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A Feasibility Study Evaluating Transportation Security Systems and Associated Multi-Modal Efficiency Impacts

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16. ABSTRACT

This The overall purpose of this research project is to conduct a feasibility study and development of a general methodology to determine the impacts on multi-modal and system efficiency of alternative freight security measures. The methodology to be examined will be developed by applying it in several case study scenarios in the Pacific Northwest. To achieve this overall purpose of the research project, the following objectives will be achieved:

1) Inventory and develop structural information on alternative freight security measures under current consideration and implementation by appropriate authorities.
2) Work with institutional and agency sponsors to determine security program detail as to form, status, funding, coverage, etc.
3) Determine costs of implementation of alternative freight security measures. Costs include initial costs of physical implementation, but will also involve consideration of system costs such as delayed movement through port facilities, increased operational cost, lost connectivity to multi-modal facilities, increased pressure and constraints (at specific time intervals) on land based transportation systems, risk and uncertainty in both seamless logistic performance and highway planning/investment performance.
4) Evaluate several programs/measures (applied to northwest ports and Washington border crossings) in a cost/benefit framework including evaluation of who bears the cost of the security measures and what are the impacts on the overall system efficiency.
5) Develop, summarize and report on a general methodology developed from the above analysis and the feasibility of applying that methodology in real time.

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Executive Summary

The perception of maritime security in the post 9/11 era has been changed to focus on prevention and managing risks of terrorist attacks on the nation's supply chains, specifically the ports. Ports remain a vulnerable terrorist target because of high volumes passing through large concentrated ports. Government and industry participants have played a major role in tightening maritime security by implementing legislation, programs, and technologies that focus on developing more secure and transparent supply chains.

This research effort was to evaluate the effects that various port security measures have on an electronic firm's supply chain for the movement televisions through the six major west coast ports. A constrained transportation optimization model was developed to represent the firm's distribution system. Using the firm's distribution network, the study expanded the model to represent all the television imports into the west coast and further expanded it to represent all of the west coast import volume. Three scenarios were evaluated for the firm, industry, and west coast volumes. The first scenario estimated the effect of increasing the rate charged for services at the port by five, ten, and fifteen percent. Scenarios two and three investigated the impacts of shutting down operations at the Ports of Seattle and Long Beach.

Results in all scenarios indicated that the impacts at the ports caused an increase in per-unit costs, while the total transportation cost decreased because of loss of quantity demanded. The results for the firm and industry level volumes were similar, but the west coast model produced larger impacts. The port rate scenarios caused the most changes among distribution centers and retail store locations in response to increased costs. The port shutdown scenarios created the largest impacts because of the shifting of volumes that occurred between the ports, thus creating a chain reaction to optimize cost for shipments to distribution centers and retail store locations. Overall, the key insights of this study are the adjustments a firm makes to their distribution systems to counteract negative impacts imposed at ports, while meeting demands and maintaining supply chain efficiency.

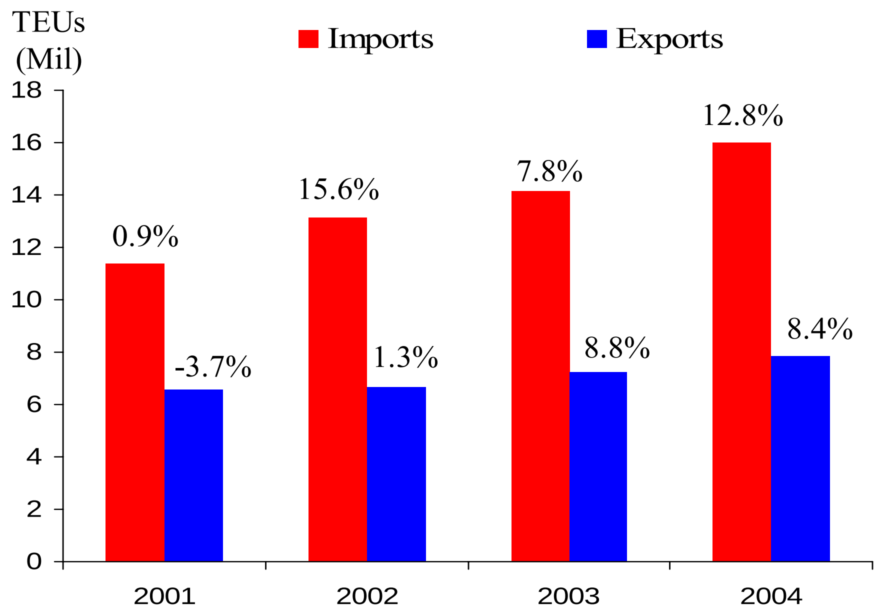
I. INTRODUCTION

Trade and the U.S. Maritime System

International trade is the largest and most crucial component to the sustainability of the United States economy. Trade creates jobs, increases the standard of living, and is the lifeline of many U.S. industries. Global marine transportation and the U.S. Maritime Transportation System (MTS) are responsible for the majority of U.S. trade movements, thus making marine transportation a crucial asset to trade. The U.S. Marine Transportation System, defined as waterways, ports, intermodal connections, vessels, vehicles, and system users, annually handles more than two billion tons of freight, three billion tons of oil, more than 134 million ferry passengers, and more than seven million cruise ship passengers. Seaports are the focal point of U.S. trade, accounting for 95 percent of all trade and contributing 27 percent to the nation's GDP (Grant, 2005). Over the past decade, increased containerization, growth of foreign economies and globalization has dramatically increased trade to record levels. In 2004, U.S. trade exports grew 13.2 percent and imports 16.9 percent and this continued high growth is expected into the future (Martin, 2005). Today, containerized trade accounts for 90 percent of all cargo movements. As of 2005, approximately 18 million containers made 200 million trips (Wilkepdia, 2006). Figure 1.1 shows the growth in container trade from 2001 to 2004.

As of October 2005, the top U.S. trading partners by value are Canada, Mexico, China, and Japan. Through October 2005, Canada is a distant first place in trading value at $411.58 billion, Mexico and China compete closely for second and third at $239.20 and $234.30 billion, respectively, and Japan is fourth with $160.28 billion (U.S. Census Bureau, 2005). Overlooking intra-continental trading, the two Pacific Rim countries, Japan and China, are the most significant overseas trading partners.

Figure 1.1: Total US Containerized Trade Growth

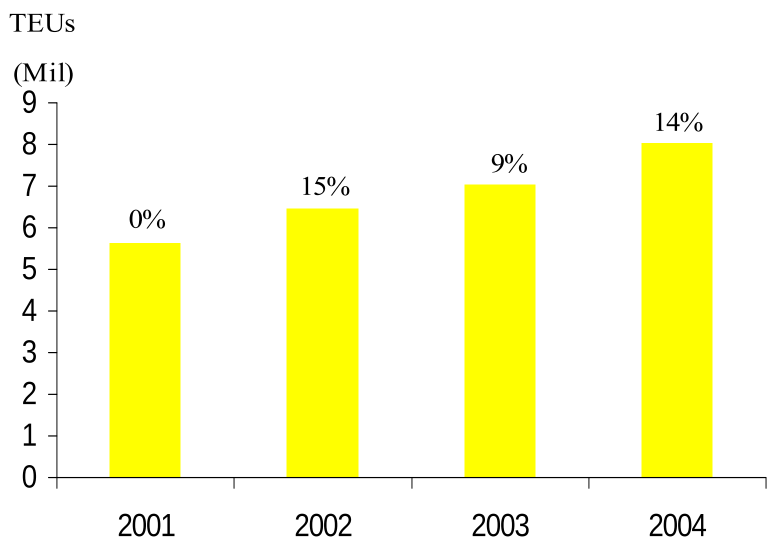


Source: McCahill, Brendan. "U.S. Containerized Trade Status and Forecast." 5th Annual Transpacific Maritime Conference. PIERS Trade Horizons. 28 Feb 2005.

Emerging Asian Markets

Over the past decade, the Pacific Rim has become the heart of U.S. trade. Asian trade volumes have been increasing by double digits, with import volumes nearly doubling export volumes. Figure 1.2 shows the growth of imports from Asia to the U.S. west coast over the past four years.

Figure 1.2: Annual Increase in Total Imports from Asia to US West Coast

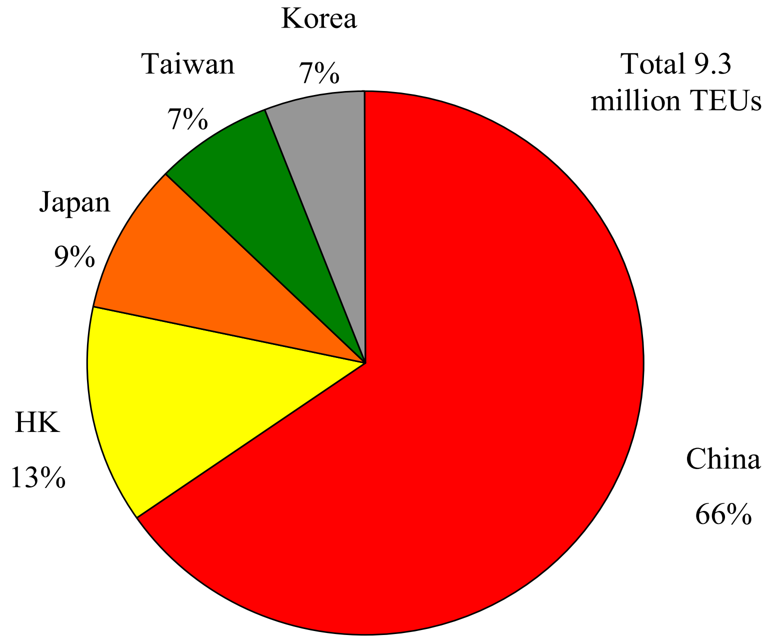


Source: McCahill, Brendan. "U.S. Containerized Trade Status and Forecast." 5th Annual Transpacific Maritime Conference. PIERS Trade Horizons. 28 Feb 2005.

Import growth with Pacific Rim countries has far exceeded exports, which is dramatically increasing the U.S. trade deficit. As of October 2005, the U.S. trade deficit with China, valued at $-166,835.41 million, far exceeds the deficit with any other country. The deficit with Japan is the second largest, at $-68,603.51 million. The U.S deficit with Canada, our top trading partner, is even smaller at $-60,882.90 million (U.S. Census Bureau, 2005).

China, Japan, Korea, Taiwan, and Hong Kong formulate the northeast region of Asia for trade. In 2004, 9.3 million twenty-foot equivalent units (TEU) were imported to the U.S. from the northeast region, which is the largest importing region for the U.S. (Figure 1.3). China is the leader, claiming 66 percent of the northeast imports, with the remaining countries importing between 7 and 13 percent. China has shown significant growth; in 1995, their share of northeast Asia imports was only 30 percent.

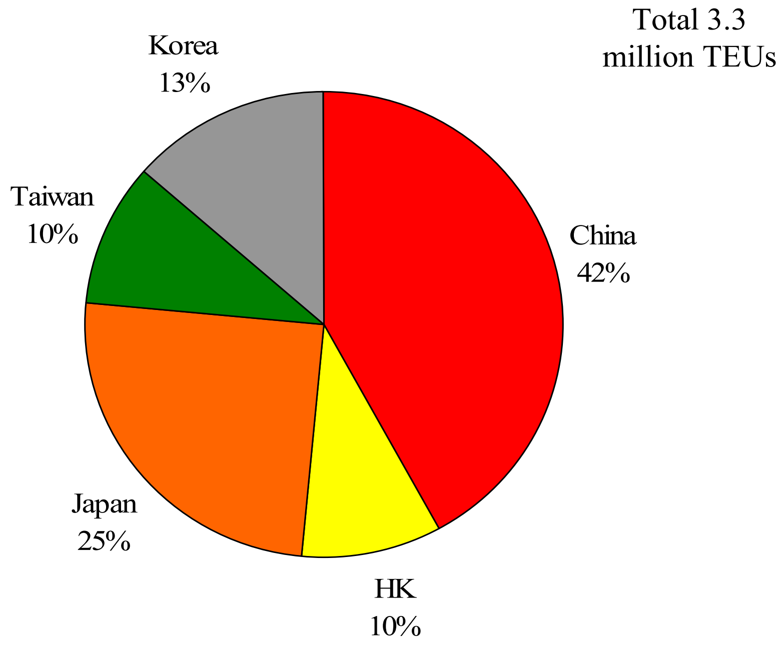
Figure 1.3 Northeast Asia Import Share by Country - 2004



Source: McCahill, Brendan. "U.S. Containerized Trade Status and Forecast." 5th Annual Transpacific Maritime Conference. PIERS Trade Horizons. 28 Feb 2005.

Northeast Asia is also the largest market for U.S. exports (Figure 1.4). China is the number one receiver of U.S. exports, receiving about 42 percent, with Japan receiving approximately 25 percent. U.S exports to China have grown significantly compared to their share of 24 percent at the turn of the century (McCahill, 2005).

Figure 1.4 Northeast Asia Export Share by Country - 2004



Source: McCahill, Brendan. "U.S. Containerized Trade Status and Forecast." 5th Annual Transpacific Maritime Conference. PIERS Trade Horizons. 28 Feb 2005.

China has not only become the leading trading country in northeast Asia, China has become the most influential global trading partner to the United States. As the primary importer to the U.S., China is a major economic indicator for the U.S. economy. China's share of the U.S. total import volume has been increasing at a record rate; it was 15 percent in 1995, 26 percent in 2000, and up to 38 percent in 2004, and is still growing. Although U.S. exports to China in 2004 were 18 percent, which is a notable increase from the nine percent in 2000, yet the deficit is large and growing (McCahill, 2005). Forecasts predict trade growth with Asia will continue at record levels, especially with China, which will have dynamic effects on the U.S. economy.

A Nation Dependent on Trade

Globalization has changed our economy. We are no longer a self-supporting society; we are a society dependent upon a large-scale global trade network. The evolution of just-in-time inventory systems and industry outsourcing has increased efficiency and productivity for U.S companies. From 1980 to 2000, one study estimated that business logistics costs dropped from 16.1 percent of U.S. GDP to 10.1 percent (Frittelli, 2005). These logistics savings are not without cost; they have increased risk by creating almost complete dependence on an uninterrupted supply chain for many U.S. companies. Stephen Flynn, senior fellow at the Council on Foreign Relations, in discussing the consequences of a U.S. port closure, noted that 90 percent of the world's general cargo moves inside containers. When containers stop moving so do assembly lines, which causes shelves at retailers such as Wal-Mart and Home Depot to go bare. In October of 2002, labor disputes erupted between the Pacific Maritime Association and the International Longshoremen Workers Union causing a 10-day closure of all the west coast ports. The resulting cost to the economy were estimated at $1 billion per day for the first five days, and then rose considerably thereafter (Flynn, 2002). The low inventory, low cost input outsourcing model of business has contributed greatly to productivity and efficiency, but in doing so, has created much vulnerability for the U.S. economy.

The Swift Evolution of Maritime Security

Prior to the terrorist attacks on September 11, 2001, the common perception of transportation security was controlling theft and reducing contraband such as drugs, illegal immigrants, and exports of stolen vehicles and machinery. Post 9/11 transportation security has been transformed to assessing threats of possible terrorist attacks on or through our supply chain systems. Our ports, coasts, and waterways are lined with military installations, nuclear power plants, oil refineries, fuel tanks, pipelines, chemical plants, and major cities with dense populations (U.S.H.R., 2004). Ports are a chief security concern, because the major cargo hubs have the best infrastructure to handle shipments. This creates a supply chokepoint because cargo traffic is concentrated at major ports. The top 50 U.S. ports account for approximately 90 percent of all cargo tonnage and 25 U.S. ports account for roughly 98 percent of all container shipments (Frittelli, 2005). The worst case threat scenario is the possibility of weapons of mass destruction being shipped into the country and detonated at a port or major city. A tragedy of this nature would be immense, causing a significant loss of lives, damaged infrastructure, and a loss of public confidence. The resulting effect on the U.S. economy from recovery measures, closed ports, congestion, and disruptions of business would be devastating. Though the effect is difficult to measure, Senator Hollings of North Carolina cited a study stating that the U.S. economy would collapse within 20 days of a successful attack on a U.S. port (Menchaca, 2003).

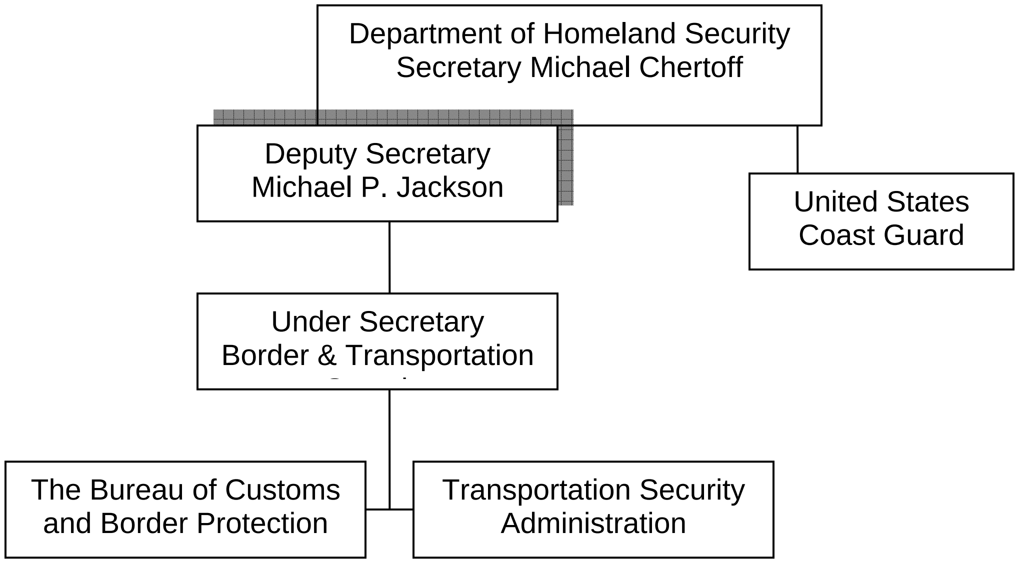
U.S. marine jurisdiction covers some 3.5 million square miles of ocean and about 95,000 miles of coastline (U.S.H.R., 2004). The U.S. has 361 river ports and seaports, in which we receive 60,000 visits from 8100 ships per year. More than nine million containers are imported to the U.S. each year, of which less than three percent are carried on U.S. flagged vessels (Frittelli, 2005). A national security concern exists, because only four to six percent of containers' contents are verified (Dinsmore, 2004). In light of 9/11 and the ongoing security concerns, government and industry participants have been working to develop and implement plans to secure our nation's ports and supply chains without stagnating trade flows.

Current Security Strategy

Prevention and awareness is the focal point of the maritime security strategy because it is the most effective method to ensuring the highest level of security. Raising inspection levels as some have suggested, will only create devastating congestion at ports, and will bring trade flows to stagnant levels without significantly increasing security. If visibility over the whole supply chain from origin to destination is achieved, then a higher level of security is obtained and trade flows are virtually uninhibited.

Prior to 9/11, the governmental agencies involved in protecting the homeland were numerous and disjointed. In June of 2002, President George W. Bush proposed the creation of a unified organization that would be focused solely on homeland security: the Department of Homeland Security (DHS). The DHS is divided into four divisions: Border and Transportation Security, Emergency Preparedness and Response, Chemical, Biological, Radiological, and Nuclear Countermeasures, and Information Analysis and Infrastructure Protection (DHS, 2006). With the new DHS, a more simplified organizational structure was achieved. Figure 1.5 displays the organization of the primary maritime security agencies in the DHS, which are the Customs and Border Protection (CBP), the United States Coast Guard (USCG), and the Transportation Security Administration (TSA).

Figure 1.5 Department of Homeland Security



Source: DHS. “Department Organization” Department of Homeland Security. http://www.dhs.gov/dhspublic/display?theme=10&content=5274. Accessed March 2006.

CBP manages, controls, and protects the nation’s borders and ports of entry through various measures such as patrolling, inspecting, and targeting security risks. The USCG’s role in our nation’s security has become increasingly important since 9/11. Not only is the USCG responsible for overseeing the waters surrounding the coastline, and any international waters if deemed necessary to protect the environment, public, and the U.S. economy, since 2002 it is also responsible for ensuring security standards on all shipping vessels, and patrolling for all incoming high-risk vessels. Though primarily involved in air transportation security, the Transportation Security Administration’s primary role in maritime security has been funding security research and development projects, such as Operation Safe Commerce and the Transportation Workers Identification Credential program.

Security Programs, Initiatives, and Methods

Security initiatives, programs, and regulations have been developed by the U.S. government to develop a more visible and secure supply chain, however, there is a great deal of work yet to be done. The DHS, CBP, USCG, local authorities, freight forwarders, shippers, carriers, and port authorities all interconnect and play an essential role in the security of our global supply chains by creating a layered approach to security from origin to destination.

24-Hour Advanced Manifest Rule

Effective since December 2002, the 24-Hour Advanced Manifest Rule requires all sea carriers with the exception of approved bulk carriers, to provide proper cargo descriptions and consignee addresses 24 hours before cargo is loaded at a foreign port for shipment to the United States. Operated by the CBP, this program provides the DHS with advance information about container shipments, which enables them to evaluate potential risks or threats before the cargo arrives at a U.S. port (DHS, 2004). Cargo descriptions must detail each container item; the 'freight all kinds' or 'general merchandise' descriptions are no longer permitted. (Bryd, 2004). Carriers in violation of this rule will not be allowed to unload any containers in U.S.

Container Security Initiative (CSI)

Created in 2002, the Container Security Initiative (CSI) was implemented to pre-screen cargo containers at foreign ports destined for the United States. CBP officials work with host nation officials to ensure the contents of containers. CSI has proved beneficial by increasing custom's ability to intercept risk-bearing containers before reaching U.S. ports. Cooperative targeting with foreign partners helps provide better and more complete advanced information to identify risks. With more information, fewer non-threatening containers are being identified as posing risks of terrorism, and the high-risk shipments are better identified, which promotes smoother trade flows with fewer inspection delays. The CSI program is enhancing the security of global supply chains, port infrastructures, and the nation by assessing and identifying risks before containers near U.S. soil (CBP, 2005). CSI is proving to be a global success. The initial plan was to establish CSI at the top 20 seaports, which represented about two thirds of all U.S. bound cargo. As of November 2005, 41 foreign ports have implemented CSI. Now, approximately 75 percent of cargo containers imported to the U.S. are shipped through a CSI port. CBP's goal is to have 50 operational CSI ports by the end of 2006. At that time, approximately 90 percent of all cargo imported into the United States will be pre-screened (CBP, 2005).

Smart Box Initiative

Probably the most discussed element to better securing and managing supply chains is the smart box. The basic smart box or smart container is a container equipped with a tamper evident seal on the door that detects intrusion and contains an electronic RFID device that provides tracking information. If the container is tampered with after it is sealed, the devices will reveal the intrusion (DHS, 2004). Many versions of smart seals have been developed, yet no national standard has been declared. Organizations, such as Operation Safe Commerce and Smart and Secure Tradelanes are conducting extensive tests of smart box technologies. Advanced smart container technologies are being developed which not only detect door intrusion, but also detect intrusion on all six walls, cargo shifting, and the presence of radiation, chemicals, and people (Wolfe, 2005). Smart container technologies are proving essential for enhancing supply chain security without stagnating container flows by providing customs agents with complete cargo information from origin to destination.

Originally, some critics believed high tech containers represented increased national security at the expense of shippers and carriers. However, studies are proving smart containers to be beneficial for the industry also. Information provided from smart containers, such as tracking and intrusion information, produces benefits for importing businesses in terms of efficiency and integrity. With shipment location information, businesses can lower logistics costs by maintaining tighter inventories, managing congestion effects, and reducing time impacts from misrouted containers. Smart container shipments have been estimated to cost approximately $50 per shipment, which would add approximately 1.5 percent to the average overseas shipping cost (Flynn, 2004). However, this cost may be viewed as a valuable investment in return for supply management gains. According to a study by the North River Consulting Group, shippers may benefit by approximately $400 per container by utilizing RFID equipped containers.

Customs Trade Partnership Against Terrorism (C-TPAT)

Created in 2002, the Customs Trade Partnership Against Terrorism (C-TPAT) is a voluntary effort between CBP and the international trade community to protect the global supply chain from terrorist attacks. C-TPAT is the largest security program consisting of 9100 companies, including shippers, carriers, marine terminal operators, port authorities, brokers, freight forwarders, and even some foreign manufacturers (CBP, 2005). Membership requires compliance with minimum security standards outlined by CBP. Security standards involve physical measures (fences, lighting, access controls, inspections), and informational requirements (manifests, shipment verifications).

Based on qualifications met, members receive ‘green lane’ treatment on shipments through ports. The ‘green lane’ is the term for the more trusted shippers, which receive faster port clearance, with fewer delays from inspection. There are three requirements that C-TPAT members must meet to receive ‘green lane’ treatment. The shipper must be a C-TPAT valid partner, the shipment must come through a CSI port, and the cargo must go through a secure container device (Bonner, 2005). A 3-tiered structure outlines the benefits received by C-TPAT members. Each tier benefit is achieved by establishing a certain minimum security requirement. Tier 1 benefits for certified members, give them reduced inspections. Tier 2 benefits for validated members, allows for greater inspection reductions. The highest benefit tier, tier 3 consists of validated members who have exceeded the minimum security requirements and have adopted C-TPAT’s best practices (CBP, 2005). The C-TPAT program is successfully enhancing the security of our supply chains by conveying information to CBP from origin to destination, which creates a safer and more transparent supply chain.

Maritime Transportation Security Act (MTSA)

On November 25, 2002, the Maritime Transportation Security Act (MTSA) was the first major legislation involving security to be enacted post 9/11. The Act sets out many provisions and regulations for federal agencies, ports, and vessel owners to enhancing security on vessels, at ports, and other trade facilities. Security upgrades include national and regional security plans, response plans, security assessments, and physical security improvements (U.S.H.R., 2004).
As the primary policing agent of the maritime industry, the USCG is responsible for ensuring that MTSA standards are met. The USCG created a comprehensive

program named Maritime Domain Awareness (MDA) to maintain awareness and understanding of anything associated with the maritime domain that could impact the security, safety, economy, or environment of the United States. MDA's primary tasks are to monitor vessels and crafts, cargo, vessel crews, passengers, and to maintain and analyze data in order to anticipate threats (U.S. Coast Guard, 2005).

A key component of MDA is the 96 Hour Advance Notice of Arrival and the Automated Identification System (AIS). The 96 Hour Advance Notice of Arrival regulations requires U.S. bound ships to notify the USCG 96 hours before arriving and provide detailed information about the shipment, including the crew, intermediate stops, cargo, and passengers. This early information is analyzed and any potential risk or threats are acted on by the USCG, which may include at sea boarding or armed escorting. The Automatic Identification System (AIS) is a vessel tracking technology that automatically sends ship information to other ships and authorities on shore. Required for most ships by the MTSA, AIS is helping the USCG track and monitor shipping vessels, thus increasing security in trade routes (DHS, 2004).

International Ship and Port Facility Security Code (ISPS)

The International Ship and Port Facility Security Code (ISPS) code is a worldwide multilateral ship and port security standard that was implemented on July 1, 2004. ISPS code compliance is required for all vessels and port facilities. ISPS measures involve security assessments, security plans, and employing security officers. All vessels are subject to onboard inspections by the USCG to ensure that vessels have proper security plans, personnel, and have met all ISPS standards. Continual worldwide compliance is promoted through the International Port Security Program, a U.S. Coast Guard effort to work with host nations to conduct inspections and periodic visits to trading countries around the world. As part of ISPS, the Ship Security Alert System (SSAS) was introduced. SSAS is an alarm system aboard vessels that allows an operator to send a covert alert to shore officials if an incident has occurred to compromise the vessel's security, such as act of piracy or terrorism. Under the ISPS code, all vessels that ship 500 gross tons or more are required to have SSAS systems. (DHS, 2004).

Operation Safe Commerce (OSC)

Operation Safe Commerce (OSC) is a government based research program to study and analyze supply chain security, develop solutions, and test technologies to enhance security while facilitating the flow of commerce. Researched through multiple demonstration projects, OSC's primary focus is security technology, such as web enabled video, RFID devices, global-positioning system tracking, and support software. The goal is to consistently verify the contents of containers at origin, ensure physical integrity of containers in transit, and track their movement through to destination.

Piloted by the TSA, the program was created in November of 2002, and is operated at the Ports of Seattle, Tacoma, New York, New Jersey, Los Angeles, and Long Beach (Port of Seattle, 2004). Funded by the Department of Homeland Security, OSC is greater than a $58 million effort. The ultimate goal of OSC is to structure international standards for a secure supply chain by developing repeatable, scalable, and cost effective measures that promote smooth trade while minimizing threat and theft. Preliminary results indicate that the most effective security solution must be architecturally open, not proprietary and must be economically and commercially viable. While an ultimate technological solution has yet to be defined, OSC declares that the solution will require a multi-sensor approach instilled with certain performance standards. OSC is currently working to determine and select the best practices, procedures and technologies for recommendation. The last funding awarded to OSC, valued at $17 million, is being used to continue testing security methods, determine trade lanes for stress testing, and develop national standards for RFID frequencies, threat detection criteria, cargo integrity, intrusion detection standards, and deviation reporting standards (TRB, 2004).

TSA's other major contribution to maritime security is the creation of the Transportation Workers Identity Card (TWIC). The TWIC program is being developed to create a uniform credential for all transportation workers, which will authenticate workers' identity with a biometric identifier. Workers will use this identification system to gain access to sensitive areas within transportation facilities (DHS, 2004).

Smart and Secure Tradelanes (SST)

An industry initiative, Smart and Secure Tradelanes (SST) was established in October of 2002 by the Strategic Council on Security Technology. The privately funded council consists of large port authorities, security technology providers, and port operators. Similar to OSC, the purpose of SST is to test security technologies, such as RFID tags, electronic seals and global-positioning tracking. The goal of SST is to discover and adopt the most efficient security technologies that produce the highest security standards and promote smooth commerce through ports. Completed in 2003, the first phase involved testing RFID and other smart container technologies that could determine container intrusion. Information gaps were found in the supply chain, either with inaccurate data, or with no data at all. SST participants have found that implementing sensoring systems and capturing trade data has potential benefits (i.e., seamless information exchange between port handlers and shipping firms). Phase two expanded the program to manufacturers, trucking companies, and railroads to focus on the complete supply chain. Also, improvements to the 24 hour electronic manifest information processing technology and testing of more advanced container security devices were conducted (Greenemeier, 2004). A Stanford University study estimated that the RFID solutions tested resulted in benefits ranging from $400 to $1800 per container trip (Kearney, 2005). The ongoing SST initiative is producing positive results in container security, some of which have been already been adopted commercially.

