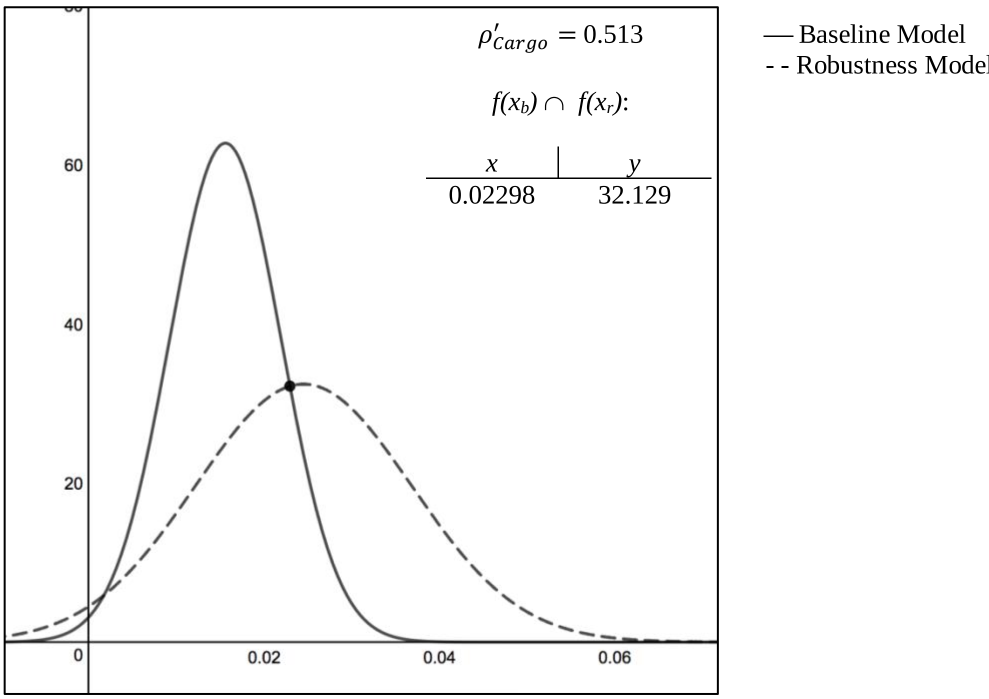


Table D-4. *Model 1.a degree of robustness calculation*

	Cargo Coefficient	Driscoll & Kraay Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0156222	0.0063695	0.0028154	0.0284289
Robustness Model	0.0245335	0.0123189	-0.0002354	0.0493024

$$\rho'_{Cargo} = \int_{0.02298}^{0.0284289} \left(\frac{1}{0.0063695\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0156222)^2}{2(0.0063695)^2}}\right) dx + \int_{0.0028154}^{0.02298} \left(\frac{1}{0.0123189\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0245335)^2}{2(0.0123189)^2}}\right) dx$$

$$\rho'_{Cargo_b} = \int_{0.02298}^{0.0284289} \left(\frac{1}{0.0063695\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0156222)^2}{2(0.0063695)^2}}\right) dx = 0.101830$$

$$\rho'_{Cargo_r} = \int_{0.0028154}^{0.02298} \left(\frac{1}{0.0123189\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0245335)^2}{2(0.0123189)^2}}\right) dx = 0.523629$$

$$\rho'_{Cargo} = 0.101830 + 0.410872 = 0.512702$$

Model 1.b ρ'_{Cargo} Measurement – *GSpend* Variable Omitted

Figure D-5. *Model 1.b Cargo variable degree of robustness*

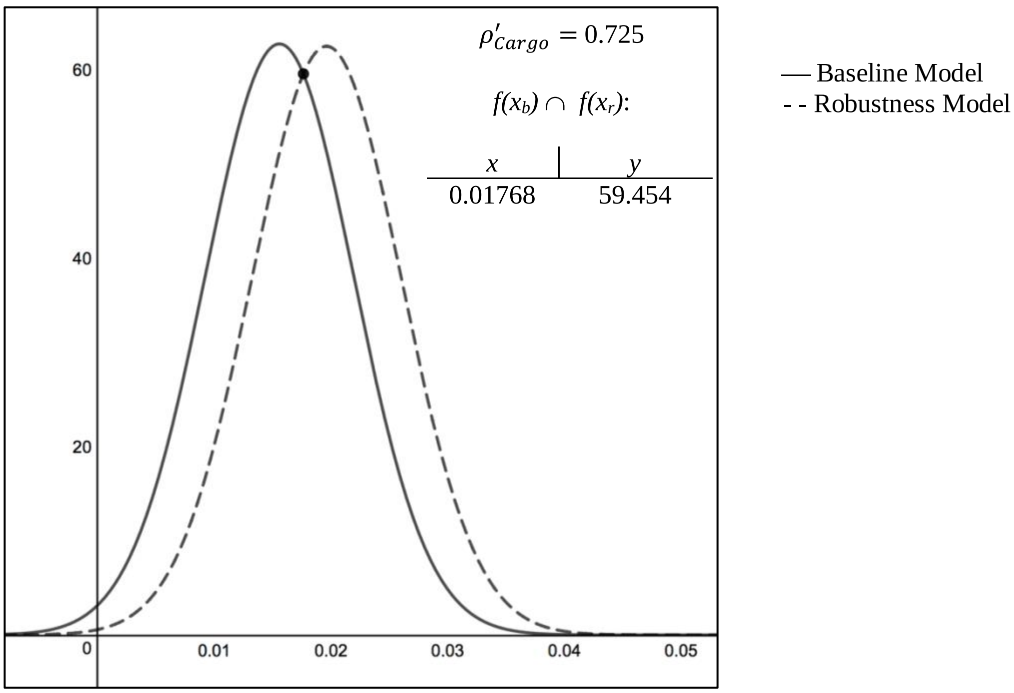


Table D-5. *Model 1.b degree of robustness calculation*

	Cargo Coefficient	Driscoll & Kraay Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0156222	0.0063695	0.0028154	0.0284289
Robustness Model	0.0196613	0.0063695	0.0068034	0.0325193

$$\rho'_{Cargo} = \int_{0.01768}^{0.0284289} \left(\frac{1}{0.0063695\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0156222)^2}{2(0.0063695)^2}}\right) dx \ \int_{0.0028154}^{0.01768} \left(\frac{1}{0.0123189\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0245335)^2}{2(0.0123189)^2}}\right) dx$$

$$\rho'_{Cargo_b} = \int_{0.01768}^{0.0284289} \left(\frac{1}{0.0063695\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0156222)^2}{2(0.0063695)^2}}\right) dx = 0.351138$$

$$\rho'_{Cargo_r} = \int_{0.0028154}^{0.01768} \left(\frac{1}{0.0063695\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0196613)^2}{20.0063695^2}}\right) dx = 0.374132$$

$$\rho'_{Cargo} = 0.351138 + 0.374132 = 0.72527$$

Model 1.c ρ'_{Cargo} Measurement – *HCapital* Variable Omitted

Figure D-6. *Model 1.c Cargo variable degree of robustness*

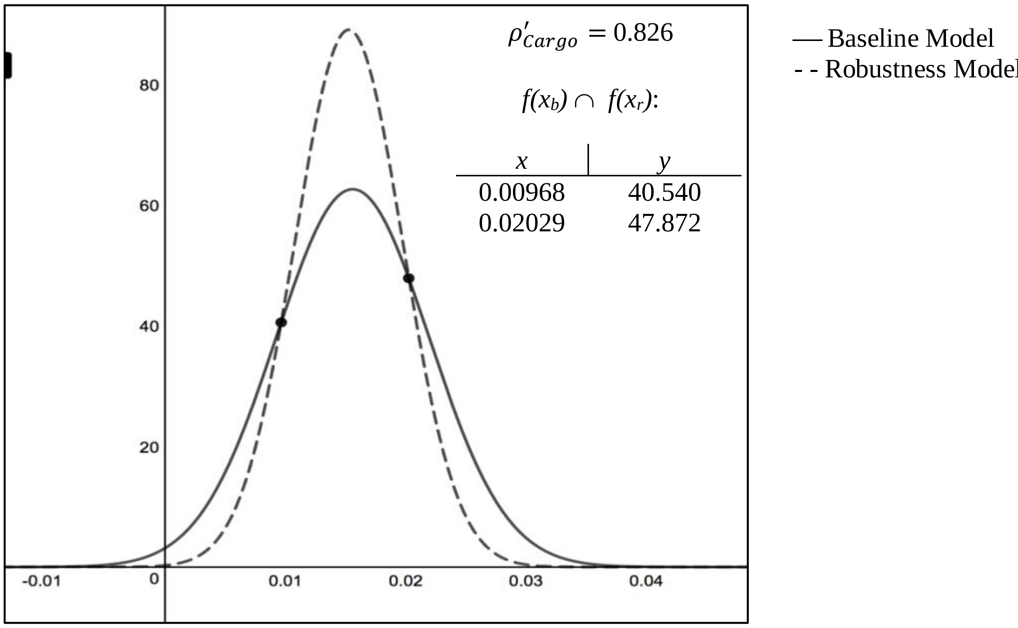


Table D-6. *Model 1.c degree of robustness calculation*

	Cargo Coefficient	Driscoll & Kraay Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0156222	0.0063695	0.0028154	0.0284289
Robustness Model	0.0153009	0.0044791	0.0062951	0.0243067

$$\rho'_{Cargo} = \int_{0.0028154}^{0.00968}\left(\frac{1}{0.0044791\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0153009)^2}{2(0.0044791)^2}}\right)dx + \int_{0.00968}^{0.02029}\left(\frac{1}{0.0063695\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0156222)^2}{2(0.0063695)^2}}\right)dx + \int_{0.02029}^{0.0284289}\left(\frac{1}{0.0044791\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0153009)^2}{2(0.0044791)^2}}\right)dx$$

$$\rho'_{Cargo_{r1}} = \int_{0.0028154}^{0.00968}\left(\frac{1}{0.0044791\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0153009)^2}{2(0.0044791)^2}}\right)dx = 0.102099$$

$$\rho'_{Cargo_{\beta}} = \int_{0.00968}^{0.02029}\left(\frac{1}{0.0063695\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0156222)^2}{2(0.0063695)^2}}\right)dx = 0.592739$$

$$\rho'_{Cargo_{r2}} = \int_{0.02029}^{0.0284289}\left(\frac{1}{0.0044791\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0153009)^2}{2(0.0044791)^2}}\right)dx = 0.130980$$

$$\rho'_{Cargo} = 0.102099 + 0.592739 + 0.130980 = 0.825818$$

Model 3.a ρ_{Cargo} Measurement – *NCargo* Variable Omitted

Figure D-7. *Model 3.a Cargo variable degree of robustness*

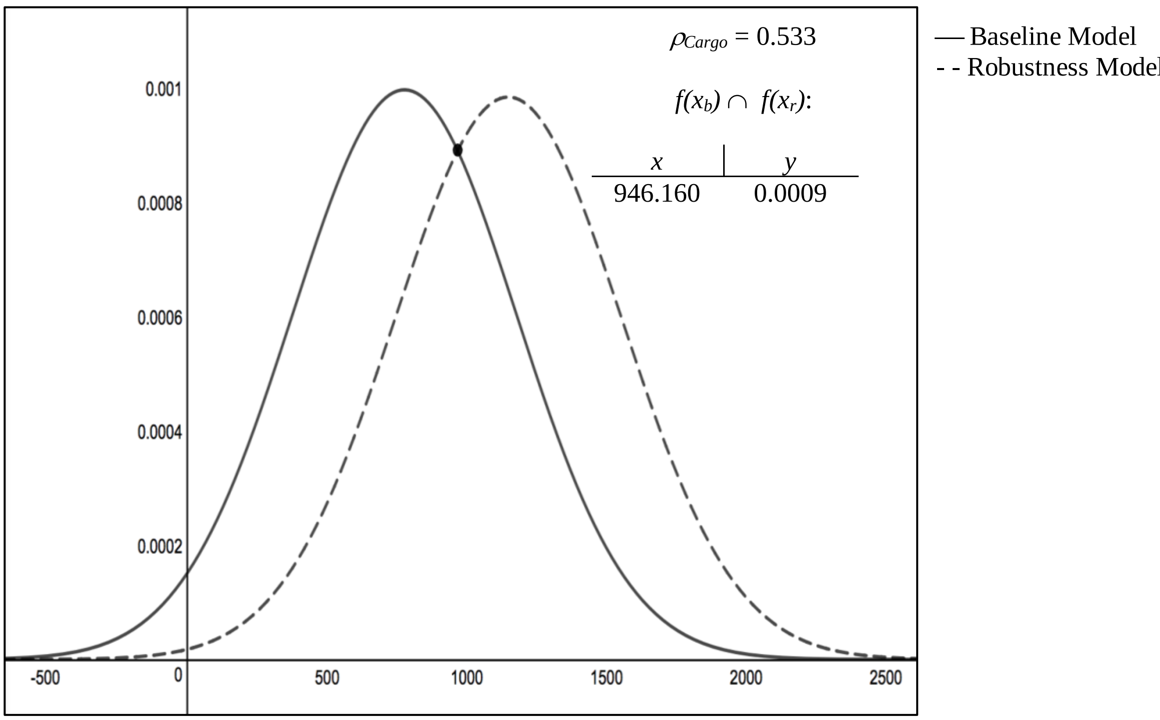


Table D-7. *Model 3.a degree of robustness calculation*

	Cargo Coefficient	Parametric Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	767.491	402.280	-23.159	1558.140
Robustness Model	1149.937	405.443	353.072	1946.797

$$\rho_{Cargo} = \int_{946.160}^{1558.140} \left(\frac{1}{402.280\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-767.491)^2}{2(402.280)^2}}\right) dx + \int_{-23.159}^{946.160} \left(\frac{1}{405.433\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-1149.937)^2}{2(405.433)^2}}\right) dx$$

$$\rho_{Cargo_b} = \int_{946.160}^{1558.140} \left(\frac{1}{402.280\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-767.491)^2}{2(402.280)^2}}\right) dx = 0.3054$$

$$\rho_{Cargo_r} = \int_{-23.159}^{946.160} \left(\frac{1}{405.433\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-1149.937)^2}{2(405.433)^2}}\right) dx = 0.2272$$

$$\rho_{Cargo} = 0.3054 + 0.2272 = 0.5326$$

Model 3.b ρ_{Cargo} Measurement – *GSpend* Variable Omitted

Figure D-8. *Model 3.b Cargo variable degree of robustness*

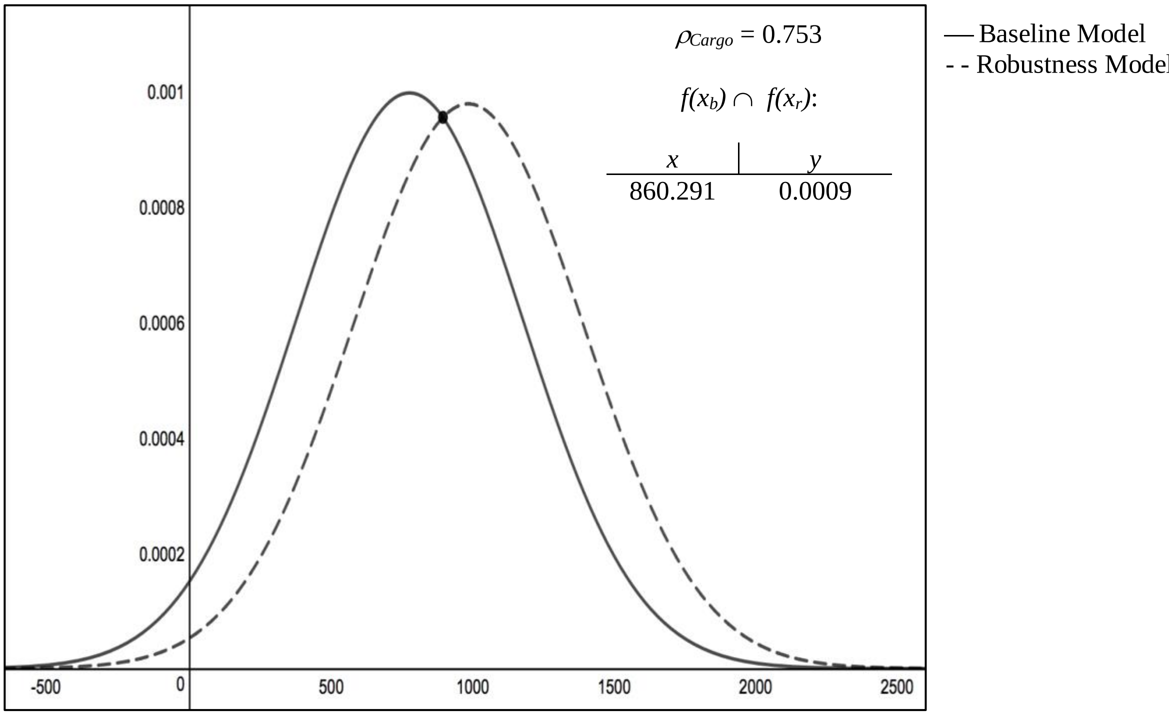


Table D-8. *Model 3.b degree of robustness calculation*

	Cargo Coefficient	Parametric Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	767.491	402.280	-23.159	1558.140
Robustness Model	988.261	410.196	182.059	1794.462

$$\rho_{Cargo} = \int_{860.291}^{1558.140} \left(\frac{1}{402.280\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-767.491)^2}{2(402.280)^2}}\right) dx + \int_{-23.159}^{860.291} \left(\frac{1}{410.196\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-988.261)^2}{2(410.196)^2}}\right) dx$$

$$\rho_{Cargo_b} = \int_{860.291}^{1558.140} \left(\frac{1}{402.280\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-767.491)^2}{2(402.280)^2}}\right) dx = 0.3827$$

$$\rho_{Cargo_r} = \int_{-23.159}^{860.291} \left(\frac{1}{410.196\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-988.261)^2}{2(410.196)^2}}\right) dx = 0.3707$$

$$\rho_{Cargo} = 0.3827 + 0.3707 = 0.7534$$

Model 3.c ρ_{Cargo} Measurement – *HCapital* Variable Omitted

Figure D-9. *Model 3.c Cargo variable degree of robustness*

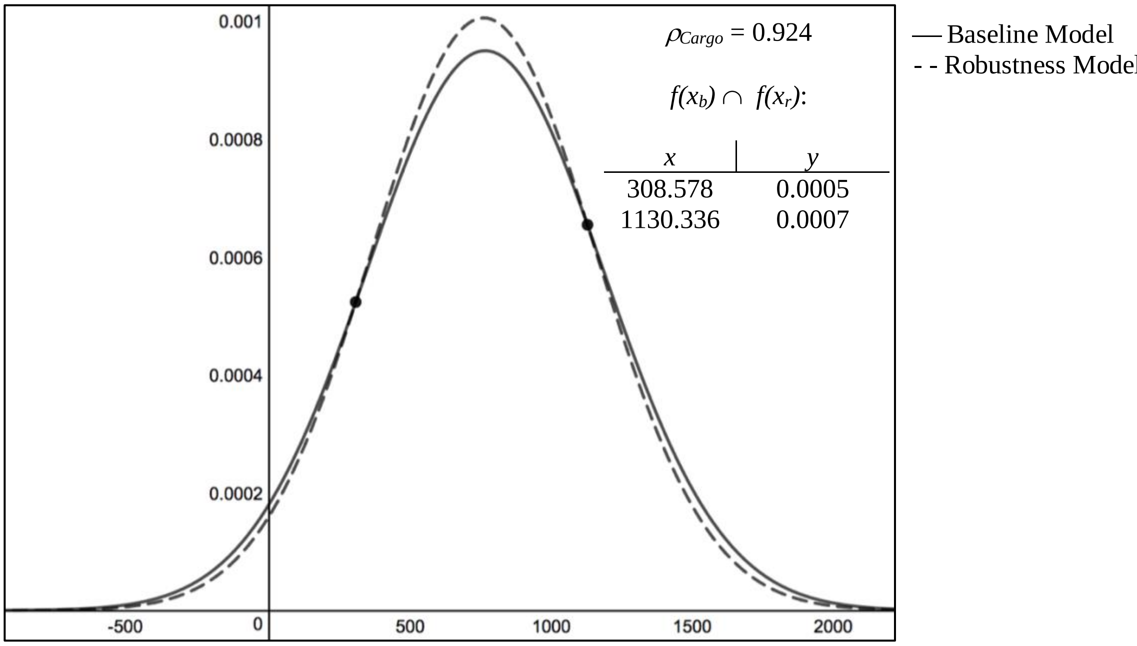


Table D-9. *Model 3.c degree of robustness calculation*

	Cargo Coefficient	Parametric Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	778.083	400.276	-8.628	1564.794
Robustness Model	762.317	397.004	-17.957	1542.591

$$\rho_{Cargo} = \int_{308.578}^{1130.336}\left(\frac{1}{400.276\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-778.083)^2}{2(400.276)^2}}\right)dx + \int_{-8.628}^{308.5784}\left(\frac{1}{397.004\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-762.317)^2}{2(397.004)^2}}\right)dx + \int_{1130.336}^{1564.794}\left(\frac{1}{397.004\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-762.317)^2}{2(397.004)^2}}\right)dx$$

$$\rho_{Cargo_b} = \int_{308.578}^{1130.336}\left(\frac{1}{400.276\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-778.083)^2}{2(400.276)^2}}\right)dx = 0.6686$$