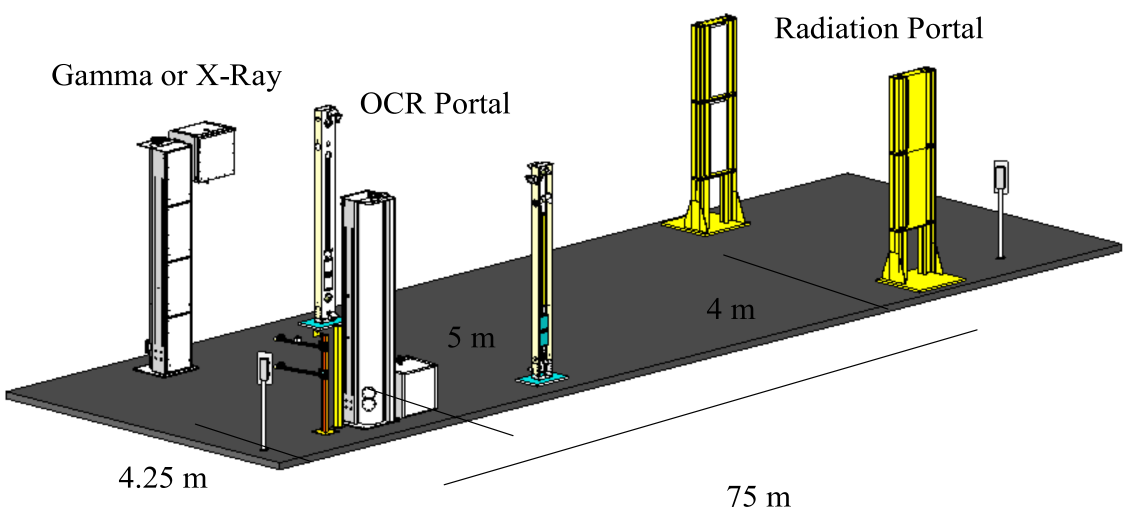
Automated Information Systems

The Automated Commercial Environment (ACE)/ International Trade Data System (ITDS) is the updated U.S. trade processing system created to streamline border processing, transactions, and collect trade information more efficiently for risk assessments. ACE/ITDS is enhancing border security, increasing data accessibility, reducing paperwork, and facilitating trade flows (CBP, 2005). Implemented by the CBP, the Automated Targeting System (ATS) assists in analyzing transactional data to determine potential risks of cargo and passengers arriving in the United States (DHS, 2004).

Non-Intrusive Inspection Technology (NII)

The CBP uses large-scale scanning devices to screen containers without physically entering the container. Radiation detectors, gamma ray and x-ray imaging technologies allow agents to screen the inside of a container for any form of contraband including weapons of mass destruction in less than one minute (DHS, 2004). These sensing technologies are incorporated into handheld devices and drive- through portals. Optical Character Recognition (OCR) technologies automatically read identification tags on containers and trucks while in motion (up to 25 kph), and then transmit information to security personnel. OCR rapidly and efficiently retrieves driver identification, container manifest, and truck information with 95 percent accuracy, but could be cost prohibitive for port agencies (Newton, 2005). Radiation, gamma ray, x-ray, and OCR scanning technologies are being set up as one complete drive through portal for containers at ports. Figure 1.6 illustrates an example scanning portal.

Figure 1.6: Non-Intrusive Inspection Technologies



Newton, Aaron. "Cargo Security Technology Concepts." Marine Log's Maritime and Port Security Expo. National Cargo Security Council. Feb 2005.

The cost of installing cargo-scanning equipment in all the world's marine container terminals is estimated at $500 million to $600 million (Flynn, 2004). NII technologies are crucial to enhancing maritime security while promoting smooth flows of trade with less congestion. NII is increasing security levels far beyond the capabilities of physical security tactics. Secretary for Border and

Transportation Security, Stewart Verdery, stated during Marine Log's Maritime and Port Security Conference 2005 that the government is looking to enact screening of 100 percent of shipments for radiation and nuclear material to eliminate weapons of mass effect.

Research Objectives

The primary objective of this research is to develop a transportation optimization model of a firm's containerized imports in order to quantify and evaluate the impacts of port security measures on transportation efficiency (costs) and catastrophic events. Specific objectives were to:

1. Obtain a general understanding of the security measures implemented throughout the maritime transportation system.
2. Develop an industry representation of a typical import product by creating a model representing a specific firm's import supply chain from origin to destination.
3. Investigate and measure the effects that specific port security situations inflict on a firm's supply chain cost and distribution.
4. Determine the effects that specific port security situations have on the cost and distribution of the product at the industry level.
5. Investigate the impacts of the aforementioned security situations when the model is used to represent the entire west coast container volumes.

II. ECONOMIC IMPACTS OF SUPPLY CHAIN SECURITY MEASURES, EVENTS, AND POLICIES

Introduction

The 9/11 tragedy forced policymakers to make some immediate decisions about the nation's transportation systems to secure the nation. The Maritime Transportation Security Act of 2002 was the most comprehensive maritime security act to date, and was developed and implemented in an expedited fashion in response to the threats and capabilities posed by terrorists. The state of emergency, which created an urgency to implement measures without careful consideration of the cost and effectiveness. However, through research, experience, and collaboration between industry and government, a great deal of progress has been achieved over the past five years.

Literature Review

Post 9/11 security research has been centered on emergency response and preparedness, economic risk assessment and analysis, and studies of efficiency associated with security technologies. To develop this research, several studies dealing with these subjects were explored. These studies consist of different objectives and modeling techniques than are used in this paper, but contribute to the understanding of the unique objectives of this research.

Two of the studies investigate the risk and economic impact of a terrorist attack on the ports of Los Angeles and Long Beach. The first study models the economic impact from the detonation of a radiological bomb in the twin ports (Gordon, 2005). The study utilizes the input-output Southern California Planning Model (SCPM) to analyze the direct, indirect, and induced effects that the impact would have on the five-county metropolitan economy of Los Angeles. Impacts in the model are measured in terms of the loss of economic activity, such as loss of demand for goods and services, employment, and transportation. The resulting effects from a closure of both ports were estimated at $1.108 billion in lost output and 10,061 person-years of employment (in total). When the study considered combined attacks of a port and one or more key access bridges, the effect was significantly amplified to $34 billion in lost output, (Gordon, 2005).

The second study involving attacks on the ports of Los Angeles and Long Beach addresses two issues: the probability of dirty bomb attacks on the twin ports, and the economic consequences associated with an attack (Rosoff, 2005). The latter issue dealing with economic impacts was estimated with a regional, spatially disaggregated input-output model similar to the model used in the first study. This study analyzed the probability of a successful attack on the ports by considering all the tasks needed to carry out the attack, such as the source of the radioactive material, the mode of transportation, and the time needed to carry out such an attack. Using undisclosed data, probabilities of successful completion of each task was derived and a logit model was used to estimate the variations in these probabilities as a function of the number of people and time necessary for each task. Uncertainty of success was incorporated into the model through use of a probabilistic simulation model. Based on attack scenario assumptions, the findings indicated that the chances of a successful dirty bomb attack are no better than 60 percent (Rosoff, 2005).

An alternative approach to port focused research was presented in Lee and Song, 2003. This study focused on optimizing port throughput while incurring delays from security inspections. Using data on the operations at a major seaport, such as typical loading/offloading times, delay times, and inspection rates, a near-optimal solution was derived by utilizing a genetic algorithm (Lee, 2003). Numerous variables influence port throughput, therefore the study produced results based certain assumptions of yard capacity (crane operations, labor, yard truck transfers). The findings display the expected vessel delays associated with various inspection levels (high security alerts inflict higher inspection rates). Non-intrusive inspections improve inspection efficiency dramatically, thus increasing throughput and lowering vessel delays. For example, the study concluded that a 10 percent increase in inspection efficiency would result in a 9.47 percent reduction in vessel delay hours (Lee, 2003).

Through a cooperative effort between the Asia-Pacific Economic Cooperation (APEC) and Bangkok/Laem Chabang, the Secure Trade in the APEC Region (STAR) and Bangkok/Laem Chabang Efficient and Secure Trade (BEST) created the STAR-BEST project (Bearing Point, 2003). The project was initiated to test concepts and technologies, specifically RFID tracking devices and electronic seals, for implementing an origin to destination supply chain security system between Thailand and Seattle, Washington. Consultants from Bearing Point conducted a cost-benefit analysis to examine the project in detail. The study measured cost and benefits in three areas: technology service providers, shippers, and the American public. The primary benefit assumptions included lower inspection rates, reduced inventory safety stocks, reduced bill of lading surcharges, reduced pilferage and insurance costs, and reduced container-tracking costs. To test these assumptions, Bearing Point employed Crystal Ball risk analysis software and created a Monte Carlo simulation to demonstrate a wider range of probable outcomes. Their findings indicate that the end to end supply chain security was feasible and could produce benefits through higher supply chain visibility, enhanced inventory management, customer service improvements, reduced theft, and reduced costs from inspection avoidance (Bearing Point, 2003).

Another study illustrating a direct relationship between security and benefits was Lee and Whang's, 2005. This study demonstrated how lessons learned with the total quality management movement apply in the security realm. Using shipment data from a high-tech manufacturer, a simple evaluation was conducted to determine the probable effects of transportation and inspection dwell time on the safety inventory stock and the firm's ability to meet demand. The study concluded that obtaining advanced information through preventive security measures (CSI, C-TPAT) increases shipment information to a firm, thus allowing firms to lower inventory levels and avoid costly delays from inspections (Lee, 2005).

The preceding studies illustrated various approaches surrounding the issue of maritime security. The objective of this research investigates maritime security with an end user perspective. In this study, the objective was to develop a transportation optimization model based on a firm's specific supply network and evaluate the effect that various security impacts, such as a closure of seaport, have on the firm's costs and trade flows. Furthermore, by utilizing the firm's distribution network, an evaluation of similar security issues on the entire industry and west coast port volumes was conducted to measure the various scales of these impacts.

III. TRANSPORTATION OPTIMIZATION MODEL

Data and Methodology

To develop an accurate representation of container trade, it was important that the study used a typical containerized shipment. The most common containerized imports are consumer goods, such as clothing, shoes, electronics, furniture, auto parts, and toys (Frittelli, 2005). Electronic products, specifically televisions, were chosen to represent import container flows. Imports of television (TV) receivers, video monitors, and projectors accounted for over $16 billion of trade in the U.S. in 2004, which is a dramatic increase from the $7.2 billion imported in 2000. Mexico, Japan, and China are the top three trade partners for television imports providing $7.4, $2.3, and $2.3 billion, respectively (Export.gov, 2006).

Since a majority of overseas television imports come from Asia, an importer was chosen to represent this trade. Through cooperation with a large U.S. electronics retailer, an accurate insight of television imports via the transpacific was developed.[1] This retailer imports TVs from Xiamen, China and ships them via ocean carrier to the west coast, and then distributes them throughout the United States.

The firm's supply chain begins with an international purchase order issued by the retailer's inventory center 60 days prior to the scheduled receipt date. This purchase order is transmitted to the vendor and freight forwarder through an electronic data interchange (EDI) system. The vendor produces the order and initiates a booking request with the freight forwarder 10 to 14 days before the ship date. Origin fees for a container shipment are approximately $100. The

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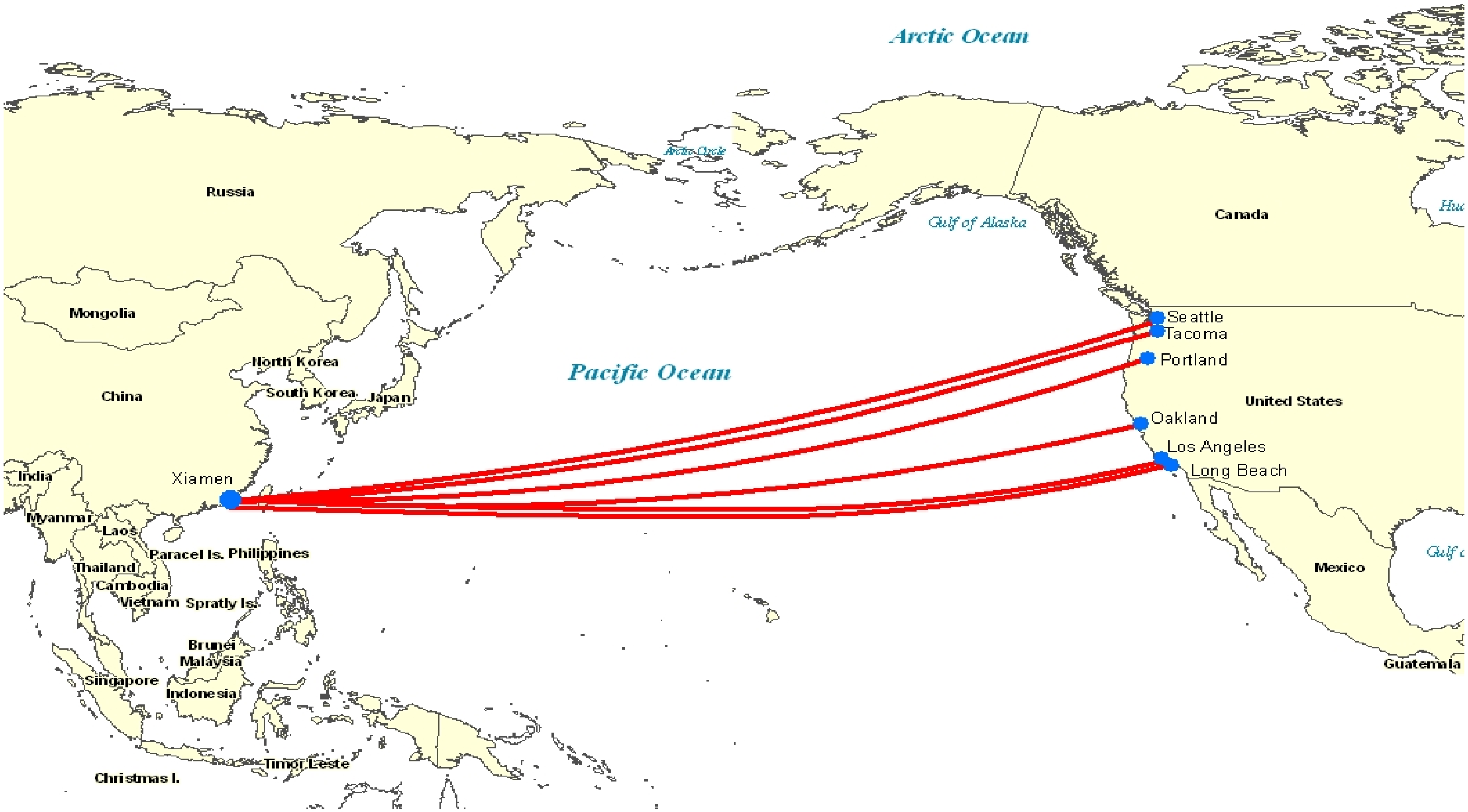
[1] The electronic retailer requested to remain anonymous.

freight forwarder sets up the shipment details, one of which is the free on board (FOB) incoterm, which holds the vendor responsible for transporting the shipment to the Port of Xiamen. Forty foot equivalent container units (FEU) are most commonly used to ship these types of products, which are loaded at the vendor's factory and transported by truck to the port. Each container is valued at approximately $80,000 in initial cost. Loaded containers are delivered to the port no less than five days prior to the vessel departure date in order to be cleared by customs, before loading onto the vessel.

Once the vessel departs, it travels to one of the six major west coast ports (Figure 3.1). Depending upon the intermediate ports of call between the Port of Xiamen and the west coast port, the average travel time varies between 14 and 16 days. Total shipping cost for one container from Xiamen to the west coast is approximately $2700. Upon port arrival, the containers are offloaded and available for pickup within 48 to 72 hours. Delays may occur when entering U.S. ports because of port congestion, labor shortages, rail and truck shortages, and possible inspection if deemed necessary by customs.

Figure 3.1. Trans-Pacific Shipment Routes



Once containers are cleared by customs, containers are unloaded from the vessel and loaded into trailers for truck transport to distribution centers (Figure 3.2). Trucking carriers typically pick up trailers within 48 hours of availability and transport shipments to one or more of the eight distribution centers within two to ten days depending on destination. The firm utilizes rail and truck transportation, but the majority is transported by truck. The eight distribution centers service all of the retail stores nationwide, a total of 826 stores (Figure 3.3).

For the purposes of this study, the mode of inland transportation is assumed to be truck only, and a trucking rate of $1.60 per mile was assessed based on the mileage between transshipment destinations (Casavant, 2006). Transport miles were calculated using Rand McNally's online mileage calculator. The annual volume of shipments was estimated by first dividing the total value of television receiver imports from all six west coast ports by the firm's average container value, ($5,601,246,357.00/$80,000) which totaled 70,016 FEUs for the industry, then the firm's volume was determined by applying the firm's electronics market share of 17 percent, thus resulting in 11,903 FEUs per year.[2]

[2] Television receiver import values were based on HS Code 8528 (Harmonized System Codes) which is the commodity class for television receivers, video monitors, and projectors. Source: U.S. Department of Transportation.

Figure 3.2 Distribution Center Locations

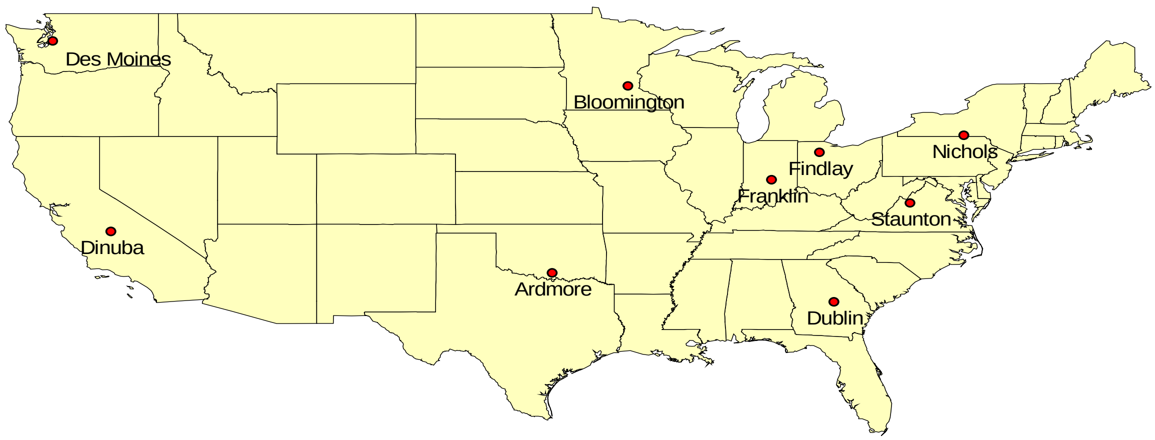
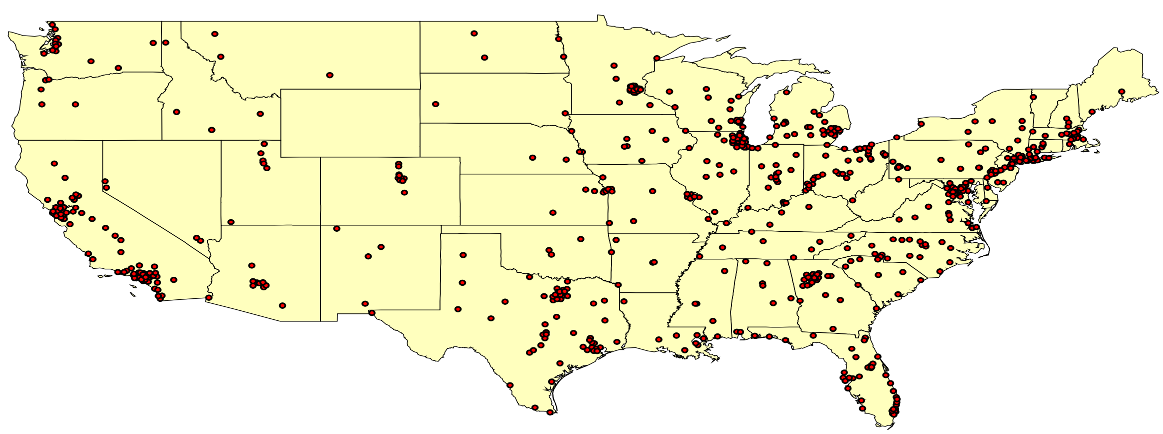


Figure 3.3 Retail Store Locations



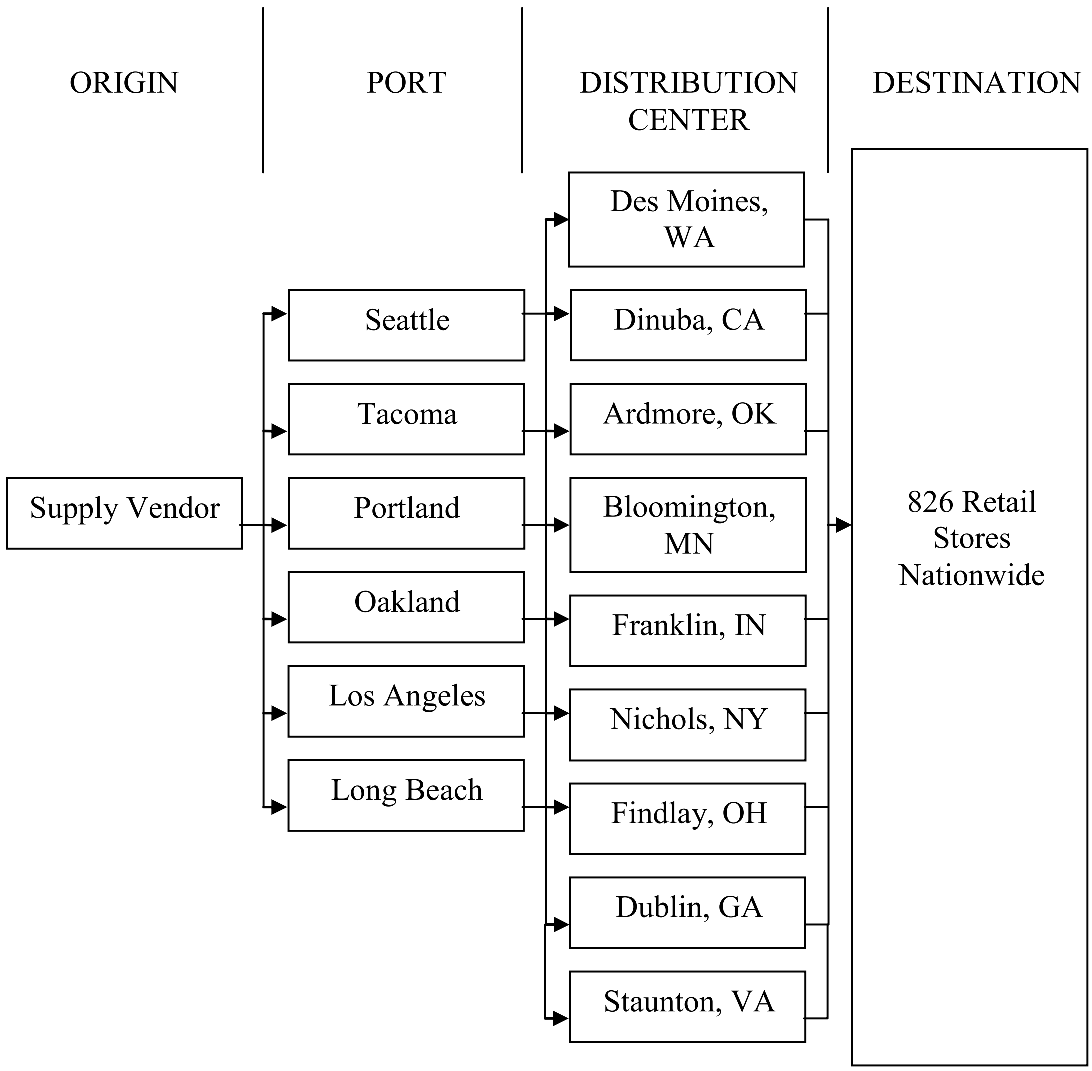
As previously mentioned, the firm primarily utilizes eight distribution centers; however, a problem arises in the Pacific Northwest region where three main ports are located. Without a distribution center existing in that region, the shipment flows in the study were subject to unrealistic results because the Dinuba, California distribution center was the only means for distribution to west coast stores. Therefore, an assumption was made that a ninth distribution center exists in Des Moines, WA. By incorporating this distribution center, the model more accurately reflected shipment flows into the Pacific Northwest region (Figure 3.2).

Transportation Optimization Model

A transportation model was developed to realistically represent movement of the firm's television shipments through the supply network. Using linear programming, a cost minimization objective was achieved by optimizing the least cost combination of transshipment points (port and distribution center) while satisfying demand at the retail stores.

The possible combinations of shipment routes from origin to destination are displayed in figure 3.4. There are four segments of shipments: the vendor and port in Xiamen, the two intermediate destinations which include the west coast ports and the distribution centers, and the final retail store destination. For purposes of this study, the

Figure 3.4 Possible Shipment Routes to Destination



vendor and the Port of Xiamen are assumed to be the combined starting point of the supply chain because of deficient information provided concerning the Chinese vendor. The available west coast port destinations are at Seattle, Washington, Tacoma, Washington, Portland, Oregon, and Oakland, Los Angeles, and Long Beach, all of California. Shipments then move from the ports move to one of the nine distribution centers: Des Moines, Washington; Dinuba, California; Ardmore, Oklahoma; Bloomington, Minnesota; Findlay, Ohio; Franklin, Indiana; Staunton, Virginia; Dublin, Georgia; or Nichols, New York. The distribution centers serve as storage warehouses and ship products to the 826 retail stores to meet consumer demands.

The firm's objective was to determine the optimal allocation and routing of shipments that minimize total transportation costs. The linear programming (LP) cost minimization model solves for the optimal allocation and cost. The cost per-unit (c_{ijkl}) for shipments between origin (i), intermediate port (j), intermediate distribution center (k), and final destination (l), is multiplied by the number of FEUs shipped (x_{ijkl}) from the origin through the corresponding port, distribution center, and final retail store. The objective function is defined as follows:

(1) Minimize $\sum_i \sum_j \sum_k \sum_l x_{ijkl} c_{ijkl}$

Where:
i = origin
j = intermediate port
k = intermediate distribution center
l = final destination (retail store)

s_j = supply of televisions at origin (FEUs)
d_l = demand for televisions at destinations (FEUs)
c_{ijkl} = cost per FEU shipment between origin i, intermediate port j, intermediate distribution center k, and final destination l.
x_{ijkl} = the number of FEUs shipped from origin i, intermediate port j, intermediate distribution center k, and final destination l.

The exogenous variables (x_{ijkl}) were decided by the model and determine the optimal objective value. The exogenous variables (x_{ijkl}) are equal to the number of FEUs shipped from origin (i), through intermediate ports (j) and intermediate distribution centers (k), to the final destination (l) and must be equal to or greater than zero (2).

(2) $x_{ijkl} \geq 0$, for all i, j, k, l.

The optimization model was constrained by the available supply at the origin and the final demand at the retail stores. The supply constraint limits the quantity (FEUs) that can be shipped by the Xiamen vendor, defined by S_i (3). The demand constraint ascertains that the sum of all shipments from origin (i), intermediate port (j), intermediate distribution center (k), are equal to or greater than the demand at each final destination (l), defined by D_l (4).

Observe supply limits at origin (i):

(3) $\sum_{il} x_{ijkl} \leq S_i$, for i

Satisfy demand at final destination (l):

(4) $\sum_{il} x_{ijkl} \geq D_l$, for all l

Constraints were placed on port volumes to more accurately represent the firm's shipments through the ports, otherwise the model would have the option of shipping all flows through a single port, thus decreasing the reality of the results. Constraints were created for each port based on each ports' typical annual television shipments by applying weighted averages of the total west coast television receiver imports to the firm's annual shipment volume. Since ports have the capacity to fluctuate considerably in volume, the constraints were allowed to fluctuate up or down 50 percent.

The rate structure for container throughput at the ports is complex. Two entities are involved, the port and the container terminal operator. Container terminals at the ports are leased by shipping carriers from the port; hence the port operates primarily as an administrative unit. The terminal operators provide services at the ports, such as drayage, de-vanning, storage, labor, etc. for a set rate per container. The service rate charge for a FEU of television products averaged $325 for shipments through the six ports (Pan, 2006). This rate varies depending on each ports tariff rates, container terminal operator, and terminal lease rates. Terminal lease rates vary with different contracts and ports. Compiling terminal lease rate information for each container terminal operator at each port proved to be an ambiguous task, as many operators were unwilling to provide this information.

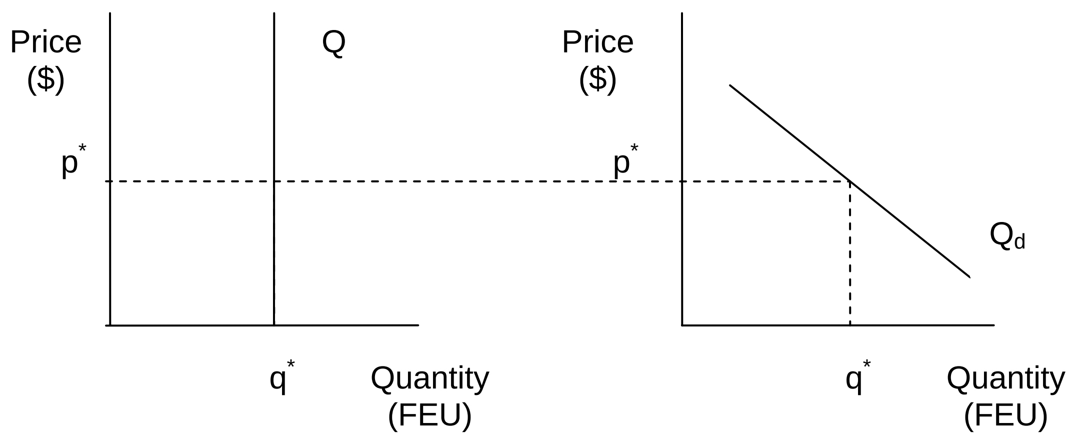
To develop a representation of the varying rates among the ports, a weighted average of each port's total revenues from leasing facilities and/or land was scaled according to their container volumes and applied to the average rate of $325 (See Appendix A). The most relevant flaw in this method occurred with the revenue component. Each port's leasing revenues were divided by their annual container volumes, thus establishing a rate per container. A problem exists because not all of a port's revenue is produced by container services alone; port revenue is also produced by the leasing of other types of shipping facilities. The most obvious outlier in these estimated rates was the Port of Portland, which produced a very high rate per container because their facility is not primarily a container facility. The Port of Portland is involved in shipping and receiving more bulk and roll-on/roll-off cargo than container cargo. Keeping these points in mind, the method remained successful in creating a relative rate that represented the supply and demand and economies of scale at each port.

To realistically represent capacity limits and typical throughput volumes, the model was volume constrained at the distribution centers. Data on the distribution centers throughput capacities were inaccessible; consequently, assumptions were made to approximate these flows. The original eight distribution centers range in size from 425,000 to 1,028,000 square feet, which was used to provide an indication of possible throughputs. Weighted averages of each distribution center's square footage were applied to the total volume shipped to develop a range of possible throughput volumes. To make the approximation more realistic the throughput volumes were allowed to fluctuate up or down 20 percent. The size of the Des Moines distribution center was established by taking an average size of the Washington distribution centers in Seattle, Tacoma, Renton, Fife, Auburn, Everett, Puyallup, Federal Way, and Kent. The data on these distribution centers was cited from a warehouse distribution study conducted by the Transportation Research Group at Washington State (Pike, 2005).

Demand volumes at the retail stores were assumed to be a function of city populations (ESRI Inc, 1994-2004). The total volume demanded, 11,903 FEUs, was distributed by a weighted average of each city's population, thereby establishing a static demand at each store location. A static demand quantity is not a realistic assumption for television products; therefore a downward sloping linear demand function was estimated by denoting quantity demanded as a function of transportation cost and a demand elasticity coefficient. The price elasticity of demand for radio and television receivers has been estimated to be elastic with a value of -1.2 (Anderson, 1997). Using this elasticity coefficient, demand functions were estimated for each retail location that respond to changes in price, which in this cost minimization model was represented by transportation cost per-unit shipped.

For the purposes of this model, it was assumed that the television vendor in Xiamen had the ability to meet all reasonable demands of this firm, thus the supply was considered constant. When quantity demanded changes as a result of a transportation cost change, the vendor's supply curve shifts horizontally up or down to satisfy the quantity demanded (Figure 3.5).