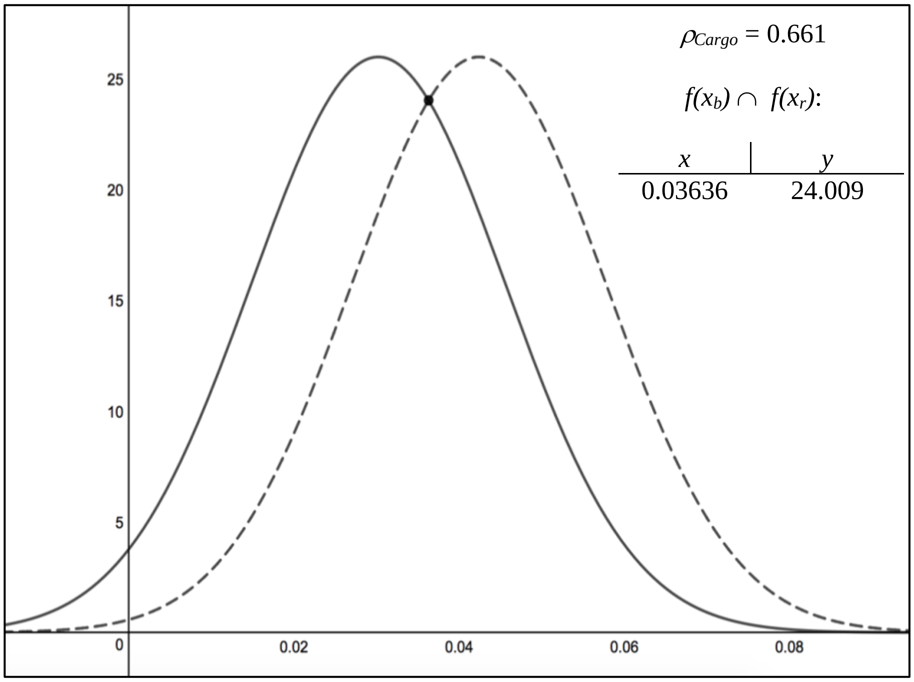
$$\rho_{Cargo_{r1}} = \int_{-8.628}^{308.5784}\left(\frac{1}{397.004\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-762.317)^2}{2(397.004)^2}}\right)dx = 0.1005$$

$$\rho_{Cargo_{r2}} = \int_{1130.336}^{1564.794}\left(\frac{1}{397.004\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-762.317)^2}{2(397.004)^2}}\right)dx = 0.1553$$

$$\rho_{Cargo} = 0.6686 + 0.1005 + 0.1553 = 0.9244$$

Model 5.a ρ_{Cargo} Measurement – *Unemploy* Variable Omitted

Figure D-10. *Model 5.a Cargo variable degree of robustness*



— Baseline Model
- - Robustness Model

Table D-10. *Model 5.a degree of robustness calculation*

	Cargo Coefficient	Parametric Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0302669	0.0153613	0.0000770	0.0604568
Robustness Model	0.0424439	0.0149651	0.0130328	0.0718550

$$\rho_{Cargo} = \int_{0.03636}^{0.0604568} \left(\frac{1}{0.0153613\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0302669)^2}{2(0.0153613)^2}}\right) dx + \int_{0.000077}^{0.03636} \left(\frac{1}{0.0149651\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0424439)^2}{2(0.0149651)^2}}\right) dx$$

$$\rho_{Cargo_b} = \int_{0.03636}^{0.0604568} \left(\frac{1}{0.0153613\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0302669)^2}{2(0.0153613)^2}}\right) dx = 0.321124$$

$$\rho_{Cargo_r} = \int_{0.000077}^{0.03636} \left(\frac{1}{0.0149651\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0424439)^2}{2(0.0149651)^2}}\right) dx = 0.339854$$

$$\rho_{Cargo} = 0.321124 + 0.339854 = 0.660978$$

Model 5.b ρ_{Cargo} Measurement – *Precip* Variable Omitted

Figure D-11. *Model 5.b Cargo variable degree of robustness*

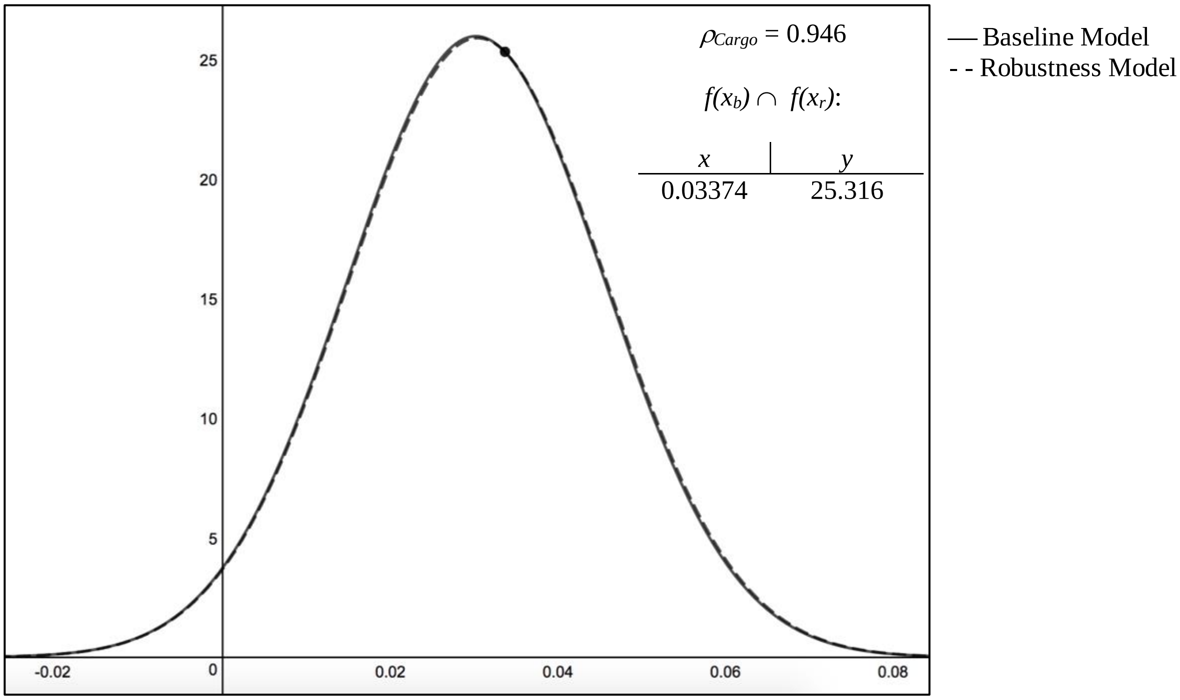


Table D-11. *Model 5.b degree of robustness calculation*

	Cargo Coefficient	Parametric Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0302669	0.0153613	0.0000770	0.0604568
Robustness Model	0.0304712	0.0154083	0.0001890	0.0607533

$$\rho_{Cargo} = \int_{0.03374}^{0.0604568} \left(\frac{1}{0.0153613\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0302669)^2}{2(0.0153613)^2}}\right) dx + \int_{0.000077}^{0.03374} \left(\frac{1}{0.0154083\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0424439)^2}{2(0.0154083)^2}}\right) dx$$

$$\rho_{Cargo_b} = \int_{0.03374}^{0.0604568} \left(\frac{1}{0.0153613\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0302669)^2}{2(0.0153613)^2}}\right) dx = 0.385877$$

$$\rho_{Cargo_r} = \int_{0.000077}^{0.03374} \left(\frac{1}{0.0154083\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0424439)^2}{2(0.0154083)^2}}\right) dx = 0.559734$$

$$\rho_{Cargo} = 0.385877 + 0.559734 = 0.945611$$

Model 5.c ρ_{Cargo} Measurement – *Temp* Variable Omitted

Figure D-12. *Model 5.c Cargo variable degree of robustness*

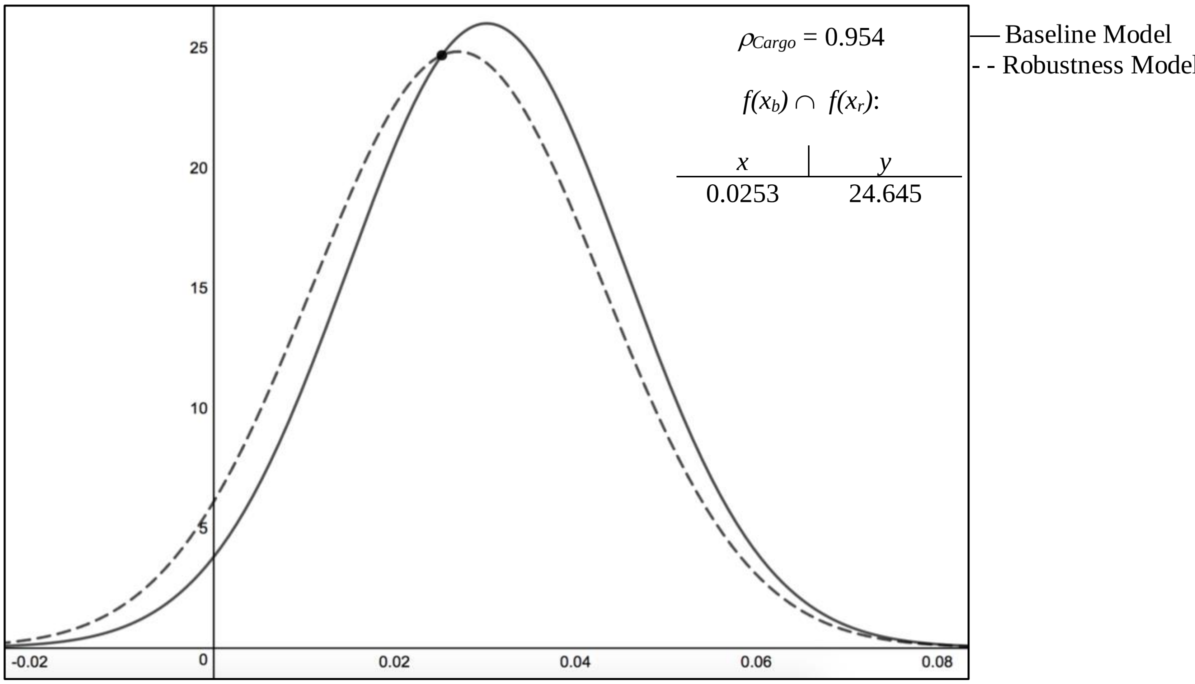


Table D-12. *Model 5.c degree of robustness calculation*

	Cargo Coefficient	Parametric Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0302669	0.0153613	0.0000770	0.0604568
Robustness Model	0.0270808	0.0160879	-0.0045368	0.0586985

$$\rho_{Cargo} = \int_{0.000077}^{0.0253} \left(\frac{1}{0.0153613\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0302669)^2}{2(0.0153613)^2}}\right) dx + \int_{0.0253}^{0.0604568} \left(\frac{1}{0.0160879\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0270808)^2}{2(0.0160879)^2}}\right) dx$$

$$\rho_{Cargo_b} = \int_{0.000077}^{0.0253} \left(\frac{1}{0.0153613\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0302669)^2}{2(0.0153613)^2}}\right) dx = 0.34853$$

$$\rho_{Cargo_r} = \int_{0.0253}^{0.0604568} \left(\frac{1}{0.0160879\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0270808)^2}{2(0.0160879)^2}}\right) dx = 0.605593$$

$$\rho_{Cargo} = 0.34853 + 0.605593 = 0.954123$$

Model 5.a ρ'_{Cargo} Measurement – *Unemploy* Variable Omitted

Figure D-13. *Model 5.a Cargo variable degree of robustness*

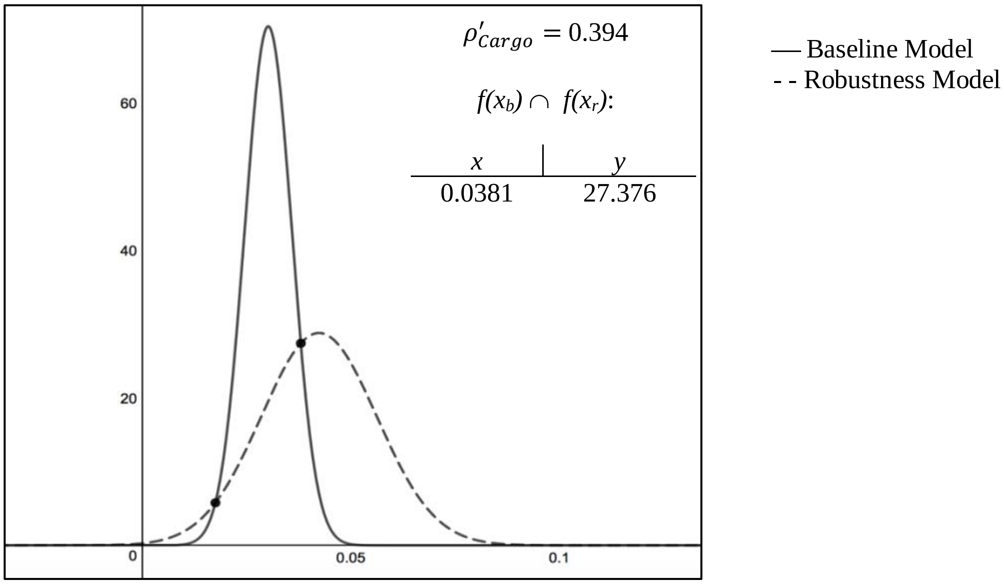


Table D-13. *Model 5.a degree of robustness calculation*

	Cargo Coefficient	Driscoll & Kraay Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0302669	0.0056715	0.018870	0.041664
Robustness Model	0.0424439	0.0138614	0.014588	0.070299

$$\rho'_{Cargo} = \int_{0.018870}^{0.0381} \left(\frac{1}{0.0138614\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0424439)^2}{2(0.0138614)^2}}\right) dx + \int_{0.0381}^{0.041664} \left(\frac{1}{0.0056715\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0302669)^2}{2(0.0056715)^2}}\right) dx$$

$$\rho'_{Cargo_b} = \int_{0.018870}^{0.0381} \left(\frac{1}{0.0138614\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0424439)^2}{2(0.0138614)^2}}\right) dx = 0.061379$$

$$\rho'_{Cargo_r} = \int_{0.0381}^{0.041664} \left(\frac{1}{0.0056715\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0302669)^2}{2(0.0056715)^2}}\right) dx = 0.332495$$

$$\rho'_{Cargo} = 0.061379 + 0.332495 = 0.393874$$

Model 5.b ρ'_{Cargo} Measurement – *Precip* Variable Omitted

Figure D-14. *Model 5.b Cargo variable degree of robustness*

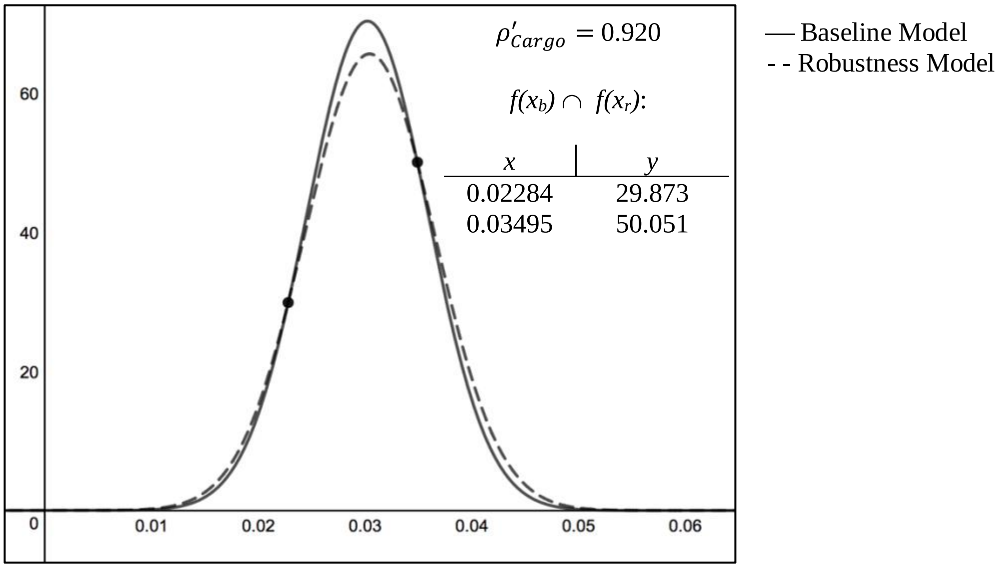


Table D-14. *Model 5.b degree of robustness calculation*

	Cargo Coefficient	Driscoll & Kraay Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0302669	0.0056715	0.018870	0.041664
Robustness Model	0.0304712	0.0060792	0.018255	0.042688

$$\rho'_{Cargo} = \int_{0.018870}^{0.02284}\left(\frac{1}{0.0056715\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0302669)^2}{2(0.0056715)^2}}\right)dx + \int_{0.02284}^{0.03495}\left(\frac{1}{0.0060792\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0304712)^2}{2(0.0060792)^2}}\right)dx + \int_{0.03495}^{0.041664}\left(\frac{1}{0.0056715\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0302669)^2}{2(0.0056715)^2}}\right)dx$$

$$\rho'_{Cargo_{b1}} = \int_{0.018870}^{0.02284}\left(\frac{1}{0.0056715\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0302669)^2}{2(0.0056715)^2}}\right)dx = 0.072939$$

$$\rho'_{Cargo_{r}} = \int_{0.02284}^{0.03495}\left(\frac{1}{0.0060792\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0304712)^2}{2(0.0060792)^2}}\right)dx = 0.182240$$

$$\rho'_{Cargo_{b2}} = \int_{0.03495}^{0.041664}\left(\frac{1}{0.0056715\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0302669)^2}{2(0.0056715)^2}}\right)dx = 0.664674$$

$$\rho'_{Cargo} = 0.072939 + 0.182240 + 0.664674 = 0.919853$$

Model 5.c ρ'_{Cargo} Measurement – *Temp* Variable Omitted

Figure D-15. *Model 5.c Cargo variable degree of robustness*

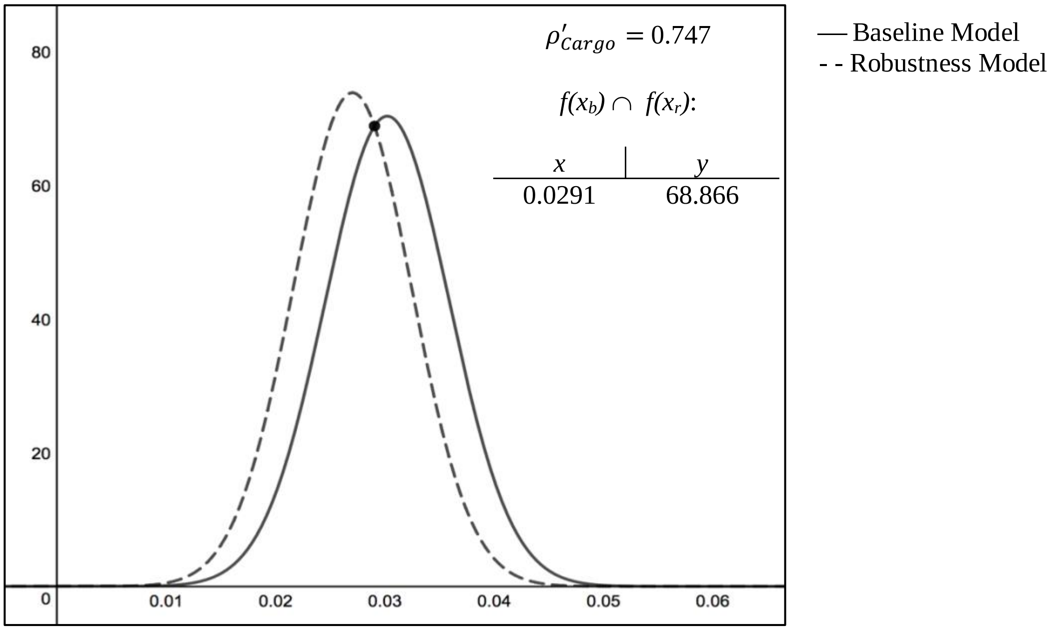


Table D-15. *Model 5.c degree of robustness calculation*

	Cargo Coefficient	Driscoll & Kraay Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0302669	0.0056715	0.018870	0.041664
Robustness Model	0.0270808	0.0054026	0.016224	0.037938

$$\rho'_{Cargo} = \int_{0.018870}^{0.0291} \left(\frac{1}{0.0056715\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0302669)^2}{2(0.0056715)^2}}\right) dx + \int_{0.0291}^{0.041664} \left(\frac{1}{0.0054026\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0270808)^2}{2(0.0054026)^2}}\right) dx$$

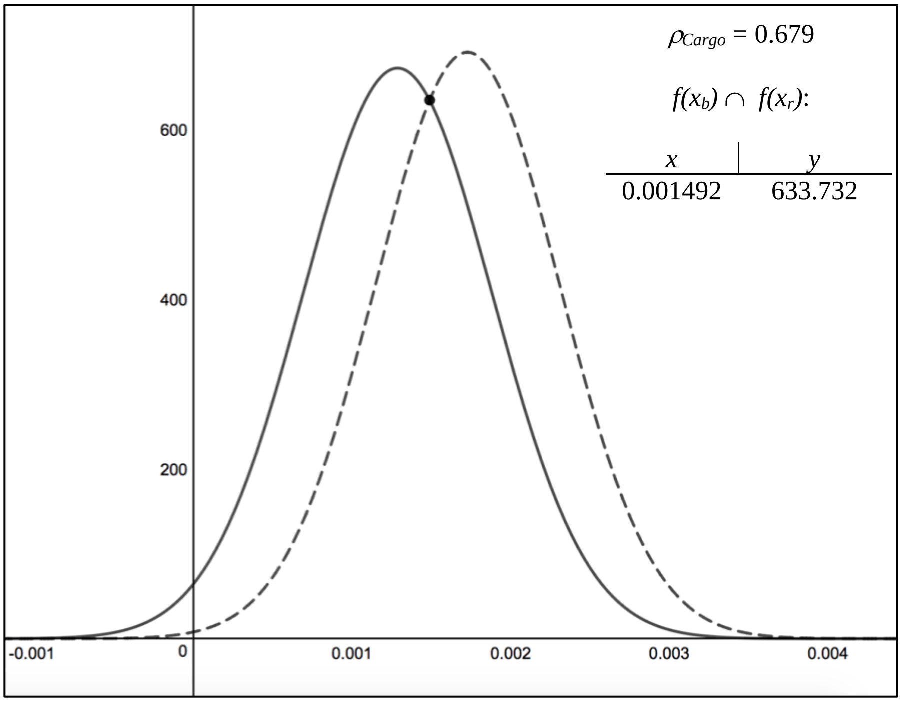
$$\rho'_{Cargo_b} = \int_{0.018870}^{0.0291} \left(\frac{1}{0.0056715\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0302669)^2}{2(0.0056715)^2}}\right) dx = 0.396252$$

$$\rho'_{Cargo_r} = \int_{0.0291}^{0.041664} \left(\frac{1}{0.0054026\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0270808)^2}{2(0.0054026)^2}}\right) dx = 0.350822$$

$$\rho'_{Cargo} = 0.396252 + 0.350822 = 0.747074$$

Model 6.a ρ_{Cargo} Measurement – *Unemploy* Variable Omitted

Figure D-16. *Model 6.a Cargo variable degree of robustness*



— Baseline Model
- - Robustness Model

Table D-16. *Model 6.a degree of robustness calculation*

	argo Coefficient	Parametric Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0012900	0.0005941	0.0001224	0.0024577
Robustness Model	0.0017308	0.0005781	0.0005948	0.0028669

$$\rho(Cargo) = \int_{0.001492}^{0.0024577}\left(\frac{1}{0.0005941\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0012900)^2}{2(0.0005941)^2}}\right)dx \int_{0.0001224}^{0.001492}\left(\frac{1}{0.0005781\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0017308)^2}{2(0.0005781)^2}}\right)dx$$

$$\rho(Cargo_b) = \int_{0.001492}^{0.0024577}\left(\frac{1}{0.0005941\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0012900)^2}{2(0.0005941)^2}}\right)dx = 0.342246$$

$$\rho(Cargo_r) = \int_{0.0001224}^{0.001492}\left(\frac{1}{0.0005781\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0017308)^2}{2(0.0005781)^2}}\right)dx = 0.337076$$

$$\rho(Cargo) = 0.342246 + 0.337076 = 0.679322$$

Model 6.b ρ_{Cargo} Measurement – *Precip* Variable Omitted

Figure D-17. *Model 6.b Cargo variable degree of robustness*

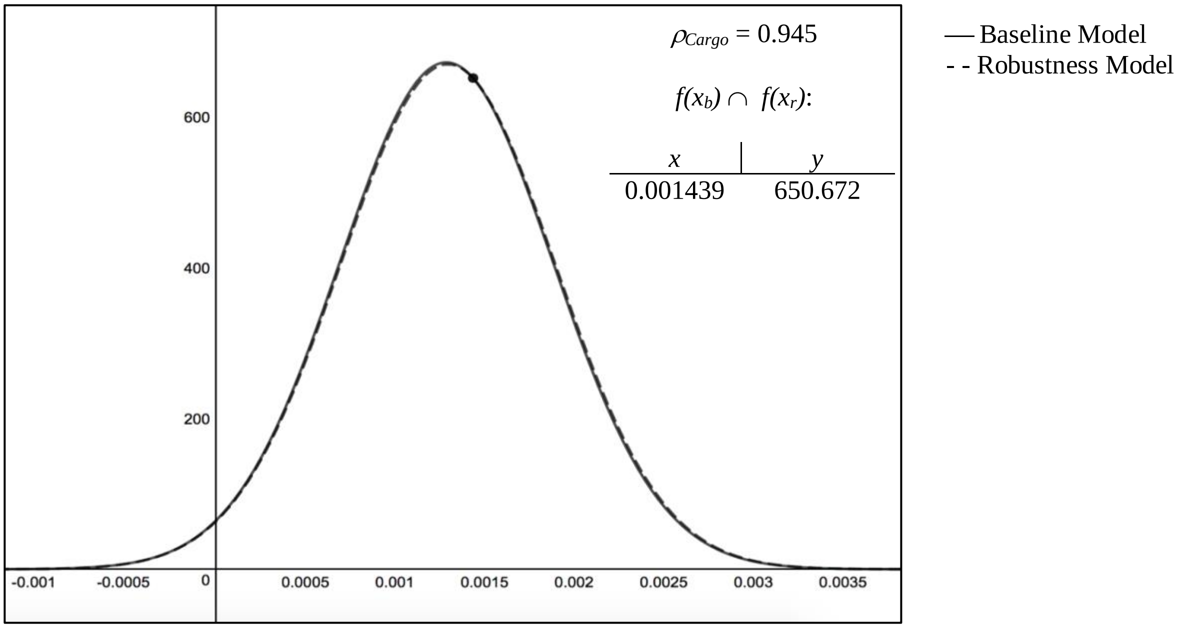


Table D-17. *Model 6.b degree of robustness calculation*

	Cargo Coefficient	Parametric Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0012900	0.0005941	0.0001224	0.0024577
Robustness Model	0.0012985	0.0005963	0.0001266	0.0024703

$$\rho(Cargo) = \int_{0.001439}^{0.0024577} \left(\frac{1}{0.0005941\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0012900)^2}{2(0.0005941)^2}}\right) dx \int_{0.0001224}^{0.001439} \left(\frac{1}{0.0005963\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0012985)^2}{2(0.0005963)^2}}\right) dx$$

$$\rho(Cargo_b) = \int_{0.001439}^{0.0024577} \left(\frac{1}{0.0005941\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0012900)^2}{2(0.0005941)^2}}\right) dx = 0.376306$$

$$\rho(Cargo_r) = \int_{0.0001224}^{0.001439} \left(\frac{1}{0.0005963\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0012985)^2}{2(0.0005963)^2}}\right) dx = 0.56885$$

$$\rho(Cargo) = 0.376306 + 0.56885 = 0.945156$$

Model 6.c ρ_{Cargo} Measurement – *Temp* Variable Omitted

Figure D-18. *Model 6.c Cargo variable degree of robustness*

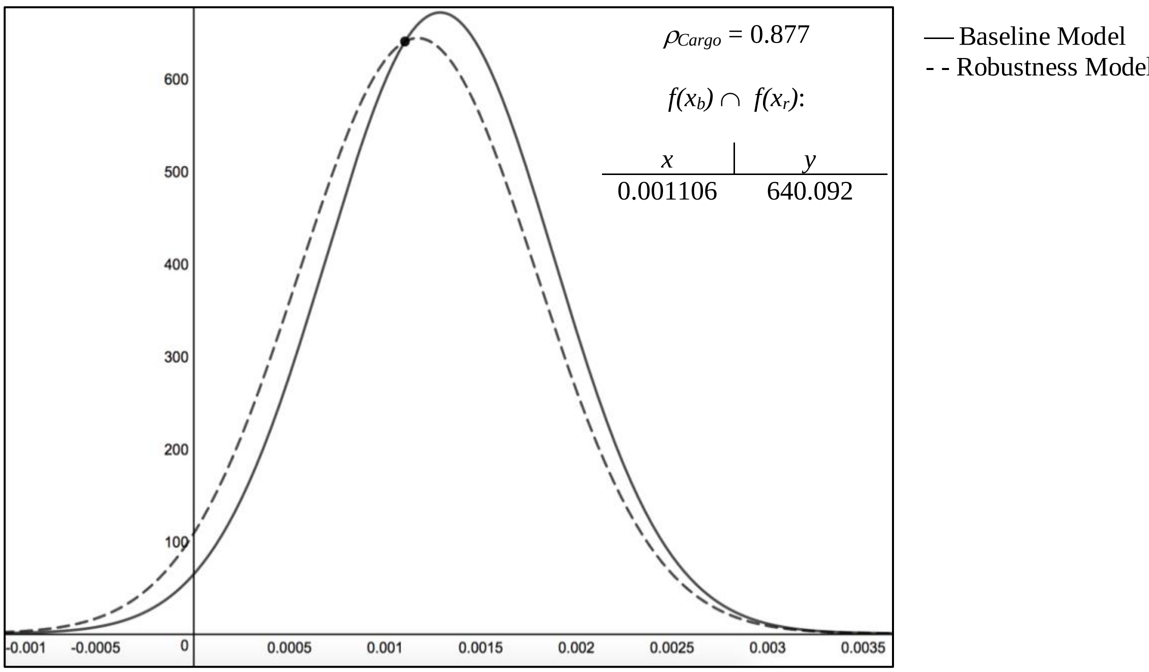


Table D-18. *Model 6.c degree of robustness calculation*

	Cargo Coefficient	Parametric Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0012900	0.0005941	0.0001224	0.0024577
Robustness Model	0.0011724	0.0006197	-0.0000455	0.0023903

$$\rho(Cargo) = \int_{0.0001224}^{0.001106} \left(\frac{1}{0.0005941\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0012900)^2}{2(0.0005941)^2}}\right) dx \int_{0.001106}^{0.0024577} \left(\frac{1}{0.0006197\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0011724)^2}{2(0.0006197)^2}}\right) dx$$

$$\rho(Cargo_b) = \int_{0.0001224}^{0.001106} \left(\frac{1}{0.0005941\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0012900)^2}{2(0.0005941)^2}}\right) dx = 0.353701$$

$$\rho(Cargo_r) = \int_{0.001106}^{0.0024577} \left(\frac{1}{0.0006197\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0011724)^2}{2(0.0006197)^2}}\right) dx = 0.523629$$

$$\rho(Cargo) = 0.353701 + 0.523629 = 0.87733$$

Model 7.a ρ_{Cargo} Measurement – *Unemploy* Variable Omitted

Figure D-19. *Model 7.a Cargo variable degree of robustness*

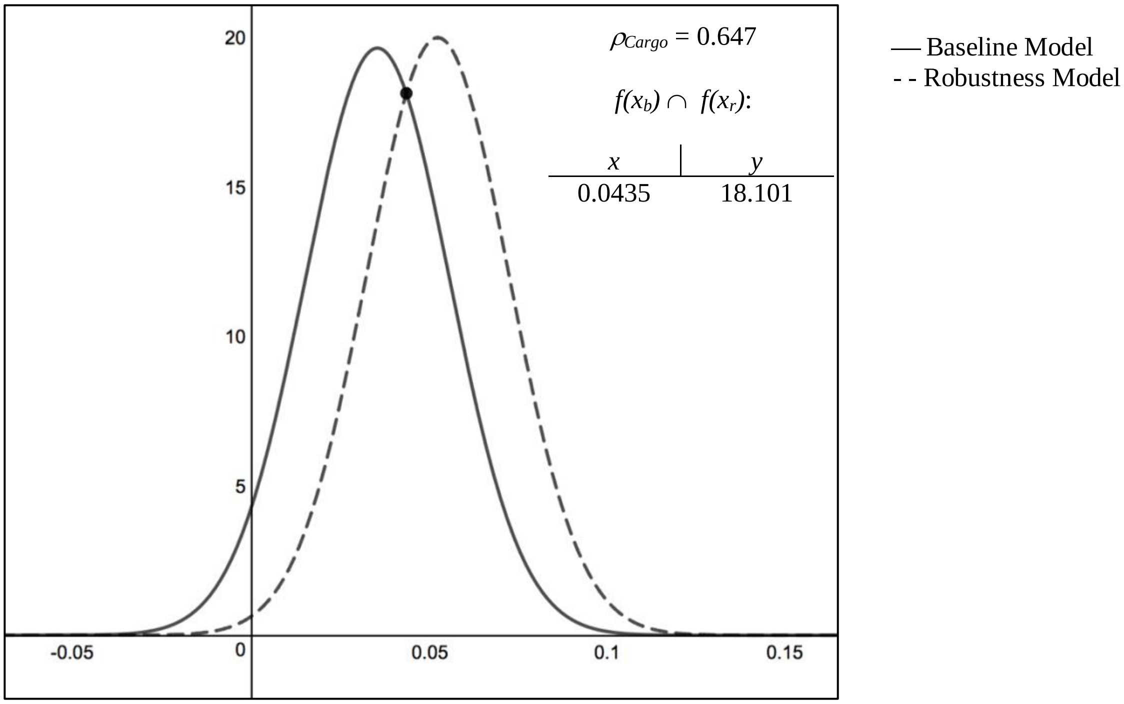


Table D-19. *Model 7.a degree of robustness calculation*

	Cargo Coefficient	Parametric Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0353408	0.0203405	-0.0046349	0.0753164
Robustness Model	0.0523283	0.0199856	0.0130504	0.0916062

$$\rho_{Cargo} = \int_{0.0435}^{0.0753164} \left(\frac{1}{0.0203405\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0353408)^2}{2(0.0203405)^2}}\right) dx \ + \int_{-0.0046349}^{0.0435} \left(\frac{1}{0.0199856\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0523283)^2}{2(0.0199856)^2}}\right) dx$$

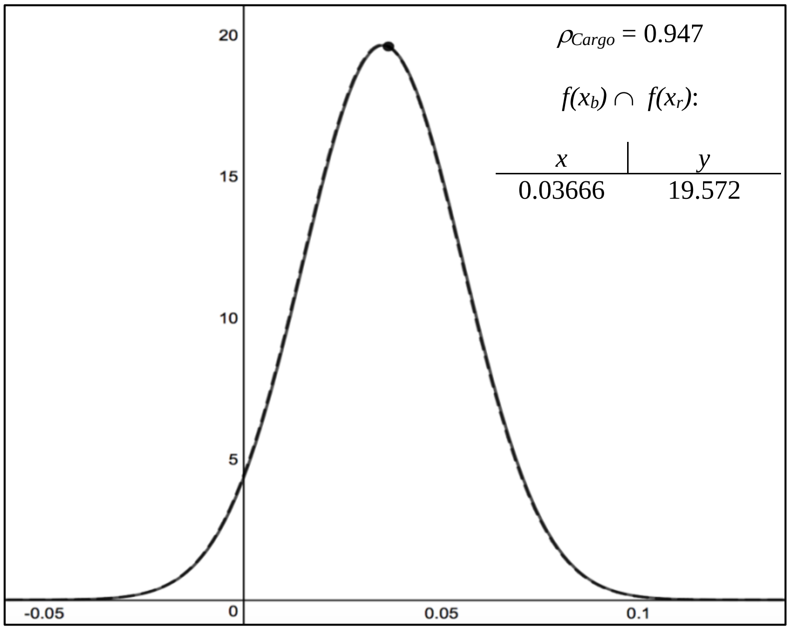
$$\rho_{Cargo_b} = \int_{0.0435}^{0.0753164} \left(\frac{1}{0.0203405\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0353408)^2}{2(0.0203405)^2}}\right) dx \ = 0.319473$$

$$\rho_{Cargo_r} = \int_{-0.0046349}^{0.0435} \left(\frac{1}{0.0199856\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0523283)^2}{2(0.0199856)^2}}\right) dx \ = 0.327157$$

$$\rho_{Cargo} = \quad 0.319473 + 0.327157 = 0.64663$$

Model 7.b ρ_{Cargo} Measurement – *Precip* Variable Omitted

Figure D-20. *Model 7.b Cargo variable degree of robustness*



— Baseline Model
- - Robustness Model

Table D-20. *Model 7.b degree of robustness calculation*

	Cargo Coefficient	Parametric Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0353408	0.0203405	-0.0046349	0.0753164
Robustness Model	0.0350980	0.0203232	-0.0076838	0.0754641

$$\rho_{Cargo} = \int_{-0.0046349}^{0.03666} \left(\frac{1}{0.0203405\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0353408)^2}{2(0.0203405)^2}}\right) dx + \int_{0.03666}^{0.0753164} \left(\frac{1}{0.0203232\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0350980)^2}{2(0.0203232)^2}}\right) dx$$

$$\rho_{Cargo_b} = \int_{-0.0046349}^{0.03666} \left(\frac{1}{0.0203405\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0353408)^2}{2(0.0203405)^2}}\right) dx = 0.501167$$

$$\rho_{Cargo_r} = \int_{0.03666}^{0.0753164} \left(\frac{1}{0.0203232\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0350980)^2}{2(0.0203232)^2}}\right) dx = 0.445457$$

$$\rho_{Cargo} = 0.501167 + 0.445457 = 00.946624$$

Model 7.c ρ_{Cargo} Measurement – *Temp* Variable Omitted

Figure D-21. *Model 7.c Cargo variable degree of robustness*

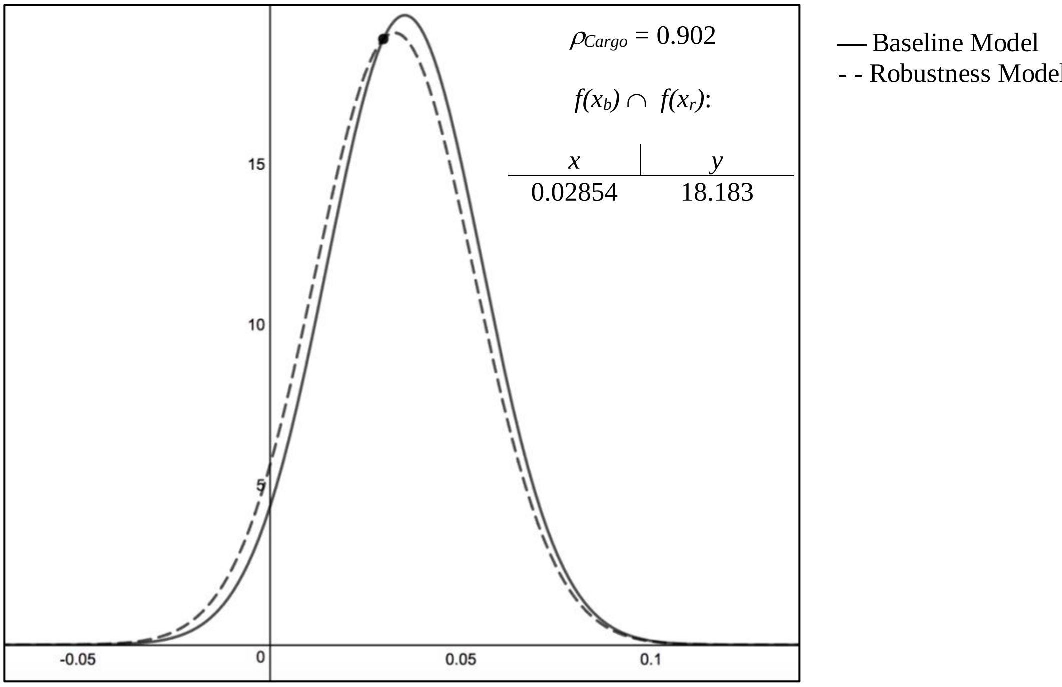


Table D-21. *Model 7.c degree of robustness calculation*

	Cargo Coefficient	Parametric Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0353408	0.0203405	-0.0046349	0.0753164
Robustness Model	0.0326805	0.0209246	-0.0084427	0.0738038

$$\rho_{Cargo} = \int_{-0.0046349}^{0.02854}\left(\frac{1}{0.0203405\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0353408)^2}{2(0.0203405)^2}}\right)dx + \int_{0.02854}^{0.0753164}\left(\frac{1}{0.0209246\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0523283)^2}{2(0.0209246)^2}}\right)dx$$