Figure 3.5. Supply and Demand



IV. FINDINGS AND RESULTS

Three scenarios were analyzed with the model to evaluate the effects of port security measures and impacts on the firm's distribution flows and costs. The first scenario measured the effect of increasing the rate charged at the port for container services by five, ten and fifteen percent. The rate increase was intended to show the impact of ports passing on the increased costs associated with increasing the security of the facilities. The second and third scenarios measured the impacts on the firm when the Port of Seattle and Port of Long Beach were shutdown, respectively. To explore the size and scale of the model, the volume shipped was expanded to represent all television imports into the west coast. All assumptions and constraints made for the firm level were maintained in the industry level. Finally, the model was further expanded to represent all west coast container import volumes. All scenarios are compared to a base model scenario, which is the optimal distribution and cost without any impacts imposed.

Firm Level Scenarios

The base scenario optimized the 11,903 FEUs at a total cost of $70,823,077.20, giving an average cost per FEU of $5,950.23 (Tables 4.1, 4.3). Long Beach handled the largest volume at 4,730 FEUs while incurring a cost of $13.6 million, and Portland handled the smallest volume at only 14.5 FEUs for a cost of $51,199. The Ports of Seattle and Portland are the highest cost ports for container throughput, which leads to smaller volumes. These ports were also the only ports that were volume constrained by their respective lower bounds; however, their shadow price values[3] were rather small (See Appendix B). The Ports of Tacoma and Oakland were constrained by upper volume constraints

[3] This shadow price is the value by which the objective function will change by relaxing this constraint one unit.

with low corresponding shadow prices, while the Ports of Los Angeles and Long Beach maintained slack between their constraints. The total cost of shipments from origin to port were $34.5 million, which included the port charges for container services.

The selection of ports for shipments by the model depends not only on the cost between port and origin, but is greatly influenced by constraints and costs at the distribution centers and the retail locations. The Bloomington distribution center (DC) sources all shipments from the Pacific Northwest ports reaching maximum capacity at a total of 941 FEUs, which was expected since the northwest ports are closer than the California ports (Table 4.1). The Des Moines DC is strategically located halfway between the Seattle and Tacoma ports, making it a viable option for either of the two ports, however, with Seattle having a $38 higher charge than Tacoma (See Appendix A), the Des Moines DC received all of its volume from Tacoma, pushing the port to its maximum volume constraint. Port of Oakland, a lower cost alternative than the northwest ports, shipped its maximum volume to the closest DC, which was Dinuba, California. Many retail stores are concentrated in California, and consume almost all of Dinuba's volume. The remaining supply for Dinuba was provided by the Port of Los Angeles. The large capacity ports, Los Angeles and Long Beach, supplied all of the midwest and eastern distribution centers. The most apparent reason for that was the two ports' large capacity, closer proximity, and lower cost per-unit of throughput. All the distribution centers maintained excess capacity except for Dinuba, Ardmore, Des Moines, and Bloomington. In fact, Findlay, Nichols, and Staunton DCs were constrained by their lower bound parameters with shadow prices in the $100 to $300 range. These positive shadow prices on the lower bound parameter demonstrate the potential cost savings of allowing one less FEU to pass through these distribution centers. Dinuba and Ardmore had high shadow prices of $-1,640 and $-1,654, respectively, which represent the per FEU cost savings of relaxing the volume constraints. The total bill for the port to distribution center movement was $28.9 million, over five million more than the origin through port movement.

Increased Port Charges - Firm

Increasing the rate charged at the ports by five, ten, and fifteen percent caused a slight decrease in demand of -0.21 percent, -0.41 percent, and -0.62 percent, respectively (Table 4.1). As a result of the reduction in quantity demanded, the total transportation cost decreased in similar intervals of -0.06 percent, -0.11 percent, and -0.17 percent. Though the total transportation costs decreased as expected with a loss of quantity demanded, the key finding in these scenarios was the incremental increase in per-unit costs. The five, ten, and fifteen percent rate increases caused the firm’s average per-unit costs to increase incrementally by 0.15, 0.30, and 0.45 percent, respectively (Table 4.3). The increase in per-unit cost is not large, increasing only $27 per FEU for the highest rate increase, but when also considering the firm’s loss of quantity demanded due to increasing prices and the shifting that occurs between ports, DCs, and retail stores, there is some significance to these results.

The decline in quantity demanded was only felt at the Port of Los Angeles in all the rate change scenarios; the other ports maintained the same volume as the base scenario while experiencing increased costs (Table 4.3). The largest shift between port and DCs occurred with Los Angeles and Long Beach and the Findlay DC. As the rate increases, Findlay shifted some of its volume from Los Angeles to Long Beach. Tables 4.2 and 4.4 show the shifts that occurred between retail locations and distribution centers as a result of the increasing port rates. The primary shifts occur in the northeastern region where the distribution centers are more geographically concentrated. Shifts between the Findlay and

Franklin DCs are the most common, which was expected because they are closely located. Most of these shifts were away from Franklin and to Findlay, most likely because Findlay was satisfying its lower bound parameter and Franklin had excess capacity. Franklin and Dublin experienced an overall decrease while the remaining DCs maintained the same volumes just by shifting volumes between each other to satisfy their constraints. As the rate increased, the shadow prices remained nearly the same, only decreasing slightly for each of the constrained DCs, which was expected given the decrease in quantity demanded.

Port of Seattle Shutdown – Firm

The Port of Seattle shutdown caused a loss of 464.30 containers that typically traveled through Seattle, which also meant a loss of one of Bloomington's optimal suppliers (Table 4.5). The overall loss of quantity demanded was approximately 31 FEUs and an increase in per-unit cost of about $11.00. The resulting shadow price for the Port of Seattle was $-333.00, which implies the incremental cost savings of allowing an additional container through that port. Previously, the port was not constrained, and therefore had no shadow price. Seattle's neighboring port, Tacoma, was already constrained in the base scenario, yet the value of potentially using Tacoma increased dramatically with the shadow price jumping from only $-23.00 to $-357. Portland's volume did not increase from its lower parameter, which would normally be expected. The main reason for this as discussed in Chapter 3, is the rate charged at the Port of Portland provides a good, relative comparison to the other ports as being the most expensive container port, yet the actual charge is extremely high in comparison to the other ports, thus causing Portland to lose its comparative advantage.

Seattle's volume shifted completely to the Port of Los Angeles, which was the only port that had the capacity available for all of Seattle's volume and also provided the lowest cost. Long Beach remained an infeasible alternative for the shipments because it was already handling its maximum volume allowed. With Seattle's volume shifting to Los Angeles, the Bloomington DC also shifted to Los Angeles for the remaining volume not supplied by Tacoma or Portland. This shift in supply caused the per-unit costs to increase for Bloomington, thus making it a less desirable DC. Notice in Table 4.5 the shifts between the retail stores and the distribution centers. Bloomington lost volume to Des Moines most likely because of the higher costs of their supply, and Franklin experienced an overall decrease in volume that was primarily due to Staunton, Nichols, and Findlay meeting their lower constraints. Dublin, Bloomington, and Franklin were not constrained after the Seattle shutdown. Franklin, Ardmore, and Des Moines retained the same volumes and shadow prices as in the base scenario, yet experienced some shifting between them.

Port of Long Beach Shutdown – Firm

The Port of Long Beach shutdown inflicted a greater loss of capacity in the supply network, but yielded a smaller change in total cost; the per-unit cost increased by approximately $6 (Table 4.6). All of the Long Beach volume was transferred to the neighboring Port of Los Angeles, thus total transportation costs were not significantly increased. No significant changes occurred in the shadow prices, since Los Angeles had the capacity to take all of the Long Beach volume without reaching capacity, however, the shadow price at Long Beach increased by $16. Per-unit costs increased for all of the distribution centers that transferred from Long Beach to Los Angeles, which caused some shifting at retail locations (Table 4.7). No major shifts occurred at the retail stores, which is primarily due to the minor impact that the firm felt when switching from Long Beach to Los Angeles.

The major cost component that was not considered in this model was the impact as a result of port congestion. If a major port such as Long Beach was actually shutdown, the firm would experience a larger negative effect than this transportation model conveyed. Increased congestion would occur because many other firms would switch to Los Angeles.

Table 4.1 Effect of Port Charges on Volume of Firm's Shipments

Shipment Segment		Base Scenario	Scenario 1: 5% Increase in Port Charge	%Δ from Base Scenario	Scenario 2: 10% Increase in Port Charge	%Δ from Base Scenario	Scenario 3: 15% Increase in Port Charge	%Δ from Base Scenario
		Volume (FEUs)						
Total Volume		11,902.57	11,878.05	-0.21%	11,853.53	-0.41%	11,829.01	-0.62%
Origin To Port:								
Xiamen, China	Seattle	464.30	464.30	0.00%	464.30	0.00%	464.30	0.00%
	Tacoma	1,902.00	1,902.00	0.00%	1,902.00	0.00%	1,902.00	0.00%
	Portland	14.50	14.50	0.00%	14.50	0.00%	14.50	0.00%
	Oakland	562.50	562.50	0.00%	562.50	0.00%	562.50	0.00%
	Los Angeles	4,229.77	4,205.25	-0.58%	4,180.73	-1.16%	4,156.21	-1.74%
	Long Beach	4,729.50	4,729.50	0.00%	4,729.50	0.00%	4,729.50	0.00%
Total		11,902.57	11,878.05	-0.21%	11,853.53	-0.41%	11,829.01	-0.62%
Port To Distribution Center:								
Seattle	Bloomington, MN	464.30	464.30	0.00%	464.30	0.00%	464.30	0.00%
Tacoma	Bloomington, MN	462.00	462.00	0.00%	462.00	0.00%	462.00	0.00%
	Des Moines, WA	1,440.00	1,440.00	0.00%	1,440.00	0.00%	1,440.00	0.00%
Portland	Bloomington, MN	14.50	14.50	0.00%	14.50	0.00%	14.50	0.00%
Oakland	Dinuba, CA	562.50	562.50	0.00%	562.50	0.00%	562.50	0.00%
Los Angeles	Ardmore, OK	1,252.80	1,252.80	0.00%	1,252.80	0.00%	1,252.80	0.00%
	Dinuba, CA	1,712.70	1,712.70	0.00%	1,712.70	0.00%	1,712.70	0.00%
	Findlay, OH	1,264.27	1,239.75	-1.94%	1,215.23	-3.88%	1,190.71	-5.82%
Long Beach	Dublin, GA	991.68	989.62	-0.21%	987.56	-0.42%	985.51	-0.62%
	Findlay, OH	226.13	250.65	10.84%	275.17	21.69%	299.69	32.53%
	Franklin, IN	1,414.89	1,392.43	-1.59%	1,369.97	-3.18%	1,347.50	-4.76%
	Nichols, NY	1,062.40	1,062.40	0.00%	1,062.40	0.00%	1,062.40	0.00%
	Staunton, VA	1,034.40	1,034.40	0.00%	1,034.40	0.00%	1,034.40	0.00%
Total		11,902.57	11,878.05	-0.21%	11,853.53	-0.41%	11,829.01	-0.62%

Table 4.2. Retail Distribution Shifts as Result of Port Charges - Firm

Retail Location by Distribution Center		Volume (FEUs) Base Scenario	Scenario 1: 5% Increase in Port Charge	%Δ from Base Scenario	Scenario 2: 10% Increase in Port Charge	%Δ from Base Scenario	Scenario 3: 15% Increase in Port Charge	%Δ from Base Scenario
Barboursville, WV	Findlay, OH	0.00	0.00	0.00%	0.02	0.00%	0.43	
	Franklin, IN	0.43	0.43	-0.23%	0.40	-6.15%	0.00	-100.00%
Baton Rouge, LA	Ardmore, OK	0.00	0.00	0.00%	14.43		27.03	
	Franklin, IN	30.79	30.80	0.03%	16.25	-47.21%	3.59	-88.33%
Battle Creek, MI	Findlay, OH	0.00	0.00	0.00%	0.00	0.00%	7.15	
	Franklin, IN	7.21	7.19	-0.28%	7.21	0.00%	0.01	-99.87%
Brooklyn 1, NY	Nichols, NY	154.48	151.95	-1.64%	154.44	-0.03%	151.90	-1.67%
	Staunton, VA	12.11	14.28	17.92%	11.44	-5.53%	13.62	12.47%
Evanston, IL	Bloomington, MN	0.00	3.12		0.65		0.00	
	Franklin, IN	10.03	6.89	-31.35%	9.34	-6.92%	9.97	-0.65%
Grand Rapids2, MI	Findlay, OH	7.76	8.89	14.58%	8.87	14.33%	8.85	14.09%
	Franklin, IN	1.15	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
Grand Rapids3, MI	Findlay, OH	0.00	6.38		8.87		8.85	
	Franklin, IN	8.91	2.51	-71.80%	0.00	-100.00%	0.00	-100.00%
Hickory, NC	Franklin, IN	5.03	5.00	-0.60%	0.00	-100.00%	0.00	-100.00%
	Staunton, VA	0.00	0.00	0.00%	5.01		5.00	
Melrose Park, IL	Bloomington, MN	0.00	3.12		3.12		3.11	
	Franklin, IN	3.13	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
New York 1, NY	Findlay, OH	139.02	134.29	-3.40%	134.57	-3.20%	129.83	-6.61%
	Nichols, NY	77.44	81.73	5.54%	81.01	4.61%	85.32	10.17%
Niles, IL	Bloomington, MN	0.33	4.05	1127.68%	4.04	1125.06%	4.03	1122.44%
	Franklin, IN	3.73	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
Norridge, IL	Bloomington, MN	0.00	1.97		1.96		1.96	
	Franklin, IN	1.97	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
San Antonio 1, TX	Ardmore, OK	9.14	11.78	28.91%	0.00	-100.00%	0.00	-100.00%
	Dinuba, CA	29.53	26.82	-9.16%	38.54	30.52%	38.48	30.30%
San Antonio 3, TX	Ardmore, OK	38.67	38.59	-0.21%	38.51	-0.41%	28.47	-26.38%
	Dinuba, CA	0.00	0.00	0.00%	0.00		9.96	
San Jose 1, CA	Des Moines, WA	14.92	7.58	-49.18%	14.67	-1.67%	19.94	33.63%
	Dinuba, CA	45.55	52.76	15.83%	45.55	0.00%	40.16	-11.84%
Tulsa 1, OK	Bloomington, MN	25.95	15.93	-38.60%	20.34	-21.62%	26.41	1.78%
	Desmoines, WA	0.61	10.58	1634.08%	6.12	903.41%	0.00	-100.00%
Tulsa 2, OK	Bloomington, MN	26.56	26.51	-0.19%	26.45	-0.41%	22.93	-13.68%
	Des Moines, WA	0.00	0.00	0.00%	0.00	0.00%	3.48	

Table 4.3 Effect of Increased Port Charges on Cost of Firm's Shipments

Shipment Segment		Base Scenario	Scenario 1: 5% Increase in Port Charge	%Δ from Base Scenario	Scenario 2: 10% Increase in Port Charge	%Δ from Base Scenario	Scenario 3: 15% Increase in Port Charge	%Δ from Base Scenario
		Transportation Costs						
Total Cost		$70,823,077.20	$70,783,946.02	-0.06%	$70,744,431.50	-0.11%	$70,704,556.30	-0.17%
Volume		$11,902.57	$11,878.05	-0.21%	$11,853.53	-0.41%	$11,829.01	-0.62%
Cost Per FEU		$5,950.23	$5,959.22	0.15%	$5,968.22	0.30%	$5,977.22	0.45%
Origin to Port:								
Xiamen, China	Seattle	$1,384,296.52	$1,390,830.85	0.47%	$1,397,365.17	0.94%	$1,403,899.50	1.42%
	Tacoma	$5,599,183.68	$5,622,372.86	0.41%	$5,645,562.05	0.83%	$5,668,751.23	1.24%
	Portland	$51,198.78	$51,801.21	1.18%	$52,403.65	2.35%	$53,006.09	3.53%
	Oakland	$1,640,953.13	$1,647,063.28	0.37%	$1,653,173.44	0.74%	$1,659,283.59	1.12%
	Los Angeles	$12,213,756.96	$12,182,390.63	-0.26%	$12,150,564.37	-0.52%	$12,118,278.18	-0.78%
	Long Beach	$13,663,099.85	$13,707,772.34	0.33%	$13,752,444.83	0.65%	$13,797,117.32	0.98%
Total		$34,552,488.90	$34,602,231.18	0.14%	$34,651,513.51	0.29%	$34,700,335.92	0.43%
Port To Distribution Center:								
Seattle	Bloomington, MN	$1,239,866.72	$1,239,866.72	0.00%	$1,239,866.72	0.00%	$1,239,866.72	0.00%
Tacoma	Bloomington, MN	$1,240,377.60	$1,240,377.60	0.00%	$1,240,377.60	0.00%	$1,240,377.60	0.00%
	Desmoines, WA	$46,080.00	$46,080.00	0.00%	$46,080.00	0.00%	$46,080.00	0.00%
Portland	Bloomington, MN	$40,321.60	$40,321.60	0.00%	$40,321.60	0.00%	$40,321.60	0.00%
Oakland	Dinuba, CA	$181,800.00	$181,800.00	0.00%	$181,800.00	0.00%	$181,800.00	0.00%
Los Angeles	Ardmore, OK	$2,806,272.00	$2,806,272.00	0.00%	$2,806,272.00	0.00%	$2,806,272.00	0.00%
	Dinuba, CA	$619,312.32	$619,312.32	0.00%	$619,312.32	0.00%	$619,312.32	0.00%
	Findlay, OH	$4,644,422.27	$4,554,343.01	-1.94%	$4,464,263.74	-3.88%	$4,374,184.47	-5.82%
Long Beach	Dublin, GA	$3,741,410.30	$3,733,645.08	-0.21%	$3,725,879.86	-0.42%	$3,718,114.64	-0.62%
	Findlay, OH	$828,178.51	$917,983.15	10.84%	$1,007,787.78	21.69%	$1,097,592.41	32.53%
	Franklin, IN	$4,785,723.94	$4,709,746.80	-1.59%	$4,633,769.65	-3.18%	$4,557,792.51	-4.76%
	Nichols, NY	$4,569,169.92	$4,569,169.92	0.00%	$4,569,169.92	0.00%	$4,569,169.92	0.00%
	Staunton, VA	$4,251,797.76	$4,251,797.76	0.00%	$4,251,797.76	0.00%	$4,251,797.76	0.00%
Total		$28,994,732.94	$28,910,715.95	-0.29%	$28,826,698.96	-0.58%	$28,742,681.96	-0.87%

Table 4.4. Retail Distribution Shifts as Result of Port Charges - Firm

Transportation Costs

Retail Location by Distribution Center		Base Scenario	Scenario 1: 5% Increase in Port Charge	%Δ from Base Scenario	Scenario 2: 10% Increase in Port Charge	%Δ from Base Scenario	Scenario 3: 15% Increase in Port Charge	%Δ from Base Scenario
Barboursville, WV	Findlay, OH	$0.00	$0.00	0.00%	$9.11	0.00%	$157.93	
	Franklin, IN	$211.22	$210.77	-0.21%	$198.23	-6.15%	$0.00	-100.00%
Baton Rouge, LA	Ardmore, OK	$0.00	$0.00	0.00%	$12,670.93		$23,743.16	
	Franklin, IN	$42,367.04	$42,290.21	-0.18%	$22,364.57	-47.21%	$4,943.27	-88.33%
Battle Creek, MI	Findlay, OH	$0.00	$0.00	0.00%	$0.00	0.00%	$1,900.28	
	Franklin, IN	$2,768.64	$2,762.75	-0.21%	$2,756.86	-0.43%	$3.58	-99.87%
Brooklyn 1, NY	Nichols, NY	$50,916.61	$50,083.78	-1.64%	$50,902.30	-0.03%	$50,066.21	-1.67%
	Staunton, VA	$7,362.88	$8,682.37	17.92%	$6,955.67	-5.53%	$8,281.18	12.47%
Evanston, IL	Bloomington, MN	$0.00	$2,063.90		$430.62		$0.00	
	Franklin, IN	$3,626.85	$2,489.70	-31.35%	$3,375.71	-6.92%	$3,603.61	-0.64%
Grand Rapids2, MI	Findlay, OH	$2,868.10	$3,286.13	14.58%	$3,279.13	14.33%	$3,272.13	14.09%
	Franklin, IN	$585.12	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
Grand Rapids3, MI	Findlay, OH	$0.00	$2,357.63		$3,279.42		$3,272.56	
	Franklin, IN	$4,533.41	$1,278.40	-71.80%	$0.00	-100.00%	$0.00	-100.00%
Hickory, NC	Franklin, IN	$4,241.30	$4,232.94	-0.20%	$0.00	-100.00%	$0.00	-100.00%
	Staunton, VA	$0.00	$0.00	0.00%	$2,068.20		$2,064.11	
Melrose Park, IL	Bloomington, MN	$0.00	$2,028.90		$2,024.55		$2,020.20	
	Franklin, IN	$1,101.76	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
New York 1, NY	Findlay, OH	$126,118.94	$121,829.25	-3.40%	$122,084.79	-3.20%	$117,786.11	-6.61%
	Nichols, NY	$25,276.42	$26,677.32	5.54%	$26,442.91	4.61%	$27,847.05	10.17%
Niles, IL	Bloomington, MN	$214.90	$2,638.24	1127.68%	$2,632.61	1125.06%	$2,626.98	1122.44%
	Franklin, IN	$1,324.90	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
Norridge, IL	Bloomington, MN	$0.00	$1,273.83		$1,271.10		$1,268.36	
	Franklin, IN	$690.29	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
San Antonio 1, TX	Ardmore, OK	$5,410.88	$6,975.24	28.91%	$0.00	-100.00%	$0.00	-100.00%
	Dinuba, CA	$73,376.14	$66,651.43	-9.16%	$95,769.98	30.52%	$95,611.37	30.30%
San Antonio 3, TX	Ardmore, OK	$22,892.64	$22,845.64	-0.21%	$22,798.64	-0.41%	$16,853.85	-26.38%
	Dinuba, CA	$0.00	$0.00	0.00%	$0.00		$24,754.79	
San Jose 1, CA	Desmoines, WA	$19,598.91	$9,960.43	-49.18%	$19,270.65	-1.67%	$26,190.09	33.63%
	Dinuba, CA	$13,045.52	$15,111.10	15.83%	$13,045.35	0.00%	$11,500.85	-11.84%
Tulsa 1, OK	Bloomington, MN	$28,814.88	$17,691.25	-38.60%	$22,585.16	-21.62%	$29,326.43	1.78%
	Desmoines, WA	$1,972.50	$34,204.71	1634.08%	$19,792.21	903.41%	$0.00	-100.00%
Tulsa 2, OK	Bloomington, MN	$29,492.22	$29,436.54	-0.19%	$29,380.86	-0.38%	$25,456.87	-13.68%
	Desmoines, WA	$0.00	$0.00	0.00%	$0.00	0.00%	$11,264.91	

Table 4.5 Effects of Port of Seattle Shutdown on Firm

		Base Scenario		Scenario 4: Seattle Shutdown			
		Volume (FEU)	Costs	Volume (FEU)	%Δ in Volume	Costs	%Δ in Cost
Total Cost		11,902.57	$70,823,077.20	11,871.36	-0.26%	$70,774,485.89	-0.07%
Cost Per FEU			$5,950.23			$5,961.78	0.19%
Origin To Port:							
Xiamen, China	Seattle	464.30	$1,384,296.52	0.00	-100.00%	$0.00	-100.00%
	Tacoma	1,902.00	$5,599,183.68	1,902.00	0.00%	$5,599,183.68	0.00%
	Portland	14.50	$51,198.78	14.50	0.00%	$51,198.78	0.00%
	Oakland	562.50	$1,640,953.13	562.50	0.00%	$1,640,953.13	0.00%
	Los Angeles	4,229.77	$12,213,756.96	4,662.86	10.24%	$13,464,338.87	10.24%
	Long Beach	4,729.50	$13,663,099.85	4,729.50	0.00%	$13,663,099.85	0.00%
Total		11,902.57	34,552,488.90	11,871.36	-0.26%	$34,418,774.30	-0.39%
Port to Distribution Center:							
Seattle	Bloomington, MN	464.30	$1,239,866.72	0.00	-100.00%	$0.00	-100.00%
Tacoma	Bloomington, MN	462.00	$1,240,377.60	462.00	0.00%	$1,240,377.60	0.00%
	Des Moines, WA	1,440.00	$46,080.00	1,440.00	0.00%	$46,080.00	0.00%
Portland	Bloomington, MN	14.50	$40,321.60	14.50	0.00%	$40,321.60	0.00%
Oakland	Dinuba, CA	562.50	$181,800.00	562.50	0.00%	$181,800.00	0.00%
Los Angeles	Ardmore, OK	1,252.80	$2,806,272.00	1,252.80	0.00%	$2,806,272.00	0.00%
	Bloomington, MN	0.00	$0.00	448.48		$1,389,205.43	
	Dinuba, CA	1,712.70	$619,312.32	1,712.70	0.00%	$619,312.32	0.00%
	Findlay, OH	1,264.27	$4,644,422.27	1,248.88	-1.22%	$4,587,898.31	-1.22%
Long Beach	Dublin, GA	991.68	$3,741,410.30	989.08	-0.26%	$3,731,600.33	-0.26%
	Findlay, OH	226.13	$828,178.51	241.52	6.80%	$884,530.14	6.80%
	Franklin, IN	1,414.89	$4,785,723.94	1,402.10	-0.90%	$4,742,475.40	-0.90%
	Nichols, NY	1,062.40	$4,569,169.92	1,062.40	0.00%	$4,569,169.92	0.00%
	Staunton, VA	1,034.40	$4,251,797.76	1,034.40	0.00%	$4,251,797.76	0.00%
Total		11,902.57	28,994,732.94	11,871.36	-0.26%	$29,090,840.81	0.33%
Retail Distribution Shifts:							
San Jose 1, CA	Des Moines, WA	14.92	$19,598.91	5.63	-62.26%	$7,396.18	-62.26%
	Dinuba, CA	45.55	$13,045.52	54.68	20.05%	$15,660.63	20.05%
Tulsa 1, OK	Bloomington, MN	25.95	$28,814.88	12.86	-50.46%	$14,275.15	-50.46%
	Des Moines, WA	0.61	$1,972.50	13.63	2135.16%	$44,088.51	2135.16%
San Antonio 1, TX	Ardmore, OK	9.14	$5,410.88	12.40	35.68%	$7,341.32	35.68%
	Dinuba, CA	29.53	$73,376.14	26.17	-11.39%	$65,021.58	-11.39%
Niles, IL	Bloomington, MN	0.33	$214.90	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	3.73	$1,324.90	4.05	8.56%	$1,438.33	8.56%
Grand Rapids2, MI	Findlay, OH	7.76	$2,868.10	8.89	14.52%	$3,284.50	14.52%
	Franklin, IN	1.15	$585.12	0.00	-100.00%	$0.00	-100.00%
Grand Rapids3, MI	Findlay, OH	0.00	0	8.26		$3,052.40	
	Franklin, IN	8.91	$4,533.41	0.63	-92.95%	$319.52	-92.95%
New York 1, NY	Findlay, OH	139.02	$126,118.94	133.16	-4.22%	$120,800.65	-4.22%
	Nichols, NY	77.44	$25,276.42	82.73	6.84%	$27,004.63	6.84%
Brooklyn 1, NY	Nichols, NY	154.48	$50,916.61	151.36	-2.02%	$49,889.16	-2.02%
	Staunton, VA	12.11	$7,362.88	14.79	22.13%	$8,992.59	22.13%

Table 4.6 Effects of Port of Long Beach Shutdown on Firm

		Base Scenario		Scenario 5: Long Beach Shutdown			
		Volume (FEU)	Costs	Volume (FEU)	%Δ in Volume	Costs	%Δ in Cost
Total Cost		11,902.57	$70,823,077.20	11,887.96	-0.12%	$70,800,166.69	-0.03%
Cost Per FEU			$5,950.23			$5,955.62	0.09%
Origin To Port:							
Xiamen, China	Seattle	464.30	$1,384,296.52	464.30	0.00%	$1,384,296.52	0.00%
	Tacoma	1,902.00	$5,599,183.68	1,902.00	0.00%	$5,599,183.68	0.00%
	Portland	14.50	$51,198.78	14.50	0.00%	$51,198.78	0.00%
	Oakland	562.50	$1,640,953.13	562.50	0.00%	$1,640,953.13	0.00%
	Los Angeles	4,229.77	$12,213,756.96	8,944.66	111.47%	$25,828,327.27	111.47%
	Long Beach	4,729.50	$13,663,099.85	0.00	-100.00%	$0.00	-100.00%
Total		11,902.57	$34,552,488.90	11,887.96	-0.12%	$34,503,959.37	-0.14%
Port to Distribution Center:							
Seattle	Bloomington, MN	464.30	$1,239,866.72	464.30	0.00%	$1,239,866.72	0.00%
Tacoma	Bloomington, MN	462.00	$1,240,377.60	462.00	0.00%	$1,240,377.60	0.00%
	Des Moines, WA	1,440.00	$46,080.00	1,440.00	0.00%	$46,080.00	0.00%
Portland	Bloomington, MN	14.50	$40,321.60	14.50	0.00%	$40,321.60	0.00%
Oakland	Dinuba, CA	562.50	$181,800.00	562.50	0.00%	$181,800.00	0.00%
Los Angeles	Ardmore, OK	1,252.80	$2,806,272.00	1,252.80	0.00%	$2,806,272.00	0.00%
	Dinuba, CA	1,712.70	$619,312.32	1,712.70	0.00%	$619,312.32	0.00%
	Dublin, GA	0.00	$0.00	996.11		$3,770,861.21	
	Findlay, OH	1,264.27	$4,644,422.27	1,490.40	17.89%	$5,475,133.44	17.89%
	Franklin, IN	0.00	$0.00	1,395.85		$4,759,296.26	
	Nichols, NY	0.00	$0.00	1,062.40		$4,582,768.64	
	Staunton, VA	0.00	$0.00	1,034.40		$4,263,383.04	
Long Beach	Dublin, GA	991.68	$3,741,410.30	0.00	-100.00%	$0.00	-100.00%
	Findlay, OH	226.13	$828,178.51	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	1,414.89	$4,785,723.94	0.00	-100.00%	$0.00	-100.00%
	Nichols, NY	1,062.40	$4,569,169.92	0.00	-100.00%	$0.00	-100.00%
	Staunton, VA	1,034.40	$4,251,797.76	0.00	-100.00%	$0.00	-100.00%
Total		11,902.57	$28,994,732.94	11,887.96	-0.12%	$29,025,472.83	0.11%

Table 4.7 Retail Distribution Shifts as Result of Port of Long Beach Shutdown - Firm

		Base Scenario		Scenario 5: Long Beach Shutdown			
		Volume (FEU)	Costs	Volume (FEU)	%Δ in Volume	Costs	%Δ in Cost
San Jose 1, CA	Des Moines, WA	14.92	$19,598.91	10.57	-29.15%	$13,885.69	-29.15%
	Dinuba, CA	45.55	$13,045.52	49.83	9.39%	$14,269.90	9.39%
Tulsa 1, OK	Bloomington, MN	25.95	$28,814.88	19.82	-23.62%	$22,007.49	-23.62%
	Des Moines, WA	0.61	$1,972.50	6.71	999.67%	$21,690.89	999.67%
San Antonio 1, TX	Ardmore, OK	9.14	$5,410.88	10.67	16.70%	$6,314.70	16.70%
	Dinuba, CA	29.53	$73,376.14	27.96	-5.33%	$69,464.60	-5.33%
Niles, IL	Bloomington, MN	0.33	$214.90	4.06	1128.79%	$2,640.63	1128.79%
	Franklin, IN	3.73	$1,324.90	0.00	-100.00%	$0.00	-100.00%
Grand Rapids2, MI	Findlay, OH	7.76	$2,868.10	8.90	14.68%	$3,289.09	14.68%
	Franklin, IN	1.15	$585.12	0.00	-100.00%	$0.00	-100.00%
Grand Rapids3, MI	Findlay, OH	0.00	$0.00	8.90		$3,289.09	
	Franklin, IN	8.91	$4,533.41	0.63	-92.95%	$0.00	-100.00%
New York 1, NY	Findlay, OH	139.02	$126,118.94	130.63	-6.03%	$118,508.72	-6.03%
	Nichols, NY	77.44	$25,276.42	85.56	10.49%	$27,927.75	10.49%
Brooklyn 1, NY	Nichols, NY	154.48	$50,916.61	147.38	-4.60%	$48,575.30	-4.60%
	Staunton, VA	12.11	$7,362.88	19.01	56.97%	$11,557.45	56.97%
Melrose Park, IL	Bloomington, MN	0.00	$0.00	3.13		$2,030.75	
	Franklin, IN	3.13	$1,101.76	0.00	-100.00%	$0.00	-100.00%
Norridge, IL	Bloomington, MN	0.00	$0.00	0.40		$260.54	
	Franklin, IN	1.97	$690.29	1.57	-20.53%	$548.56	-20.53%
Wilmington, DE	Dublin, GA	0.00	$0.00	5.64		$3,738.59	
	Staunton, VA	10.25	$6,215.60	4.59	-55.19%	$2,785.45	-55.19%

Industry Level Scenarios

The industry scenario involved using the firm's supply network to model the flows of all incoming televisions to the United States through the six west coast ports. This scenario was evaluated to test the effect that a larger scale of volume would have on the transportation cost and distribution characteristics. All assumptions made in the firm level model were maintained in the industry model.