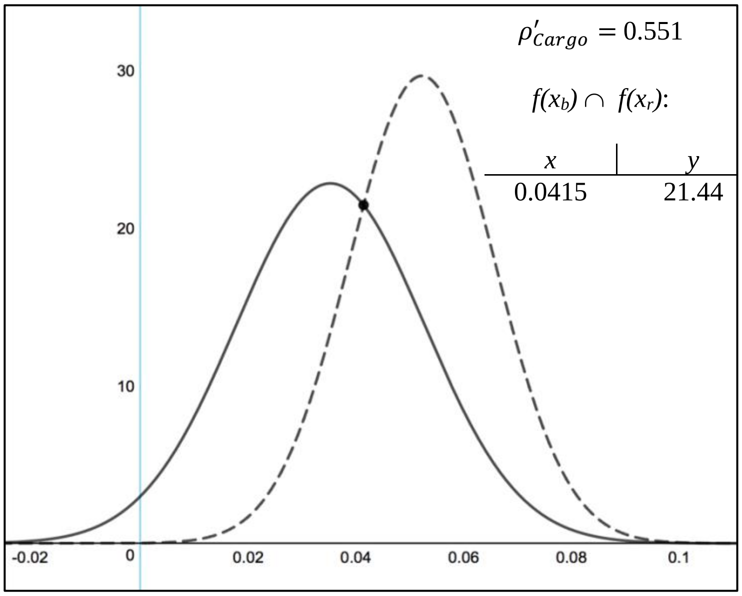
$$\rho_{Cargo_b} = \int_{-0.0046349}^{0.02854}\left(\frac{1}{0.0203405\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0353408)^2}{2(0.0203405)^2}}\right)dx = 0.344370$$

$$\rho_{Cargo_r} = \int_{0.02854}^{0.0753164}\left(\frac{1}{0.0209246\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0523283)^2}{2(0.0209246)^2}}\right)dx = 0.557634$$

$$\rho_{Cargo} = 0.344370 + 0.557634 = 0.902004$$

Model 7.a ρ'_{Cargo} Measurement – *Unemploy* Variable Omitted

Figure D-22. *Model 5.a Cargo variable degree of robustness*



— Baseline Model
- - Robustness Model

Table D-22. *Model 7.a degree of robustness calculation*

	Cargo Coefficient	Driscoll & Kraay Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0353408	0.0174844	0.0002045	0.070477
Robustness Model	0.0523283	0.0134625	0.0252745	0.0793821

$$\rho'_{Cargo} = \int_{0.0415}^{0.070477} \left(\frac{1}{0.0174844\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0353408)^2}{2(0.0174844)^2}}\right) dx + \int_{0.0415}^{0.0002045} \left(\frac{1}{0.0134625\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0523283)^2}{2(0.0134625)^2}}\right) dx$$

$$\rho'_{Cargo_b} = \int_{0.0415}^{0.070477} \left(\frac{1}{0.0174844\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0353408)^2}{2(0.0174844)^2}}\right) dx = 0.340080$$

$$\rho'_{Cargo_r} = \int_{0.0415}^{0.0002045} \left(\frac{1}{0.0134625\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0523283)^2}{2(0.0134625)^2}}\right) dx = 0.210549$$

$$\rho'_{Cargo} = 0.340080 + 0.210549 = 0.550629$$

Model 7.b ρ'_{Cargo} Measurement – *Precip* Variable Omitted

Figure D-23. *Model 7.b Cargo variable degree of robustness*

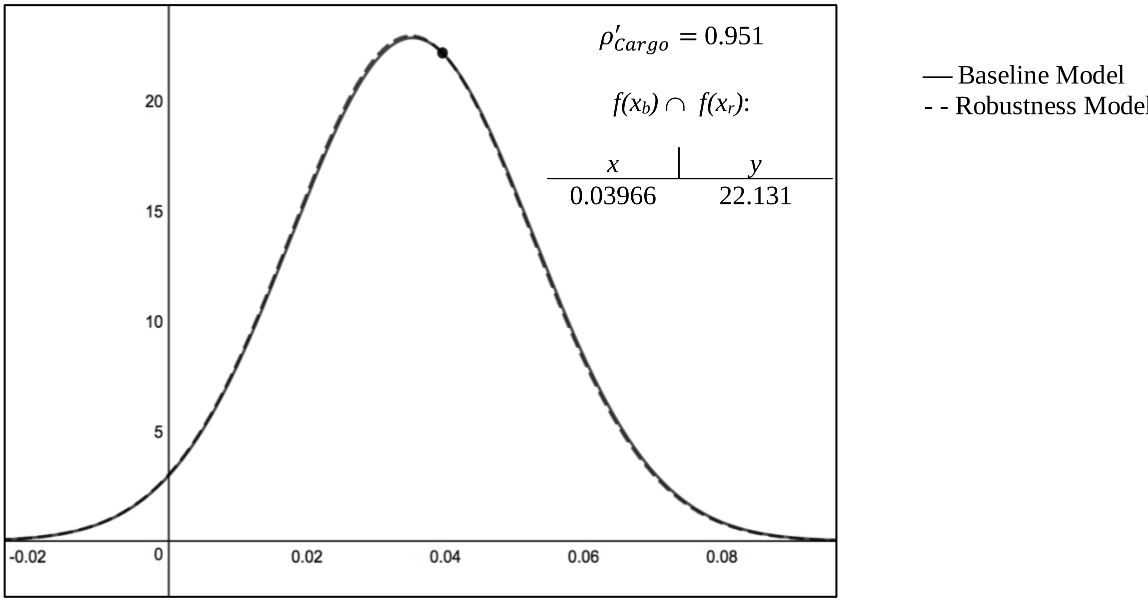


Table D-23. *Model 7.b degree of robustness calculation*

	Cargo Coefficient	Driscoll & Kraay Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0353408	0.0174844	0.0002045	0.0704770
Robustness Model	0.0350980	0.0174183	0.0000946	0.0701015

$$\rho'_{Cargo} = \int_{0.0002045}^{0.03966} \left(\frac{1}{0.0174844\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0353408)^2}{2(0.0174844)^2}}\right) dx + \int_{0.03966}^{0.0704770} \left(\frac{1}{0.0174183\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0350980)^2}{2(0.0174183)^2}}\right) dx$$

$$\rho'_{Cargo_b} = \int_{0.0002045}^{0.03966} \left(\frac{1}{0.0174844\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0353408)^2}{2(0.0174844)^2}}\right) dx = 0.575320$$

$$\rho'_{Cargo_r} = \int_{0.03966}^{0.0704770} \left(\frac{1}{0.0174183\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0350980)^2}{2(0.0174183)^2}}\right) dx = 0.375576$$

$$\rho'_{Cargo} = 0.575320 + 0.375576 = 0.950896$$

Model 7.c ρ'_{Cargo} Measurement – *Temp* Variable Omitted

Figure D-24. *Model 7.c Cargo variable degree of robustness*

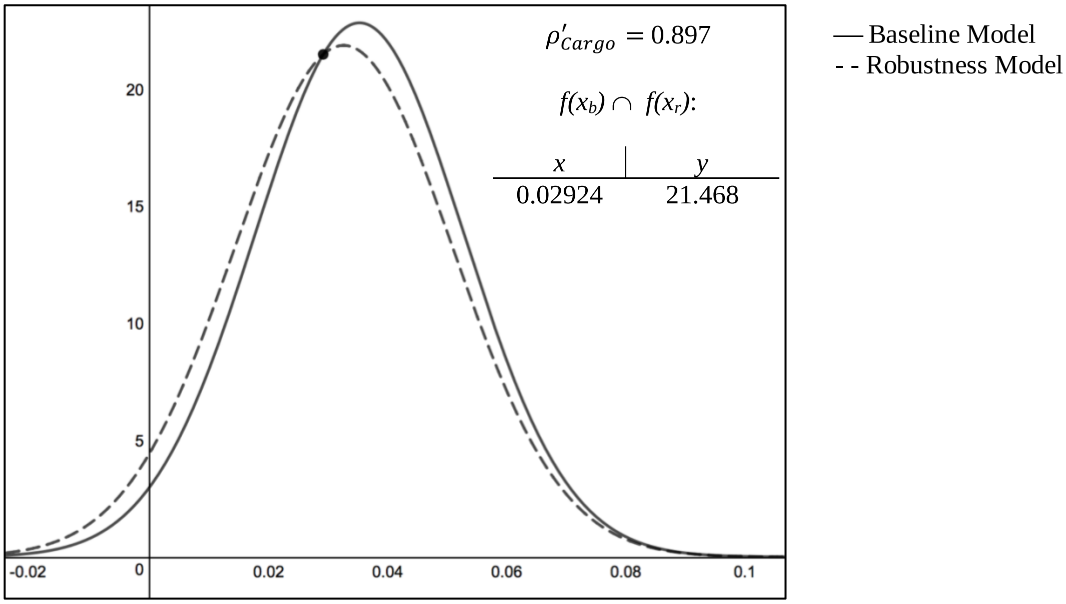


Table D-24. *Model 7.c degree of robustness calculation*

	Cargo Coefficient	Driscoll & Kraay Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0353408	0.0174844	0.0002045	0.0704770
Robustness Model	0.0326805	0.0182555	-0.0040053	0.0693664

$$\rho'_{Cargo} = \int_{0.0002045}^{0.02924} \left(\frac{1}{0.0174844\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0353408)^2}{2(0.0174844)^2}}\right) dx + \int_{0.02924}^{0.0704770} \left(\frac{1}{0.0182555\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0326805)^2}{2(0.0182555)^2}}\right) dx$$

$$\rho'_{Cargo_b} = \int_{0.0002045}^{0.02924} \left(\frac{1}{0.0174844\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0353408)^2}{2(0.0174844)^2}}\right) dx = 0.341334$$

$$\rho'_{Cargo_r} = \int_{0.02924}^{0.0704770} \left(\frac{1}{0.0182555\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0326805)^2}{2(0.0182555)^2}}\right) dx = 0.555537$$

$$\rho'_{Cargo} = 0.341334 + 0.555537 = 0.896871$$

Model 8.a ρ_{Cargo} Measurement – *Unemploy* Variable Omitted

Figure D-25. *Model 8.a Cargo variable degree of robustness*

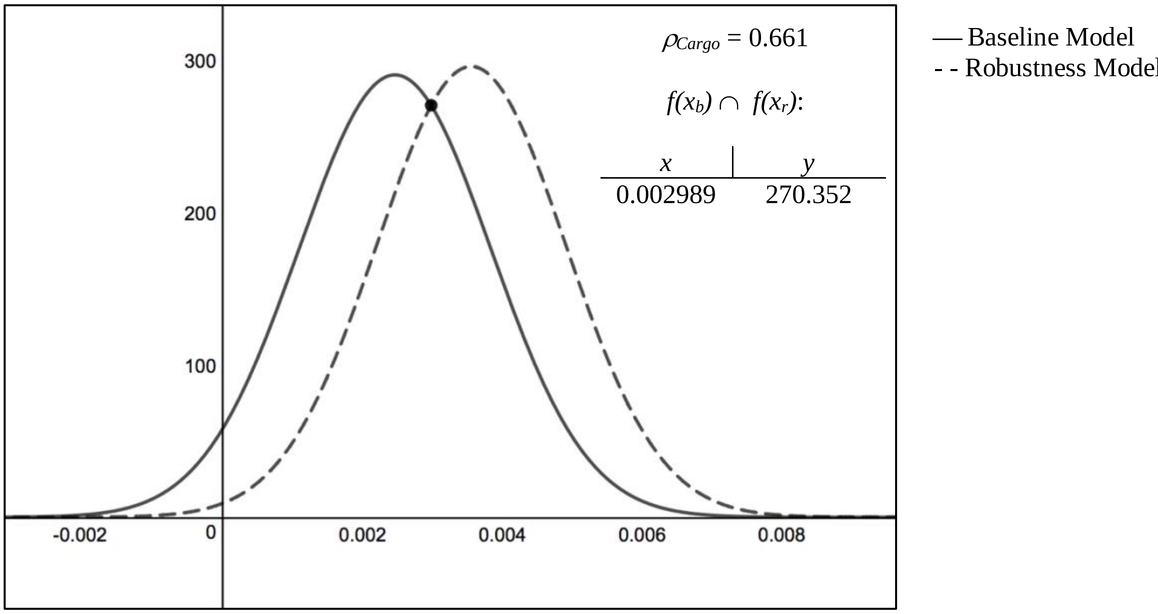


Table D-25. *Model 8.a degree of robustness calculation*

	Cargo Coefficient	Parametric Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0024700	0.0013740	-0.0002302	0.0051703
Robustness Model	0.0035619	0.0013483	0.0009121	0.0062117

$$\rho_{Cargo} = \int_{0.002989}^{0.0051703} \left(\frac{1}{0.0013740\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0024700)^2}{2(0.0013740)^2}}\right) dx + \int_{-0.0002302}^{0.002989} \left(\frac{1}{0.0013483\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0035619)^2}{2(0.0013483)^2}}\right) dx$$

$$\rho_{Cargo_b} = \int_{0.002989}^{0.0051703} \left(\frac{1}{0.0013740\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0024700)^2}{2(0.0013740)^2}}\right) dx = 0.328125$$

$$\rho_{Cargo_r} = \int_{-0.0002302}^{0.002989} \left(\frac{1}{0.0013483\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0035619)^2}{2(0.0013483)^2}}\right) dx = 0.332993$$

$$\rho_{Cargo} = 0.328125 + 0.332993 = 0.661118$$

Model 8.b ρ_{Cargo} Measurement – *Precip* Variable Omitted

Figure D-26. *Model 8.b Cargo variable degree of robustness*

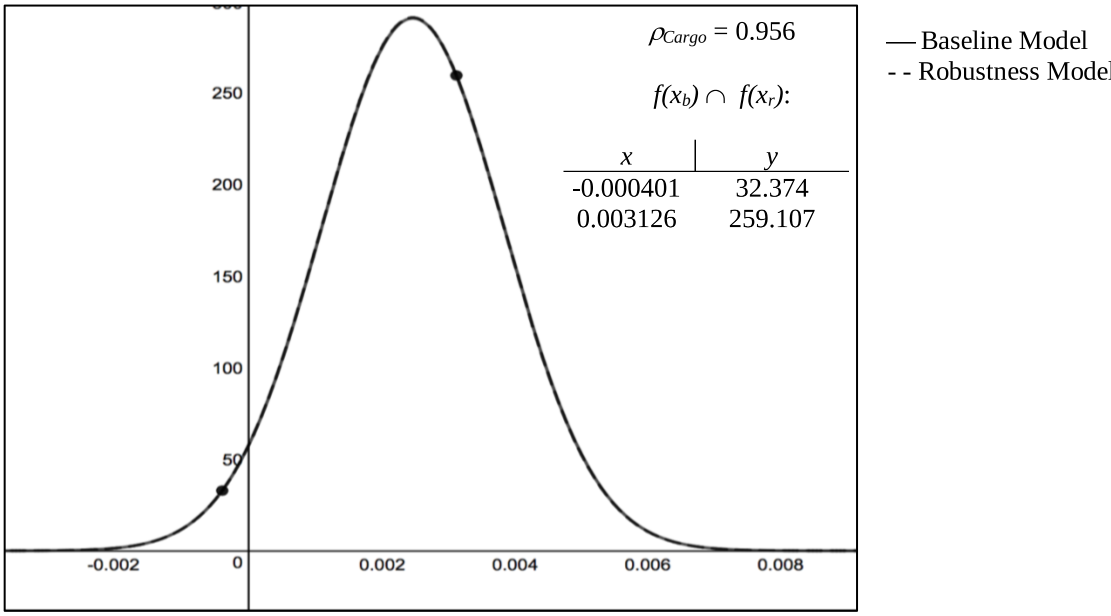


Table D-26. *Model 8.b degree of robustness calculation*

	Cargo Coefficient	Parametric Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0024700	0.0013740	-0.0002302	0.0051703
Robustness Model	0.0024671	0.0013722	-0.0002297	0.0051639

$$\rho_{Cargo} = \int_{-0.0002302}^{-0.000401}\left(\frac{1}{0.0013722\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0024671)^2}{2(0.0013722)^2}}\right)dx + \int_{-0.000401}^{0.003126}\left(\frac{1}{0.0013740\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0024700)^2}{2(0.0013740)^2}}\right)dx + \int_{0.003126}^{0.0051703}\left(\frac{1}{0.0013671\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0023866)^2}{2(0.0013671)^2}}\right)dx$$

$$\rho_{Cargo_b} = \int_{-0.000401}^{0.003126}\left(\frac{1}{0.0013740\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0024700)^2}{2(0.0013740)^2}}\right)dx = 0.665144$$

$$\rho_{Cargo_{r1}} = \int_{-0.0002302}^{-0.000401}\left(\frac{1}{0.0013722\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0024671)^2}{2(0.0013722)^2}}\right)dx + = -0.006366;$$ outside of 95% C.I.

$$\rho_{Cargo_{r2}} = \int_{0.003126}^{0.0051703}\left(\frac{1}{0.0013671\sqrt{2\pi}}\right)\cdot\left(e^{-\frac{(x-0.0023866)^2}{2(0.0013671)^2}}\right)dx = 0.291130$$

$$\rho_{Cargo} = 0.665144 + 0.291130 = 0.956274$$

Model 8.c ρ_{Cargo} Measurement – *Temp* Variable Omitted

Figure D-27. *Model 8.c Cargo variable degree of robustness*

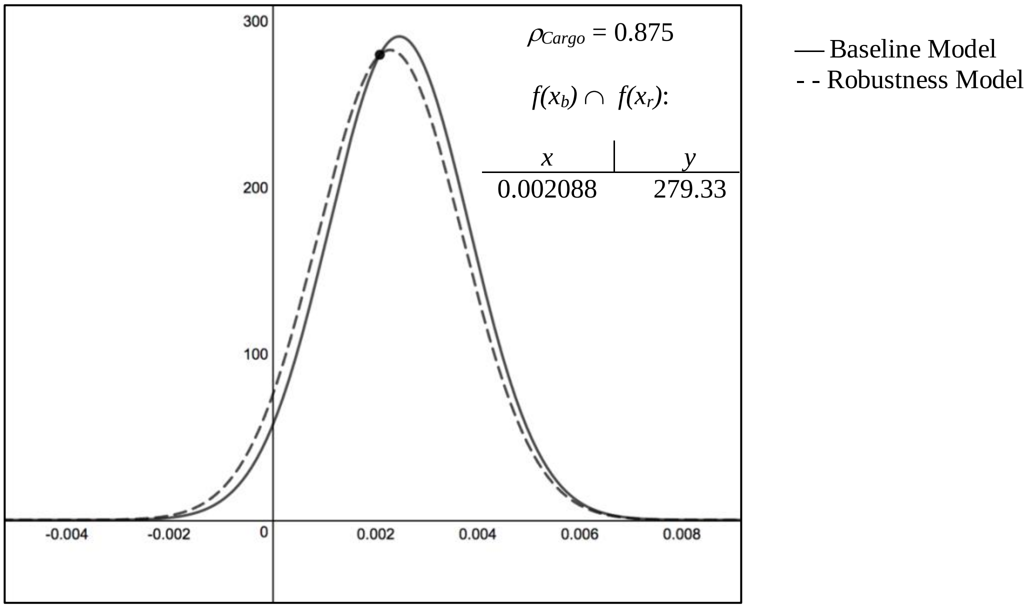


Table D-27. *Model 8.c degree of robustness calculation*

	Cargo Coefficient	Parametric Standard Error	95% Lower Confidence Limit	95% Upper Confidence Limit
Baseline Model	0.0024700	0.0013740	-0.0002302	0.0051703
Robustness Model	0.0022898	0.0014137	-0.0004885	0.0050681

$$\rho_{Cargo} = \int_{-0.0002302}^{0.002088} \left(\frac{1}{0.0013740\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0024700)^2}{2(0.0013740)^2}}\right) dx + \int_{0.002088}^{0.0051703} \left(\frac{1}{0.0014137\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0022898)^2}{2(0.0014137)^2}}\right) dx$$

$$\rho_{Cargo_b} = \int_{-0.0002302}^{0.002088} \left(\frac{1}{0.0013740\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0024700)^2}{2(0.0013740)^2}}\right) dx = 0.338962$$

$$\rho_{Cargo_r} = \int_{0.002088}^{0.0051703} \left(\frac{1}{0.0014137\sqrt{2\pi}}\right) \cdot \left(e^{-\frac{(x-0.0022898)^2}{2(0.0014137)^2}}\right) dx = 0.535958$$

$$\rho_{Cargo} = 0.338962 + 0.535958 = 0.87492$$

APPENDIX E:

FINANCIAL RATIO CALCULATIONS

Appendix E contains the financial ratio calculations across the period of the study for each port and the airport ratio data. Tables E-1 through E-20 illustrate the financial ratio data for each seaport by calendar year, Tables E-21 through E-25 show the public airport data used in this dissertation.

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Table E-1. *U.S. seaports' financial ratio calculations - 2006*

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Anacortes, WA	0.55	0.50	2.38	1.16	0.33	0.28	0.50	0.21	0.40	0.62	0.31	0.16	3.00	0.09	0.11	0.15
Anchorage, AK	1.14	0.47	36.99	1.24	0.00	0.00	0.00	0.19	32.32	0.56	22.23	0.06	39.66	0.06	0.09	0.11
Boston, MA	0.52	0.63	0.15	1.10	0.58	0.49	1.38	0.20	0.04	0.16	0.64	0.06	1.98	0.02	0.03	0.15
Cleveland, OH	0.24	0.69	1.84	0.77	0.29	0.21	0.41	0.13	0.49	0.29	-0.20	0.04	2.77	0.02	0.03	0.08
Conneaut, OH	1.02	0.49	2.29	0.95	0.15	0.11	0.18	0.33	0.47	-0.05	1.62	-0.02	2.54	-0.01	-0.02	0.29
Corpus Christi, TX	0.48	0.53	1.30	0.99	0.14	0.10	0.16	0.16	0.58	0.35	0.86	0.06	2.50	0.05	0.05	0.14
Duluth, MN	0.73	0.58	3.92	2.72	0.06	0.03	0.07	0.16	3.37	0.47	-0.17	0.06	5.69	0.05	0.06	0.11
Everett, WA	0.73	0.58	0.10	1.01	0.13	0.10	0.15	0.24	0.77	0.50	0.29	0.05	3.76	0.04	0.10	0.08
Freeport, TX	0.19	0.70	1.06	1.19	0.12	0.07	0.13	0.09	1.67	1.06	5.51	0.09	5.61	0.07	0.07	0.07
Galveston, TX	0.68	0.55	1.46	1.26	0.50	0.42	0.99	0.28	0.24	0.45	0.76	0.19	3.24	0.08	0.10	0.18
Grays Harbor, WA	1.28	0.39	1.88	0.63	0.20	0.16	0.24	0.11	0.47	-0.21	-0.09	-0.02	3.65	-0.02	-0.02	0.08
Gulfport, MS	0.39	0.72	1.11	0.99	0.19	0.16	0.24	0.12	1.77	0.09	0.56	0.03	12.86	0.02	0.02	0.08
Houston, TX	0.39	0.44	0.95	1.21	0.38	0.28	0.60	0.17	0.30	0.37	0.47	0.08	2.62	0.05	0.05	0.13
Jacksonville, FL	0.54	0.53	0.40	1.36	0.27	0.23	0.37	0.10	0.16	0.20	0.66	-0.03	1.56	0.02	0.02	0.09
Kalama, WA	0.40	0.71	7.86	2.46	0.11	0.08	0.12	0.27	3.85	0.77	2.65	0.10	16.47	0.08	0.10	0.10
Long Beach, CA	0.36	0.56	3.85	4.83	0.39	0.35	0.64	0.16	0.44	0.43	2.09	0.08	6.53	0.05	0.05	0.11
Longview, WA	0.48	0.60	1.15	1.01	0.33	0.30	0.50	0.22	0.33	0.14	0.42	0.04	2.24	0.03	0.03	0.19
Los Angeles, CA	0.32	0.61	0.57	2.26	0.33	0.26	0.50	0.14	0.23	0.25	0.98	0.05	1.42	0.03	0.03	0.12
Monroe, MI	0.42	0.48	0.30	0.26	0.26	0.13	0.35	0.03	-0.22	0.94	-0.46	0.00	1.09	0.03	0.03	0.03
N. York - N. Jersey	0.55	0.57	0.02	1.44	0.65	0.51	1.85	0.23	0.11	0.17	0.26	0.07	1.24	0.02	0.04	0.14
New Orleans, LA	0.48	0.60	0.47	1.35	0.23	0.19	0.30	0.08	0.12	0.24	0.35	0.02	1.73	0.02	0.02	0.06
Oakland, CA	0.31	0.67	0.92	1.24	0.69	0.65	2.22	0.13	0.02	0.23	1.21	0.08	3.37	0.02	0.03	0.10
Olympia, WA	0.48	0.53	1.01	0.90	0.32	0.27	0.47	0.09	0.38	1.01	-0.05	0.12	3.04	0.07	0.08	0.07

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Palm Beach, FL	0.32	0.71	1.58	1.54	0.35	0.33	0.55	0.11	0.15	0.12	1.12	0.02	6.15	0.01	0.01	0.09
Panama City, FL	0.39	0.67	1.18	1.07	0.12	0.10	0.14	0.21	0.69	0.50	0.41	0.11	4.57	0.09	0.09	0.17
Philadelphia, PA	0.93	0.52	0.16	0.47	0.57	0.50	1.35	0.06	0.00	1.79	-0.87	0.32	0.48	0.10	0.11	0.05
Port Angeles, WA	0.82	0.39	0.55	1.06	0.21	0.17	0.27	0.15	1.34	0.42	-0.27	0.06	4.15	0.04	0.05	0.10
Port Canaveral, FL	0.49	0.63	2.21	1.50	0.29	0.25	0.41	0.24	0.41	0.34	1.54	0.10	3.36	0.07	0.07	0.19
Port Everglades, FL	0.47	0.47	1.29	1.57	0.41	0.33	0.70	0.21	0.51	0.10	0.52	0.04	2.60	0.02	0.02	0.15
Port Manatee, FL	0.50	0.58	5.01	1.44	0.41	0.38	0.68	0.13	0.24	0.21	1.74	0.04	6.77	0.02	0.03	0.11
Portland, OR	1.00	0.36	0.89	1.02	0.32	0.27	0.47	0.23	0.41	0.01	0.70	0.00	6.93	0.00	0.00	0.11
Redwood City, CA	0.31	0.49	2.16	1.93	0.32	0.21	0.47	0.18	0.83	0.44	0.59	0.07	2.60	0.05	0.06	0.12
San Diego, CA	0.76	0.57	2.67	1.21	0.23	0.19	0.31	0.28	0.47	0.13	0.96	0.04	5.30	0.03	0.03	0.19
San Francisco, CA	0.68	0.59	6.15	1.31	0.14	0.11	0.16	0.22	0.78	0.27	1.44	0.06	6.79	0.05	0.05	0.17
Seattle, WA	0.21	0.73	0.20	2.01	0.60	0.53	1.51	0.09	0.05	0.45	0.48	0.10	1.00	0.04	0.04	0.08
South Louisiana	0.22	0.82	1.08	1.37	0.49	0.47	0.95	0.13	0.17	0.26	0.59	-0.34	5.09	0.01	0.03	0.05
Stockton, CA	0.63	0.49	0.16	1.28	0.47	0.38	0.88	0.32	0.02	0.05	0.48	0.02	1.21	0.01	0.02	0.19
Tacoma, WA	0.35	0.61	0.05	1.99	0.54	0.46	1.19	0.11	0.10	0.17	0.62	0.04	0.87	0.02	0.02	0.10
Tampa, FL	0.22	0.75	4.03	1.99	0.33	0.30	0.50	0.09	0.17	0.55	1.07	0.06	5.79	0.04	0.04	0.07
Toledo, OH	0.86	0.42	1.33	1.40	0.23	0.20	0.30	0.08	0.30	0.58	0.73	0.05	3.21	0.04	0.04	0.06
Vancouver, WA	0.50	0.59	5.08	1.46	0.41	0.39	0.70	0.18	0.33	0.07	-1.86	0.01	6.74	0.01	0.01	0.10
Virginia	0.36	0.63	0.46	1.19	0.58	0.51	1.39	0.35	0.09	0.05	0.31	0.13	2.28	0.01	0.02	0.25
Wilmington, DE	0.21	0.80	0.44	1.13	0.30	0.24	0.42	0.19	0.11	0.44	0.44	0.12	0.95	0.07	0.08	0.17

Table E-2. *U.S. seaports' financial ratio calculations - 2007*

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Anacortes, WA	0.89	0.53	1.71	1.14	0.31	0.25	0.45	0.31	0.31	0.34	0.92	0.08	4.16	0.05	0.08	0.14
Anchorage, AK	1.20	0.45	9.79	1.10	0.01	0.00	0.01	0.18	9.79	0.40	4.93	0.17	10.65	0.03	0.06	0.09
Boston, MA	0.50	0.64	0.21	1.09	0.57	0.48	1.30	0.20	0.06	0.13	0.73	0.05	1.71	0.02	0.02	0.16
Cleveland, OH	0.27	0.66	2.50	0.77	0.30	0.23	0.42	0.12	0.58	0.32	-0.01	0.01	3.41	0.03	0.03	0.08
Conneaut, OH	0.97	0.49	0.22	0.93	0.15	0.10	0.18	0.22	-0.42	0.13	1.34	0.03	0.44	0.03	0.03	0.22
Corpus Christi, TX	0.50	0.50	1.42	1.06	0.13	0.10	0.15	0.20	0.54	0.17	1.24	0.04	2.54	0.03	0.03	0.17
Duluth, MN	0.80	0.56	6.18	2.27	0.08	0.06	0.09	0.17	3.16	0.37	2.45	0.05	8.34	0.04	0.05	0.12
Everett, WA	0.55	0.65	0.19	1.09	0.16	0.14	0.19	0.20	0.54	0.42	0.77	0.04	4.32	0.04	0.07	0.09
Freeport, TX	0.20	0.69	1.41	1.23	0.12	0.07	0.13	0.09	1.97	1.03	1.12	0.08	5.44	0.07	0.07	0.07
Galveston, TX	0.67	0.55	0.95	1.33	0.47	0.40	0.89	0.26	0.25	0.30	0.90	0.11	3.41	0.05	0.06	0.17
Grays Harbor, WA	1.32	0.39	0.97	0.70	0.20	0.15	0.24	0.13	0.44	-0.01	-0.13	0.00	4.05	0.00	0.00	0.10
Gulfport, MS	0.37	0.73	0.95	0.62	0.18	0.15	0.22	0.07	2.39	1.75	-0.42	0.10	13.98	0.07	0.07	0.04
Houston, TX	0.37	0.57	0.63	1.11	0.40	0.25	0.67	0.17	0.25	0.21	0.30	0.05	1.36	0.03	0.03	0.13
Jacksonville, FL	0.50	0.52	0.20	1.52	0.41	0.35	0.71	0.10	0.09	0.34	0.53	0.00	2.38	0.03	0.03	0.08
Kalama, WA	0.35	0.74	12.70	2.22	0.09	0.07	0.10	0.22	4.37	0.76	2.69	0.08	20.03	0.07	0.09	0.09
Long Beach, CA	0.38	0.53	3.39	4.04	0.37	0.31	0.59	0.16	0.53	0.43	1.44	0.08	5.31	0.05	0.05	0.11
Longview, WA	0.52	0.58	0.53	0.95	0.35	0.27	0.54	0.23	0.44	0.05	0.24	0.01	0.91	0.01	0.01	0.19
Los Angeles, CA	0.35	0.60	1.30	2.34	0.32	0.25	0.47	0.15	0.33	0.28	0.91	0.05	2.21	0.03	0.04	0.12
Monroe, MI	0.39	0.42	0.26	0.29	0.21	0.11	0.27	0.03	-0.25	3.37	-0.58	0.17	1.11	0.11	0.12	0.03
N. York - N. Jersey	0.54	0.55	0.03	1.42	0.62	0.49	1.65	0.21	0.11	0.41	0.00	0.17	1.17	0.05	0.08	0.13
New Orleans, LA	0.49	0.61	1.53	1.34	0.23	0.20	0.29	0.08	0.21	0.17	0.61	0.01	3.53	0.01	0.01	0.06
Oakland, CA	0.32	0.67	0.81	1.22	0.67	0.63	2.06	0.13	0.02	0.25	1.18	0.08	2.36	0.03	0.03	0.10
Olympia, WA	0.47	0.56	0.60	1.00	0.29	0.24	0.42	0.09	0.22	0.49	-0.05	0.06	1.86	0.04	0.04	0.08

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Palm Beach, FL	0.30	0.72	0.72	1.52	0.36	0.32	0.56	0.10	0.15	0.16	0.75	0.02	4.78	0.01	0.01	0.08
Panama City, FL	0.37	0.67	1.37	1.07	0.19	0.14	0.24	0.16	0.47	0.43	0.22	0.08	3.06	0.06	0.06	0.14
Philadelphia, PA	1.00	0.50	0.09	0.46	0.54	0.44	1.17	0.06	0.00	0.97	-0.69	0.13	0.32	0.05	0.06	0.05
Port Angeles, WA	0.74	0.38	1.49	1.03	0.17	0.14	0.21	0.13	1.76	1.62	0.40	0.21	4.00	0.14	0.19	0.09
Port Canaveral, FL	0.51	0.61	2.60	1.38	0.27	0.23	0.36	0.23	0.45	0.29	2.03	0.08	3.63	0.05	0.06	0.19
Port Everglades, FL	0.50	0.47	0.79	1.56	0.39	0.31	0.63	0.22	0.57	0.13	0.68	0.03	2.89	0.02	0.02	0.16
Port Manatee, FL	0.51	0.59	4.97	1.34	0.43	0.41	0.75	0.12	0.19	0.19	1.67	0.03	6.41	0.02	0.02	0.10
Portland, OR	0.98	0.36	0.87	0.95	0.34	0.29	0.52	0.24	0.31	0.04	0.02	0.01	5.93	0.01	0.01	0.12
Redwood City, CA	0.33	0.48	4.28	1.76	0.28	0.20	0.38	0.18	1.05	0.51	1.25	0.08	5.05	0.06	0.07	0.12
San Diego, CA	0.78	0.56	1.30	1.25	0.22	0.18	0.29	0.29	0.66	0.26	0.98	0.07	5.67	0.05	0.06	0.20
San Francisco, CA	0.69	0.59	6.58	1.25	0.14	0.11	0.16	0.22	1.01	0.27	1.29	0.05	7.23	0.04	0.05	0.16
Seattle, WA	0.22	0.71	0.05	1.91	0.61	0.50	1.58	0.09	0.07	0.45	0.32	0.09	0.89	0.03	0.04	0.07
South Louisiana	0.24	0.81	1.08	1.21	0.44	0.42	0.78	0.13	0.18	0.15	0.50	0.02	5.59	0.01	0.02	0.06
Stockton, CA	0.63	0.49	0.17	1.30	0.50	0.42	0.98	0.34	0.03	0.08	0.72	0.04	1.06	0.02	0.03	0.22
Tacoma, WA	0.33	0.59	0.07	1.95	0.56	0.42	1.29	0.11	0.04	0.21	0.29	0.04	0.64	0.02	0.02	0.09
Tampa, FL	0.24	0.74	5.78	1.82	0.31	0.29	0.46	0.09	0.16	0.68	1.12	0.07	6.79	0.05	0.05	0.07
Toledo, OH	0.86	0.42	1.52	1.30	0.23	0.19	0.29	0.07	0.32	0.34	0.41	0.03	2.32	0.02	0.02	0.06
Vancouver, WA	0.53	0.56	5.29	1.52	0.38	0.34	0.60	0.20	0.43	0.52	2.37	0.11	6.97	0.06	0.08	0.12
Virginia	0.38	0.65	0.56	1.23	0.58	0.51	1.36	0.36	0.12	0.12	0.61	0.08	2.36	0.03	0.04	0.26
Wilmington, DE	0.25	0.79	0.49	1.12	0.24	0.20	0.33	0.21	0.11	0.55	0.71	0.13	1.12	0.09	0.11	0.17