With the exception of a few minor fluctuations, the findings in the industry scenarios mirrored the results in the firm level, but with an incremental increase in volume and cost (Tables 4.8 – 4.14). The percentage changes in volume, total cost, and per-unit costs all imitated the changes reflected in the firm scenario.

Shadow prices varied only minimally. The major difference that occurred at the industry level was the Ardmore distribution center received supply from Los Angeles and Long Beach; which at the firm level, only Los Angeles was used. Ardmore operated at maximum capacity at both levels and also maintained almost all the same client stores, so the justification for this change remains difficult to identify. One suggestion for this one shipment variance lies within the modeling structure. In a constrained optimization problem, even fractional differences in any one of the constraints may have an influential impact on the results of the dependent variable, which in this case was the flow of goods. For example, in the process of scaling the supply, demand, and constraints to represent total television imports, numbers may have been rounded slightly different, this may have been enough of a difference to allow the model to shift to a slightly different optimal solution.

Table 4.8 Effect of Increased Port Charges on Volume of Industry Shipments

Shipment Segment		Base Scenario	Scenario 1: 5% Increase in Port Charge	%Δ from Base Scenario	Scenario 2: 10% Increase in Port Charge	%Δ from Base Scenario	Scenario 3: 15% Increase in Port Charge	%Δ from Base Scenario
		Volume (FEUs)						
Total Volume		70,015.93	69,871.70	-0.21%	69,727.46	-0.41%	69,583.23	-0.62%
Origin To Port:								
Xiamen, China	Seattle	2,730.50	2,730.50	0.00%	2,730.50	0.00%	2,730.50	0.00%
	Tacoma	11,186.60	11,186.60	0.00%	11,186.60	0.00%	11,186.60	0.00%
	Portland	84.50	84.50	0.00%	84.50	0.00%	84.50	0.00%
	Oakland	3,306.00	3,306.00	0.00%	3,306.00	0.00%	3,306.00	0.00%
	Los Angeles	24,892.33	24,748.10	-0.58%	24,603.86	-1.16%	24,459.63	-1.74%
	Long Beach	27,816.00	27,816.00	0.00%	27,816.00	0.00%	27,816.00	0.00%
Total		70,015.93	69,871.70	-0.21%	69,727.46	-0.41%	69,583.23	-0.62%
Port To Distribution Center:								
Seattle	Bloomington, MN	2,730.50	2,730.50	0.00%	2,730.50	0.00%	2,730.50	0.00%
Tacoma	Bloomington, MN	2,719.40	2,719.40	0.00%	2,719.40	0.00%	2,719.40	0.00%
	Des Moines, WA	8,467.20	8,467.20	0.00%	8,467.20	0.00%	8,467.20	0.00%
Portland	Bloomington, MN	84.50	84.50	0.00%	84.50	0.00%	84.50	0.00%
Oakland	Dinuba, CA	3,306.00	3,306.00	0.00%	3,306.00	0.00%	3,306.00	0.00%
Los Angeles	Ardmore, OK	6,044.33	5,900.10	-2.39%	5,755.86	-4.77%	5,611.63	-7.16%
	Dinuba, CA	10,080.00	10,080.00	0.00%	10,080.00	0.00%	10,080.00	0.00%
	Findlay, OH	8,768.00	8,768.00	0.00%	8,768.00	0.00%	8,768.00	0.00%
Long Beach	Ardmore, OK	1,326.07	1,470.30	10.88%	1,614.54	21.75%	1,758.77	32.63%
	Dublin, GA	5,833.31	5,821.20	-0.21%	5,809.10	-0.42%	5,796.99	-0.62%
	Franklin, IN	8,320.62	8,188.49	-1.59%	8,056.37	-3.18%	7,924.24	-4.76%
	Nichols, NY	6,250.40	6,250.40	0.00%	6,250.40	0.00%	6,250.40	0.00%
	Staunton, VA	6,085.60	6,085.60	0.00%	6,085.60	0.00%	6,085.60	0.00%
Total		70,015.93	69,871.70	-0.21%	69,727.46	-0.41%	69,583.23	-0.62%

Table 4.9 Retail Distribution Shifts as Result of Port Charges - Industry

		Volume (FEUs)						
Retail Location by Distribution Center		Base Scenario	Scenario 1: 5% Increase in Port Charge	%Δ from Base Scenario	Scenario 2: 10% Increase in Port Charge	%Δ from Base Scenario	Scenario 3: 15% Increase in Port Charge	%Δ from Base Scenario
Barboursville, WV	Findlay, OH	0.00	0.00	0.00%	2.52		2.51	
	Franklin, IN	2.53	2.52	-0.21%	0.00	-100.00%	0.00	-100.00%
Baton Rouge, LA	Ardmore, OK	0.00	18.33	0.00%	85.62		101.16	
	Franklin, IN	181.11	162.45	-10.30%	94.84	-47.64%	78.96	-56.40%
Battle Creek, MI	Findlay, OH	0.00	0.00	0.00%	0.24	0.00%	42.15	
	Franklin, IN	42.42	42.33	-0.21%	42.00	-0.98%	0.00	-100.00%
Evanston, IL	Bloomington, MN	0.00	0.00		3.03		57.79	
	Franklin, IN	59.02	58.89	-0.21%	55.74	-5.55%	0.85	-98.56%
Grand Rapids1, MI	Findlay, OH	48.28	52.31	8.34%	52.20	8.11%	52.09	7.88%
	Franklin, IN	4.14	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
Grand Rapids2, MI	Findlay, OH	0.00	40.14		52.20		52.09	
	Franklin, IN	52.42	12.17	-100.00%	0.00	-100.00%	0.00	-100.00%
Granville, WV	Findlay, OH	0.00	0.00		0.00		2.54	
	Franklin, IN	12.93	12.90	-76.79%	12.88	-75.44%	10.31	-80.34%
Hickory, NC	Franklin, IN	29.59	29.53	-0.20%	0.00	-100.00%	0.00	-100.00%
	Staunton, VA	0.00	0.00	0.00%	29.47		29.42	
Melrose Park, IL	Bloomington, MN	0.00	18.38		18.34		18.30	
	Franklin, IN	18.42	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
New York 3, NY	Findlay, OH	832.29	817.36	-1.79%	802.42	-3.59%	787.49	-5.38%
	Nichols, NY	441.00	453.37	2.80%	465.74	5.61%	478.10	8.41%
New York 4, NY	Findlay, OH	221.20	207.86	-6.03%	223.98	1.26%	210.58	-4.80%
	Staunton, VA	1,052.09	1,062.85	1.02%	1,044.13	-0.76%	1,054.95	0.27%
Niles, IL	Bloomington, MN	1.93	23.85	1135.71%	23.80	1133.07%	23.75	1130.43%
	Franklin, IN	21.97	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
Norridge, IL	Bloomington, MN	0.00	11.57		11.54		11.52	
	Franklin, IN	11.59	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
San Antonio 2, TX	Ardmore, OK	54.53	51.74	-5.11%	0.00	-100.00%	0.00	-100.00%
	Dinuba, CA	172.96	175.37	1.39%	226.74	31.09%	226.36	30.88%
San Jose 1, CA	Des Moines, WA	84.70	59.87	-29.31%	84.00	-0.83%	56.38	-33.44%
	Dinuba, CA	271.03	295.12	8.89%	270.26	-0.28%	297.14	9.63%
Tulsa 1, OK	Bloomington, MN	153.07	112.48	-26.52%	120.83	-21.06%	77.45	-49.40%
	Desmoines, WA	3.16	43.46	1275.37%	34.81	1001.57%	77.90	2365.17%

Table 4.10 Effect of Increased Port Charges on Cost of Industry Shipments

Shipment Segment		Base Scenario	Scenario 1: 5% Increase in Port Charge	%Δ from Base Scenario	Scenario 2: 10% Increase in Port Charge	%Δ from Base Scenario	Scenario 3: 15% Increase in Port Charge	%Δ from Base Scenario
			Transportation Costs					
Total Cost		$416,608,682.00	$416,378,508.30	-0.06%	$416,146,126.96	-0.11%	$415,911,592.98	-0.17%
Volume		70,015.93	69,871.70	-0.21%	69,727.46	-0.41%	69,583.23	-0.62%
Cost per FEU		$5,950.20	$5,959.19	0.15%	$5,968.18	0.30%	$5,977.18	0.45%
Origin To Port:								
Xiamen, China	Seattle	$8,140,903.84	$8,179,331.53	0.47%	$8,217,759.20	0.94%	$8,256,186.91	1.42%
	Tacoma	$32,931,560.54	$33,067,947.57	0.41%	$33,204,335.00	0.83%	$33,340,721.63	1.24%
	Portland	$298,365.28	$301,876.04	1.18%	$305,386.80	2.35%	$308,897.57	3.53%
	Oakland	$9,644,428.50	$9,680,339.93	0.37%	$9,716,251.40	0.74%	$9,752,162.78	1.12%
	Los Angeles	$71,878,345.34	$71,693,960.77	-0.26%	$71,506,871.00	-0.52%	$71,317,075.47	-0.78%
	Long Beach	$80,357,920.56	$80,620,656.59	0.33%	$80,883,393.00	0.65%	$81,146,128.64	0.98%
Total		$203,251,524.05	$203,544,112.42	0.14%	$203,833,996.40	0.29%	$204,121,172.99	0.43%
Port To Distribution Center:								
Seattle	Bloomington, MN	$7,291,527.20	$7,291,527.20	0.00%	$7,291,527.20	0.00%	$7,291,527.20	0.00%
Tacoma	Bloomington, MN	$7,301,045.12	$7,301,045.12	0.00%	$7,301,045.12	0.00%	$7,301,045.12	0.00%
	Des Moines, WA	$270,950.40	$270,950.40	0.00%	$270,950.40	0.00%	$270,950.40	0.00%
Portland	Bloomington, MN	$234,977.60	$234,977.60	0.00%	$234,977.60	0.00%	$234,977.60	0.00%
Oakland	Dinuba, CA	$1,068,499.20	$1,068,499.20	0.00%	$1,068,499.20	0.00%	$1,068,499.20	0.00%
Los Angeles	Ardmore, OK	$13,539,299.20	$13,216,215.96	-2.39%	$12,893,132.72	-4.77%	$12,570,049.47	-7.16%
	Dinuba, CA	$3,644,928.00	$3,644,928.00	0.00%	$3,644,928.00	0.00%	$3,644,928.00	0.00%
	Findlay, OH	$32,210,124.80	$32,210,124.80	0.00%	$32,210,124.80	0.00%	$32,210,124.80	0.00%
Long Beach	Ardmore, OK	$2,955,544.82	$3,277,012.64	10.88%	$3,598,480.47	21.75%	$3,919,948.29	32.63%
	Dublin, GA	$22,007,911.97	$21,962,237.99	-0.21%	$21,916,564.02	-0.42%	$21,870,890.04	-0.62%
	Franklin, IN	$28,143,665.09	$27,696,757.14	-1.59%	$27,249,849.19	-3.18%	$26,802,941.24	-4.76%
	Nichols, NY	$26,881,720.32	$26,881,720.32	0.00%	$26,881,720.32	0.00%	$26,881,720.32	0.00%
	Staunton, VA	$25,014,250.24	$25,014,250.24	0.00%	$25,014,250.24	0.00%	$25,014,250.24	0.00%
Total		$170,564,443.95	$170,070,246.61	-0.29%	$169,576,049.27	-0.58%	$169,081,851.93	-0.87%

Table 4.11 Retail Distribution Shifts as Result of Increased Port Charges - Industry

Retail Location by Distribution Center		Transportation Costs						
		Base Scenario	Scenario 1: 5% Increase in Port Charge	%Δ from Base Scenario	Scenario 2: 10% Increase in Port Charge	%Δ from Base Scenario	Scenario 3: 15% Increase in Port Charge	%Δ from Base Scenario
Barboursville, WV	Findlay, OH	$0.00	$0.00	0.00%	$931.18		$929.23	
	Franklin, IN	$1,242.74	$1,240.14	-0.21%	$0.00	-100.00%	$0.00	-100.00%
Baton Rouge, LA	Ardmore, OK	$0.00	$16,102.59		$75,206.18		$88,859.69	
	Franklin, IN	$249,207.36	$223,531.03	-10.30%	$130,494.30	-47.64%	$108,654.41	-56.40%
Battle Creek, MI	Findlay, OH	$0.00	$0.00	0.00%	$62.52		$11,194.84	
	Franklin, IN	$16,289.28	$16,254.62	-0.21%	$16,129.57	-0.98%	$0.00	-100.00%
Evanston, IL	Bloomington, MN	$0.00	$0.00	0.00%	$1,999.73		$38,190.50	
	Franklin, IN	$21,341.63	$21,296.05	-0.21%	$20,156.18	-5.55%	$306.45	-98.56%
Grand Rapids1, MI	Findlay, OH	$17,844.29	$19,333.19	8.34%	$19,291.94	8.11%	$19,250.70	7.88%
	Franklin, IN	$2,106.43	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
Grand Rapids2, MI	Findlay, OH	$0.00	$14,837.59		$19,293.75		$19,253.41	
	Franklin, IN	$26,671.30	$6,189.99	-100.00%	$0.00	-100.00%	$0.00	-100.00%
Granville, WV	Findlay, OH	$0.00	$0.00	0.00%	$0.00	0.00%	$972.77	
	Franklin, IN	$6,433.97	$6,420.55	-76.79%	$6,407.12	-75.98%	$5,127.88	-80.77%
Hickory, NC	Franklin, IN	$24,950.29	$24,901.15	-0.20%	$0.00	-100.00%	$0.00	-100.00%
	Staunton, VA	$0.00	$0.00	0.00%	$12,166.64		$12,142.58	
Melrose Park, IL	Bloomington, MN	$0.00	$11,940.03		$11,914.43		$11,888.83	
	Franklin, IN	$6,483.84	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
New York 3, NY	Findlay, OH	$755,053.49	$741,506.35	-1.79%	$727,959.21	-3.59%	$714,412.08	-5.38%
	Nichols, NY	$143,942.40	$147,979.40	2.80%	$152,016.39	5.61%	$156,053.39	8.41%
New York 4, NY	Findlay, OH	$200,672.64	$188,566.75	-6.03%	$203,199.18	1.26%	$191,040.42	-4.80%
	Staunton, VA	$636,304.03	$642,810.92	1.02%	$631,492.26	-0.76%	$638,034.39	0.27%
Niles, IL	Bloomington, MN	$1,256.82	$15,530.54	1135.71%	$15,497.40	1133.07%	$15,464.26	1130.43%
	Franklin, IN	$7,803.74	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
Norridge, IL	Bloomington, MN	$0.00	$7,494.25		$7,478.17		$7,462.10	
	Franklin, IN	$4,061.14	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
San Antonio 2, TX	Ardmore, OK	$32,281.76	$30,631.20	-5.11%	$0.00	-100.00%	$0.00	-100.00%
	Dinuba, CA	$429,771.01	$435,765.05	1.39%	$563,399.43	31.09%	$562,465.56	30.88%
San Jose 1, CA	Des Moines, WA	$111,261.92	$78,646.25	-29.31%	$110,336.25	-0.83%	$74,058.11	-33.44%
	Dinuba, CA	$77,622.99	$84,522.75	8.89%	$77,402.16	-0.28%	$85,100.43	9.63%
Tulsa 1, OK	Bloomington, MN	$169,968.93	$124,892.55	-26.52%	$134,174.44	-21.06%	$86,002.14	-49.40%
	Desmoines, WA	$10,218.18	$140,537.83	1275.37%	$112,560.56	1001.57%	$251,895.86	2365.17%

Table 4.12 Effects of Port of Seattle Shutdown on Industry

		Base Scenario		Scenario 4: Seattle Shutdown			
		Volume (FEU)	Costs	Volume (FEU)	%Δ in Volume	Costs	%Δ in Cost
Total Cost		70,015.93	$416,608,681.97	69,832.52	-0.26%	$416,323,084.07	-0.07%
Cost Per FEU			$5,950.20			$5,961.74	0.19%
Origin To Port:							
Xiamen, China	Seattle	2,730.50	$8,140,903.84	0.00	-100.00%	$0.00	-100.00%
	Tacoma	11,186.60	$32,931,560.54	11,188.50	0.00%	$32,937,153.84	0.02%
	Portland	84.50	$298,365.28	84.50	0.00%	$298,365.28	0.00%
	Oakland	3,306.00	$9,644,428.50	3,306.00	0.00%	$9,644,428.50	0.00%
	Los Angeles	24,892.33	$71,878,345.34	27,437.52	10.24%	$79,227,773.12	10.22%
	Long Beach	27,816.00	$80,357,920.56	27,816.00	0.00%	$80,357,920.56	0.00%
Total		70,015.93	$203,251,524.05	69,832.52	-0.26%	$202,465,641.29	-0.39%
Port to Distribution Center:							
Seattle	Bloomington, MN	2,730.50	$7,291,527.20	0.00	-100.00%	$0.00	-100.00%
Tacoma	Bloomington, MN	2,719.40	$7,301,045.12	2,721.30	0.07%	$7,306,146.24	0.07%
	Des Moines, WA	8,467.20	$270,950.40	8,467.20	0.00%	$270,950.40	0.00%
Portland	Bloomington, MN	84.50	$234,977.60	84.50	0.00%	$234,977.60	0.00%
Oakland	Dinuba, CA	3,306.00	$1,068,499.20	3,306.00	0.00%	$1,068,499.20	0.00%
Los Angeles	Ardmore, OK	6,044.33	$13,539,299.20	5,953.90	-1.50%	$13,336,730.40	-1.50%
	Bloomington, MN	0.00	$0.00	2,635.63		$8,164,118.72	
	Dinuba, CA	10,080.00	$3,644,928.00	10,080.00	0.00%	$3,644,928.00	0.00%
	Findlay, OH	8,768.00	$32,210,124.80	8,768.00	0.00%	$32,210,124.80	0.00%
Long Beach	Ardmore, OK	1,326.07	$2,955,544.82	1,416.50	6.82%	$3,157,100.77	6.82%
	Dublin, GA	5,833.31	$22,007,911.97	5,818.03	-0.26%	$21,950,262.68	-0.26%
	Franklin, IN	8,320.62	$28,143,665.09	8,245.47	-0.90%	$27,889,470.09	-0.90%
	Nichols, NY	6,250.40	$26,881,720.32	6,250.40	0.00%	$26,881,720.32	0.00%
	Staunton, VA	6,085.60	$25,014,250.24	6,085.60	0.00%	$25,014,250.24	0.00%
Total		70,015.93	$170,564,443.95	69,832.52	-0.26%	$171,129,279.46	0.33%
Retail Distribution Shifts:							
San Jose 1, CA	Des Moines, WA	84.70	$111,261.92	30.11	-64.45%	$39,548.76	-64.45%
	Dinuba, CA	271.03	$77,622.99	324.69	19.80%	$92,991.51	19.80%
Tulsa 1, OK	Bloomington, MN	153.07	$169,968.93	76.12	-50.27%	$84,521.87	-50.27%
	Des Moines, WA	3.16	$10,218.18	79.70	2422.23%	$257,725.55	2422.23%
San Antonio 2, TX	Ardmore, OK	54.53	$32,281.76	73.69	35.14%	$43,626.71	35.14%
	Dinuba, CA	172.96	$429,771.01	153.20	-11.42%	$380,672.15	-11.42%
Niles, IL	Bloomington, MN	1.93	$1,256.82	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	21.97	$7,803.74	23.84	8.50%	$8,467.04	8.50%
Grand Rapids1, MI	Findlay, OH	48.28	$17,844.29	52.28	8.29%	$19,323.68	8.29%
	Franklin, IN	4.14	$2,106.43	0.00	-100.00%	$0.00	-100.00%
Grand Rapids2, MI	Findlay, OH	0.00	$0.00	51.15		$18,905.91	
	Franklin, IN	52.42	$26,671.30	1.13	-97.84%	$575.12	-97.84%
New York 3, NY	Findlay, OH	832.29	$755,053.49	813.74	-2.23%	$738,222.24	-2.23%
	Nichols, NY	441.00	$143,942.40	456.22	3.45%	$148,909.43	3.45%
New York 4, NY	Findlay, OH	221.20	$200,672.64	204.68	-7.47%	$185,685.21	-7.47%
	Staunton, VA	1,052.09	$636,304.03	1,065.28	1.25%	$644,278.43	1.25%

Table 4.13 Effects of Port of Long Beach Shutdown on Industry

		Base Scenario		Scenario 5: Long Beach Shutdown			
		Volume (FEU)	Costs	Volume (FEU)	%Δ in Volume	Costs	%Δ in Cost
Total Cost		70,015.93	$416,608,681.97	69,929.98	-0.12%	$416,473,858.39	-0.03%
Cost Per FEU			$5,950.20			$5,955.58	0.09%
Origin To Port:							
Xiamen, China	Seattle	2,730.50	$8,140,903.84	2,730.50	0.00%	$8,140,903.84	0.00%
	Tacoma	11,186.60	$32,931,560.54	11,186.60	0.00%	$32,931,560.54	0.00%
	Portland	84.50	$298,365.28	84.50	0.00%	$298,365.28	0.00%
	Oakland	3,306.00	$9,644,428.50	3,306.00	0.00%	$9,644,428.50	0.00%
	Los Angeles	24,892.33	$71,878,345.34	52,622.38	111.40%	$151,950,803.75	111.40%
	Long Beach	27,816.00	$80,357,920.56	0.00	-100.00%	$0.00	-100.00%
Total		70,015.93	$203,251,524.05	69,929.98	-0.12%	$202,966,061.90	-0.14%
Port to Distribution Center:							
Seattle	Bloomington, MN	2,730.50	$7,291,527.20	2,730.50	0.00%	$7,291,527.20	0.00%
Tacoma	Bloomington, MN	2,719.40	$7,301,045.12	2,719.40	0.00%	$7,301,045.12	0.00%
	Des Moines, WA	8,467.20	$270,950.40	8,467.20	0.00%	$270,950.40	0.00%
Portland	Bloomington, MN	84.50	$234,977.60	84.50	0.00%	$234,977.60	0.00%
Oakland	Dinuba, CA	3,306.00	$1,068,499.20	3,306.00	0.00%	$1,068,499.20	0.00%
Los Angeles	Ardmore, OK	6,044.33	$13,539,299.20	7,370.40	21.94%	$16,509,696.00	21.94%
	Dinuba, CA	10,080.00	$3,644,928.00	10,080.00	0.00%	$3,644,928.00	0.00%
	Findlay, OH	8,768.00	$32,210,124.80	8,768.00	0.00%	$32,210,124.80	0.00%
	Franklin, IN	0.00	$0.00	8,211.25		$27,997,066.53	
	Nichols, NY	0.00	$0.00	6,250.40		$26,961,725.44	
	Dublin, GA	0.00	$0.00	5,856.73		$22,171,247.12	
	Staunton, VA	0.00	$0.00	6,085.60		$25,082,408.96	
Long Beach	Ardmore, OK	1,326.07	$2,955,544.82	0.00	-100.00%	$0.00	-100.00%
	Dublin, GA	5,833.31	$22,007,911.97	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	8,320.62	$28,143,665.09	0.00	-100.00%	$0.00	-100.00%
	Nichols, NY	6,250.40	$26,881,720.32	0.00	-100.00%	$0.00	-100.00%
	Staunton, VA	6,085.60	$25,014,250.24	0.00	-100.00%	$0.00	-100.00%
Total		70,015.93	$170,564,443.95	69,929.98	-0.12%	$170,744,196.36	0.11%

Table 4.14 Retail Distibution Shifts as Result of Long Beach Shutdown - Industry

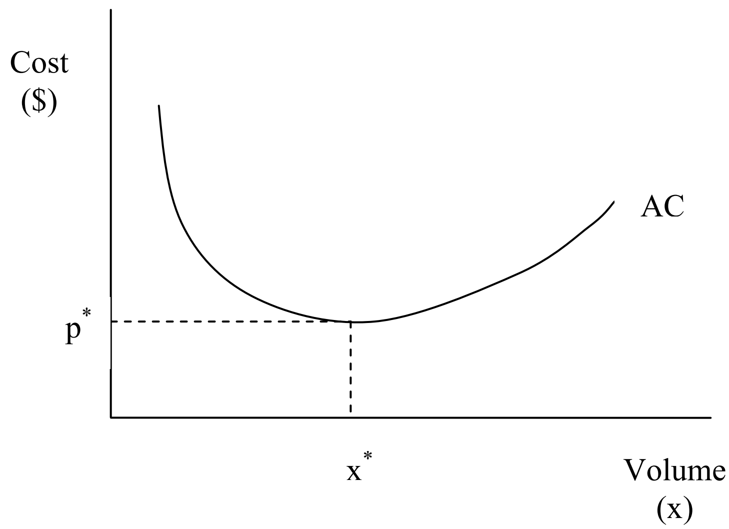
		Base Scenario		Scenario 5: Long Beach Shutdown			
		Volume (FEU)	Costs	Volume (FEU)	%Δ in Volume	Costs	%Δ in Cost
San Jose 1, CA	Des Moines, WA	84.70	$111,261.92	59.12	-30.21%	$77,654.40	-30.21%
	Dinuba, CA	271.03	$77,622.99	296.18	9.28%	$84,825.26	9.28%
Tulsa 1, OK	Bloomington, MN	153.07	$169,968.93	117.01	-23.56%	$129,925.19	-23.56%
	Des Moines, WA	3.16	$10,218.18	39.03	1135.15%	$126,209.55	1135.15%
San Antonio 2, TX	Ardmore, OK	54.53	$32,281.76	63.51	16.47%	$37,598.44	16.47%
	Dinuba, CA	172.96	$429,771.01	163.70	-5.35%	$406,761.42	-5.35%
Melrose Park, IL	Bloomington, MN	0.00	$0.00	18.40		$11,950.94	
	Franklin, IN	18.42	$6,483.84	0.00	-100.00%	$0.00	-100.00%
Niles, IL	Bloomington, MN	1.93	$1,256.82	23.87	1136.82%	$15,544.57	1136.82%
	Franklin, IN	21.97	$7,803.74	0.00	-100.00%	$0.00	-100.00%
Norridge, IL	Bloomington, MN	0.00	$0.00	2.33		$1,508.60	
	Franklin, IN	11.59	$4,061.14	9.25	-20.21%	$3,240.39	-20.21%
Grand Rapids1, MI	Findlay, OH	48.28	$17,844.29	52.36	8.44%	$19,350.65	8.44%
	Franklin, IN	4.14	$2,106.43	0.00	-100.00%		-100.00%
Grand Rapids2, MI	Findlay, OH	0.00	$0.00	52.36		$19,350.65	
	Franklin, IN	52.42	$26,671.30	0.00	-100.00%		-100.00%
New York 3, NY	Findlay, OH	832.29	$755,053.49	823.60	-1.04%	$747,165.72	-1.04%
	Nichols, NY	441.00	$143,942.40	448.13	1.62%	$146,270.14	1.62%
New York 4, NY	Findlay, OH	221.20	$200,672.64	182.87	-17.33%	$165,903.56	-17.33%
	Staunton, VA	1,052.09	$636,304.03	1,088.85	3.49%	$658,538.07	3.49%
Wilmington, NC	Dublin, GA	0.00	$0.00	30.58		$20,258.54	
	Staunton, VA	60.29	$36,559.86	29.63	-50.85%	$17,969.11	-50.85%

West Coast Port Scenarios

The west coast level model was developed to analyze the effects of the different impacts at the largest scale: total imported container volumes into the six west coast ports while implementing some slightly different assumptions. The imported volume data was obtained from the U.S. Maritime Administration for the most recent year, 2004. Each port's import volume was used to establish the corresponding volume constraint, which was allowed to fluctuate up or down 50 percent as in the previous scenarios. The total imported volume was assumed to be the quantity demanded, and thus, the quantity supplied.

The key assumption that differs from the previous scenarios was each port's cost structure. Since this model was analyzing total port shipment flows, shifts in volumes between ports would impose a substantial impact on the costs incurred at each port. As in other businesses, port operations have an optimal volume level where costs are minimized and profits are maximized (Figure 4.1). When volumes increase beyond this optimal equilibrium, where p* and x* intersect, costs increase and profits diminish For example, when a port experiences volume increases above x*, the cost per-unit of volume increases because of time delays, labor shortages, capacity constraints etc. Similarly, when volume decreases below the optimal level, costs increase because of unused capacity, excess labor, etc.

Figure 4.1 Example Long Run Average Cost Curve



To reflect the economies of scale at the ports, quadratic cost functions were estimated for each port and implemented into the charge assessed at the ports (See Appendix C). The functions were merely an approximation of the cost structure for each port. The smaller ports, Seattle, Tacoma, Portland, and Oakland were assumed to have similar sloped cost curves based on their volumes. The Ports of Los Angeles and Long Beach operate at much larger capacities than the other ports, therefore, they were assumed to have smaller slope coefficients to reflect the capacity differences. The current operating volumes at each port were assumed to be the optimal operating volume for each port, which were assessed using the same rate as in the previous scenarios (Appendix A). With this assumption in effect, the volumes shipped through each port will move along these curves and reflect the cost changes associated with the movement.

Base Scenario – West Coast

The base scenario resulted in a similar cost per FEU as seen in the previous scenarios, but differed greatly at the ports because of the new assumptions (Table 4.17). With the port cost assumptions in effect, the competitiveness of the northwest Ports of Seattle and Tacoma improved, causing volumes at those ports to increase (Table 4.15). Refer to Appendix A for a table of each port's optimal volume and rate. The only constrained port was Portland, which remained on its lower bound parameter. The shadow price at Portland was $53.00, which when comparing past port shadow prices, was a relatively small value. The twin Ports of Los Angeles and Long Beach operated at volumes slightly below their optimal levels, yet when noting the shallow slope of their cost functions, the cost increase of this move was insignificant. The Port of Oakland also operated at volumes less than optimal, but the deviation was not enough to cause a large cost increase.