Table E-3. *U.S. seaports' financial ratio calculations - 2008*

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Anacortes, WA	0.81	0.55	0.49	1.16	0.59	0.35	1.43	0.33	0.26	0.74	0.17	-0.22	1.03	0.10	0.24	0.13
Anchorage, AK	1.25	0.45	0.21	1.07	0.21	0.00	0.27	0.17	0.25	3.72	0.14	0.32	0.74	0.19	0.77	0.05
Boston, MA	0.56	0.62	0.22	1.08	0.55	0.47	1.25	0.22	0.07	0.13	0.78	0.05	1.40	0.02	0.03	0.16
Cleveland, OH	0.32	0.63	1.91	0.62	0.31	0.24	0.46	0.11	0.42	0.09	-0.28	-0.04	2.75	0.01	0.01	0.07
Conneaut, OH	1.13	0.45	0.13	1.07	0.16	0.03	0.18	0.24	-0.18	0.04	0.71	0.01	0.77	0.01	0.01	0.22
Corpus Christi, TX	0.54	0.57	3.92	1.15	0.11	0.09	0.12	0.23	1.02	0.18	2.50	0.04	5.64	0.03	0.04	0.19
Duluth, MN	0.74	0.58	6.83	1.96	0.14	0.12	0.16	0.18	1.44	0.61	2.87	0.09	8.75	0.07	0.09	0.12
Everett, WA	0.56	0.64	0.23	1.08	0.19	0.17	0.23	0.21	0.47	0.21	1.03	-0.01	4.96	0.02	0.04	0.09
Freeport, TX	0.18	0.68	1.25	1.19	0.24	0.18	0.33	0.09	0.92	0.78	0.76	0.06	5.35	0.05	0.05	0.06
Galveston, TX	0.60	0.56	0.34	1.20	0.56	0.41	1.30	0.24	0.15	0.51	-0.01	0.17	2.72	0.06	0.08	0.12
Grays Harbor, WA	1.37	0.37	1.00	0.74	0.18	0.14	0.22	0.16	0.54	0.10	-0.50	0.02	4.74	0.01	0.01	0.13
Gulfport, MS	0.33	0.75	0.66	1.02	0.15	0.12	0.18	0.09	2.73	2.68	0.65	0.17	15.03	0.12	0.13	0.05
Houston, TX	0.38	0.62	2.20	1.06	0.42	0.38	0.72	0.17	0.33	0.24	1.12	0.06	4.63	0.03	0.03	0.13
Jacksonville, FL	0.39	0.50	0.10	1.44	0.56	0.41	1.34	0.08	0.03	0.24	0.20	0.02	1.17	0.02	0.02	0.06
Kalama, WA	0.35	0.74	10.19	2.52	0.08	0.06	0.08	0.30	3.22	0.55	3.18	0.08	17.63	0.07	0.09	0.12
Long Beach, CA	0.42	0.52	2.90	3.28	0.33	0.26	0.50	0.16	0.57	0.44	1.11	0.08	4.31	0.05	0.05	0.11
Longview, WA	0.53	0.58	1.37	1.02	0.33	0.29	0.49	0.28	0.43	0.11	0.13	0.04	2.74	0.03	0.03	0.24
Los Angeles, CA	0.37	0.57	1.73	2.23	0.30	0.23	0.44	0.15	0.43	0.33	1.01	0.06	2.60	0.04	0.04	0.12
Monroe, MI	0.37	0.37	0.09	0.26	0.19	0.09	0.24	0.03	-0.32	2.46	0.07	0.14	0.91	0.08	0.09	0.03
N. York - N. Jersey	0.52	0.56	0.15	1.43	0.61	0.51	1.55	0.21	0.12	0.25	0.00	0.10	1.08	0.04	0.05	0.14
New Orleans, LA	0.53	0.61	1.98	1.25	0.23	0.20	0.29	0.08	0.40	0.70	0.44	0.06	5.15	0.04	0.05	0.06
Oakland, CA	0.34	0.67	0.68	1.19	0.66	0.61	1.95	0.12	0.01	0.17	2.88	0.06	1.63	0.02	0.02	0.11
Olympia, WA	0.45	0.66	3.30	0.98	0.36	0.32	0.57	0.08	0.19	0.72	0.20	0.08	4.68	0.05	0.05	0.06

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Palm Beach, FL	0.32	0.70	0.44	1.32	0.36	0.33	0.57	0.10	0.15	0.45	0.54	-0.07	4.64	0.04	0.04	0.08
Panama City, FL	0.37	0.70	1.17	1.00	0.18	0.15	0.22	0.13	0.21	0.43	-0.12	0.07	2.92	0.05	0.05	0.12
Philadelphia, PA	0.96	0.47	0.18	0.46	0.45	0.34	0.86	0.06	0.04	3.47	-0.58	0.41	0.44	0.15	0.19	0.05
Port Angeles, WA	0.69	0.47	0.62	0.93	0.16	0.13	0.19	0.12	1.57	0.24	-0.48	0.02	2.17	0.02	0.03	0.08
Port Canaveral, FL	0.57	0.61	2.89	1.16	0.31	0.28	0.45	0.22	0.42	0.11	2.05	0.03	6.27	0.02	0.02	0.16
Port Everglades, FL	0.54	0.44	0.34	1.60	0.37	0.30	0.59	0.23	0.60	0.17	0.79	0.05	3.22	0.03	0.03	0.16
Port Manatee, FL	0.52	0.58	1.65	1.22	0.42	0.35	0.73	0.10	0.14	0.37	0.49	0.06	2.20	0.03	0.03	0.09
Portland, OR	1.00	0.36	0.88	0.99	0.34	0.29	0.52	0.30	0.32	0.23	0.18	0.05	5.76	0.03	0.04	0.14
Redwood City, CA	0.35	0.46	7.38	1.65	0.23	0.19	0.30	0.17	1.29	0.50	1.69	0.07	8.40	0.06	0.06	0.11
San Diego, CA	0.79	0.56	1.38	1.28	0.21	0.17	0.27	0.31	0.78	0.23	1.19	0.06	6.07	0.05	0.05	0.20
San Francisco, CA	0.72	0.58	7.53	1.17	0.13	0.10	0.15	0.23	1.29	0.19	1.16	0.04	8.19	0.03	0.03	0.17
Seattle, WA	0.23	0.72	0.07	1.74	0.57	0.50	1.34	0.09	0.10	0.32	0.59	0.06	0.82	0.03	0.03	0.08
South Louisiana	0.27	0.79	0.89	1.11	0.44	0.41	0.77	0.13	0.16	0.08	0.41	0.01	4.77	0.01	0.01	0.07
Stockton, CA	0.60	0.52	0.19	1.27	0.49	0.43	0.95	0.31	0.03	0.03	0.78	0.01	0.94	0.01	0.01	0.22
Tacoma, WA	0.32	0.56	0.21	1.87	0.64	0.60	1.78	0.10	0.06	0.04	0.68	0.01	2.81	0.00	0.00	0.08
Tampa, FL	0.27	0.72	6.87	1.77	0.30	0.27	0.42	0.09	0.21	0.44	1.26	0.05	7.99	0.03	0.03	0.07
Toledo, OH	0.84	0.42	1.56	1.29	0.23	0.20	0.29	0.07	0.33	0.22	0.65	0.02	2.57	0.01	0.02	0.06
Vancouver, WA	0.51	0.53	5.04	1.56	0.47	0.44	0.88	0.18	0.12	-0.06	1.08	-0.01	10.35	-0.01	-0.01	0.10
Virginia	0.38	0.64	0.55	1.23	0.58	0.51	1.36	0.35	0.14	0.18	0.67	0.12	2.42	0.05	0.06	0.25
Wilmington, DE	0.32	0.76	0.57	1.07	0.21	0.19	0.27	0.21	0.08	0.29	0.66	0.07	1.31	0.05	0.07	0.15

Table E-4. *U.S. seaports' financial ratio calculations - 2009*

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Anacortes, WA	0.84	0.54	0.42	1.04	0.50	0.21	1.01	0.34	0.03	0.59	0.21	0.18	1.11	0.08	0.19	0.13
Anchorage, AK	1.34	0.43	0.32	0.99	0.20	0.00	0.25	0.17	0.34	1.20	0.12	0.08	1.07	0.06	0.19	0.05
Boston, MA	0.62	0.59	0.17	1.06	0.54	0.45	1.16	0.22	0.07	0.15	0.71	0.06	1.23	0.02	0.03	0.16
Cleveland, OH	0.36	0.60	1.38	0.53	0.31	0.20	0.45	0.10	0.47	-0.09	-0.37	-0.01	2.32	-0.01	-0.01	0.07
Conneaut, OH	1.29	0.42	0.99	0.76	0.14	0.08	0.17	0.25	-0.47	-0.24	0.57	-0.06	1.17	-0.06	-0.06	0.23
Corpus Christi, TX	0.56	0.54	2.66	1.01	0.11	0.08	0.12	0.20	0.80	0.05	1.75	0.01	3.99	0.01	0.01	0.17
Duluth, MN	0.75	0.57	9.10	2.70	0.11	0.09	0.12	0.23	2.27	0.59	7.06	0.11	15.42	0.09	0.10	0.15
Everett, WA	0.50	0.67	0.17	1.04	0.19	0.17	0.24	0.17	0.27	0.08	1.31	0.01	3.80	0.01	0.01	0.09
Freeport, TX	0.17	0.68	0.86	1.16	0.27	0.21	0.36	0.08	0.61	0.61	0.40	0.05	4.40	0.03	0.04	0.06
Galveston, TX	0.58	0.56	1.43	1.01	0.51	0.45	1.06	0.21	0.13	0.05	0.69	0.01	5.39	0.01	0.01	0.13
Grays Harbor, WA	1.35	0.36	0.59	0.87	0.17	0.12	0.21	0.19	0.58	0.43	0.05	0.08	3.88	0.06	0.07	0.15
Gulfport, MS	0.30	0.77	0.76	1.10	0.13	0.10	0.15	0.09	2.86	2.32	1.02	0.16	14.85	0.12	0.13	0.05
Houston, TX	0.39	0.60	0.15	0.95	0.44	0.30	0.80	0.13	0.26	0.04	0.25	0.01	0.56	0.00	0.01	0.10
Jacksonville, FL	0.37	0.58	0.13	1.42	0.58	0.49	1.36	0.08	0.03	0.17	0.36	0.03	0.87	0.01	0.01	0.07
Kalama, WA	0.27	0.71	15.67	2.22	0.06	0.05	0.07	0.16	6.25	0.40	3.20	0.04	26.20	0.04	0.04	0.09
Long Beach, CA	0.45	0.50	3.31	3.16	0.30	0.24	0.42	0.14	0.71	0.41	0.85	0.06	4.36	0.04	0.05	0.09
Longview, WA	0.54	0.55	2.06	1.01	0.35	0.30	0.55	0.29	0.55	0.21	0.62	0.08	3.14	0.05	0.05	0.23
Los Angeles, CA	0.39	0.55	2.03	1.75	0.30	0.23	0.43	0.15	0.36	0.22	0.81	0.02	2.94	0.03	0.03	0.12
Monroe, MI	0.39	0.34	0.22	0.22	0.26	0.14	0.36	0.03	-0.47	-0.43	0.07	-0.10	0.80	-0.01	-0.01	0.02
N. York - N. Jersey	0.50	0.56	0.82	1.46	0.61	0.52	1.55	0.19	0.12	0.24	0.63	0.09	1.55	0.03	0.04	0.13
New Orleans, LA	0.56	0.59	0.78	1.08	0.23	0.20	0.30	0.07	0.48	0.42	0.14	0.04	5.74	0.03	0.03	0.06
Oakland, CA	0.38	0.66	0.66	1.13	0.66	0.61	1.92	0.13	0.01	0.01	2.71	0.00	1.38	0.00	0.00	0.11
Olympia, WA	0.47	0.56	2.92	1.13	0.34	0.29	0.51	0.08	0.10	0.63	0.21	0.07	3.36	0.04	0.05	0.07

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Palm Beach, FL	0.37	0.67	1.17	1.34	0.37	0.34	0.58	0.09	0.14	-0.10	0.85	-0.05	4.52	-0.01	-0.01	0.08
Panama City, FL	0.39	0.69	1.59	1.02	0.17	0.15	0.21	0.15	0.23	0.24	0.19	0.04	3.72	0.03	0.03	0.14
Philadelphia, PA	0.75	0.44	0.20	0.48	0.36	0.23	0.55	0.04	0.05	7.66	-0.42	0.72	0.51	0.27	0.37	0.04
Port Angeles, WA	0.73	0.46	1.22	0.93	0.14	0.12	0.17	0.11	1.70	0.16	-0.55	0.02	2.49	0.01	0.02	0.08
Port Canaveral, FL	0.62	0.59	2.37	1.08	0.32	0.28	0.47	0.20	0.34	0.16	1.74	0.04	5.91	0.02	0.02	0.15
Port Everglades, FL	0.52	0.40	0.09	1.52	0.41	0.34	0.69	0.20	0.50	0.19	0.71	0.05	3.28	0.03	0.03	0.14
Port Manatee, FL	0.56	0.57	0.73	1.27	0.41	0.32	0.70	0.10	0.13	0.14	0.19	0.02	1.09	0.01	0.01	0.08
Portland, OR	1.00	0.36	0.93	0.98	0.34	0.28	0.51	0.31	0.33	0.22	0.08	0.03	6.23	0.03	0.04	0.15
Redwood City, CA	0.61	0.45	9.95	1.79	0.27	0.23	0.37	0.27	1.09	0.57	1.61	-0.18	11.19	0.08	0.08	0.14
San Diego, CA	0.81	0.55	1.22	1.20	0.21	0.17	0.27	0.31	0.75	0.07	0.97	0.02	5.70	0.01	0.02	0.20
San Francisco, CA	0.81	0.48	5.62	1.15	0.17	0.13	0.21	0.25	0.81	0.03	0.82	-0.06	6.41	0.00	0.00	0.17
Seattle, WA	0.25	0.71	0.13	1.83	0.58	0.50	1.40	0.08	0.11	0.25	0.43	0.04	0.66	0.02	0.02	0.07
South Louisiana	0.29	0.77	0.18	0.99	0.45	0.40	0.80	0.13	0.09	0.00	0.12	0.00	1.88	0.00	0.00	0.06
Stockton, CA	0.58	0.54	0.20	1.22	0.48	0.42	0.93	0.29	0.03	-0.02	0.55	-0.01	0.90	0.00	-0.01	0.22
Tacoma, WA	0.36	0.56	0.05	1.86	0.63	0.58	1.72	0.09	0.08	-0.26	0.51	-0.05	2.61	-0.02	-0.02	0.08
Tampa, FL	0.30	0.69	5.89	1.78	0.29	0.26	0.40	0.09	0.25	0.65	1.29	0.07	6.78	0.05	0.05	0.07
Toledo, OH	0.90	0.40	1.01	1.29	0.21	0.18	0.26	0.07	0.37	0.00	0.17	0.00	2.88	0.00	0.00	0.06
Vancouver, WA	0.34	0.55	1.66	1.51	0.49	0.44	0.98	0.12	0.10	0.55	1.02	0.11	2.72	0.05	0.06	0.09
Virginia	0.39	0.65	0.39	1.17	0.58	0.48	1.36	0.29	0.12	0.08	0.41	0.06	1.85	0.02	0.02	0.22
Wilmington, DE	0.36	0.73	0.47	1.06	0.20	0.18	0.26	0.21	0.09	-0.04	0.25	-0.01	1.09	-0.01	-0.01	0.15

Table E-5. *U.S. seaports' financial ratio calculations - 2010*

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Anacortes, WA	0.90	0.53	1.23	1.09	0.46	0.29	0.85	0.36	0.24	0.30	0.02	0.08	2.00	0.04	0.08	0.14
Anchorage, AK	1.53	0.39	0.51	1.08	0.17	0.00	0.20	0.19	0.54	4.17	0.12	0.25	0.96	0.17	0.80	0.04
Boston, MA	0.66	0.57	0.17	1.04	0.52	0.43	1.09	0.21	0.06	0.08	0.66	0.03	1.28	0.01	0.02	0.16
Cleveland, OH	0.38	0.58	2.60	0.75	0.27	0.20	0.37	0.11	0.67	0.90	-0.11	0.09	3.56	0.06	0.08	0.07
Conneaut, OH	1.50	0.38	0.64	0.77	0.10	0.03	0.11	0.28	-0.39	-0.14	0.33	-0.04	0.83	-0.04	-0.04	0.26
Corpus Christi, TX	0.42	0.62	2.11	1.10	0.08	0.05	0.08	0.15	1.01	2.23	1.68	0.50	4.13	0.30	0.31	0.14
Duluth, MN	0.78	0.56	3.45	2.41	0.10	0.08	0.11	0.22	2.68	0.36	8.07	0.06	21.18	0.05	0.06	0.14
Everett, WA	0.53	0.65	0.13	0.95	0.21	0.19	0.26	0.16	0.11	0.11	0.75	0.01	3.58	0.01	0.02	0.08
Freeport, TX	0.18	0.66	0.63	1.22	0.25	0.20	0.34	0.08	0.54	0.50	0.48	0.04	3.46	0.03	0.03	0.06
Galveston, TX	0.61	0.54	1.70	1.13	0.47	0.41	0.89	0.24	0.20	0.41	0.56	0.12	5.14	0.06	0.07	0.14
Grays Harbor, WA	1.25	0.39	0.78	1.07	0.17	0.11	0.20	0.31	0.40	0.40	1.59	0.13	3.44	0.09	0.10	0.24
Gulfport, MS	0.27	0.79	1.76	0.79	0.12	0.08	0.13	0.07	2.79	2.08	0.26	0.13	10.30	0.10	0.11	0.05
Houston, TX	0.40	0.63	1.00	0.93	0.49	0.47	0.97	0.14	0.23	0.10	0.35	0.00	5.87	0.01	0.01	0.10
Jacksonville, FL	0.41	0.59	0.21	1.55	0.56	0.51	1.26	0.08	0.06	0.14	0.54	0.02	1.14	0.01	0.01	0.07
Kalama, WA	0.30	0.67	16.02	3.21	0.06	0.04	0.06	0.23	7.55	0.50	4.90	0.07	23.38	0.06	0.07	0.13
Long Beach, CA	0.47	0.47	2.73	3.26	0.27	0.22	0.37	0.14	0.58	0.38	1.16	0.05	3.76	0.04	0.04	0.09
Longview, WA	0.52	0.54	2.36	1.02	0.33	0.29	0.49	0.29	0.36	0.07	0.66	0.03	1.69	0.02	0.02	0.25
Los Angeles, CA	0.39	0.53	2.20	1.76	0.31	0.26	0.46	0.14	0.25	0.19	0.80	0.01	2.96	0.02	0.02	0.11
Monroe, MI	0.41	0.31	0.28	0.20	0.31	0.20	0.46	0.02	-0.62	-0.13	-0.63	-0.09	0.73	0.00	0.00	0.02
N. York - N. Jersey	0.48	0.55	1.00	1.40	0.63	0.54	1.68	0.18	0.09	0.10	0.60	0.03	1.36	0.01	0.02	0.12
New Orleans, LA	0.59	0.57	2.10	1.11	0.23	0.20	0.29	0.07	0.40	-0.12	0.30	-0.01	6.53	-0.01	-0.01	0.06
Oakland, CA	0.42	0.63	0.85	1.13	0.66	0.61	1.91	0.12	0.00	-0.03	1.31	-0.02	1.38	0.00	0.00	0.11
Olympia, WA	0.43	0.58	2.52	1.14	0.30	0.26	0.43	0.08	0.26	0.81	0.22	0.10	2.93	0.06	0.06	0.07

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Palm Beach, FL	0.41	0.64	1.56	1.60	0.36	0.33	0.56	0.11	0.15	-0.15	1.13	-0.02	4.77	-0.01	-0.01	0.09
Panama City, FL	0.44	0.67	5.63	1.09	0.16	0.15	0.19	0.16	0.29	0.18	3.12	0.03	12.79	0.03	0.03	0.15
Philadelphia, PA	0.51	0.45	0.12	0.56	0.26	0.15	0.37	0.04	0.03	10.80	-0.22	0.72	0.41	0.31	0.41	0.03
Port Angeles, WA	0.78	0.44	2.01	1.17	0.18	0.16	0.23	0.14	1.65	0.11	0.65	0.01	6.51	0.01	0.01	0.10
Port Canaveral, FL	0.65	0.56	2.39	1.16	0.30	0.26	0.43	0.20	0.37	0.18	1.78	0.04	4.98	0.03	0.03	0.15
Port Everglades, FL	0.54	0.43	0.39	1.64	0.40	0.33	0.66	0.21	0.57	0.17	0.75	0.04	3.47	0.03	0.03	0.15
Port Manatee, FL	0.59	0.56	0.79	1.22	0.41	0.34	0.71	0.10	0.10	0.11	0.28	0.02	1.34	0.01	0.01	0.09
Portland, OR	0.99	0.36	1.18	0.96	0.34	0.30	0.52	0.26	0.32	0.06	0.16	0.00	7.20	0.01	0.01	0.13
Redwood City, CA	0.86	0.45	11.53	1.74	0.31	0.26	0.44	0.37	0.86	0.54	1.85	-0.17	13.03	0.09	0.09	0.16
San Diego, CA	0.83	0.55	1.27	1.10	0.22	0.17	0.28	0.28	0.62	-0.05	0.60	-0.01	4.96	-0.01	-0.01	0.19
San Francisco, CA	0.90	0.38	4.06	1.14	0.25	0.19	0.33	0.26	0.34	0.10	0.49	-0.04	6.12	0.02	0.02	0.17
Seattle, WA	0.28	0.68	0.27	1.86	0.57	0.52	1.35	0.09	0.11	0.11	0.53	0.02	1.06	0.01	0.01	0.07
South Louisiana	0.30	0.77	0.72	1.12	0.44	0.40	0.77	0.16	0.10	0.30	0.38	0.05	2.61	0.03	0.05	0.08
Stockton, CA	0.60	0.52	0.19	1.19	0.47	0.41	0.90	0.26	0.03	0.01	0.32	0.00	0.94	0.00	0.00	0.21
Tacoma, WA	0.39	0.52	0.05	1.84	0.63	0.58	1.67	0.10	0.14	0.21	0.85	0.05	2.66	0.02	0.02	0.08
Tampa, FL	0.27	0.68	5.09	1.81	0.27	0.24	0.37	0.07	0.31	0.59	1.40	0.06	5.87	0.04	0.04	0.07
Toledo, OH	0.88	0.41	1.34	1.35	0.19	0.15	0.23	0.06	0.39	1.59	0.44	0.11	2.95	0.08	0.09	0.05
Vancouver, WA	0.35	0.55	1.08	1.50	0.45	0.41	0.82	0.12	0.03	0.36	0.29	0.07	2.34	0.04	0.04	0.10
Virginia	0.42	0.63	0.43	1.15	0.58	0.49	1.40	0.25	0.10	-0.06	0.25	-0.02	1.76	-0.01	-0.01	0.20
Wilmington, DE	0.41	0.71	0.36	1.11	0.20	0.17	0.24	0.22	0.07	-0.01	0.61	0.00	1.09	0.00	0.00	0.16