The effect on flows between ports and distribution centers was similar to the firm and industry scenarios, yet had some significant differences. All the shipments through Tacoma went to the Des Moines DC, yet Des Moines still received some supply from Seattle. Tacoma had the capacity to supply all of Des Moines, but the cost per-unit would have become infeasible, so the remaining Des Moines supply was shifted to Seattle to achieve a lower cost per-unit[4]. Portland and the California ports maintained similar distributions as in the previous scenarios. Findlay, Staunton, and Nichols DCs were constrained by lower bounds, yet had moderately small shadow prices ranging between $140 and $290. Dinuba, Ardmore, Des Moines, and Bloomington were upper bound constrained and showed shadow prices of $-1,640, $-1,650, $-680, and $-160, respectively. As in the previous scenarios, Dublin and Franklin were not constrained.

[4] Refer to Appendix C. For the following scenarios, notice the position of each port's volume on their corresponding cost curves to understand the shifting that occurs and the costs associated.

With the highest shadow prices, Dinuba, Des Moines, and Ardmore prove to be the most strategically located distribution centers for shipments coming through the west coast. The model consistently causes the northeastern distribution centers to be lower bound constrained and the west and midwest distribution centers to be upper bound constrained. The reason for this consistency is simple: if more volume was allowed to pass through the western distribution centers, they could supply more retail stores to the east of them, thus eliminating the need for shipping containers to a distribution center in the far northeast and then back-tracking shipments to a retail store west of them. For example, if the Ardmore distribution center was allowed unlimited capacity, it would supply all of the east coast retail stores at a lower cost because there would be no back-tracking of shipments. On the contrary, if shipments travel to Nichols and then are supplied to a retail location in Pennsylvania, the total transportation miles would be higher because of the back tracking to the store, and thus the cost is higher.

Increased Port Charges – West Coast

Increasing the port charge by five, ten, and fifteen percent caused the per-unit costs to increase incrementally from $5,970 up to $6,188 at the fifteen percent charge, which was a 3.65 percent increase (Table 4.17). Total volume decreased by 4.77 percent, yet the increased charges at the port caused the cost for the origin through port segment to increase up to three percent. The high cost nature of the Port of Portland caused the volume there to remain at its lowest level. The Port of Oakland experienced the largest change as the rates were increased, with a 37.69 percent increase in volume, which moved them nearer to the optimal operating volume of 306,648 FEUs. The remaining ports absorbed the loss in quantity demanded.

Three primary changes occurred in the port to distribution center segment. First, Bloomington incurred a significant loss of volume when the rate was increased by 15 percent (Table 4.15). Bloomington may have passed a cost threshold with the rate increase that caused it to be a less viable option for distribution. The two highest cost ports, Seattle and Portland, supplied all of Bloomington, which increased the costs and possibly caused the decrease in volume. The decrease in volume at Bloomington caused many retail stores to shift to Ardmore and Des Moines, both of which maintained maximum capacity (Table 4.16).

Second, all of Oakland's increasing volumes went to Dinuba, yet Dinuba maintained maximum capacity in all scenarios. The Dinuba volume was simply shifting from Los Angeles to Oakland, which caused significant efficiency gains at Oakland and losses at Los Angeles. The shift in Dinuba's supplier induced some competition with Des Moines for retail locations, yet both DCs maintained maximum capacity.

The last major change occurred with Staunton and Franklin. Franklin decreased volume because of the loss of quantity demanded and the trend of retail location shifts to other DCs, primarily Findlay (Table 4.16). In the 15 percent rate increase scenario, Franklin's volume decreased to its lower constraint, which produced a shadow price of $200. Staunton's volume remained bound by its lower constraint, yet it shifted a large amount of this volume from Los Angeles to Long Beach. This also increased the costs, causing the shadow price to increase by approximately $40. The shadow prices for the upper bound constrained distribution centers all decreased approximately $300 to $400 dollars, which was primarily a result of the decrease in overall volume shipped.

Port of Seattle Shutdown – West Coast

The scenario evaluating a Port of Seattle shutdown caused an increase in volume across all of the remaining ports. The Ports of Tacoma and Portland increased volumes to maximum capacity and the California ports handled the remaining supply. The cost per FEU increased by approximately $35 with total volume decreasing by 0.83 percent. The total loss of capacity at Seattle caused a $-960 shadow price. Tacoma and Portland produced shadow prices of $910 and $310, respectively, which demonstrates the opportunity cost of losing operations at the Port of Seattle.

The primary distribution centers affected by the shutdown were Des Moines and Bloomington. Des Moines lost its supply from Seattle, but consumed the remaining capacity at Tacoma and Portland. Des Moines resulted in having an overall loss of volume because Tacoma and Portland did not have enough capacity and Oakland was not a cost effective option. As a result of Des Moines' loss of affordable volume, many retail stores shifted to Bloomington for their supply (Table 4.20). Bloomington remained at full capacity by shifting its supply source from Seattle to Los Angeles and Long Beach, and therefore, was able to supply some of the mid-western retail stores previously supplied by Des Moines. With its supply now sourced in southern California, Bloomington's per-unit costs increased for the same volume causing a loss of competitiveness, which resulted in a lower shadow price of only $20. As in the previous scenarios, Dinuba shifted some of its supply from Los Angeles to Oakland, this had a large impact on Oakland, increasing their volume by 87 percent and caused Dinuba to take on some of Des Moines' supply. Staunton remained bounded by lower constraints, and, shifted a portion of its supply to Los Angeles. This may have occurred because of cost increases incurred at Long Beach from an increase in volume. The shadow prices for Dinuba and Ardmore increased to $-1,760 and $-1,780, respectively, which most likely was from the loss of Des Moines' typical distribution; a normal competitor with these two DC's.

Port of Long Beach Shutdown – West Coast

The Port of Long Beach shutdown resulted in a loss of volume of 1.43 million FEUs, which caused significant impacts on the distribution system (Table 4.21). This increased the per-unit cost by $183, a much larger impact than with the Port of Seattle shutdown. All the remaining ports increased to maximum capacity except for Los Angeles, which increased by 35 percent. The northwest ports, including Oakland, had high shadow prices ranging $-1600 to $-2000. This is a good indicator of the value of these ports to this distribution network, especially since Long Beach's sister port, Los Angeles, did not reach maximum capacity.

Bloomington and Franklin experienced significant losses in volume causing a trend of retail store shifts to other DCs (Table 4.22). The primary reason for Bloomington's loss was because of the shift of the Nichols DC to Seattle and Portland. This increase in volume pushed Seattle and Portland to maximum capacity, thus forcing a decrease in supply to Bloomington. The Franklin decrease was caused by retail store shifts to Dublin and Findlay. One major influence present in the shifts mentioned here is that Nichols and Findlay are bounded by their lower constraints and Franklin and Bloomington are not, thus the model will force Franklin and Bloomington to decrease volume to ensure that the lower bound constraints are met. The Long Beach shutdown also caused a large shift of Dinuba's supply from Los Angeles to Oakland, increasing Oakland by 115 percent. After the shutdown, Bloomington and Dublin were decreased to the lower bound constraint. The only DCs that remained at maximum capacity were Dinuba and Ardmore with shadow prices of $-410 and $-420. Des Moines had a decrease in volume, and the others were all constrained with shadow prices ranging from $114 to $165.

Reasons for the shifts and decreases in volume at the distribution centers were many. The most obvious reason was the actual shutdown and the 380,000 FEU decrease in volume. The other most prominent reason for changes at Des Moines and Bloomington resulted from the combined shock of shifting Nichols' supply source to the northwest and the increase of Dinuba's supply at Oakland, which had always caused competition between Dinuba and Des Moines. Findlay and Franklin made some shifts as well as Dublin and Staunton, but most of these shifts occurred in order to optimize the cost and satisfy their respective lower bound constraints. Dinuba and Ardmore consistently remained the most efficient DCs; many of the shifts involving these DCs were incoming volumes to maximize their usage.

Table 4.15 Effect of Increased Port Charges on Volume of West Coast Shipments

Shipment Segment		Base Scenario	Scenario 1: 5% Increase in Port Charge	%Δ from Base Scenario	Scenario 2: 10% Increase in Port Charge	%Δ from Base Scenario	Scenario 3: 15% Increase in Port Charge	%Δ from Base Scenario
		Volume (FEUs)						
Total Volume		4,381,210.47	4,311,615.96	-1.59%	4,242,021.45	-3.18%	4,172,426.93	-4.77%
Origin To Port:								
Xiamen, China	Seattle	435,255.19	434,234.44	-0.23%	433,213.69	-0.47%	401,936.95	-7.65%
	Tacoma	423,336.61	424,357.36	0.24%	425,378.11	0.48%	399,123.38	-5.72%
	Portland	17,545.00	17,545.00	0.00%	17,545.00	0.00%	17,545.00	0.00%
	Oakland	213,828.29	226,183.49	5.78%	242,811.88	13.55%	294,414.37	37.69%
	Los Angeles	1,866,194.16	1,818,633.78	-2.55%	1,768,015.84	-5.26%	1,725,730.37	-7.53%
	Long Beach	1,425,051.22	1,390,661.89	-2.41%	1,355,056.93	-4.91%	1,333,676.86	-6.41%
Total		4,381,210.47	4,311,615.96	-1.59%	4,242,021.45	-3.18%	4,172,426.93	-4.77%
Port To Distribution Center:								
Seattle	Bloomington, MN	328,755.80	328,755.80	0.00%	328,755.80	0.00%	271,224.33	-17.50%
	Des Moines, WA	106,499.39	105,478.64	-0.96%	104,457.89	-1.92%	130,712.62	22.74%
Tacoma	Des Moines, WA	423,336.61	424,357.36	0.24%	425,378.11	0.48%	399,123.38	-5.72%
Portland	Bloomington, MN	17,545.00	17,545.00	0.00%	17,545.00	0.00%	17,545.00	0.00%
Oakland	Dinuba, CA	213,828.29	226,183.49	5.78%	242,811.88	13.55%	294,414.37	37.69%
Los Angeles	Ardmore, OK	461,191.20	461,191.20	0.00%	461,191.20	0.00%	461,191.20	0.00%
	Dinuba, CA	623,812.51	611,457.31	-1.98%	594,828.92	-4.65%	543,226.43	-12.92%
	Findlay, OH	548,648.80	548,648.80	0.00%	548,648.80	0.00%	548,648.80	0.00%
	Staunton, VA	232,541.65	197,336.47	-15.14%	163,346.92	-29.76%	172,663.94	-25.75%
Long Beach	Dublin, GA	365,016.03	353,250.51	-3.22%	346,572.80	-5.05%	346,572.80	-5.05%
	Franklin, IN	520,665.64	462,836.64	-11.11%	399,919.85	-23.19%	387,856.80	-25.51%
	Nichols, NY	391,116.00	391,116.00	0.00%	391,116.00	0.00%	391,116.00	0.00%
	Staunton, VA	148,253.55	183,458.73	23.75%	217,448.28	46.67%	208,131.26	40.39%
Total		4,381,210.47	4,311,615.96	-1.59%	4,242,021.45	-3.18%	4,172,426.93	-4.77%

Table 4.16 Retail Distribution Shifts as Result of Port Charges -West Coast

Retail Location by Distribution Center		Volume (FEUs) Base Scenario	Scenario 1: 5% Increase in Port Charge	%Δ from Base Scenario	Scenario 2: 10% Increase in Port Charge	%Δ from Base Scenario	Scenario 3: 15% Increase in Port Charge	%Δ from Base Scenario
Arden, NC	Dublin, GA	0.00	0.00		0.00		731.98	
	Franklin, IN	767.63	755.75	-1.55%	743.87	-3.10%	0.00	-100.00%
Barboursville, WV	Findlay, OH	0.00	155.79		153.24		150.69	
	Franklin, IN	158.34	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
Baton Rouge, LA	Ardmore, OK	0.00	11,174.44		11,015.90		10,857.36	
	Franklin, IN	11,332.98	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
Battle Creek, MI	Findlay, OH	0.00	2,611.08		2,567.53		2,523.98	
	Franklin, IN	2,654.63	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
Baxter, MN	Bloomington, MN	276.34	271.68	-1.69%	267.02	-3.37%	0.00	-100.00%
	Des Moines, WA	0.00	0.00		0.00		262.36	
Benton Harbor, MI	Findlay, OH	0.00	0.00		538.01		528.88	
	Franklin, IN	556.26	547.13	-1.64%	0.00	-100.00%	0.00	-100.00%
Birmingham, AL	Dublin, GA	0.00	0.00		0.00		11,518.79	
	Franklin, IN	12,079.26	11,892.44	-1.55%	11,705.61	-3.09%	0.00	-100.00%
Boling Brook, IL	Bloomington, MN	0.00	2,755.55		2,709.36		2,663.18	
	Franklin, IN	2,801.73	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
Charlotte, 2, NC	Dublin, GA	13,451.95	13,232.36	-1.63%	12,707.62	-5.53%	357.11	-97.35%
	Staunton, VA	0.00	0.00		305.15		12,436.07	
Councilbluffs, IA	Bloomington, MN	2,898.59	2,852.56	-1.59%	0.00	-100.00%	0.00	-100.00%
	Des Moines, WA	0.00	0.00		2,806.53		2,760.51	
Countryside, IL	Bloomington, MN	0.00	293.10		288.18		0.00	
	Franklin, IN	298.03	0.00	-100.00%	0.00	-100.00%	283.25	-4.96%
Covington, LA	Dublin, GA	0.00	0.00		409.99		403.98	
	Franklin, IN	421.99	415.99	-1.42%	0.00	-100.00%	0.00	-100.00%
Dayton, 1-3, OH	Findlay, OH	0.00	0.00		7,987.45		7,847.82	
	Franklin, IN	8,266.71	8,127.08	-1.69%	0.00	-100.00%	0.00	-100.00%
Downers Grove, 1,2, IL	Bloomington, MN	0.00	2,383.84		2,343.87		2,303.89	
	Franklin, IN	2,423.82	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
Evanston, IL	Bloomington, MN	0.00	3,632.25		3,571.42		3,510.60	
	Franklin, IN	3,693.07	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
Fairborn, OH	Findlay, OH	0.00	0.00		1,540.65		1,513.75	
	Franklin, IN	1,594.45	1,567.55	-1.69%	0.00	-100.00%	0.00	-100.00%

Table 4.16 Continued

Retail Location by Distribution Center		Base Scenario	Scenario 1: 5% Increase in Port Charge	%Δ from Base Scenario	Scenario 2: 10% Increase in Port Charge	%Δ from Base Scenario	Scenario 3: 15% Increase in Port Charge	%Δ from Base Scenario
		Volume (FEUs)						
Fayetteville, AR	Ardmore, OK	0.00	0.00		0.00		1,570.53	
	Bloomington, MN	2,887.59	2,845.18	-1.47%	2,802.77	-2.94%	1,189.83	-58.79%
Fayetteville, NC	Dublin, GA	6,019.98	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
	Staunton, VA	0.00	5,923.61		5,827.23		5,730.86	
Flowood, MS	Dublin, GA	0.00	0.00		0.00		225.93	
	Franklin, IN	236.29	232.84	-1.46%	229.39	-2.92%	0.00	-100.00%
Fort Smith, AR	Ardmore, OK	0.00	0.00		3,877.23		3,819.35	
	Bloomington, MN	3,992.99	3,935.11	-1.45%	0.00	-100.00%	0.00	-100.00%
Fort Wayne, 1,2, IN	Findlay, OH	0.00	2,654.58		9,889.37		9,717.01	
	Franklin, IN	10,234.10	7,407.17	-27.62%	0.00	-100.00%	0.00	-100.00%
Grand Rapids, 1-3, MI	Findlay, OH	6,289.18	9,679.24	53.90%	9,518.82	51.35%	9,358.39	48.80%
	Franklin, IN	3,550.49	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
Grandville, WV	Findlay, OH	0.00	796.00		782.99		769.97	
	Franklin, IN	809.02	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
Hamilton, OH	Findlay, OH	0.00	0.00		0.00		1,472.09	
	Franklin, IN	3,019.07	2,967.57	-1.71%	2,916.08	-3.41%	1,392.49	-53.88%
Hattiesburg, MS	Dublin, GA	0.00	0.00		0.00		2,130.21	
	Franklin, IN	2,227.56	2,195.11	-1.46%	2,162.66	-2.91%	0.00	-100.00%
Hickory, NC	Franklin, IN	1,851.64	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
	Staunton, VA	0.00	1,823.51		1,795.38		1,767.25	
Holland, MI	Findlay, OH	0.00	0.00		0.00		1,658.86	
	Franklin, IN	1,743.49	1,715.28	-1.62%	1,687.07	-3.24%	0.00	-100.00%
Houma, LA	Ardmore, OK	0.00	0.00		147.44		1,539.66	
	Dublin, GA	1,611.41	1,587.49	-1.48%	1,416.14	-12.12%	0.00	-100.00%
Jackson, MS	Ardmore, OK	0.00	0.00		0.00		6,209.34	
	Dublin, GA	0.00	0.00		0.00		2,554.75	
	Franklin, IN	9,165.95	9,032.00	-1.46%	8,898.04	-2.92%	0.00	-100.00%
Johnson City, TN	Franklin, IN	2,759.35	2,716.47	-1.55%	2,673.59	-3.11%	0.00	-100.00%
	Staunton, VA	0.00	0.00		0.00		2,630.71	
Lagrange, IL	Bloomington, MN	0.00	763.61		750.79		737.97	
	Franklin, IN	776.43	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%

Table 4.16 Continued

Retail Location by Distribution Center		Volume (FEUs) Base Scenario	Scenario 1: 5% Increase in Port Charge	%Δ from Base Scenario	Scenario 2: 10% Increase in Port Charge	%Δ from Base Scenario	Scenario 3: 15% Increase in Port Charge	%Δ from Base Scenario
Little Rock, AR	Ardmore, OK	0.00	0.00		0.00		8,702.28	
	Franklin, IN	9,110.09	8,974.15	-1.49%	8,838.21	-2.98%	0.00	-100.00%
Mason, OH	Findlay, OH	0.00	0.00		0.00		1,039.27	
	Franklin, IN	1,095.20	1,076.56	-1.70%	1,057.91	-3.40%	0.00	-100.00%
Melrose Park, IL	Bloomington, MN	0.00	1,133.64		1,114.63		1,095.61	
	Franklin, IN	1,152.66	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
Miamisburg, OH	Findlay, OH	0.00	0.00		0.00		920.28	
	Franklin, IN	969.49	953.09	-1.69%	936.68	-3.38%	0.00	-100.00%
Mishawaka, IN	Findlay, OH	0.00	0.00		0.00		2,199.79	
	Franklin, IN	2,316.01	2,277.27	-1.67%	2,238.53	-3.35%	0.00	-100.00%
Muskegon, MI	Findlay, OH	0.00	0.00		1,931.12		1,899.16	
	Franklin, IN	1,995.05	1,963.09	-1.60%	0.00	-100.00%	0.00	-100.00%
New York, 1-5, NY	Findlay, OH	143,211.05	136,880.20	-4.42%	124,395.62	-13.14%	122,104.99	-14.74%
	Nichols, NY	194,061.59	197,266.47	1.65%	200,471.35	3.30%	203,676.23	4.95%
	Staunton, VA	61,105.26	57,902.08	-5.24%	60,852.63	-0.41%	53,609.23	-12.27%
Niles, IL	Bloomington, MN	124.50	1,471.20	1081.69%	1,446.65	1061.96%	1,422.09	1042.24%
	Franklin, IN	1,371.26	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
Norridge, IL	Bloomington, MN	0.00	713.42		701.45		689.48	
	Franklin, IN	725.39	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
North Little Rock, AR	Ardmore, OK	0.00	0.00		0.00		2,871.67	
	Franklin, IN	3,006.28	2,961.41	-1.49%	2,916.54	-2.99%	0.00	-100.00%
North Riverside, IL	Bloomington, MN	0.00	327.21		321.72		316.22	
	Franklin, IN	332.70	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
Omaha, 1-3, NE	Bloomington, MN	19,401.15	19,093.74	-1.58%	0.00	-100.00%	0.00	-100.00%
	Des Moines, WA	0.00	0.00		18,786.32		18,478.91	
Portage, MI	Bloomington, MN	2,233.43	2,198.22	-1.58%	2,163.01	-3.15%	0.00	-100.00%
	Findlay, OH	0.00	0.00		0.00		2,127.80	
Riverside, IL	Bloomington, MN	0.00	435.18		427.87		420.57	
	Franklin, IN	442.49	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
San Antonio, 1-4, TX	Ardmore, OK	31,874.56	27,749.48	-12.94%	30,932.71	-2.95%	17,161.54	-46.16%
	Dinuba, CA	25,066.80	28,393.40	13.27%	24,411.69	-2.61%	37,384.39	49.14%

Table 4.16 Continued

Retail Location by Distribution Center		Base Scenario	Scenario 1: 5% Increase in Port Charge	%Δ from Base Scenario	Scenario 2: 10% Increase in Port Charge	%Δ from Base Scenario	Scenario 3: 15% Increase in Port Charge	%Δ from Base Scenario
		Volume (FEUs)						
San Jose, 1,2, CA	Des Moines, WA	27,550.57	17,587.79	-36.16%	316.69	-98.85%	0.00	-100.00%
	Dinuba, CA	16,969.09	26,261.46	54.76%	42,862.14	152.59%	42,508.41	150.50%
Skokie, 1,2, IL	Bloomington, MN	0.00	3,099.31		3,047.32		2,995.33	
	Franklin, IN	3,151.30	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
Slidell, LA	Dublin, GA	0.00			1,241.69		1,223.43	
	Franklin, IN	1,278.22	1,259.96	-1.43%	0.00	-100.00%	0.00	-100.00%
South Setauket, NY	Findlay, OH	396.25	383.95	-3.11%	371.64	-6.21%	359.34	-9.32%
	Nichols, NY	396.25	396.25	0.00%	396.25	0.00%	396.25	0.00%
Springfield, OH	Findlay, OH	0.00	3,196.60		3,141.92		3,087.24	
	Franklin, IN	3,251.28	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
Topeka, KS	Bloomington, MN	6,087.74	5,994.32	-1.53%	4,722.73	-22.42%	0.00	-100.00%
	Des Moines, WA	0.00	0.00		1,178.17		5,807.48	
Tulsa, 1,2, OK	Ardmore, OK	0.00	0.00		0.00		290.93	
	Bloomington, MN	19,339.44	1,938.36	-89.98%	0.00	-100.00%	0.00	-100.00%
	Des Moines, WA	213.12	17,330.45	8031.78%	18,985.07	8808.16%	18,410.39	8538.51%
Union City, NJ	Findlay, OH	1,960.62	1,960.63	0.00%	1,960.63	0.00%	1,960.63	0.00%
	Staunton, VA	1,376.72	1,325.50	-3.72%	1,274.28	-7.44%	1,223.08	-11.16%
Whitehall, PA	Franklin, IN	718.53	0.00	-100.00%	0.00	-100.00%	0.00	-100.00%
	Staunton, VA	0.00	707.67		696.82		685.96	

Table 4.17 Effect of Increased Port Charges on Cost of West Coast Shipments

Shipment Segment		Base Scenario	Scenario 1: 5% Increase in Port Charge	%Δ from Base Scenario	Scenario 2: 10% Increase in Port Charge	%Δ from Base Scenario	Scenario 3: 15% Increase in Port Charge	%Δ from Base Scenario
		Transportation Cost						
Total Cost		$26,157,064,907.35	$26,046,929,162.41	-0.42%	$25,930,237,299.15	-0.87%	$25,819,092,262.31	-1.29%
Volume		4,381,210.47	4,311,615.96	-1.59%	4,242,021.45	-3.18%	4,172,426.93	-4.77%
Cost per FEU		$5,970.28	$6,041.11	1.19%	$6,112.71	2.39%	$6,188.03	3.65%
Origin To Port:								
Xiamen, China	Seattle	$1,304,599,201.74	$1,310,279,948.66	0.44%	$1,315,920,687.62	0.87%	$1,226,279,013.45	-6.00%
	Tacoma	$1,256,350,612.81	$1,266,767,989.39	0.83%	$1,277,221,972.20	1.66%	$1,201,980,593.95	-4.33%
	Portland	$61,995,751.36	$62,728,472.45	1.18%	$63,461,193.55	2.36%	$64,193,914.64	3.55%
	Oakland	$625,428,866.08	$664,703,307.31	6.28%	$716,903,441.88	14.63%	$873,170,475.79	39.61%
	Los Angeles	$5,423,735,537.87	$5,504,843,474.75	1.50%	$5,570,452,624.43	2.71%	$5,653,172,228.62	4.23%
	Long Beach	$4,132,601,865.67	$4,136,757,914.52	0.10%	$4,134,177,293.40	0.04%	$4,169,885,651.64	0.90%
Total		$12,804,711,835.53	$12,946,081,107.09	1.10%	$13,078,137,213.08	2.14%	$13,188,681,878.09	3.00%
Port To Distribution Center:								
Seattle	Bloomington, MN	$877,909,488.32	$877,909,488.32	0.00%	$877,909,488.32	0.00%	$724,277,461.66	-17.50%
	Des Moines, WA	$2,896,783.49	$2,869,019.09	-0.96%	$2,841,254.69	-1.92%	$3,555,383.29	22.74%
Tacoma	Des Moines, WA	$13,546,771.43	$13,579,435.43	0.24%	$13,612,099.42	0.48%	$12,771,948.13	-5.72%
Portland	Bloomington, MN	$48,789,136.00	$48,789,136.00	0.00%	$48,789,136.00	0.00%	$48,789,136.00	0.00%
Oakland	Dinuba, CA	$69,109,304.82	$73,102,504.21	5.78%	$78,476,798.73	13.55%	$95,154,723.56	37.69%
Los Angeles	Ardmore, OK	$1,033,068,288.00	$1,033,068,288.00	0.00%	$1,033,068,288.00	0.00%	$1,033,068,288.00	0.00%
	Dinuba, CA	$225,570,601.94	$221,102,963.03	-1.98%	$215,090,138.47	-4.65%	$196,430,678.01	-12.92%
	Findlay, OH	$2,015,516,231.68	$2,015,516,231.68	0.00%	$2,015,516,231.68	0.00%	$2,015,516,231.68	0.00%
	Staunton, VA	$958,443,675.86	$813,342,006.63	-15.14%	$673,250,649.31	-29.76%	$711,651,701.15	-25.75%
Long Beach	Dublin, GA	$1,377,132,477.98	$1,332,743,540.52	-3.22%	$1,307,549,859.84	-5.05%	$1,307,549,859.84	-5.05%
	Franklin, IN	$1,761,099,460.74	$1,565,498,663.56	-11.11%	$1,352,688,887.23	-23.19%	$1,311,886,840.32	-25.51%
	Nichols, NY	$1,682,111,692.80	$1,682,111,692.80	0.00%	$1,682,111,692.80	0.00%	$1,682,111,692.80	0.00%
	Staunton, VA	$609,381,380.73	$754,088,751.95	23.75%	$893,799,426.23	46.67%	$855,502,725.07	40.39%
Total		$10,674,575,293.79	$10,433,721,721.21	-2.26%	$10,194,703,950.72	-4.50%	$9,998,266,669.51	-6.34%

Table 4.18 Retail Distribution Shifts as Result of Port Charges -West Coast

Retail Location by Distribution Center		Base Scenario	Scenario 1: 5% Increase in Port Charge	%Δ from Base Scenario	Scenario 2: 10% Increase in Port Charge	%Δ from Base Scenario	Scenario 3: 15% Increase in Port Charge	%Δ from Base Scenario
			Tranportation Costs					
Arden, NC	Dublin, GA	$0.00	$0.00		$0.00		$319,730.79	
	Franklin, IN	$558,834.64	$550,184.65	-1.55%	$541,534.65	-3.10%	$0.00	-100.00%
Barboursville, WV	Findlay, OH	$0.00	$57,579.95		$56,637.44		$55,694.92	
	Franklin, IN	$77,776.61	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
Baton Rouge, LA	Ardmore, OK	$0.00	$9,815,626.78		$9,676,363.93		$9,537,101.08	
	Franklin, IN	$15,594,180.48	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
Battle Creek, MI	Findlay, OH	$0.00	$693,502.52		$681,935.30		$670,368.09	
	Franklin, IN	$1,019,377.92	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
Baxter, MN	Bloomington, MN	$62,784.45	$61,725.51	-1.69%	$60,666.57	-3.37%	$0.00	-100.00%
	Des Moines, WA	$0.00	$0.00		$0.00		$658,202.58	
Benton Harbor, MI	Findlay, OH	$0.00	$0.00		$189,378.90		$186,166.60	
	Franklin, IN	$213,603.84	$210,099.50	-1.64%	$0.00	-100.00%	$0.00	-100.00%
Birmingham, AL	Dublin, GA	$0.00	$0.00		$0.00		$5,197,278.39	
	Franklin, IN	$8,851,681.73	$8,714,777.77	-1.55%	$8,577,873.82	-3.09%	$0.00	-100.00%
Boling Brook, IL	Bloomington, MN	$0.00	$1,847,318.53		$1,816,357.26		$1,785,396.00	
	Franklin, IN	$999,657.26	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
Charlotte, 2, NC	Dublin, GA	$5,552,964.96	$5,462,318.85	-1.63%	$5,245,707.36	-5.53%	$147,416.10	-97.35%
	Staunton, VA	$0.00	$0.00		$133,288.95		$5,432,076.27	
Councilbluffs, IA	Bloomington, MN	$1,664,950.10	$1,638,511.81	-1.59%	$0.00	-100.00%	$0.00	-100.00%
	Des Moines, WA	$0.00	$0.00		$7,696,640.74		$7,570,414.50	
Countryside, IL	Bloomington, MN	$0.00	$196,027.64		$192,732.82		$0.00	
	Franklin, IN	$101,568.62	$0.00	-100.00%	$0.00	-100.00%	$96,531.80	-4.96%
Covington, LA	Dublin, GA	$0.00	$0.00		$368,003.86		$362,616.68	
	Franklin, IN	$534,070.54	$526,474.71	-1.42%	$0.00	-100.00%	$0.00	-100.00%
Dayton, 1-3, OH	Findlay, OH	$0.00	$0.00		$1,354,672.05		$1,330,991.06	
	Franklin, IN	$1,812,062.83	$1,781,456.28	-1.69%	$0.00	-100.00%	$0.00	-100.00%
Downers Grove, 1,2, IL	Bloomington, MN	$0.00	$1,563,801.50		$1,537,577.09		$1,511,352.67	
	Franklin, IN	$857,062.75	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
Evanston, IL	Bloomington, MN	$0.00	$2,400,187.56		$2,359,994.47		$2,319,801.38	
	Franklin, IN	$1,335,414.11	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
Fairborn, OH	Findlay, OH	$0.00	$0.00		$276,084.44		$271,263.94	
	Franklin, IN	$359,707.92	$353,639.25	-1.69%	$0.00	-100.00%	$0.00	-100.00%

Table 4.18 Continued

Retail Location by Distribution Center		Base Scenario	Scenario 1: 5% Increase in Port Charge	%Δ from Base Scenario	Scenario 2: 10% Increase in Port Charge	%Δ from Base Scenario	Scenario 3: 15% Increase in Port Charge	%Δ from Base Scenario
		Transportation Costs						
Fayetteville, AR	Ardmore, OK	$0.00	$0.00		$0.00		$728,723.73	
	Bloomington, MN	$3,049,295.04	$3,004,509.38	-1.47%	$2,959,723.73	-2.94%	$1,256,463.39	-58.79%
Fayetteville, NC	Dublin, GA	$3,168,917.47	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
	Staunton, VA	$0.00	$2,985,498.01		$2,936,926.09		$2,888,354.18	
Flowood, MS	Dublin, GA	$0.00	$253,699.89		$0.00		$186,530.22	
	Franklin, IN	$257,461.58	$0.00	-100.00%	$249,938.20	-2.92%	$0.00	-100.00%
Fort Smith, AR	Ardmore, OK	$0.00	$0.00		$1,451,634.32		$1,429,963.75	
	Bloomington, MN	$4,555,202.99	$4,489,172.59	-1.45%	$0.00	-100.00%	$0.00	-100.00%
Fort Wayne, 1,2, IN	Findlay, OH	$0.00	$378,009.11		$1,408,246.53		$1,383,701.87	
	Franklin, IN	$2,407,060.32	$1,742,168.15	-27.62%	$0.00	-100.00%	$0.00	-100.00%
Grand Rapids, 1-3, MI	Findlay, OH	$2,324,480.93	$3,577,448.15	53.90%	$1,408,246.53	-39.42%	$3,458,860.38	48.80%
	Franklin, IN	$1,806,489.31	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
Grandville, WV	Findlay, OH	$0.00	$304,392.25		$299,415.26		$294,438.26	
	Franklin, IN	$402,568.35	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
Hamilton, OH	Findlay, OH	$0.00	$0.00		$0.00		$343,880.40	
	Franklin, IN	$497,542.74	$489,056.25	-1.71%	$480,569.77	-3.41%	$229,482.74	-53.88%
Hattiesburg, MS	Dublin, GA	$0.00	$0.00		$0.00		$1,755,294.09	
	Franklin, IN	$2,469,918.53	$2,433,938.44	-1.46%	$2,397,958.35	-2.91%	$0.00	-100.00%
Hickory, NC	Franklin, IN	$1,561,302.85	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
	Staunton, VA	$0.00	$752,745.54		$741,134.09		$729,522.64	
Holland, MI	Findlay, OH	$0.00	$0.00		$0.00		$745,823.01	
	Franklin, IN	$808,979.36	$795,889.77	-1.62%	$782,800.17	-3.24%	$0.00	-100.00%
Houma, LA	Ardmore, OK	$0.00	$0.00		$141,538.23		$1,478,070.70	
	Dublin, GA	$1,593,362.21	$1,569,712.41	-1.48%	$1,400,278.24	-12.12%	$0.00	-100.00%
Jackson, MS	Ardmore, OK	$0.00	$0.00		$0.00		$5,086,687.91	
	Dublin, GA	$0.00	$0.00		$0.00		$2,109,203.16	
	Franklin, IN	$9,972,553.60	$9,826,811.54	-1.46%	$9,681,069.49	-2.92%	$0.00	-100.00%
Johnson City, TN	Franklin, IN	$1,942,582.40	$1,912,394.86	-1.55%	$1,882,207.32	-3.11%	$0.00	-100.00%
	Staunton, VA	$0.00	$0.00		$0.00		$1,081,747.92	
Lagrange, IL	Bloomington, MN	$0.00	$503,371.66		$494,920.66		$486,469.67	
	Franklin, IN	$269,576.50	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%

Table 4.18 Continued

			Transportation Costs					
Retail Location by Distribution Center		Base Scenario	Scenario 1: 5% Increase in Port Charge	%Δ from Base Scenario	Scenario 2: 10% Increase in Port Charge	%Δ from Base Scenario	Scenario 3: 15% Increase in Port Charge	%Δ from Base Scenario
Little Rock, AR	Ardmore, OK	$0.00	$0.00		$0.00		$5,416,296.87	
	Franklin, IN	$8,701,957.97	$8,572,110.14	-1.49%	$8,442,262.30	-2.98%	$0.00	-100.00%
Mason, OH	Findlay, OH	$0.00	$0.00		$0.00		$232,796.84	
	Franklin, IN	$192,755.20	$189,474.07	-1.70%	$186,192.94	-3.40%	$0.00	-100.00%
Melrose Park, IL	Bloomington, MN	$0.00	$736,414.99		$724,062.05		$711,709.10	
	Franklin, IN	$405,736.32	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
Miamisburg, OH	Findlay, OH	$0.00	$0.00		$0.00		$172,276.41	
	Franklin, IN	$203,205.10	$199,766.96	-1.69%	$196,328.82	-3.38%	$0.00	-100.00%
Mishawaka, IN	Findlay, OH	$0.00	$0.00		$0.00		$658,176.59	
	Franklin, IN	$633,660.34	$623,060.90	-1.67%	$612,461.45	-3.35%	$0.00	-100.00%
Muskegon, MI	Findlay, OH	$0.00	$0.00		$837,334.08		$823,474.27	
	Franklin, IN	$1,040,618.08	$1,023,945.40	-1.60%	$0.00	-100.00%	$0.00	-100.00%
New York, 1-5, NY	Findlay, OH	$129,921,061.65	$124,177,715.80	-4.42%	$112,851,706.30	-13.14%	$110,773,648.07	-14.74%
	Nichols, NY	$63,341,703.31	$64,387,776.22	1.65%	$65,433,849.21	3.30%	$66,479,922.84	4.95%
	Staunton, VA	$36,956,462.56	$35,019,179.39	-5.24%	$36,803,671.83	-0.41%	$32,422,862.24	-12.27%
Niles, IL	Bloomington, MN	$81,074.40	$958,047.46	1081.69%	$942,056.01	1061.96%	$926,064.56	1042.24%
	Franklin, IN	$487,071.55	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
Norridge, IL	Bloomington, MN	$0.00	$462,295.76		$454,538.80		$446,781.84	
	Franklin, IN	$254,176.66	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
North Little Rock, AR	Ardmore, OK	$0.00	$0.00		$0.00		$1,782,732.52	
	Franklin, IN	$2,866,788.61	$2,824,000.46	-1.49%	$2,781,212.32	-2.99%	$0.00	-100.00%
North Riverside, IL	Bloomington, MN	$0.00	$215,695.61		$212,075.37		$208,455.14	
	Franklin, IN	$116,045.76	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
Omaha, 1-3, NE	Bloomington, MN	$11,392,355.28	$11,508,401.04	1.02%	$0.00	-100.00%	$0.00	-100.00%
	Des Moines, WA	$0.00	$0.00		$51,579,725.66		$50,735,689.76	
Portage, MI	Bloomington, MN	$1,379,366.37	$1,357,621.28	-1.58%	$1,335,876.19	-3.15%	$0.00	-100.00%
	Findlay, OH	$0.00	$0.00		$0.00		$657,065.55	
Riverside, IL	Bloomington, MN	$0.00	$287,568.10		$282,738.80		$277,909.51	
	Franklin, IN	$152,924.54	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
San Antonio, 1-4, TX	Ardmore, OK	$18,869,739.52	$16,427,691.42	-12.94%	$18,312,166.35	-2.95%	$10,159,630.34	-46.16%
	Dinuba, CA	$62,285,984.64	$70,551,932.47	13.27%	$60,658,176.90	-2.61%	$92,892,740.18	49.14%

Table 4.18 Continued

Retail Location by Distribution Center		Base Scenario	Scenario 1: 5% Increase in Port Charge	%Δ from Base Scenario	Scenario 2: 10% Increase in Port Charge	%Δ from Base Scenario	Scenario 3: 15% Increase in Port Charge	%Δ from Base Scenario
			Transportation Costs					
San Jose, 1,2, CA	Des Moines, WA	$36,190,428.75	$23,103,317.22	-36.16%	$416,001.89	-98.85%	$0.00	-100.00%
	Dinuba, CA	$4,859,947.38	$7,521,281.07	54.76%	$12,275,716.44	152.59%	$12,174,408.69	150.50%
Skokie, 1,2, IL	Bloomington, MN	$0.00	$2,033,147.89		$1,999,042.99		$1,964,938.08	
	Franklin, IN	$1,109,257.60	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
Slidell, LA	Dublin, GA	$0.00	$0.00		$1,068,849.64		$1,053,128.57	
	Franklin, IN	$1,578,857.34	$1,556,298.49	-1.43%	$0.00	-100.00%	$0.00	-100.00%
South Setauket, NY	Findlay, OH	$396,250.00	$383,946.06	-3.11%	$371,642.17	-6.21%	$359,338.01	-9.32%
	Nichols, NY	$166,108.00	$166,107.97	0.00%	$166,107.92	0.00%	$166,107.99	0.00%
Springfield, OH	Findlay, OH	$0.00	$409,164.76		$402,165.68		$395,166.60	
	Franklin, IN	$790,711.30	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
Topeka, KS	Bloomington, MN	$4,753,307.39	$4,680,365.41	-1.53%	$3,687,507.47	-22.42%	$0.00	-100.00%
	Des Moines, WA	$0.00	$0.00		$3,519,432.58		$17,348,108.31	
Tulsa, 1,2, OK	Ardmore, OK	$0.00	$0.00		$0.00		$93,562.03	
	Bloomington, MN	$21,474,514.18	$2,152,359.49	-89.98%	$0.00	-100.00%	$0.00	-100.00%
	Des Moines, WA	$689,144.83	$56,039,741.40	8031.78%	$61,390,113.04	8808.16%	$59,531,849.95	8538.51%
Union City, NJ	Findlay, OH	$1,775,541.31	$1,775,543.39	0.00%	$1,775,546.66	0.00%	$1,775,542.24	0.00%
	Staunton, VA	$830,434.95	$799,542.02	-3.72%	$768,648.30	-7.44%	$737,759.70	-11.16%
Whitehall, PA	Franklin, IN	$630,007.10	$0.00	-100.00%	$0.00	-100.00%	$0.00	-100.00%
	Staunton, VA	$0.00	$327,228.24		$322,208.21		$317,188.17	

Table 4.19 Effects of Port of Seattle Shutdown on Volume of West Coast Shipments

		Base Scenario		Scenario 4: Seattle Shutdown			
		Volume (FEU)	Costs	Volume (FEU)	%Δ in Volume	Costs	%Δ in Cost
Total Cost		4,381,210.47	$26,157,064,907.35	4,345,039.72	-0.83%	$26,094,768,260.22	-0.24%
Cost Per FEU			$5,970.28			$6,005.65	0.59%
Origin To Port:							
Xiamen, China	Seattle	435,255.19	$1,304,599,201.74	0.00	-100.00%	$0.00	-100.00%
	Tacoma	423,336.61	$1,256,350,612.81	450,891.00	6.51%	$1,342,686,402.22	6.87%
	Portland	17,545.00	$61,995,751.36	52,635.00	200.00%	$185,952,053.19	199.94%
	Oakland	213,828.29	$625,428,866.08	399,854.71	87.00%	$1,172,522,877.34	87.48%
	Los Angeles	1,866,194.16	$5,423,735,537.87	1,932,377.01	3.55%	$5,617,121,674.41	3.57%
	Long Beach	1,425,051.22	$4,132,601,865.67	1,509,282.00	5.91%	$4,379,598,783.82	5.98%
Total		4,381,210.47	$12,804,711,835.53	4,345,039.72	-0.83%	$12,697,881,790.97	-0.83%
Port to Distribution Center:							
Seattle	Bloomington, MN	328,755.80	$877,909,488.32	0.00	-100.00%	$0.00	-100.00%
	Des Moines, WA	106,499.39	$2,896,783.49	0.00	-100.00%	$0.00	-100.00%
Tacoma	Des Moines, WA	423,336.61	$13,546,771.43	450,891.00	6.51%	$14,428,512.00	6.51%
Portland	Bloomington, MN	17,545.00	$48,789,136.00	0.00	-100.00%	$0.00	-100.00%
	Des Moines, WA	0.00	$0.00	52,635.00		$13,474,560.00	
Oakland	Dinuba, CA	213,828.29	$69,109,304.82	399,854.71	87.00%	$129,233,041.82	87.00%
Los Angeles	Ardmore, OK	461,191.20	$1,033,068,288.00	461,191.20	0.00%	$1,033,068,288.00	0.00%
	Bloomington, MN	0.00	$0.00	182,618.13		$565,677,915.37	
	Dinuba, CA	623,812.51	$225,570,601.94	437,786.09	-29.82%	$158,303,450.64	-29.82%
	Findlay, OH	548,648.80	$2,015,516,231.68	548,648.80	0.00%	$2,015,516,231.68	0.00%
	Staunton, VA	232,541.65	$958,443,675.86	302,132.79	29.93%	$1,245,270,523.93	29.93%
Long Beach	Bloomington, MN	0.00	$0.00	163,682.67		$505,190,196.79	
	Dublin, GA	365,016.03	$1,377,132,477.98	362,002.50	-0.83%	$1,365,763,037.50	-0.83%
	Franklin, IN	520,665.64	$1,761,099,460.74	513,818.42	-1.32%	$1,737,939,426.00	-1.32%
	Nichols, NY	391,116.00	$1,682,111,692.80	391,116.00	0.00%	$1,682,111,692.80	0.00%
	Staunton, VA	148,253.55	$609,381,380.73	78,662.41	-46.94%	$323,333,953.45	-46.94%
Total		4,381,210.47	$10,674,575,293.79	4,345,039.72	-0.83%	$10,789,310,829.98	1.07%

Table 4.20 Retail Distribution Shifts as Result of Seattle Shutdown - West Coast

Retail Location by Distribution Center		Base Scenario Volume (FEU)	Base Scenario Costs	Scenario 4: Seattle Shutdown Volume (FEU)	%Δ in Volume	Costs	%Δ in Cost
Addison, IL	Bloomington, MN	1,786.57	$1,146,263.31	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	0.00	$0.00	1,771.82		$640,690.22	
Barboursville, WV	Findlay, OH	0.00	$0.00	157.03		$58,039.31	
	Franklin, IN	158.34	$77,776.61	0.00	-100.00%	$0.00	-100.00%
Battlecreek, MI	Findlay, OH	0.00	$0.00	2,632.71		$699,248.76	
	Franklin, IN	2,654.63	$1,019,377.92	0.00	-100.00%	$0.00	-100.00%
Columbia, MO	Bloomington, MN	4,205.06	$3,660,084.22	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	0.00	$0.00	4,170.34		$2,428,808.07	
Deerfield, IL	Bloomington, MN	916.32	$596,707.58	708.63	-22.67%	$461,460.45	-22.67%
	Franklin, IN	0.00	$0.00	200.12		$74,606.25	
Easthanover, NJ	Findlay, OH	283.38	$248,009.80	278.70	-1.65%	$243,914.72	-1.65%
	Nichols, NY	283.37	$83,425.60	283.38	0.00%	$83,425.60	0.00%
Grand Rapids,1-3, MI	Findlay, OH	6,289.18	$2,324,480.93	9,758.43	55.16%	$3,606,717.53	55.16%
	Franklin, IN	3,550.49	$1,806,489.31	0.00	-100.00%	$0.00	-100.00%
Grandville, WV	Findlay, OH	0.00	$0.00	802.34		$306,815.13	
	Franklin, IN	809.02	$402,568.35	0.00	-100.00%	$0.00	-100.00%
Hickory, NC	Franklin, IN	1,851.64	$1,561,302.85	0.00	-100.00%	$0.00	-100.00%
	Staunton, VA	0.00	$0.00	1,836.35		$758,046.55	
Lincoln, NE	Bloomington, MN	0.00	$0.00	690.94		$466,520.18	
	Des Moines, WA	11,221.70	$30,199,839.04	10,438.12	-6.98%	$28,091,065.07	-6.98%
Lombard, IL	Bloomington, MN	2,105.34	$1,364,260.32	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	0.00	$0.00	2,087.96		$744,983.62	
New York, 1-5, NY	Findlay, OH	143,211.05	$129,921,061.65	137,500.59	-3.99%	$124,740,537.05	-3.99%
	Nichols, NY	194,061.59	$63,341,703.31	195,686.66	0.84%	$63,872,126.56	0.84%
	Staunton, VA	61,105.26	$36,956,462.56	61,901.69	1.30%	$37,438,139.47	1.30%
Niles, IL	Bloomington, MN	124.50	$81,074.40	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	1,371.26	$487,071.55	1,483.41	8.18%	$526,907.65	8.18%
Paramus, 1,2, NJ	Findlay, OH	640.18	$576,674.14	629.61	-1.65%	$567,152.24	-1.65%
	Nichols, NY	640.18	$204,857.60	640.18	0.00%	$204,857.60	0.00%
San Antonio, 1-4, TX	Ardmore, OK	31,874.56	$18,869,739.52	35,418.95	11.12%	$12,610,270.10	-33.17%
	Dinuba, CA	25,066.80	$62,285,984.64	21,052.31	-16.02%	$52,310,785.61	-16.02%
San Jose, 2, CA	Des Moines, WA	22,259.83	$29,240,512.69	16,600.11	-25.43%	$21,805,910.63	-25.43%
	Dinuba-Ca	0.00	$0.00	5,475.94		$1,568,309.46	

Table 4.20 Continued

Retail Location by Distribution Center		Base Scenario		Scenario 4: Seattle Shutdown			
		Volume (FEU)	Costs	Volume (FEU)	%Δ in Volume	Costs	%Δ in Cost
Sioux City, IA	Bloomington, MN	0.00	$0.00	4,194.13		$2,315,157.31	
	Des Moines, WA	4,229.04	$10,961,671.68	0.00	-100.00%	$0.00	-100.00%
Sioux Falls, SD	Bloomington, MN	0.00	$0.00	6,116.31		$2,192,086.97	
	Des Moines, WA	6,167.23	$15,196,054.72	0.00	-100.00%	$0.00	-100.00%
South Setauket, NY	Findlay, OH	396.25	$396,250.00	389.71	-1.65%	$389,707.22	-1.65%
	Nichols, NY	396.25	$166,108.00	396.25	0.00%	$166,108.00	0.00%
Springfield, OH	Findlay, OH	0.00	$0.00	1,952.77		$249,954.17	
	Franklin, IN	3,251.28	$790,711.30	1,271.67	-60.89%	$309,270.36	-60.89%
Tulsa, 1,2, OK	Bloomington, MN	19,339.44	$21,474,514.18	19,391.14	0.27%	$21,531,917.87	0.27%
	Des Moines, WA	213.12	$689,144.83	0.00	-100.00%	$0.00	-100.00%
West Paterson, NJ	Findlay, OH	273.28	$241,798.14	268.77	-1.65%	$237,805.63	-1.65%
	Nichols, NY	273.28	$83,077.12	273.28	0.00%	$83,077.12	0.00%

Table 4.21 Effects of Port of Long Beach Shutdown on West Coast Shipments

		Base Scenario		Scenario 5: Long Beach Shutdown			
		Volume (FEU)	Costs	Volume (FEU)	%Δ in Volume	Costs	%Δ in Cost
Total Cost		4,381,210.47	$26,157,064,907.35	4,005,550.87	-8.57%	$24,648,189,922.28	-5.77%
Cost Per FEU			$5,970.28			$6,153.51	3.07%
Origin To Port:							
Xiamen, China	Seattle	435,255.19	$1,304,599,201.74	510,585.00	17.31%	$1,544,171,690.24	18.36%
	Tacoma	423,336.61	$1,256,350,612.81	450,891.00	6.51%	$1,342,686,402.22	6.87%
	Portland	17,545.00	$61,995,751.36	52,635.00	200.00%	$185,952,053.19	199.94%
	Oakland	213,828.29	$625,428,866.08	459,972.00	115.11%	$1,358,085,885.33	117.14%
	Los Angeles	1,866,194.16	$5,423,735,537.87	2,531,467.87	35.65%	$7,976,263,751.28	47.06%
	Long Beach	1,425,051.22	$4,132,601,865.67	0.00	-100.00%	$0.00	-100.00%
Total		4,381,210.47	$12,804,711,835.53	4,005,550.87	-8.57%	$12,407,159,782.26	-3.10%
Port to Distribution Center:							
Seattle	Bloomington, MN	328,755.80	$877,909,488.32	200,838.27	-38.91%	$536,318,512.43	-38.91%
	Des Moines, WA	106,499.39	$2,896,783.49	0.00	-100.00%	$0.00	-100.00%
	Nichols, NY	0.00	$0.00	309,746.73		$1,390,143,330.59	
Tacoma	Des Moines, WA	423,336.61	$13,546,771.43	420,862.07	-0.58%	$13,467,586.19	-0.58%
	Bloomington, MN	0.00	$0.00	30,028.93		$80,621,675.07	
Portland	Bloomington, MN	17,545.00	$48,789,136.00	0.00	-100.00%	$0.00	-100.00%
	Nichols, NY	0.00	$0.00	52,635.00		$233,952,048.00	
Oakland	Dinuba, CA	213,828.29	$69,109,304.82	459,972.00	115.11%	$148,662,950.40	115.11%
Los Angeles	Ardmore, OK	461,191.20	$1,033,068,288.00	461,191.20	0.00%	$1,033,068,288.00	0.00%
	Dinuba, CA	623,812.51	$225,570,601.94	377,668.80	-39.46%	$136,565,038.08	-39.46%
	Dublin, GA	0.00	$0.00	346,572.80		$1,311,985,991.68	
	Findlay, OH	548,648.80	$2,015,516,231.68	548,648.80	0.00%	$2,015,516,231.68	0.00%
	Franklin, IN	0.00	$0.00	387,856.80		$1,322,436,545.28	
	Nichols, NY	0.00	$0.00	28,734.27		$123,948,140.96	
	Staunton, VA	232,541.65	$958,443,675.86	380,795.20	63.75%	$1,569,485,496.32	63.75%
Long Beach	Dublin, GA	365,016.03	$1,377,132,477.98	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	520,665.64	$1,761,099,460.74	0.00	-100.00%	$0.00	-100.00%
	Nichols, NY	391,116.00	$1,682,111,692.80	0.00	-100.00%	$0.00	-100.00%
	Staunton, VA	148,253.55	$609,381,380.73	0.00	-100.00%	$0.00	-100.00%
Total		4,381,210.47	$10,674,575,293.79	4,005,550.87	-8.57%	$9,916,171,834.69	-7.10%

Table 4.22 Retail Distribution Shifts as Result of Long Beach Shutdown - West Coast

Retail Location by Distribution Center		Base Scenario Volume (FEU)	Base Scenario Costs	Scenario 5: Long Beach Shutdown Volume (FEU)	%Δ in Volume	Costs	%Δ in Cost
Addison, IL	Bloomington, MN	1,786.57	$1,146,263.31	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	0.00	$0.00	1,633.38		$590,631.48	
Amarillo, TX	Des Moines, WA	8,637.21	$24,474,398.26	0.00	-100.00%	$0.00	-100.00%
	Dinuba, CA	0.00	$0.00	7,896.63		$14,921,466.00	
Arden, NC	Dublin, GA	0.00	$0.00	701.81		$306,550.98	
	Franklin, IN	767.63	$558,834.64	0.00	-100.00%	$0.00	-100.00%
Arlington Heights, IL	Bloomington, MN	3,782.22	$2,390,363.04	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	0.00	$0.00	3,457.92		$1,283,579.84	
Asheville, NC	Franklin, IN	3,426.93	$2,472,872.69	0.00	-100.00%	$0.00	-100.00%
	Staunton, VA	0.00	$0.00	3,133.09		$1,589,105.07	
Aurora, IL	Bloomington, MN	7,113.14	$4,620,695.74	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	0.00	$0.00	6,503.24		$2,528,458.02	
Barboursville, WV	Findlay, OH	0.00	$0.00	144.76		$53,504.55	
	Franklin, IN	158.34	$77,776.61	0.00	-100.00%	$0.00	-100.00%
Baton Rouge, LA	Dublin, GA	0.00	$0.00	10,361.25		$10,361,252.49	
	Franklin, IN	11,332.98	$15,594,180.48	0.00	-100.00%	$0.00	-100.00%
Battle Creek, MI	Findlay, OH	0.00	$0.00	2,427.01		$644,614.70	
	Franklin, IN	2,654.63	$1,019,377.92	0.00	-100.00%	$0.00	-100.00%
Benton Harbor, MI	Findlay, OH	0.00	$0.00	508.56		$179,014.67	
	Franklin, IN	556.26	$213,603.84	0.00	-100.00%	$0.00	-100.00%
Birmingham, AL	Dublin, GA	0.00	$0.00	11,043.54		$4,982,847.03	
	Franklin, IN	12,079.26	$8,851,681.73	0.00	-100.00%	$0.00	-100.00%
Bloomingdale, IL	Bloomington, MN	1,078.24	$690,073.60	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	0.00	$0.00	985.79		$364,347.28	
Brooklyn, 1, 2, NY	Findlay, OH	59,943.03	$54,572,138.13	56,061.99	-6.47%	$19,757,224.00	-63.80%
	Nichols, NY	59,943.03	$19,757,224.00	56,061.99	-6.47%	$18,478,031.93	-6.47%
	Staunton, VA	2,753.43	$1,674,086.69	0.00	-100.00%	$0.00	-100.00%
Carol Stream, IL	Bloomington, MN	2,011.62	$1,274,562.43	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	0.00	$0.00	1,839.14		$688,572.89	
Charlotte, 1,2, NC	Dublin, GA	26,903.90	$11,105,929.92	1,587.03	-94.10%	$655,124.27	-94.10%
	Staunton, VA	0.00	$0.00	23,010.04		$10,050,787.23	
Chattanooga, TN	Dublin, GA	0.00	$0.00	7,074.66		$2,875,139.88	
	Franklin, IN	7,738.15	$4,927,653.92	0.00	-100.00%	$0.00	-100.00%

Table 4.22 Continued

Retail Location by Distribution Center		Base Scenario: Volume (FEU)	Base Scenario: Costs	Scenario 5: Long Beach Shutdown: Volume (FEU)	%Δ in Volume	Costs	%Δ in Cost
Chicago, 1-4, IL	Findlay, OH	0.00	$0.00	14,934.36		$6,499,434.33	
	Franklin, IN	144,064.48	$47,944,658.94	116,777.55	-18.94%	$38,863,568.28	-18.94%
Cincinnati, 1-4, OH	Findlay, OH	0.00	$0.00	15,066.91		$3,833,022.73	
	Franklin, IN	16,479.96	$2,610,425.66	0.00	-100.00%	$0.00	-100.00%
Columbia, MO	Bloomington, MN	4,205.06	$3,660,084.22	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	0.00	$0.00	3,844.50		$2,239,039.20	
Councilbluffs, IA	Bloomington, MN	2,898.59	$1,664,950.10	0.00	-100.00%	$0.00	-100.00%
	Des Moines, WA	0.00	$0.00	2,650.06		$7,267,511.45	
Covington, LA	Dublin, GA	0.00	$0.00	385.81		$346,300.52	
	Franklin, IN	421.99	$534,070.54	0.00	-100.00%	$0.00	-100.00%
Dayton, 1-3, OH	Findlay, OH	0.00	$0.00	7,557.89		$1,281,818.94	
	Franklin, IN	8,266.71	$1,812,062.83	0.00	-100.00%	$0.00	-100.00%
Deerfield, IL	Bloomington, MN	916.32	$596,707.58	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	0.00	$0.00	837.75		$312,313.82	
Dublin, CA	Des Moines, WA	1,491.03	$1,891,818.86		-100.00%		-100.00%
	Dinuba, CA	0.00	$0.00	1,363.18		$390,415.93	
Easthanover, NJ	Findlay, OH	283.38	$248,009.80	234.78	-17.15%	$205,479.42	-17.15%
	Nichols, NY	283.37	$83,425.60	283.38	0.00%	$83,425.60	0.00%
East Palo Alto, CA	Des Moines, WA	1,467.80	$1,918,708.16	0.00	-100.00%	$0.00	-100.00%
	Dinuba, CA	0.00	$0.00	1,341.95		$450,893.83	
Fairborn, OH	Findlay, OH	0.00	$0.00	1,457.74		$261,226.39	
	Franklin, IN	1,594.45	$359,707.92	0.00	-100.00%	$0.00	-100.00%
Fayetteville, AR	Ardmore, OK	0.00	$0.00	536.89		$249,117.41	
	Bloomington, MN	2,887.59	$3,049,295.04	2,103.11	-27.17%	$2,220,881.46	-27.17%
Fayetteville, NC	Dublin, GA	6,019.98	$3,168,917.47	0.00	-100.00%	$0.00	-100.00%
	Staunton, VA	0.00	$0.00	5,503.81		$2,773,918.64	
Florence, KY	Findlay, OH	0.00	$0.00	1,071.11		$291,340.98	
	Franklin, IN	1,171.56	$202,445.57	0.00	-100.00%	$0.00	-100.00%
Flowood, MS	Dublin, GA	0.00	$0.00	216.03		$178,354.13	
	Franklin, IN	236.29	$257,461.58	0.00	-100.00%	$0.00	-100.00%
Fort Smith, AR	Ardmore, OK	0.00	$0.00	3,650.62		$1,366,791.27	
	Bloomington, MN	3,992.99	$4,555,202.99	0.00	-100.00%	$0.00	-100.00%

Table 4.22 Continued

Retail Location by Distribution Center		Base Scenario Volume (FEU)	Base Scenario Costs	Scenario 5: Long Beach Shutdown Volume (FEU)	%Δ in Volume	Costs	%Δ in Cost
Fort Wayne, 1,2, IN	Findlay, OH	0.00	$0.00	9,356.59		$1,332,379.00	
	Franklin, IN	10,234.10	$2,407,060.32	0.00	-100.00%	$0.00	-100.00%
Geneva, IL	Bloomington, MN	970.79	$602,666.43	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	0.00	$0.00	887.55		$343,659.84	
Grand Rapids, 1-3, MI	Findlay, OH	6,289.18	$2,324,480.93	8,995.98	43.04%	$3,324,915.64	43.04%
	Franklin, IN	3,550.49	$1,806,489.31	0.00	-100.00%	$0.00	-100.00%
Grandville, MI	Findlay, OH	0.00	$0.00	739.65		$282,842.90	
	Franklin, IN	809.02	$402,568.35	0.00	-100.00%	$0.00	-100.00%
Gurnee, IL	Bloomington, MN	1,434.37	$892,751.89	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	0.00	$0.00	1,311.38		$522,454.72	
Hamilton, OH	Findlay, OH	0.00	$0.00	2,760.20		$644,783.86	
	Franklin, IN	3,019.07	$497,542.74	0.00	-100.00%	$0.00	-100.00%
Hattiesburg, MS	Dublin, GA	0.00	$0.00	2,036.56		$1,678,126.74	
	Franklin, IN	2,227.56	$2,469,918.53	0.00	-100.00%	$0.00	-100.00%
Hickory, NC	Franklin, IN	1,851.64	$1,561,302.85	0.00	-100.00%	$0.00	-100.00%
	Staunton, VA	0.00	$0.00	1,692.87		$698,818.47	
Holland, MI	Findlay, OH	0.00	$0.00	1,594.00		$716,661.21	
	Franklin, IN	1,743.49	$808,979.36	0.00	-100.00%	$0.00	-100.00%
Jackson, MS	Dublin, GA	0.00	$0.00	8,380.03		$6,918,553.49	
	Franklin, IN	9,165.95	$9,972,553.60	0.00	-100.00%	$0.00	-100.00%
Johnson City, TN	Franklin, IN	2,759.35	$1,942,582.40	0.00	-100.00%	$0.00	-100.00%
	Staunton, VA	0.00	$0.00	2,522.75		$1,037,356.50	
Kildeer, IL	Bloomington, MN	172.12	$108,504.45	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	0.00	$0.00	157.36		$61,434.07	
Libertyville, IL	Bloomington, MN	1,031.83	$650,465.63	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	0.00	$0.00	943.36		$371,305.49	
Livermore, CA	Des Moines, WA	3,648.60	$4,687,721.28	0.00	-100.00%	$0.00	-100.00%
	Dinuba, CA	0.00	$0.00	3,335.76		$923,337.50	
Lombard, IL	Bloomington, MN	2,105.34	$1,364,260.32	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	0.00	$0.00	1,924.82		$686,776.18	
Mason, OH	Findlay, OH	0.00	$0.00	1,001.29		$224,289.83	
	Franklin, IN	1,095.20	$192,755.20	0.00	-100.00%	$0.00	-100.00%