Table E-6. *U.S. seaports' financial ratio calculations - 2011*

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Anacortes, WA	0.85	0.54	1.93	0.95	0.36	0.29	0.56	0.34	0.19	0.43	-0.04	0.12	2.81	0.07	0.12	0.16
Anchorage, AK	1.43	0.41	0.28	1.13	0.17	0.01	0.20	0.17	0.24	1.01	0.14	0.05	0.43	0.04	0.28	0.04
Boston, MA	0.70	0.56	0.17	1.03	0.52	0.44	1.10	0.21	0.05	0.07	0.62	0.02	1.70	0.01	0.01	0.15
Cleveland, OH	0.39	0.58	2.26	0.89	0.26	0.19	0.35	0.13	0.64	0.34	0.13	0.04	3.10	0.03	0.04	0.08
Conneaut, OH	1.45	0.37	1.81	0.82	0.28	0.19	0.39	0.27	0.31	0.05	0.34	0.02	1.93	0.01	0.01	0.22
Corpus Christi, TX	0.44	0.59	2.92	1.17	0.07	0.05	0.08	0.17	1.28	0.31	2.17	0.05	4.76	0.05	0.05	0.15
Duluth, MN	0.84	0.54	4.70	1.71	0.09	0.08	0.10	0.17	2.98	0.20	3.28	0.03	21.97	0.02	0.02	0.10
Everett, WA	0.54	0.65	0.18	0.98	0.21	0.19	0.27	0.17	0.13	0.02	0.96	0.00	3.51	0.00	0.00	0.09
Freeport, TX	0.19	0.66	1.08	1.27	0.24	0.18	0.32	0.08	0.59	0.45	0.55	0.04	3.54	0.03	0.03	0.07
Galveston, TX	0.56	0.56	0.90	1.09	0.42	0.36	0.73	0.21	0.08	0.06	0.67	0.02	3.77	0.01	0.01	0.16
Grays Harbor, WA	1.07	0.45	0.82	0.97	0.25	0.22	0.34	0.22	0.26	0.14	0.24	0.04	4.51	0.03	0.03	0.18
Gulfport, MS	0.28	0.78	2.48	0.55	0.10	0.07	0.12	0.07	2.97	1.44	-0.29	0.08	9.40	0.07	0.07	0.05
Houston, TX	0.43	0.61	3.92	1.07	0.48	0.45	0.92	0.15	0.30	0.16	1.37	0.04	7.36	0.02	0.02	0.11
Jacksonville, FL	0.45	0.56	0.29	1.62	0.55	0.50	1.24	0.08	0.07	-0.08	0.56	-0.01	1.17	-0.01	-0.01	0.08
Kalama, WA	0.34	0.68	13.42	3.26	0.06	0.03	0.06	0.28	8.58	0.53	3.60	-0.01	18.93	0.07	0.07	0.14
Long Beach, CA	0.48	0.44	3.16	4.00	0.25	0.20	0.33	0.14	0.63	0.32	1.53	0.04	3.82	0.03	0.04	0.10
Longview, WA	0.55	0.54	1.20	1.00	0.33	0.28	0.49	0.30	0.36	0.04	0.58	0.01	2.63	0.01	0.01	0.25
Los Angeles, CA	0.39	0.53	2.19	1.92	0.33	0.27	0.49	0.13	0.24	0.26	0.85	0.04	2.72	0.03	0.03	0.11
Monroe, MI	0.51	0.29	0.37	0.19	0.36	0.24	0.57	0.02	-0.63	-7.60	-0.59	-0.18	0.78	-0.16	-0.19	0.02
N. York - N. Jersey	0.46	0.56	1.25	1.48	0.65	0.58	1.89	0.16	0.06	0.18	0.51	0.06	1.53	0.02	0.03	0.11
New Orleans, LA	0.60	0.55	3.02	1.27	0.22	0.19	0.28	0.07	0.35	0.24	0.56	0.02	5.82	0.02	0.02	0.06
Oakland, CA	0.47	0.60	1.20	1.19	0.65	0.60	1.83	0.13	0.01	0.06	1.46	0.02	1.62	0.01	0.01	0.11
Olympia, WA	0.45	0.56	2.13	1.13	0.34	0.30	0.52	0.09	0.44	-1.33	0.26	-0.14	2.55	-0.10	-0.11	0.08

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Palm Beach, FL	0.47	0.61	1.56	1.69	0.36	0.32	0.55	0.11	0.16	-0.10	1.21	-0.01	4.65	-0.01	-0.01	0.10
Panama City, FL	0.48	0.64	4.44	1.09	0.14	0.14	0.17	0.16	0.33	0.23	1.92	0.04	9.33	0.03	0.03	0.15
Philadelphia, PA	0.37	0.57	0.16	0.64	0.16	0.11	0.19	0.03	0.00	8.81	-0.54	0.44	0.43	0.23	0.27	0.03
Port Angeles, WA	0.75	0.46	2.57	1.23	0.18	0.15	0.22	0.16	1.39	0.19	0.81	0.03	3.46	0.02	0.03	0.11
Port Canaveral, FL	0.66	0.56	1.69	1.26	0.34	0.29	0.52	0.22	0.34	0.34	1.57	0.09	5.10	0.05	0.06	0.16
Port Everglades, FL	0.58	0.48	0.32	1.83	0.37	0.31	0.60	0.24	0.66	0.19	1.12	0.05	3.95	0.03	0.03	0.16
Port Manatee, FL	0.57	0.54	0.51	1.17	0.40	0.32	0.67	0.08	0.00	0.78	0.17	0.10	1.02	0.05	0.06	0.07
Portland, OR	1.02	0.35	1.29	1.01	0.35	0.30	0.54	0.21	0.32	0.03	0.37	0.00	6.52	0.00	0.00	0.11
Redwood City, CA	0.81	0.47	9.98	1.71	0.29	0.24	0.40	0.35	0.97	0.56	1.79	0.12	11.45	0.08	0.09	0.15
San Diego, CA	0.85	0.54	1.92	1.11	0.22	0.18	0.28	0.27	0.55	-0.04	0.92	-0.01	5.55	-0.01	-0.01	0.19
San Francisco, CA	0.93	0.37	4.65	1.26	0.27	0.22	0.38	0.26	0.33	0.14	0.68	0.03	7.61	0.02	0.02	0.17
Seattle, WA	0.29	0.66	0.47	1.81	0.56	0.51	1.29	0.09	0.13	0.22	0.65	0.04	1.32	0.02	0.02	0.07
South Louisiana	0.31	0.76	1.78	1.45	0.29	0.27	0.49	0.18	0.83	0.53	0.72	0.09	5.21	0.06	0.08	0.11
Stockton, CA	0.62	0.51	0.29	1.24	0.45	0.39	0.82	0.26	0.04	0.16	0.55	0.07	1.19	0.03	0.04	0.21
Tacoma, WA	0.43	0.50	0.08	1.91	0.68	0.63	2.12	0.12	0.18	0.19	1.14	0.03	2.92	0.02	0.02	0.10
Tampa, FL	0.33	0.67	4.82	1.81	0.25	0.23	0.34	0.08	0.38	0.29	1.36	0.03	6.29	0.02	0.02	0.07
Toledo, OH	0.84	0.43	1.04	1.18	0.21	0.17	0.26	0.05	0.38	2.24	0.26	0.13	2.62	0.09	0.10	0.04
Vancouver, WA	0.36	0.54	0.21	1.41	0.41	0.36	0.69	0.14	0.01	0.41	0.89	0.08	1.85	0.05	0.05	0.11
Virginia	0.46	0.61	0.54	1.05	0.58	0.51	1.39	0.30	0.10	-0.02	0.31	-0.01	1.98	0.00	0.00	0.24
Wilmington, DE	0.44	0.70	0.27	1.10	0.19	0.16	0.23	0.22	0.05	0.08	0.64	0.02	0.98	0.01	0.02	0.16

Table E-7. *U.S. seaports' financial ratio calculations - 2012*

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Anacortes, WA	0.81	0.55	1.84	1.04	0.37	0.31	0.59	0.36	0.08	-0.05	0.53	-0.01	2.53	-0.01	-0.01	0.19
Anchorage, AK	1.53	0.39	0.25	1.04	0.17	0.01	0.20	0.17	0.22	0.19	0.12	0.00	0.49	0.01	0.05	0.04
Boston, MA	0.75	0.53	0.15	1.03	0.53	0.44	1.12	0.21	0.06	0.14	0.59	0.05	1.84	0.02	0.03	0.15
Cleveland, OH	0.37	0.62	6.23	0.72	0.27	0.25	0.37	0.11	0.54	0.84	-0.52	0.08	8.82	0.06	0.07	0.07
Conneaut, OH	1.31	0.41	0.35	0.94	0.22	0.15	0.28	0.25	-0.15	0.28	1.06	0.09	0.52	0.07	0.07	0.24
Corpus Christi, TX	0.63	0.49	12.22	1.15	0.06	0.03	0.06	0.24	5.88	0.08	1.58	0.01	13.49	0.01	0.01	0.16
Duluth, MN	0.86	0.54	3.78	1.92	0.08	0.07	0.09	0.19	3.97	0.46	3.89	0.06	26.99	0.05	0.06	0.11
Everett, WA	0.55	0.64	0.29	1.03	0.21	0.19	0.27	0.19	0.29	0.09	1.12	0.01	5.22	0.01	0.01	0.10
Freeport, TX	0.22	0.64	1.14	1.22	0.23	0.17	0.30	0.08	0.64	0.21	0.76	0.02	3.44	0.01	0.01	0.06
Galveston, TX	0.55	0.58	1.85	1.05	0.36	0.30	0.56	0.20	0.27	0.93	0.47	0.24	5.12	0.13	0.14	0.14
Grays Harbor, WA	1.09	0.44	0.58	0.99	0.23	0.20	0.30	0.29	0.38	0.19	0.68	0.06	4.60	0.04	0.05	0.24
Gulfport, MS	0.30	0.77	1.91	0.38	0.11	0.06	0.12	0.07	2.97	0.97	-0.07	0.05	6.01	0.05	0.05	0.05
Houston, TX	0.47	0.58	1.22	1.12	0.46	0.44	0.86	0.16	0.38	0.24	1.59	0.05	7.27	0.03	0.03	0.12
Jacksonville, FL	0.47	0.55	0.40	1.70	0.56	0.52	1.27	0.08	0.06	0.01	0.74	0.00	1.17	0.00	0.00	0.08
Kalama, WA	0.38	0.65	17.36	2.50	0.04	0.02	0.05	0.23	11.69	0.35	3.28	0.04	23.63	0.04	0.04	0.11
Long Beach, CA	0.48	0.43	3.00	3.92	0.23	0.18	0.30	0.13	0.66	0.39	1.39	0.05	3.75	0.04	0.04	0.09
Longview, WA	0.58	0.52	1.65	1.18	0.31	0.26	0.44	0.36	0.44	0.15	1.47	0.07	3.25	0.04	0.05	0.29
Los Angeles, CA	0.40	0.55	2.44	1.98	0.32	0.27	0.47	0.12	0.24	0.30	1.05	0.05	3.02	0.03	0.03	0.10
Monroe, MI	0.61	0.27	0.57	0.20	0.36	0.24	0.57	0.03	-0.60	-0.40	-0.50	0.15	0.89	-0.02	0.04	0.02
N. York - N. Jersey	0.45	0.54	1.32	1.56	0.66	0.58	1.90	0.16	0.10	0.28	0.51	0.10	1.68	0.03	0.04	0.11
New Orleans, LA	0.60	0.56	1.78	1.32	0.21	0.19	0.27	0.08	0.33	0.72	0.57	0.06	4.98	0.05	0.05	0.06
Oakland, CA	0.52	0.57	1.38	1.23	0.64	0.58	1.75	0.14	0.03	0.12	1.19	0.03	2.05	0.01	0.02	0.12
Olympia, WA	0.45	0.59	1.72	1.20	0.32	0.27	0.46	0.11	0.11	0.26	0.38	0.04	2.34	0.02	0.03	0.09

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Palm Beach, FL	0.50	0.59	1.27	1.93	0.35	0.30	0.54	0.13	0.18	0.21	1.17	0.04	3.49	0.02	0.03	0.11
Panama City, FL	0.50	0.61	2.43	1.03	0.13	0.11	0.15	0.15	0.68	0.70	0.34	0.11	6.30	0.09	0.09	0.13
Philadelphia, PA	0.36	0.66	0.16	0.74	0.11	0.09	0.13	0.02	-0.02	6.02	-0.54	0.18	0.56	0.13	0.15	0.02
Port Angeles, WA	0.80	0.47	2.31	1.25	0.20	0.15	0.25	0.16	1.20	-0.10	0.59	-0.01	2.91	-0.01	-0.01	0.11
Port Canaveral, FL	0.59	0.60	0.87	1.42	0.34	0.27	0.51	0.21	0.21	0.39	1.56	0.11	2.69	0.07	0.07	0.17
Port Everglades, FL	0.60	0.48	0.09	1.56	0.38	0.31	0.60	0.24	0.64	0.24	1.24	0.06	4.16	0.04	0.04	0.16
Port Manatee, FL	0.59	0.51	0.42	1.19	0.39	0.33	0.63	0.08	-0.02	0.48	0.19	0.06	1.47	0.03	0.04	0.07
Portland, OR	1.08	0.34	1.25	1.02	0.35	0.30	0.54	0.20	0.29	0.10	-0.02	0.01	6.07	0.01	0.01	0.09
Redwood City, CA	0.75	0.49	10.17	1.64	0.34	0.28	0.52	0.32	0.78	0.61	1.47	0.12	11.31	0.08	0.09	0.13
San Diego, CA	0.86	0.54	1.92	1.11	0.22	0.17	0.28	0.27	0.45	-0.04	0.87	-0.01	5.02	-0.01	-0.01	0.19
San Francisco, CA	0.92	0.36	3.71	1.39	0.26	0.20	0.36	0.27	0.37	0.23	0.61	0.06	6.01	0.04	0.04	0.17
Seattle, WA	0.32	0.66	0.31	1.75	0.55	0.50	1.23	0.09	0.13	0.11	0.60	0.02	0.87	0.01	0.01	0.08
South Louisiana	0.31	0.76	2.12	1.29	0.10	0.07	0.11	0.14	1.68	0.51	1.14	0.07	6.42	0.06	0.06	0.12
Stockton, CA	0.56	0.49	0.48	1.39	0.39	0.33	0.64	0.26	0.08	0.64	0.94	0.28	1.52	0.13	0.15	0.21
Tacoma, WA	0.43	0.50	0.06	1.89	0.67	0.60	2.05	0.13	0.26	0.18	0.63	0.05	2.39	0.02	0.02	0.10
Tampa, FL	0.37	0.65	3.62	1.84	0.24	0.21	0.32	0.08	0.47	0.49	1.15	0.05	4.85	0.03	0.04	0.07
Toledo, OH	0.83	0.45	1.28	1.08	0.15	0.11	0.17	0.06	0.52	0.43	-0.07	0.03	2.24	0.02	0.02	0.05
Vancouver, WA	0.34	0.56	1.63	1.40	0.32	0.28	0.48	0.10	0.11	1.84	2.26	0.31	2.14	0.16	0.18	0.09
Virginia	0.48	0.60	0.56	0.95	0.59	0.52	1.44	0.37	0.10	-0.01	0.27	-0.01	1.95	0.00	0.00	0.28
Wilmington, DE	0.46	0.68	0.55	1.13	0.18	0.15	0.22	0.24	0.09	0.08	0.72	0.01	1.19	0.01	0.02	0.18

Table E-8. *U.S. seaports' financial ratio calculations - 2013*

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Anacortes, WA	0.86	0.54	1.04	1.05	0.36	0.26	0.57	0.37	0.01	-0.07	0.37	-0.02	1.61	-0.01	-0.02	0.21
Anchorage, AK	0.59	0.63	11.63	0.97	0.22	0.22	0.29	0.06	0.44	-6.06	6.96	-0.31	35.41	-0.32	-0.34	0.05
Boston, MA	0.79	0.51	0.13	1.02	0.52	0.43	1.09	0.21	0.08	0.12	0.58	0.04	1.61	0.02	0.02	0.15
Cleveland, OH	0.38	0.60	6.94	0.97	0.21	0.18	0.26	0.29	0.78	0.22	0.36	0.06	9.13	0.04	0.05	0.19
Conneaut, OH	1.54	0.37	1.20	0.89	0.24	0.18	0.31	0.28	-0.05	-0.18	1.22	-0.06	1.40	-0.05	-0.05	0.25
Corpus Christi, TX	0.61	0.50	6.60	1.70	0.05	0.03	0.05	0.27	6.93	0.49	5.48	0.10	19.77	0.09	0.09	0.18
Duluth, MN	0.88	0.53	5.30	1.83	0.08	0.07	0.09	0.17	4.11	0.24	4.05	0.03	22.25	0.02	0.03	0.10
Everett, WA	0.52	0.66	0.19	0.98	0.21	0.18	0.27	0.17	0.24	-0.03	0.80	-0.01	3.43	0.00	0.00	0.11
Freeport, TX	0.23	0.68	1.03	1.11	0.26	0.17	0.35	0.08	0.74	0.51	0.30	0.04	2.76	0.03	0.03	0.06
Galveston, TX	0.55	0.57	0.91	1.02	0.31	0.25	0.44	0.18	0.33	0.54	0.38	0.12	4.36	0.07	0.08	0.13
Grays Harbor, WA	0.90	0.47	1.45	0.99	0.16	0.12	0.19	0.23	0.62	2.07	0.79	0.82	5.05	0.38	0.40	0.18
Gulfport, MS	0.29	0.77	0.93	0.40	0.10	0.05	0.11	0.06	3.09	2.20	0.03	0.11	4.44	0.09	0.10	0.04
Houston, TX	0.47	0.58	0.43	1.16	0.44	0.41	0.80	0.16	0.39	0.29	1.59	0.07	4.81	0.04	0.04	0.12
Jacksonville, FL	0.50	0.53	0.53	1.94	0.54	0.50	1.17	0.09	0.06	0.21	0.94	0.04	1.35	0.02	0.02	0.08
Kalama, WA	0.42	0.61	19.60	2.44	0.03	0.01	0.03	0.24	16.49	0.32	1.92	0.03	24.76	0.03	0.04	0.11
Long Beach, CA	0.42	0.42	1.56	3.61	0.22	0.17	0.28	0.11	0.39	0.95	1.28	0.12	2.47	0.08	0.09	0.09
Longview, WA	0.57	0.53	1.90	1.14	0.27	0.23	0.38	0.32	0.33	0.17	1.82	0.05	3.57	0.05	0.05	0.27
Los Angeles, CA	0.42	0.56	2.26	1.99	0.30	0.26	0.43	0.12	0.20	0.31	1.27	0.04	2.85	0.03	0.03	0.10
Monroe, MI	0.62	0.25	0.66	-0.13	0.29	0.20	0.41	0.04	-0.55	7.93	-0.70	0.36	1.24	0.16	0.26	0.02
N. York - N. Jersey	0.45	0.54	0.72	1.61	0.64	0.56	1.81	0.15	0.15	0.25	0.65	0.07	1.13	0.03	0.04	0.11
New Orleans, LA	0.61	0.56	2.15	1.33	0.21	0.18	0.26	0.08	0.37	0.54	0.45	0.05	5.05	0.04	0.04	0.07
Oakland, CA	0.57	0.54	1.42	1.26	0.62	0.57	1.62	0.14	0.03	0.12	1.21	0.05	2.31	0.01	0.02	0.12
Olympia, WA	0.45	0.59	1.24	1.24	0.40	0.33	0.66	0.12	0.03	0.60	0.64	0.10	3.38	0.06	0.06	0.09