Table 4.22 Continued

Retail Location by Distribution Center		Base Scenario Volume (FEU)	Base Scenario Costs	Scenario 5: Long Beach Shutdown Volume (FEU)	%Δ in Volume	Costs	%Δ in Cost
Miamisburg, OH	Findlay, OH	0.00	$0.00	886.36		$165,927.10	
	Franklin, IN	969.49	$203,205.10	0.00	-100.00%	$0.00	-100.00%
Milpitas, CA	Des Moines, WA	3,118.96	$4,067,123.84	0.00	-100.00%	$0.00	-100.00%
	Dinuba, CA	0.00	$0.00	2,851.53		$921,614.48	
Mishawaka, IN	Findlay, OH	0.00	$0.00	2,117.43		$633,534.33	
	Franklin, IN	2,316.01	$633,660.34	0.00	-100.00%	$0.00	-100.00%
Muncie, IN	Findlay, OH	0.00	$0.00	3,066.75		$623,162.78	
	Franklin, IN	3,354.36	$445,459.01	0.00	-100.00%	$0.00	-100.00%
Muskegon, MI	Findlay, OH	0.00	$0.00	1,823.99		$790,881.09	
	Franklin, IN	1,995.05	$1,040,618.08	0.00	-100.00%	$0.00	-100.00%
New York, 1-5, NY	Findlay, OH	64,912.18	$129,921,061.65	26,040.23	-59.88%	$89,707,709.18	-30.95%
	Nichols, NY	194,061.59	$63,341,703.31	209,562.43	7.99%	$68,401,175.60	7.99%
	Staunton, VA	61,105.26	$36,956,462.56	55,773.07	-8.73%	$33,731,550.00	-8.73%
Niles, IL	Bloomington, MN	124.50	$81,074.40	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	1,371.26	$487,071.55	1,367.51	-0.27%	$485,739.04	-0.27%
Oakland, CA	Des Moines, WA	19,872.63	$25,023,615.70	0.00	-100.00%	$0.00	-100.00%
	Dinuba, CA	0.00	$0.00	18,168.68		$5,901,188.70	
Omaha, 1-3, NE	Bloomington, MN	19,401.15	$11,392,355.28	0.00	-100.00%	$0.00	-100.00%
	Des Moines, WA	0.00	$0.00	17,737.63		$48,700,438.79	
Paramus, 1,2, NJ	Findlay, OH	640.18	$576,674.14	530.40	-17.15%	$477,782.23	-17.15%
	Nichols, NY	640.18	$204,857.60	640.18	0.00%	$204,857.59	0.00%
Portage, MI	Bloomington, MN	2,233.43	$1,379,366.37	0.00	-100.00%	$0.00	-100.00%
	Findlay, OH	0.00	$0.00	2,041.93		$630,547.45	
Riverside, IL	Findlay, OH	0.00	$0.00	206.77		$92,632.81	
	Franklin, IN	442.49	$152,924.54	197.78	-55.30%	$68,352.69	-55.30%
San Antonio, 1-4, TX	Ardmore, OK	31,874.56	$18,869,739.52	46,622.03	46.27%	$27,600,244.10	46.27%
	Dinuba, CA	25,066.80	$62,285,984.64	5,436.98	-78.31%	$13,509,817.54	-78.31%
San Francisco,1,2, CA	Des Moines, WA	38,639.22	$48,963,619.58	26,290.08	-31.96%	$33,314,795.55	-31.96%
	Dinuba, CA	0.00	$0.00	9,036.08		$3,093,953.62	
San Jose, 1,2, CA	Des Moines, WA	27,550.57	$36,190,428.75	0.00	-100.00%	$0.00	-100.00%
	Dinuba, CA	16,969.09	$4,859,947.38	40,702.40	139.86%	$11,657,166.17	139.86%
Schaumburg, IL	Bloomington, MN	3,750.13	$2,358,081.74	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	0.00	$0.00	3,428.58		$1,294,632.32	

Table 4.22 Continued

Retail Location by Distribution Center		Base Scenario Volume (FEU)	Base Scenario Costs	Scenario 5: Long Beach Shutdown Volume (FEU)	%Δ in Volume	Costs	%Δ in Cost
Slidell, LA	Dublin, GA	0.00	$0.00	1,168.62		$1,005,949.09	
	Franklin, IN	1,278.22	$1,005,949.09	0.00	-100.00%	$0.00	-100.00%
South Setauket, NY	Findlay, OH	396.25	$396,250.00	328.30	-17.15%	$328,298.42	-17.15%
	Nichols, NY	396.25	$166,108.00	396.25	0.00%	$166,107.99	0.00%
Springdale, OH	Findlay, OH	0.00	$0.00	480.41		$111,454.03	
	Franklin, IN	525.46	$81,551.39	0.00	-100.00%	$0.00	-100.00%
Springfield, MO	Bloomington, MN	7,540.46	$7,094,064.77	1,316.65	-82.54%	$1,238,699.96	-82.54%
	Franklin, IN	0.00	$0.00	5,577.27		$4,122,718.31	
Springfield, OH	Findlay, OH	0.00	$0.00	2,972.50		$380,480.56	
	Franklin, IN	3,251.28	$790,711.30	0.00	-100.00%	$0.00	-100.00%
St Charles, IL	Bloomington, MN	1,387.71	$857,049.70	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	0.00	$0.00	1,268.72		$493,279.55	
Stockton, CA	Des Moines, WA	12,126.57	$15,230,971.92	0.00	-100.00%	$0.00	-100.00%
	Dinuba, CA	0.00	$0.00	11,086.80		$2,714,048.01	
Sunnyvale, CA	Des Moines, WA	6,554.50	$8,641,452.80	0.00	-100.00%	$0.00	-100.00%
	Dinuba, CA	0.00	$0.00	5,992.50		$1,802,542.59	
Topeka, KS	Bloomington, MN	6,087.74	$4,753,307.39	0.00	-100.00%	$0.00	-100.00%
	Des Moines, WA	0.00	$0.00	5,565.76		$16,626,028.90	
Tulsa, 1,2, OK	Ardmore, OK	0.00	$0.00	17,876.06		$5,748,940.34	
	Bloomington, MN	19,339.44	$21,474,514.18	0.00	-100.00%	$0.00	-100.00%
	Des Moines, WA	213.12	$689,144.83	0.00	-100.00%	$0.00	-100.00%
Union City, CA	Des Moines, WA	3,326.45	$4,300,434.56	0.00	-100.00%	$0.00	-100.00%
	Dinuba, CA	0.00	$0.00	3,041.23		$978,059.27	
Union City, NJ	Findlay, OH	1,960.62	$1,775,541.31	3,051.19	55.62%	$2,763,153.44	55.62%
	Staunton, VA	1,376.72	$830,434.95	0.00	-100.00%	$0.00	-100.00%
Valparaiso, IN	Findlay, OH	0.00	$0.00	1,247.44		$463,049.44	
	Franklin, IN	1,364.43	$382,040.40	0.00	-100.00%	$0.00	-100.00%
Vernon Hills, IL	Bloomington, MN	1,000.88	$643,766.02	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	0.00	$0.00	915.06		$354,311.70	
West Dundee, IL	Bloomington, MN	270.02	$163,308.10	0.00	-100.00%	$0.00	-100.00%
	Franklin, IN	0.00	$0.00	246.87		$97,957.06	
West Paterson, NJ	Findlay, OH	273.28	$241,798.14	226.42	-17.15%	$200,332.99	-17.15%
	Nichols, NY	273.28	$83,077.12	273.28	0.00%	$83,077.12	0.00%
Whitehall, PA	Franklin, IN	718.53	$630,007.10	0.00	-100.00%	$0.00	-100.00%
	Staunton, VA	0.00	$0.00	656.92		$303,760.20	

Summary and Conclusion

The post 9/11 era created urgency for maritime security reform in order to protect one of the nation's most vulnerable entities, the U.S. ports. Pre 9/11 security focused on controlling events, such as theft and illegal exporting/importing. Post 9/11 security focuses on preventing possibilities of events, mainly terrorist attacks on one of our nation's ports or major cities. A wave of research, legislation, and programs have been developed to promote increased security from origin to destination without significantly impeding transportation flows and increasing costs. These security measures focus on developing a more transparent and traceable supply chain through information exchange/sharing in industry and customs partnerships, and in alliances with foreign trade partners.

All the efforts since 9/11 have dramatically increased the security and visibility of our supply chains; however, there are many gaps to be filled and the risks of terrorist attacks are very relevant. Ports represent one major nexus in the international supply chain, thus making them opportune targets for a terrorist attack. A terrorist attack on a major port would have detrimental local and macroeconomic effects on the U.S. economy, but also would significantly impact transportation costs and distribution routes for individual firms.

In this study, a constrained transportation optimization model was developed to estimate the effects that security related impacts had on an electronic firm's supply chain of televisions through the six major west coast ports. This modeling effort was developed using primary data obtained through interviews with the firm, and maritime experts. Assuming the firm's distribution to be a reasonable representation of television imports, the model was expanded to represent all television imports to the six west coast ports while maintaining the assumptions from the original model. Furthermore, an evaluation of the total west coast port import volumes was conducted using the firm's model distribution system, in which new assumptions were made to reflect the economies of scale for each port's operations.

Three different scenarios involving port security measures and impacts were presented and evaluated. The first scenario involved increasing the rate charged for port services by five, ten, and fifteen percent. The second scenario considered the impact resulting from a shutdown of the Port of Seattle, and the third scenario evaluated the effect of a shutdown at the Port of Long Beach. All three scenarios were presented and evaluated at the firm, industry, and west coast port volume levels.

Results for the port rate increases provide similar conclusions for the firm and industry level. The rate increases caused a slight decrease in quantity demanded and thus the total transportation costs, yet the average cost per container shipped increased by $27 during the highest rate increase. At the west coast level the rate increases resulted in a cost per container increase up to $218, which was a significant increase when considering a total import volume of over four million forty foot containers.

The Port of Seattle shutdown created an $11 increase in per-unit costs at the firm and industry level, and caused Seattle's volume to shift to the lower cost Port of Los Angeles. The shift in distribution increased costs and decreased throughput for the Bloomington distribution center, which was previously supplied by Seattle. Shutting down Seattle in the west coast scenario, caused a larger per-unit increase of approximately $35 which dramatically increased the volume shipped through the Ports of Portland and Oakland, and the Port of Tacoma expanded to its maximum capacity.

The Port of Long Beach shutdown caused a direct shift of Long Beach bound shipments to Los Angeles in the firm and industry scenarios. The per-unit cost increase was only $5 because of the firm's ease of redirecting shipments to the neighboring port. Perhaps a more realistic conclusion was reached when the Port of Long Beach shutdown was imposed on all container volumes. The cost increase from the loss of the port caused an 8.5 percent decrease in quantity demanded. The large volume from Long Beach was reallocated across all of the remaining ports, which increased per-unit costs at each port and resulted in a $183 increase in average cost per container shipped.

The shadow prices for the ports and the distribution centers in each scenario provide meaningful insight of the value that the corresponding port or distribution center holds in the modeling framework. Throughout most of the scenarios, the Dinuba, Ardmore, Bloomington, and Des Moines distribution centers were operating at maximum capacity and maintained the highest shadow prices. With all of the supply originating on the west coast, the closest distribution centers were expected to be in high demand because they were en route to all the eastern retail locations.

The northeastern distribution centers of Staunton, Nichols, and Findlay consistently shipped volumes at their lowest capacity causing positive shadow prices, which indicated the cost savings achieved if one less unit was shipped through these DCs. The shadow prices were significantly lower than the distribution centers operating at maximum capacity, but they existed primarily for the same reason. These distribution centers were a less desirable option because of their location and their supply from the west coast. In many cases, the supply would be shipped to one of these eastern distribution centers and shipped westward to a retail store, thus increasing the transportation cost and diminishing their competitiveness.

Future Research

Using a firm perspective, this study demonstrated the effects that port security measures and catastrophic events might impose on a typical importer, and estimated the possible outcomes of these effects on the television industry and all the west coast imports. Though a great deal of insight can be gained in evaluating these effects through a transportation cost model, there are several improvements that would produce more robust results. The anomaly that existed in this study was not considering the effects of congestion at the nation's ports on both the water and land side. With record breaking volumes each year, the ports experience ever increasing problems of congestion. In the model, the firm was able to easily change ports without facing the problems and costs associated with congestion, when in all reality; every other firm would also change shipment ports, thus magnifying the problem. If the congestion component was implemented into the model, the costs incurred by the firm would be more accurately represented.

The rates established for container services at the ports successfully demonstrated the economies of scale characteristics at the ports. However, the rates were estimations based on port lease revenues and typical container service fees. In the future, further investigation of each port's cost structure and terminal lease rates would assist in establishing a more precise representation of the rates assessed at the ports.

Lastly, the firm analyzed in the study also used some rail as a means of transportation to some of the distribution centers located in the eastern parts of the United States. Information and data regarding the firm's use of rail was not provided. Adding the rail mode of transportation would most likely increase the competitiveness of the northeastern distribution centers and decrease the dependence on the western distribution centers for the lowest cost transportation, which would result in a more accurate representation of the firm.

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APPENDIX A

PORT RATE ESTIMATIONS

Port Rate Estimations

	2001 -2004 Averages					
Port	FEUs	Avg Revenue	Avg Rev/FEU	Wtd Rev/FEU	Std Cost/FEU	Wtd Cost/FEU
Seattle	442,262	$96,438,000.00	$218.06	0.144346	325	$281.47
Tacoma	406,574	$76,802,580.50	$188.90	0.125046	325	$243.84
Portland	101,408	$65,279,928.50	$643.74	0.426131	325	$830.95
Oakland	525,489	$88,440,000.00	$168.30	0.111409	325	$217.25
Los Angeles	2,128,323	$309,270,000.00	$145.31	0.096191	325	$187.57
Long Beach	1,654,215	$242,090,879.00	$146.35	0.096877	325	$188.91
Total	5,258,270	$878,321,388.00		1	Average	$325.00

West Coast Scenario - Optimal Import Volumes

	Volume	$/FEU
Seattle	340,390	$281.47
Tacoma	300,594	$243.84
Portland	35,090	$830.95
Oakland	306,648	$217.25
Los Angeles	1,922,770	$187.57
Long Beach	1,475,720	$188.91
Total	4,381,211	
Average Rate/FEU		$325

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APPENDIX B

VOLUME CONSTRAINTS

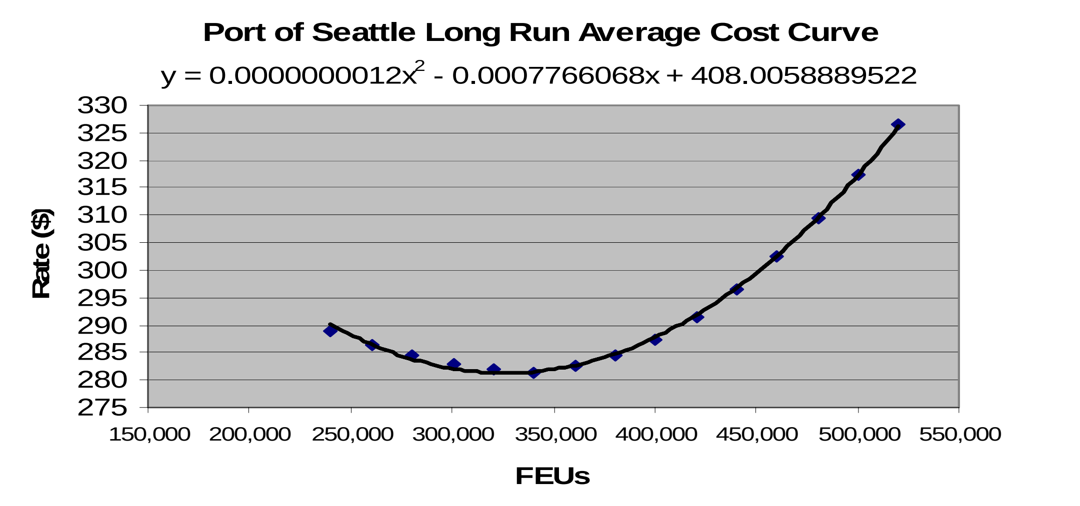
CONSTRAINTS

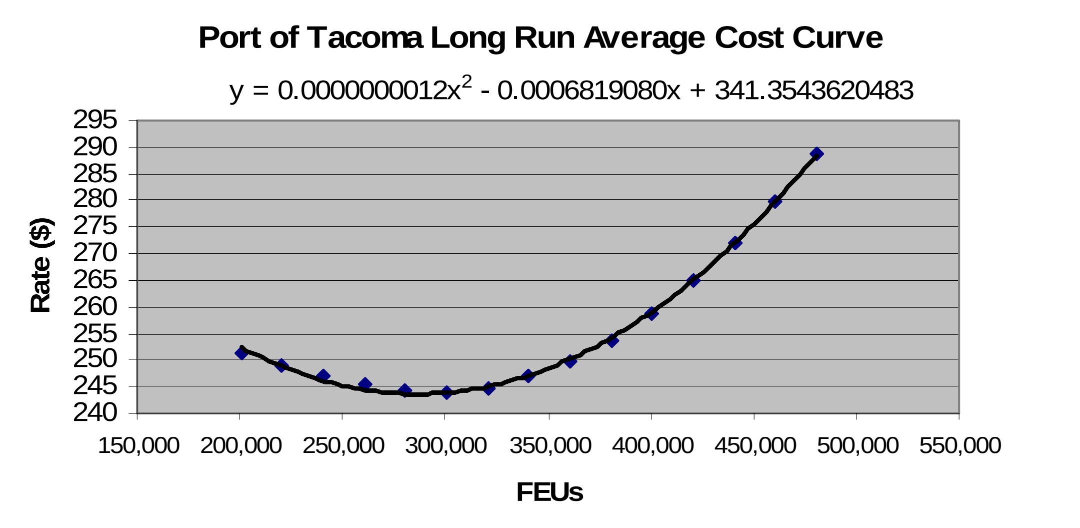
	Firm Volume			Industry Volume			West Coast Volume		
Port	**50%**	**0%**	**50%**	**50%**	**0%**	**50%**	**50%**	**0%**	**50%**
Seattle	464.21	928.42	1,392.63	2,730.65	5,461.30	8,191.95	170,195.00	340,390.00	510,585.00
Tacoma	633.97	1,267.95	1,901.92	3,729.25	7,458.50	11,187.75	150,297.00	300,594.00	450,891.00
Portland	14.35	28.70	43.04	84.40	168.80	253.20	17,545.00	35,090.00	52,635.00
Oakland	187.35	374.70	562.05	1,102.05	2,204.10	3,306.15	153,324.00	306,648.00	459,972.00
Losangeles	3,075.20	6,150.40	9,225.59	18,089.40	36,178.80	54,268.20	961,385.00	1,922,770.00	2,884,155.00
Longbeach	1,576.26	3,152.51	4,728.77	9,272.10	18,544.20	27,816.30	737,860.00	1,475,720.00	2,213,580.00
Distribution Center	**0.20**	**0.00**	**0.20**	**0.20**	**0.00**	**0.20**	**0.20**	**0.00**	**0.20**
Staunton, VA	1,034.56	1,293.19	1,551.83	6,085.48	7,606.84	9,128.21	380,795.14	475,993.92	571,192.70
Findlay, OH	1,490.59	1,863.23	2,235.88	8,767.95	10,959.93	13,151.92	548,649.20	685,811.50	822,973.80
Dublin, GA	941.58	1,176.97	1,412.37	5,538.56	6,923.21	8,307.85	346,572.46	433,215.58	519,858.69
Franklin, IN	1,053.74	1,317.18	1,580.61	6,198.33	7,747.91	9,297.50	387,856.96	484,821.20	581,785.44
Bloomington, MN	627.23	784.03	940.84	3,689.48	4,611.85	5,534.22	230,867.24	288,584.05	346,300.85
Nichols, NY	1,062.60	1,328.24	1,593.89	6,250.42	7,813.02	9,375.63	391,116.26	488,895.32	586,674.39
Dinuba, CA	1,517.15	1,896.44	2,275.73	8,924.21	11,155.26	13,386.31	558,427.10	698,033.88	837,640.65
Ardmore, OK	835.32	1,044.15	1,252.98	4,913.52	6,141.90	7,370.28	307,460.84	384,326.05	461,191.26
Des Moines, WA	959.65	1,199.56	1,439.47	5,644.86	7,056.07	8,467.28	353,223.61	441,529.52	529,835.42
Total Demand		11,902.67			70,015.70			4,381,212.00	

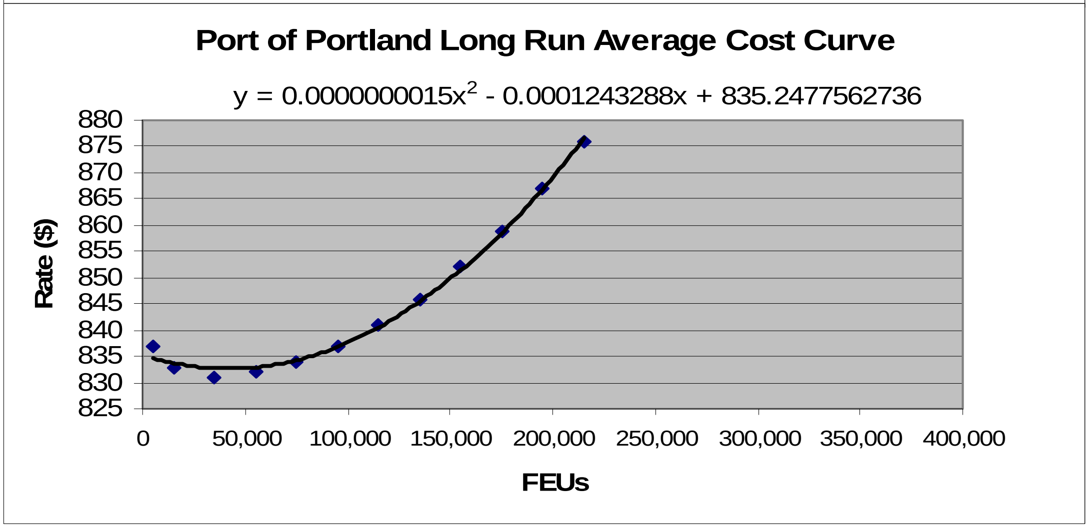
APPENDIX C

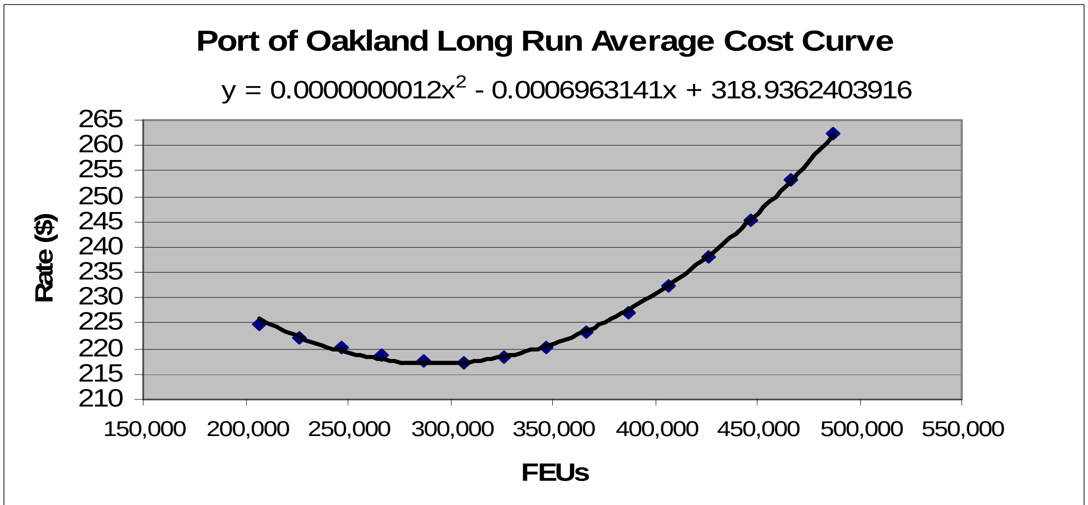
ESTIMATED PORT COST CURVES

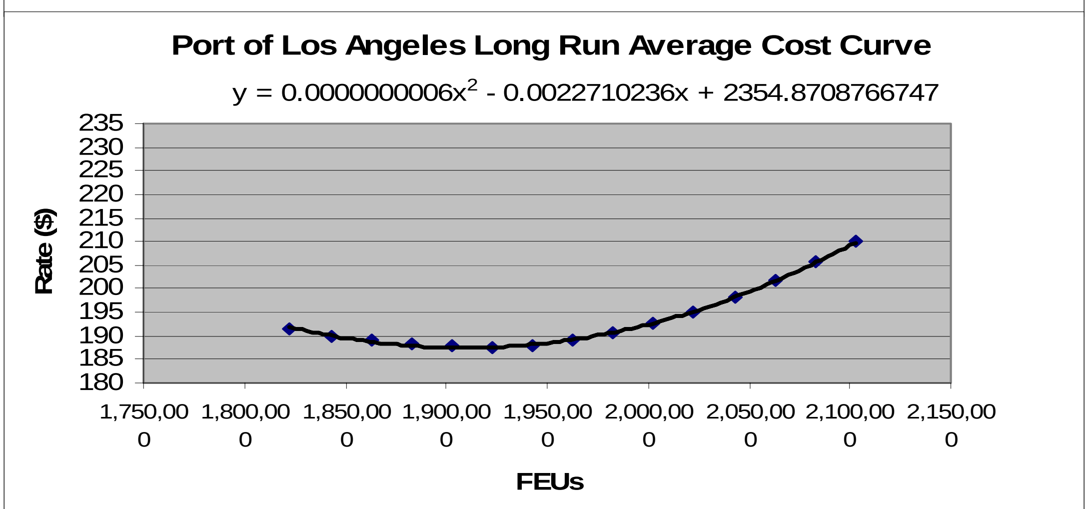
ESTIMATED PORT COST CURVES

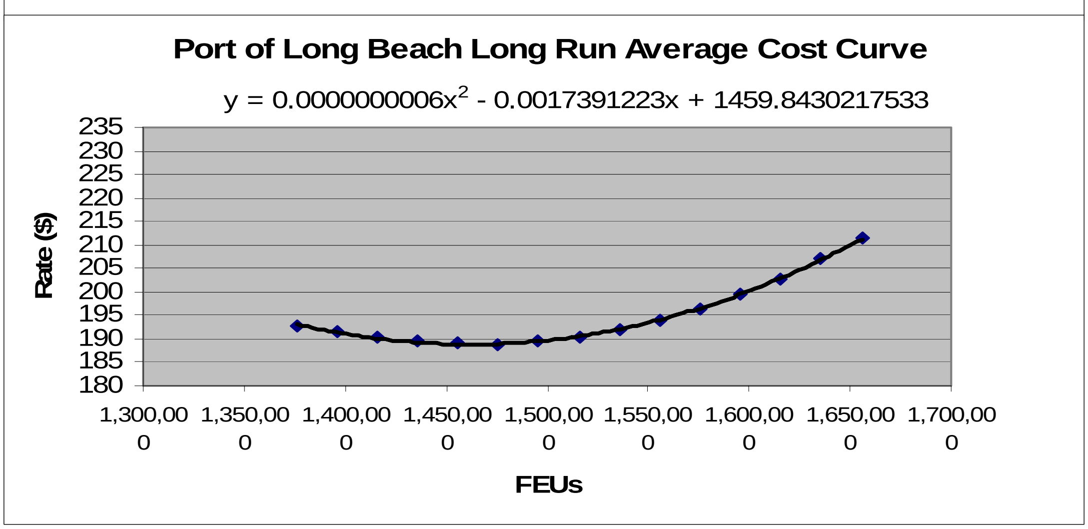







Port of Oakland Long Run Average Cost Curve
y = 0.0000000012x2 - 0.0006963141x + 318.9362403916
Rate ($)
265
260
255
250
245
240
235
230
225
220
215
210
150,000
200,000
250,000
300,000
350,000
400,000
450,000
500,000
550,000
FEUs


Port of Los Angeles Long Run Average Cost Curve
y = 0.0000000006x2 - 0.0022710236x + 2354.8708766747
Rate ($)
235
230
225
220
215
210
205
200
195
190
185
180
1,750,00 0
1,800,00 0
1,850,00 0
1,900,00 0
1,950,00 0
2,000,00 0
2,050,00 0
2,100,00 0
2,150,00 0
FEUs


Port of Long Beach Long Run Average Cost Curve
y = 0.0000000006x2 - 0.0017391223x + 1459.8430217533
Rate ($)
235
230
225
220
215
210
205
200
195
190
185
180
1,300,00 0
1,350,00 0
1,400,00 0
1,450,00 0
1,500,00 0
1,550,00 0
1,600,00 0
1,650,00 0
1,700,00 0
FEUs