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Palm Beach, FL	0.52	0.56	1.08	1.92	0.33	0.27	0.50	0.14	0.19	0.36	1.03	0.07	3.02	0.04	0.04	0.11
Panama City, FL	0.51	0.60	5.73	1.04	0.15	0.14	0.18	0.16	0.63	0.36	0.38	0.06	8.15	0.05	0.05	0.14
Philadelphia, PA	0.36	0.63	0.12	0.76	0.10	0.07	0.11	0.02	-0.02	4.48	-0.23	0.13	0.74	0.10	0.11	0.02
Port Angeles, WA	0.85	0.45	3.13	1.38	0.18	0.14	0.21	0.18	1.54	0.38	0.91	0.06	5.33	0.05	0.06	0.12
Port Canaveral, FL	0.58	0.58	0.48	1.33	0.31	0.24	0.44	0.19	0.12	0.35	1.26	0.09	1.45	0.06	0.06	0.17
Port Everglades, FL	0.63	0.49	0.11	1.44	0.34	0.26	0.52	0.24	0.73	0.25	1.04	0.07	3.58	0.04	0.05	0.17
Port Manatee, FL	0.61	0.48	0.56	1.22	0.36	0.32	0.56	0.07	-0.02	0.53	0.53	0.06	1.94	0.04	0.04	0.07
Portland, OR	1.14	0.33	1.26	0.98	0.35	0.30	0.55	0.18	0.19	0.00	-0.19	0.00	5.80	0.00	0.00	0.08
Redwood City, CA	0.64	0.47	8.71	1.57	0.40	0.34	0.66	0.27	0.53	0.36	1.17	0.06	9.87	0.04	0.04	0.12
San Diego, CA	0.87	0.54	1.42	1.08	0.23	0.17	0.29	0.26	0.33	-0.05	0.54	-0.01	3.96	-0.01	-0.01	0.20
San Francisco, CA	0.78	0.44	1.94	1.35	0.30	0.20	0.43	0.23	0.22	0.34	0.35	0.08	3.28	0.05	0.06	0.16
Seattle, WA	0.34	0.64	0.12	1.78	0.54	0.48	1.18	0.10	0.14	0.20	0.53	0.03	0.89	0.02	0.02	0.08
South Louisiana	0.29	0.77	3.01	1.32	0.16	0.13	0.19	0.13	0.92	0.75	1.02	0.10	5.74	0.07	0.08	0.10
Stockton, CA	0.51	0.52	0.71	1.40	0.34	0.28	0.51	0.24	0.11	0.62	0.80	0.25	1.70	0.12	0.14	0.20
Tacoma, WA	0.46	0.47	0.08	1.84	0.65	0.55	1.87	0.13	0.25	0.00	0.50	0.00	1.74	0.00	0.00	0.10
Tampa, FL	0.40	0.63	3.44	1.83	0.22	0.19	0.29	0.08	0.48	0.57	0.99	0.05	4.55	0.04	0.04	0.07
Toledo, OH	0.84	0.45	1.96	1.23	0.13	0.10	0.15	0.06	0.64	0.72	0.26	0.04	3.85	0.03	0.04	0.05
Vancouver, WA	0.35	0.54	1.17	1.41	0.29	0.25	0.41	0.09	0.07	0.75	0.39	0.09	1.85	0.06	0.06	0.08
Virginia	0.53	0.58	0.63	1.03	0.59	0.53	1.45	0.42	0.12	-0.06	0.29	-0.01	2.31	-0.02	-0.02	0.31
Wilmington, DE	0.50	0.66	0.70	1.15	0.18	0.14	0.21	0.26	0.10	0.11	0.71	0.03	1.28	0.02	0.03	0.18

Table E-9. *U.S. seaports' financial ratio calculations - 2014*

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Anacortes, WA	0.97	0.51	1.23	1.04	0.46	0.37	0.87	0.43	-0.21	-0.50	0.30	-0.18	2.03	-0.11	-0.18	0.23
Anchorage, AK	0.62	0.62	7.57	0.71	0.23	0.22	0.30	0.06	0.36	-0.19	2.70	-0.01	15.24	-0.01	-0.01	0.06
Boston, MA	0.83	0.50	0.12	1.29	0.52	0.42	1.07	0.21	0.08	0.12	0.54	0.02	1.41	0.02	0.02	0.16
Cleveland, OH	0.44	0.56	2.47	0.79	0.23	0.16	0.30	0.33	0.68	-0.05	-0.39	-0.01	3.74	-0.01	-0.01	0.20
Conneaut, OH	1.83	0.33	1.26	0.89	0.28	0.20	0.39	0.32	-0.12	-0.13	1.14	-0.12	1.39	-0.04	-0.04	0.28
Corpus Christi, TX	0.61	0.48	5.02	1.59	0.06	0.03	0.07	0.27	5.22	0.48	2.87	0.10	10.81	0.08	0.09	0.17
Duluth, MN	0.90	0.53	8.68	1.88	0.07	0.06	0.08	0.18	4.31	0.27	3.73	0.03	24.04	0.03	0.03	0.10
Everett, WA	0.55	0.64	0.19	0.96	0.23	0.17	0.30	0.17	0.25	0.19	0.47	0.03	2.25	0.02	0.03	0.11
Freeport, TX	0.24	0.70	1.68	1.15	0.26	0.19	0.36	0.08	0.66	0.41	0.48	0.04	3.33	0.03	0.03	0.06
Galveston, TX	0.60	0.55	0.80	1.00	0.35	0.29	0.53	0.20	0.21	-0.05	0.92	-0.01	4.98	-0.01	-0.01	0.14
Grays Harbor, WA	0.94	0.46	1.52	0.95	0.15	0.11	0.17	0.24	1.05	0.10	0.81	0.02	5.14	0.02	0.02	0.20
Gulfport, MS	0.27	0.79	1.13	0.55	0.07	0.03	0.07	0.05	3.99	3.19	-0.23	0.15	5.46	0.12	0.14	0.04
Houston, TX	0.48	0.57	0.65	1.22	0.42	0.40	0.74	0.18	0.41	0.27	1.88	0.07	4.64	0.04	0.04	0.13
Jacksonville, FL	0.54	0.50	0.54	1.84	0.55	0.51	1.21	0.09	0.05	0.19	0.91	0.01	1.39	0.01	0.02	0.08
Kalama, WA	0.33	0.68	7.79	1.66	0.06	0.00	0.06	0.15	6.84	0.19	1.11	0.02	8.17	0.02	0.02	0.08
Long Beach, CA	0.39	0.48	1.47	3.35	0.25	0.21	0.34	0.09	0.25	0.88	1.29	0.10	2.31	0.07	0.08	0.08
Longview, WA	0.57	0.54	2.31	1.23	0.26	0.21	0.35	0.38	0.55	0.24	1.55	0.09	3.66	0.07	0.08	0.31
Los Angeles, CA	0.43	0.54	1.88	2.01	0.28	0.24	0.39	0.11	0.14	0.35	1.10	0.05	2.45	0.03	0.04	0.10
Monroe, MI	0.61	0.27	1.62	-0.15	0.25	0.21	0.34	0.04	-0.59	1.18	-2.40	0.04	3.09	0.03	0.05	0.03
N. York - N. Jersey	0.43	0.61	0.54	1.53	0.65	0.57	1.83	0.15	0.14	0.23	0.70	0.08	0.94	0.03	0.03	0.11
New Orleans, LA	0.65	0.55	2.68	1.31	0.20	0.17	0.25	0.09	0.42	0.07	0.52	0.00	5.03	0.00	0.01	0.07
Oakland, CA	0.61	0.52	1.49	1.25	0.59	0.54	1.43	0.15	0.06	1.65	1.17	0.09	2.41	0.21	0.22	0.12
Olympia, WA	0.40	0.63	1.10	1.28	0.39	0.33	0.64	0.11	-0.05	0.09	-0.53	-0.02	1.63	0.01	0.01	0.10

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Palm Beach, FL	0.52	0.53	1.07	1.91	0.30	0.25	0.43	0.13	0.17	0.66	0.85	0.11	3.17	0.07	0.08	0.11
Panama City, FL	0.53	0.60	3.82	1.00	0.15	0.14	0.18	0.15	0.47	0.24	-0.06	0.04	8.02	0.03	0.03	0.14
Philadelphia, PA	0.39	0.61	0.08	0.77	0.11	0.06	0.12	0.02	-0.04	2.31	-0.13	0.06	0.83	0.05	0.06	0.02
Port Angeles, WA	0.88	0.44	3.44	1.31	0.17	0.13	0.21	0.21	1.64	0.21	0.94	0.04	5.10	0.03	0.04	0.14
Port Canaveral, FL	0.51	0.58	0.35	1.20	0.42	0.33	0.74	0.17	0.17	0.25	0.86	0.06	1.65	0.04	0.04	0.14
Port Everglades, FL	0.67	0.47	0.19	1.42	0.31	0.25	0.45	0.25	0.78	0.27	1.51	0.07	5.13	0.05	0.05	0.17
Port Manatee, FL	0.64	0.49	0.99	1.15	0.34	0.32	0.51	0.07	-0.03	0.20	0.81	0.02	3.63	0.01	0.01	0.07
Portland, OR	1.12	0.32	1.36	0.93	0.36	0.31	0.57	0.18	0.23	-0.08	-0.08	-0.01	5.44	-0.01	-0.01	0.08
Redwood City, CA	0.52	0.43	5.51	1.67	0.38	0.32	0.62	0.22	0.47	0.24	1.06	0.03	6.75	0.03	0.03	0.12
San Diego, CA	0.87	0.53	1.31	1.14	0.23	0.18	0.30	0.27	0.27	0.01	0.69	0.00	3.66	0.00	0.00	0.21
San Francisco, CA	0.67	0.51	1.64	1.33	0.35	0.26	0.55	0.20	0.14	0.22	0.42	0.05	3.02	0.03	0.04	0.15
Seattle, WA	0.36	0.63	0.16	1.73	0.52	0.46	1.06	0.10	0.15	0.24	0.69	0.04	0.71	0.02	0.02	0.08
South Louisiana	0.28	0.78	4.50	1.20	0.11	0.09	0.13	0.12	1.21	1.28	0.86	0.16	8.50	0.12	0.12	0.09
Stockton, CA	0.54	0.55	0.72	1.25	0.32	0.26	0.47	0.26	0.09	0.15	0.52	0.04	1.61	0.03	0.04	0.22
Tacoma, WA	0.48	0.45	0.01	1.64	0.66	0.57	1.98	0.14	0.24	0.03	0.57	0.01	1.98	0.00	0.00	0.11
Tampa, FL	0.42	0.63	3.32	1.75	0.20	0.17	0.25	0.08	0.51	0.47	0.79	0.04	4.50	0.03	0.04	0.07
Toledo, OH	0.89	0.43	2.24	1.22	0.13	0.10	0.15	0.06	0.53	-0.28	0.65	-0.02	3.82	-0.01	-0.01	0.05
Vancouver, WA	0.35	0.58	0.64	1.39	0.58	0.49	1.35	0.11	0.04	0.53	0.48	0.07	1.39	0.11	0.06	0.20
Virginia	0.59	0.54	0.80	1.09	0.58	0.51	1.39	0.48	0.17	-0.05	0.38	0.01	2.59	-0.02	-0.02	0.36
Wilmington, DE	0.54	0.65	0.73	1.41	0.17	0.12	0.20	0.26	0.11	0.23	0.47	0.05	1.25	0.04	0.06	0.18

Table E-10. *U.S. seaports' financial ratio calculations - 2015*

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Anacortes, WA	0.97	0.51	1.23	1.04	0.46	0.37	0.87	0.43	-0.21	-0.50	0.30	-0.18	2.03	-0.11	-0.18	0.23
Anchorage, AK	0.62	0.62	7.57	0.71	0.23	0.22	0.30	0.06	0.36	-0.19	2.70	-0.01	15.24	-0.01	-0.01	0.06
Boston, MA	0.83	0.50	0.12	1.29	0.52	0.42	1.07	0.21	0.08	0.12	0.54	0.02	1.41	0.02	0.02	0.16
Cleveland, OH	0.44	0.56	2.47	0.79	0.23	0.16	0.30	0.33	0.68	-0.05	-0.39	-0.01	3.74	-0.01	-0.01	0.20
Conneaut, OH	1.83	0.33	1.26	0.89	0.28	0.20	0.39	0.32	-0.12	-0.13	1.14	-0.12	1.39	-0.04	-0.04	0.28
Corpus Christi, TX	0.61	0.48	5.02	1.59	0.06	0.03	0.07	0.27	5.22	0.48	2.87	0.10	10.81	0.08	0.09	0.17
Duluth, MN	0.90	0.53	8.68	1.88	0.07	0.06	0.08	0.18	4.31	0.27	3.73	0.03	24.04	0.03	0.03	0.10
Everett, WA	0.55	0.64	0.19	0.96	0.23	0.17	0.30	0.17	0.25	0.19	0.47	0.03	2.25	0.02	0.03	0.11
Freeport, TX	0.24	0.70	1.68	1.15	0.26	0.19	0.36	0.08	0.66	0.41	0.48	0.04	3.33	0.03	0.03	0.06
Galveston, TX	0.60	0.55	0.80	1.00	0.35	0.29	0.53	0.20	0.21	-0.05	0.92	-0.01	4.98	-0.01	-0.01	0.14
Grays Harbor, WA	0.94	0.46	1.52	0.95	0.15	0.11	0.17	0.24	1.05	0.10	0.81	0.02	5.14	0.02	0.02	0.20
Gulfport, MS	0.27	0.79	1.13	0.55	0.07	0.03	0.07	0.05	3.99	3.19	-0.23	0.15	5.46	0.12	0.14	0.04
Houston, TX	0.48	0.57	0.65	1.22	0.42	0.40	0.74	0.18	0.41	0.27	1.88	0.07	4.64	0.04	0.04	0.13
Jacksonville, FL	0.54	0.50	0.54	1.84	0.55	0.51	1.21	0.09	0.05	0.19	0.91	0.01	1.39	0.01	0.02	0.08
Kalama, WA	0.33	0.68	7.79	1.66	0.06	0.00	0.06	0.15	6.84	0.19	1.11	0.02	8.17	0.02	0.02	0.08
Long Beach, CA	0.39	0.48	1.47	3.35	0.25	0.21	0.34	0.09	0.25	0.88	1.29	0.10	2.31	0.07	0.08	0.08
Longview, WA	0.57	0.54	2.31	1.23	0.26	0.21	0.35	0.38	0.55	0.24	1.55	0.09	3.66	0.07	0.08	0.31
Los Angeles, CA	0.43	0.54	1.88	2.01	0.28	0.24	0.39	0.11	0.14	0.35	1.10	0.05	2.45	0.03	0.04	0.10
Monroe, MI	0.61	0.27	1.62	-0.15	0.25	0.21	0.34	0.04	-0.59	1.18	-2.40	0.04	3.09	0.03	0.05	0.03
N. York - N. Jersey	0.43	0.61	0.54	1.53	0.65	0.57	1.83	0.15	0.14	0.23	0.70	0.08	0.94	0.03	0.03	0.11
New Orleans, LA	0.65	0.55	2.68	1.31	0.20	0.17	0.25	0.09	0.42	0.07	0.52	0.00	5.03	0.00	0.01	0.07
Oakland, CA	0.61	0.52	1.49	1.25	0.59	0.54	1.43	0.15	0.06	1.65	1.17	0.09	2.41	0.21	0.22	0.12
Olympia, WA	0.40	0.63	1.10	1.28	0.39	0.33	0.64	0.11	-0.05	0.09	-0.53	-0.02	1.63	0.01	0.01	0.10

Seaport (Port of)	*Acc. dep. to fixed assets*	*Capital assets condition*	*Cash*	*Charge to expense*	*Debt*	*Debt to asset*	*Debt to equity*	*Fixed assets turnover*	*Net assets*	*Net profit margin*	*Operating cash flow*	*Percent change in net assets*	*Quick*	*Return on assets*	*Return on net assets*	*Total assets turnover*
Palm Beach, FL	0.52	0.53	1.07	1.91	0.30	0.25	0.43	0.13	0.17	0.66	0.85	0.11	3.17	0.07	0.08	0.11
Panama City, FL	0.53	0.60	3.82	1.00	0.15	0.14	0.18	0.15	0.47	0.24	-0.06	0.04	8.02	0.03	0.03	0.14
Philadelphia, PA	0.39	0.61	0.08	0.77	0.11	0.06	0.12	0.02	-0.04	2.31	-0.13	0.06	0.83	0.05	0.06	0.02
Port Angeles, WA	0.88	0.44	3.44	1.31	0.17	0.13	0.21	0.21	1.64	0.21	0.94	0.04	5.10	0.03	0.04	0.14
Port Canaveral, FL	0.51	0.58	0.35	1.20	0.42	0.33	0.74	0.17	0.17	0.25	0.86	0.06	1.65	0.04	0.04	0.14
Port Everglades, FL	0.67	0.47	0.19	1.42	0.31	0.25	0.45	0.25	0.78	0.27	1.51	0.07	5.13	0.05	0.05	0.17
Port Manatee, FL	0.64	0.49	0.99	1.15	0.34	0.32	0.51	0.07	-0.03	0.20	0.81	0.02	3.63	0.01	0.01	0.07
Portland, OR	1.12	0.32	1.36	0.93	0.36	0.31	0.57	0.18	0.23	-0.08	-0.08	-0.01	5.44	-0.01	-0.01	0.08
Redwood City, CA	0.52	0.43	5.51	1.67	0.38	0.32	0.62	0.22	0.47	0.24	1.06	0.03	6.75	0.03	0.03	0.12
San Diego, CA	0.87	0.53	1.31	1.14	0.23	0.18	0.30	0.27	0.27	0.01	0.69	0.00	3.66	0.00	0.00	0.21
San Francisco, CA	0.67	0.51	1.64	1.33	0.35	0.26	0.55	0.20	0.14	0.22	0.42	0.05	3.02	0.03	0.04	0.15
Seattle, WA	0.36	0.63	0.16	1.73	0.52	0.46	1.06	0.10	0.15	0.24	0.69	0.04	0.71	0.02	0.02	0.08
South Louisiana	0.28	0.78	4.50	1.20	0.11	0.09	0.13	0.12	1.21	1.28	0.86	0.16	8.50	0.12	0.12	0.09
Stockton, CA	0.54	0.55	0.72	1.25	0.32	0.26	0.47	0.26	0.09	0.15	0.52	0.04	1.61	0.03	0.04	0.22
Tacoma, WA	0.48	0.45	0.01	1.64	0.66	0.57	1.98	0.14	0.24	0.03	0.57	0.01	1.98	0.00	0.00	0.11
Tampa, FL	0.42	0.63	3.32	1.75	0.20	0.17	0.25	0.08	0.51	0.47	0.79	0.04	4.50	0.03	0.04	0.07
Toledo, OH	0.89	0.43	2.24	1.22	0.13	0.10	0.15	0.06	0.53	-0.28	0.65	-0.02	3.82	-0.01	-0.01	0.05
Vancouver, WA	0.35	0.58	0.64	1.39	0.58	0.49	1.35	0.11	0.04	0.53	0.48	0.07	1.39	0.11	0.06	0.20
Virginia	0.59	0.54	0.80	1.09	0.58	0.51	1.39	0.48	0.17	-0.05	0.38	0.01	2.59	-0.02	-0.02	0.36
Wilmington, DE	0.54	0.65	0.73	1.41	0.17	0.12	0.20	0.26	0.11	0.23	0.47	0.05	1.25	0.04	0.06	0.18

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