APPENDIX D

GAMS MODEL

GAMS MODEL

The complete GAMS model was too large to place in the appendix so the model provided here is a scaled down example which includes all of the sets, equations, and constraints, but excludes complete listings of tables and elements.

```
*Port Security NLP MODEL
$offlisting
SET     O      Origin  /XIAMEN/ ;

SET     P      Port    /SEATTLE-PORT, TACOMA-PORT, PORTLAND-PORT, OAKLAND-PORT,
LOSANGELES-PORT, LONGBEACH-PORT/ ;

SET     DC     DC      /DINUBA-CA, ARDMORE-OK, BLOOMINGTON-MN, FRANKLIN-IN, NICHOLS-NY,
FINDLAY-OH, DUBLIN-GA, STAUNTON-VA, DESMOINES-WA/  ;


SET     D      Destination
/BELLEVUE
BELLINGHAM
BURLINGTON-WA
FEDERALWAY
KENNEWICK
LYNNWOOD
OLYMPIA
PUYALLUP
SEATTLE

TABLE    C1(P,O) Transportation Cost from Origin to Port
                XIAMEN
SEATTLE-PORT        2700
TACOMA-PORT         2700
;
TABLE    C2(DC,P)       Transportation Cost from Port to DC
                  SEATTLE-PORT  TACOMA-PORT   PORTLAND-PORT OAKLAND-PORT
DINUBA-CA             1523.2       1473.6       1243.2       323.2        ARDMORE-OK            3355.2
3369.6       3228.8       2683.2
;
TABLE    C3(D,DC)       Transportation Costs from DC to Destination
                  STAUNTON-VA    FINDLAY-OH     DUBLIN-GA      BELLEVUE              4508.8
3835.2         4529.6
BELLINGHAM            4816          3976          4670.4
BURLINGTON-WA            4657.6         3937.6          4632
FEDERALWAY             4526.4         3852.8         4547.2
KENNEWICK             4276.8         3619.2         4224          LYNNWOOD              4584          3865.6
4558.4
OLYMPIA               4582.4         3908.8         4603.2

PARAMETER supply(O)       supply constraint
/XIAMEN  11902.67/;


PARAMETER portcons(P)     port constraint
```

```
/SEATTLE-PORT        928
TACOMA-PORT          1268
PORTLAND-PORT          29
OAKLAND-PORT         375
LOSANGELES-PORT       6150
LONGBEACH-PORT       3153/
;

PARAMETER dccons(DC)   DC constraint
/STAUNTON-VA            1293
FINDLAY-OH             1863
DUBLIN-GA              1177
FRANKLIN-IN            1317
BLOOMINGTON-MN           784
NICHOLS-NY             1328
DINUBA-CA              1896
ARDMORE-OK              1044
DESMOINES-WA            1200  /;

PARAMETER Demand(D)      Retail Demand

/BIRMINGHAM            32.82
FLORENCE-AL             4.90
HOOVER               8.48
HUNTSVILLE            21.38
MOBILE               26.88
MONTGOMERY             27.24
OPELIKA               3.18
SPANISHFORT            0.73
FAYETTEVILLE-AR         7.84
FORTSMITH             10.85


*------Allow fluctuations in Ports-----------
Parameter fluct(P) "allowed percentage fluctuation" ;

fluct(P) = .50 ;


* ---- Allow fluctuations in DC --------------
Parameter fluc(DC) "allowed percentage fluctuation" ;

fluc(DC) = 0.20 ;


*---- Define parameters of port cost functions

Parameter
*SlopeQ,
*SlopeL,
Intercept;

* --- linear slope coeffcient
*SlopeL(P) = 0;
*SlopeL("Seattle-Port") = ;
*SlopeL("Tacoma-Port") = ;
*SlopeL("Portland-Port") = ;
*SlopeL("Oakland-Port") = ;
*SlopeL("LosAngeles-Port") = ;
```

```
*SlopeL("LongBeach-Port") = ;

* --- quadratic slope coeffcient
*SlopeQ(P) = 0;
*SlopeQ("Seattle-Port") = ;
*SlopeQ("Tacoma-Port") = ;
*SlopeQ("Portland-Port") = ;
*SlopeQ("Oakland-Port") = ;
*SlopeQ("LosAngeles-Port") = ;
*SlopeQ("LongBeach-Port") = ;

* --- intercept

Intercept("Seattle-Port") = 281.47;
Intercept("Tacoma-Port") = 243.84;
Intercept("Portland-Port") = 830.95;
Intercept("Oakland-Port") = 217.25;
Intercept("LosAngeles-Port") = 187.57;
Intercept("LongBeach-Port") = 188.91;

*Display
*SlopeL,
*SlopeQ, ;

* ---- Define the variables ------------------

Variable
Costs  total costs
;

Positive Variables
Flow(*,*)   flow of goods through the different nodes
;

* ---- Define equations ----------------------

Equations
Node1          ports
Node2          distribution centers
Destination     destination
Objective      objective function
DClower         lower dc constraint
DCupper         uppper dc constraint
Pupper         upper port constraint
Plower         lower port constraint
*-------------------------------------------------------------------------
* node 1 maintain equal flow,( =G= allows greater or equal supply to demand)
Node1(P)..    SUM(O, Flow(P,O)) =G= SUM(DC, Flow(DC,P));

* node 2 maintain equal flow
Node2(DC)..   SUM(P, Flow(DC,P)) =E= SUM(D, Flow(D,DC));
*------------------------------------------------------------------------


*Constaining Port node with percentage upper and lower bounds
Plower(P)..             SUM(O,Flow(P,O)) =G= portcons(P) * (1 - fluct(P));
Pupper(P)..             SUM(O,Flow(P,O)) =L= portcons(P) * (1 + fluct(P));

*------------------------------------------------------------------------
```

```
* Constraining DC node with percentage upper and lower bounds
DClower(DC)..      SUM(P,Flow(DC,P)) =G= dccons(DC) * (1 - fluc(DC));
DCupper(DC)..      SUM(P,Flow(DC,P)) =L= dccons(DC) * (1 + fluc(DC));

*------------------------------------------------------------------------
* Final destination demand
Destination(D)..   SUM(DC, Flow(D,DC)) =E= Demand(D);

* Objective function: minimize costs (we have to scale the values because the
*objective function reached an upper internal GAMS limit)

Objective..     Costs =E=
*                        --- transportation costs
                       SUM((P,O),  Flow(P,O)  * C1(P,O))    /1000
                     + SUM((DC,P), Flow(DC,P) * C2(DC,P))   /1000
                     + SUM((D,DC), Flow(D,DC) * C3(D,DC))   /1000

*                        --- costs at port
                     + SUM((P,O), Flow(P,O) * Intercept(P)) /1000
                         ;

* ---- Define the model ----------------------

Model BestBuy /

Node1
Node2
Destination
Objective
DClower
DCupper
Pupper
Plower

/;
BestBuy.limrow = 0;
BestBuy.limcol = 0;


* ---- Solve the model -----------------------

 Solve BestBuy minimizing Costs using NLP;

* ---- Results -------------------------------

Set aSets specify a set that includes all subsets;
aSets(O) = YES;
aSets(P) = YES;
aSets(DC) = YES;
aSets(D) = YES;

alias(asets,asets1);

Parameter Results store results of Base and simulation;

Results(aSets,aSets1,"BAS") = Flow.L(aSets,aSets1);

*Display Results;
```

```
* --- check that data is correct (i.e. supply at origin is equal to demand at final destinations)
Parameter CHECK verify that supply and final demand balance;

CHECK("Data")  = SUM(O, SUPPLY(O)) - SUM(D, Demand(D));

* --- check that flows at final destination equal supply at origin
CHECK("Model") = SUM(O, SUPPLY(O)) - SUM((D,DC), Flow.L(D,DC));

Display Check;

* --- check that incoming flows equal outgoing flows at each location
Parameter CHECKF flows at each location;

* --- ports
CHECKF(P,"Pin")  = SUM(O , Flow.L(P,O)) ;
CHECKF(P,"Pout") = SUM(DC, Flow.L(DC,P));

* --- distribution center
CHECKF(DC,"DCin")  = SUM(P, Flow.L(DC,P));
CHECKF(DC,"DCout") = SUM(D, Flow.L(D,DC));

* --- origin
CHECKF(O,"Oout")       = SUM(P, Flow.L(P,O)) ;
CHECKF(O,"SUMorigin") = SUM(P, CHECKF(P,"Pin")) ;

* --- final
CHECKF(D,"Din")       = SUM(DC, Flow.L(D,DC)) ;
CHECKF(O,"SUMfinal") = SUM(D, CHECKF(D,"Din")) ;

Display Check, Checkf;

* --- report the cost components of the objective function

Parameter cc cost components;

CC("total","Portcosts") = SUM((P,O),  Flow.L(P,O) * Intercept(P));
CC("total","O to P")    = SUM((P,O),  Flow.L(P,O) * C1(P,O));
CC("total","P to DC")   = SUM((DC,P), Flow.L(DC,P) * C2(DC,P));
CC("total","DC to D")   = SUM((D,DC), Flow.L(D,DC) * C3(D,DC));
CC("total","total") = CC("total","Portcosts") + CC("total","O to P") + CC("total","P to DC") + CC("total","DC to
D") ;
CC("total","total") = CC("total","total") / 1000;

CC(P,"Portcosts") = SUM(O, Flow.L(P,O) * Intercept(P));
CC(P,"O to P")    = SUM(O,  Flow.L(P,O) * C1(P,O));
CC(DC,"P to DC")  = SUM(P, Flow.L(DC,P) * C2(DC,P));
CC(D,"DC to D")   = SUM(DC, Flow.L(D,DC) * C3(D,DC));



CC(DC,P)  = Flow.L(DC,P) * C2(DC,P);
CC(D,DC)   = Flow.L(D,DC) * C3(D,DC);
Display CC;

* --- calcualte average costs for O to P and P to DC

Parameter Av;
Av("C1") = SUM((P,O)  $ Flow.L(P,O),  Flow.L(P,O)  * C1(P,O))  / SUM(P, CHECKF(P,"Pin"));
Av("C2") = SUM((DC,P) $ Flow.L(DC,P), Flow.L(DC,P) * C2(DC,P)) / SUM(DC, CHECKF(DC,"DCin"));
```

```
Av("PortC") = SUM((P,O) $ Flow.L(P,O), Flow.L(P,O) * Intercept(P)) /SUM (P, CHECKF (P,"Pin"));
Display Av;

* --- total distribution costs for the whole transport per final demand destination

Parameter DistC total distribution costs per final demand unit;

DistC(D) = SUM(DC $ Flow.L(D,DC), Flow.L(D,DC) * (C3(D,DC) + Av("C2") + Av("C1") + Av("PortC")));

* --- this total is very similar to the total on the CC parameter. But due to the use of
*     average values for O to P and P to DC do the numbers vary slightly.

DistC("Total") = SUM(D, DistC(D)) / 1000;

Display DistC;

Parameter AvDist per unit distribution costs;

AvDist(D) = DistC(D) / SUM(DC, Flow.L(D,DC));
*AvDist(D) = DistC(D) / CHECKF(D,"Din");

Display AvDist;

*-----------------------------------------------------------------------------
* --- calculate parameters of demand function

Parameters
b(D) slope parameter
a(D) intercept
Elas known price elasticty of demand with respect to transportation costs
;
Elas = 1.2;

* --- calculate slopes

b(D) = AvDist(D) / (Elas * Demand(D));

Display b;
* --- calculate intercepts

a(D) = AvDist(D) + (b(D) * Demand(D));
Display a;

Parameter ccc check if base situation is still working (right demand quantity is coming back);
ccc(D,"ori") = (AvDist(D) - a(D)) / (-b(D));


* ---------- Specify the new demand functions
Equation
Destination1
FinDemand
;
Positive variable VarDemand;

* Final destination demand dependent on price

Destination1(D)..   SUM(DC, Flow(D,DC)) =E= VarDemand(D);

FinDemand(D)..      AvDist(D) =E= a(D) - b(D) * VarDemand(D);
```

```
Model BestBuy1 /

Node1
Node2
Destination1
FinDemand
Objective
DClower
DCupper
Pupper
Plower

/;

BestBuy1.limrow = 0;
BestBuy1.limcol = 0;
BestBuy1.Holdfixed = 1;

*---------------------------------------------------------------------------
* --- Scenario1: increase transportation costs

*---Specify Change in port security charge----------------------
Scalar pchange Percentage change in port charge /0/ ;

Intercept(P) = Intercept(P) * (1 + pchange) ;

Display intercept ;

Av("PortC") = SUM((P,O) $ Flow.L(P,O), Flow.L(P,O) * Intercept(P)) /SUM (P, CHECKF (P,"Pin"));
DistC(D) = SUM(DC $ Flow.L(D,DC), Flow.L(D,DC) * (C3(D,DC) + Av("C2") + Av("C1") + Av("PortC")));
AvDist(D) = DistC(D) / SUM(DC, Flow.L(D,DC));

*Display AvDist;

*------Shutdown Ports-------------------------
*portcons ("SEATTLE-PORT") = 0 ;
*portcons ("LONGBEACH-PORT") = 0 ;

*AvDist(D) = AvDist(D) * 1.;

*-----Limit Port to 50% Capacity--------------
*portcons ("SEATTLE-PORT") = portcons ("SEATTLE-PORT") * 0.50 ;
*portcons ("LONGBEACH-PORT") = portcons ("LONGBEACH-PORT") * 0.50 ;

* --- show recalculate demand
ccc(D,"sim") = (AvDist(D) - a(D)) / (- b(D));

option ccc:5:1:1;
Display ccc;

* --- Problem: resulting negative demand quantities cannot enter the equation system => eliminate them
AvDist(D) $ (ccc(D,"sim") LT 0.) = 0;

* --- flag these demand quantities and display
SET FLAG(D);
FLAG(D) = NO;
FLAG(D) $ (ccc(D,"sim") LT 0.) = YES;
```

```
Display FLAG;
*------------------------------------------------------------------------

*Flow.L(asets,asets1) = Flow.L(asets,asets1);
*VarDemand.L(D) = Demand(D);

Solve BestBuy1 minimizing Costs using NLP;

*---------Report simulation cost components-----------------------
Parameter CCsim cost components;

CCsim("total","Portcosts") = SUM((P,O),  Flow.L(P,O) * Intercept(P));
CCsim("total","O to P")    = SUM((P,O),  Flow.L(P,O) * C1(P,O));
CCsim("total","P to DC")   = SUM((DC,P), Flow.L(DC,P) * C2(DC,P));
CCsim("total","DC to D")   = SUM((D,DC), Flow.L(D,DC) * C3(D,DC));
CCsim("total","total") = CC("total","Portcosts") + CC("total","O to P") + CC("total","P to DC") + CC("total","DC
to D") ;
CCsim("total","total") = CC("total","total") / 1000;
CCsim(P,"Portcosts") = SUM(O, Flow.L(P,O) * Intercept(P));
CCsim(P,"O to P")    = SUM(O,  Flow.L(P,O) * C1(P,O));
CCsim(DC,"P to DC")  = SUM(P, Flow.L(DC,P) * C2(DC,P));
CCsim(D,"DC to D")   = SUM(DC, Flow.L(D,DC) * C3(D,DC));
CCsim(DC,P)  = Flow.L(DC,P) * C2(DC,P);
CCsim(D,DC)  = Flow.L(D,DC) * C3(D,DC);
Display CCsim;

* --- Results reporting
Results(aSets,aSets1,"SIM") = Flow.L(aSets,aSets1);
Results(aSets,aSets1,"%CH") $ Results(aSets,aSets1,"BAS")
                    = (Results(aSets,aSets1,"SIM") / Results(aSets,aSets1,"BAS") - 1) ;
Display Results;
---------------------------------
* --- dump everything into excel

* 1) unload all parameters of interest (= store)
execute_unload 'bestBuy.gdx' Flow, Costs, DistC, Results, cc, ccsim;

* 2) write the stored parameters into excel sheets

*execute 'gdxxrw.exe bestBuy.gdx var Flow rng=Flows!a1 var costs rng=TotalCosts!a1 par DistC
rng=DISTC! RDIM=1 par Results rng=SCEN!a1';
execute 'gdxxrw.exe bestBuy.gdx var Flow rng=Flows!a1 var costs rng=TotalCosts!a1 par DistC rng=DISTC!
RDIM=1 par Results rng=SCEN!a1 par cc rng=cc! RDIM=1 par ccsim rng=ccsim! RDIM=1';
```

APPENDIX E

RETAIL STORE LOCATIONS

RETAIL STORE LOCATIONS BY STATE

AL	BIRMINGHAM
AL	FLORENCE-AL
AL	HOOVER
AL	HUNTSVILLE
AL	MOBILE
AL	MONTGOMERY
AL	OPELIKA
AL	SPANISHFORT
AR	FAYETTEVILLE-AR
AR	NORTHLITTLEROCK
AR	FORTSMITH
AR	LITTLEROCK
AZ	CHANDLER
AZ	GLENDALE
AZ	GOODYEAR
AZ	MESA1
AZ	MESA2
AZ	PHOENIX1
AZ	PHOENIX2
AZ	PHOENIX3
AZ	PHOENIX4
AZ	PRESCOTT
AZ	SCOTTSDALE1
AZ	SCOTTSDALE2
AZ	SURPRISE
AZ	TUCSON1
AZ	TUCSON2
AZ	YUMA
CA	AZUSA
CA	BAKERSFIELD
CA	BURBANK-CA
CA	CANOGAPARK
CA	CERRITOS
CA	CHICO
CA	CHINO
CA	CHINOHILLS
CA	CHULAVISTA
CA	CITRUSHEIGHTS
CA	CITYOFINDUSTRY
CA	COLMA
CA	CORONA
CA	COSTAMESA
CA	GILROY
CA	HAWTHORNE
CA	IRVINE
CA	LAKEWOOD-CA
CA	LIVERMORE
CA	LOSANGELES1
CA	LOSANGELES2
CA	LOSANGELES3
CA	MARINCITY
CA	MERCED
CA	MILPITAS
CA	MIRALOMA
CA	MISSIONVIEJO
CA	MODESTO
CA	MONTCLAIR
CA	MORENOVALLEY
CA	MURRIETA
CA	NORTHRIDGE
CA	OAKLAND
CA	OCEANSIDE
CA	ORANGE-CA
CA	OXNARD
CA	PALMDALE
CA	PALMDESERT
CA	PASADENA
CA	PINOLE
CA	PITTSBURG
CA	PLEASANTHILL1
CA	PLEASANTHILL2
CA	PORTERRANCH
CA	RANCHOCUCAMONGA
CA	REDDING
CA	RIVERSIDE1
CA	RIVERSIDE2
CA	ROSEVILLE-CA
CA	SACRAMENTO
CA	SANBERNARDINO
CA	SANCARLOS
CA	SANDIEGO1
CA	SANDIEGO2
CA	SANFRANCISCO1
CA	SANFRANCISCO2

CA	CULVERCITY
CA	DOWNEY
CA	DUBLIN-CA
CA	EASTPALOALTO
CA	EJCAJON
CA	ELKGROVE
CA	FAIRFIELD
CA	FOLSOM
CA	FRESNO
CA	FULLERTON
CA	SUNNYVALE
CA	THOUSANDOAKS
CA	TORRANCE
CA	TRACY
CA	TUSTIN
CA	UNIONCITY-CA
CA	VICTORVILLE
CA	VISALIA
CA	WESTCOVINA
CA	WESTHOLLYWOOD1
CA	WESTHOLLYWOOD2
CA	WESTMINSTER-CA
CA	YORBALINDA
CO	AURORA1
CO	AURORA2
CO	AURORA3
CO	BROOMFIELD
CO	COLORADOSPRINGS1
CO	COLORADOSPRINGS2
CO	COLORADOSPRINGS3
CO	DENVER1
CO	DENVER2
CO	FORTCOLLINS
CO	LAKEWOOD-CO
CO	LITTLETON
CO	LONETREE
CO	LOVELAND
CO	WESTMINSTER-CO
CT	DANBURY
CT	ENFIELD
CT	MANCHESTER
CT	MERIDEN
CT	NEWINGTON
CT	NORWALK
CA	SANJOSE1
CA	SANJOSE2
CA	SANLUISOBISPO
CA	SANMARCOS-CA
CA	SANTACLARITA
CA	SANTAMARIA
CA	SANTAROSA
CA	SIERRAMADRE
CA	SIMIVALLEY
CA	STOCKTON
FL	GAINESVILLE
FL	HIALEAH
FL	HOLLYWOOD
FL	JACKSONVILLE1
FL	JACKSONVILLE2
FL	JACKSONVILLE3
FL	LAKELAND
FL	MELBOURNE
FL	MIAMI1
FL	MIAMI2
FL	MIAMI3
FL	MIAMI4
FL	MIAMI5
FL	NAPLES
FL	OCALA
FL	OCOEE
FL	ORANGEPARK
FL	ORLANDO1
FL	ORLANDO2
FL	ORLANDO3
FL	ORLANDO4
FL	PALMBEACHGARDENS
FL	PANAMACITY
FL	PEMBROKEPINES
FL	PENSACOLA
FL	PLANTATION
FL	PORTRICHEY
FL	SANFORD
FL	SARASOTA
FL	STPETERSBURG
FL	STUART
FL	TALLAHASSEE
FL	TAMPA1
FL	TAMPA2

CT	ORANGE-CT
CT	WATERFORD-CT
CT	WESTHARTFORD
DC	WASHINGTON-DC
DE	DOVER
DE	WILMINGTON1-DE
DE	WILMINGTON2-DE
FL	ALTAMONTESPRINGS
FL	AVENTURA
FL	BOCARATON
FL	BOYNTONBEACH
FL	BRANDON
FL	CLEARWATER
FL	DAYTONABEACH
FL	DESTIN
FL	FORTLAUDERDALE1
FL	FORTLAUDERDALE2
FL	FORTMYERS
GA	FAYETTEVILLE-GA
GA	KENNESAW
GA	LITHONIA
GA	MACON
GA	MCDONOUGH
GA	MORROW
GA	NEWNAN
GA	PEACHTREECITY
GA	SAVANNAH
GA	SMYRNA
GA	SNELLVILLE
GA	STONEMOUNTAIN
GA	SUWANEE
GA	TUCKER
GA	VALDOSTA
IA	AMES
IA	CEDARRAPIDS
IA	CORALVILLE
IA	COUNCILBLUFFS
IA	DESMOINES1
IA	DESMOINES2
IA	DUBUQUE
IA	SIOUXCITY
IA	WATERLOO
IA	WESTDESMOINES1
IA	WESTDESMOINES2
FL	VEROBEACH
FL	WESTPALMBEACH
FL	WINTERPARK
GA	ALPHARETTA
GA	ATHENS
GA	ATLANTA1
GA	ATLANTA2
GA	ATLANTA3
GA	ATLANTA4
GA	ATLANTA5
GA	ATLANTA6
GA	AUGUSTA
GA	BOGART
GA	BUFORD
GA	COLUMBUS
GA	DOUGLASVILLE
GA	DUBLIN-GA
GA	DULUTH-GA
IL	DOWNERSGROVE2
IL	EVANSTON
IL	FAIRVIEWHEIGHTS1
IL	FAIRVIEWHEIGHTS2
IL	FORSYTH
IL	GENEVA
IL	GURNEE
IL	JOLIET
IL	KILDEER
IL	LAGRANGE
IL	LANSING-IL
IL	LIBERTYVILLE
IL	LOMBARD
IL	MATTESON
IL	MELROSEPARK
IL	MOLINE
IL	NILES-IL
IL	NORRIDGE
IL	NORTHRIVERSIDE
IL	ORLANDPARK
IL	PEORIA
IL	RIVERSIDE
IL	ROCKFORD
IL	SCHAUMBURG
IL	SKOKIE1
IL	SKOKIE2

IA	WESTDESMOINES3
ID	BOISE
ID	COEURDALENE
ID	IDAHOFALLS
ID	TWINFALLS
IL	ADDISON
IL	ARLINGTONHEIGHTS
IL	AURORA
IL	BLOOMINGDALE
IL	BLOOMINGTON-IL
IL	BOLINGBROOK
IL	BURBANK-IL
IL	CARBONDALE
IL	CAROLSTREAM
IL	CHAMPAIGN
IL	CHICAGO1
IL	CHICAGO2
IL	CHICAGO3
IL	CHICAGO4
IL	CHICAGOHEIGHTS
IL	COUNTRYSIDE
IL	CRESTWOOD-IL
IL	CRYSTALLAKE
IL	DEERFIELD
IL	DEKALB
IL	DOWNERSGROVE1
KS	LAWRENCE
KS	LENEXA
KS	OLATHE
KS	OVERLANDPARK1
KS	OVERLANDPARK2
KS	TOPEKA
KS	WICHITA
KY	BOWLINGGREEN
KY	ELIZABETHTOWN
KY	FLORENCE-KY
KY	LEXINGTON
KY	LOUISVILLE1
KY	LOUISVILLE2
KY	PADUCAH
KY	STMATTHEWS
LA	BATONROUGE
LA	COVINGTON
LA	HARVEY
IL	SPRINGFIELD-IL
IL	STCHARLES
IL	VERNONHILLS
IL	WESTDUNDEE
IN	AVON
IN	BLOOMINGTON-IN
IN	CARMEL
IN	CLARKSVILLE-IN
IN	EVANSVILLE
IN	FISHERS
IN	FORTWAYNE1
IN	FORTWAYNE2
IN	FRANKLIN
IN	GREENWOOD
IN	INDIANAPOLIS1
IN	INDIANAPOLIS2
IN	INDIANAPOLIS3
IN	INDIANAPOLIS4
IN	INDIANAPOLIS5
IN	KOKOMO
IN	LAFAYETTE-IN
IN	MERRILLVILLE
IN	MISHAWAKA
IN	MUNCIE
IN	NOBLESVILLE
IN	VALPARAISO
MD	ELKRIDGE2
MD	FREDERICK
MD	GAITHERSBURG
MD	GERMANTOWN
MD	GLENBURNIE
MD	LAUREL
MD	LUTHERVILLETIMONIUM
MD	NOTTINGHAM
MD	ROCKVILLE
MD	SALISBURY
MD	TIMONIUM
MD	WALDORF
ME	BANGOR
ME	SOUTHPORTLAND
MI	ANNARBOR
MI	AUBURNHILLS
MI	BATTLECREEK
MI	BENTONHARBOR

LA	HOUMA
LA	LAFAYETTE-LA
LA	METAIRIE
LA	SHREVEPORT
LA	SLIDELL
MA	BOSTON
MA	BRAINTREE
MA	BROCKTON
MA	CAMBRIDGE
MA	DANVERS
MA	DEDHAM
MA	FRAMINGHAM
MA	HADLEY
MA	HOLYOKE
MA	HYANNIS
MA	KINGSTON-MA
MA	LANESBORO
MA	MANSFIELD-MA
MA	MARLBOROUGH
MA	NORTHATTLEBORO
MA	NORTHDARTMOUTH
MA	PITTSFIELD
MA	SAUGUS
MA	SEEKONK
MA	WATERTOWN
MA	WORCESTER
MD	ANNAPOLIS
MD	BALTIMORE1
MD	BALTIMORE2
MD	BELAIR
MD	BOWIE
MD	CALIFORNIA
MD	COLUMBIA-MD
MD	ELKRIDGE1
MN	BURNSVILLE
MN	COONRAPIDS
MN	DULUTH-MN
MN	EDENPRAIRIE
MN	EDINA
MN	HOPKINS
MN	INVERGROVEHEIGHTS
MN	MANKATO
MN	MAPLEGROVE
MN	MAPLEWOOD
MI	BRIGHTON
MI	COMSTOCKPARK
MI	DEARBORN
MI	FARMINGTONHILLS
MI	FLINT
MI	FORTGRATIOT
MI	GRANDRAPIDS1
MI	GRANDRAPIDS2
MI	GRANDRAPIDS3
MI	GRANDVILLE
MI	HOLLAND
MI	JACKSON
MI	LANSING-MI
MI	LIVONIA
MI	MADISONHEIGHTS
MI	MIDLAND1
MI	MIDLAND2
MI	MUSKEGON
MI	NOVI
MI	OKEMOS
MI	PORTAGE
MI	ROCHESTERHILLS
MI	ROSEVILLE-MI
MI	SAGINAW
MI	SOUTHFIELD
MI	SOUTHGATE
MI	TRAVERSECITY
MI	UTICA
MI	WATERFORD
MI	WESTLAND
MN	APPLEVALLEY
MN	BAXTER
MN	BLAINE
MN	BROOKLYNCENTER
NC	ARDEN
NC	ASHEVILLE
NC	BURLINGTON-NC
NC	CARY
NC	CHARLOTTE1
NC	CHARLOTTE2
NC	DURHAM
NC	FAYETTEVILLE-NC
NC	GARNER
NC	GASTONIA

MN	MINNEAPOLIS
MN	MINNETONKA
MN	OAKDALE
MN	OSSEO
MN	RICHFIELD1
MN	RICHFIELD2
MN	ROCHESTER
MN	ROSEVILLE-MN
MN	STCLOUD
MN	STPAUL
MN	WOODBURY
MO	BRIDGETON
MO	CAPEGIRARDEAU
MO	CHESTERFIELD
MO	COLUMBIA
MO	CRESTWOOD
MO	EARTHCITY
MO	ELLISVILLE
MO	FENTON
MO	INDEPENDENCE1
MO	INDEPENDENCE2
MO	JOPLIN
MO	KANSASCITY1
MO	KANSASCITY2
MO	KANSASCITY3
MO	KANSASCITY4
MO	LEESSUMMIT
MO	SPRINGFIELD-MO
MO	STJOSEPH
MO	STLOUIS1
MO	STLOUIS2
MO	STPETERS1
MO	STPETERS2
MS	FLOWOOD
MS	GULFPORT
MS	HATTIESBURG
MS	JACKSON-MS
MS	TUPELO
MT	BILLINGS
MT	KALISPELL
MT	MISSOULA
NC	ABERDEEN
NJ	UNION
NJ	UNIONCITY-NJ
NC	GREENSBORO
NC	GREENVILLE-NC
NC	HICKORY
NC	JACKSONVILLE-NC
NC	MONROE
NC	PINEVILLE
NC	RALEIGH1
NC	RALEIGH2
NC	ROCKYMOUNT
NC	WILMINGTON
NC	WINSTONSALEM
ND	BISMARCK
ND	FARGO
ND	GRANDFORKS
ND	MINOT
NE	GRANDISLAND
NE	LINCOLN
NE	OMAHA1
NE	OMAHA2
NE	OMAHA3
NH	CONCORD-NH
NH	MANCHESTER-NH
NH	NASHUA
NH	NEWINGTON-NH
NH	SALEM-NH
NH	WESTLEBANON
NJ	BRICK
NJ	BRIDGEWATER
NJ	DEPTFORD
NJ	EASTBRUNSWICK
NJ	EASTHANOVER
NJ	ENGLISHTOWN
NJ	HOLMDEL
NJ	ISELIN
NJ	MANALAPAN
NJ	MAYSLANDING
NJ	MTLAUREL
NJ	PARAMUS1
NJ	PARAMUS2
NJ	PRINCETON
NJ	ROCKAWAY
NJ	SECAUCUS
OH	AVON-OH
OH	BOARDMAN

NJ	VINELAND	OH	CANTON
NJ	WESTPATERSON	OH	CINCINNATI1
NJ	WOODBRIDGE-NJ	OH	CINCINNATI2
NM	ALBUQUERQUE1	OH	CINCINNATI3
NM	ALBUQUERQUE2	OH	CINCINNATI4
NM	FARMINGTON	OH	CLEVELAND
NM	LASCRUCES	OH	COLUMBUS1
NM	SANTAFE	OH	COLUMBUS2
NV	CARSONCITY	OH	CUYAHOGAFALLS
NV	HENDERSON	OH	DAYTON1
NV	LASVEGAS1	OH	DAYTON2
NV	LASVEGAS2	OH	DAYTON3
NV	RENO	OH	DUBLIN-OH
NY	ALBANY	OH	ELYRIA
NY	AMHERST	OH	FAIRBORN
NY	BAYSHORE	OH	FINDLAY
NY	BROOKLYN1	OH	HAMILTON
NY	BROOKLYN2	OH	HEATH
NY	BUFFALO	OH	LANCASTER
NY	CHELSEA	OH	MACEDONIA
NY	EASTNORTHPORT	OH	MANSFIELD-OH
NY	ELMHURST	OH	MASON
NY	HARTSDALE	OH	MAYFIELDHEIGHTS
NY	HENRIETTA	OH	MENTOR
NY	HUNTINGTONSTATION	OH	MIAMISBURG
NY	ITHACA	OH	NILES-OH
NY	KINGSTON-NY	OH	NORTHCANTON
NY	LEVITTOWN	OH	NORTHOLMSTED
NY	LONGISLANDCITY	OH	REYNOLDSBURG
NY	MIDDLETOWN	OH	SANDUSKY
NY	MOUNTVERNON	OH	SPRINGDALE
NY	NEWHARTFORD	OH	SPRINGFIELD-OH
NY	NEWYORK1	OH	TOLEDO1
NY	NEWYORK2	OH	TOLEDO2
NY	NEWYORK3	OH	WESTLAKE
NY	NEWYORK4	OH	WOOSTER
NY	NEWYORK5	OH	YOUNGSTOWN
NY	PATCHOGUE	OK	NORMAN
NY	POUGHKEEPSIE	OK	OKLAHOMACITY1
NY	RIVERHEAD	OK	OKLAHOMACITY2
NY	SARATOGASPRINGS	OK	OKLAHOMACITY3
NY	SOUTHSETAUKET	OK	TULSA1
NY	STATENISLAND	OK	TULSA2
NY	SYRACUSE	OR	BEAVERTON

NY	TUCKAHOE
NY	WESTBURY
NY	WESTNYACK
NY	YONKERS
OH	AKRON1
OH	AKRON2
PA	CRANBERRYTOWNSHIP
PA	DICKSONCITY
PA	ERIE
PA	FAIRLESSHILLS
PA	GREENSBURG
PA	HARRISBURG
PA	KINGOFPRUSSIA
PA	MONACA
PA	MONROEVILLE
PA	MUNHALL
PA	NORTHWALES
PA	PHILADELPHIA1
PA	PHILADELPHIA2
PA	PITTSBURGH1
PA	PITTSBURGH2
PA	PITTSBURGH3
PA	PITTSBURGH4
PA	PITTSBURGH5
PA	PLYMOUTHMEETING
PA	READING
PA	SPRINGFIELD-PA
PA	STATECOLLEGE
PA	WHITEHALL
PA	WILKESBARRE
PA	WILLOWGROVE
PA	WYOMISSING
RI	WARWICK
SC	ANDERSON
SC	COLUMBIA1-SC
SC	COLUMBIA2-SC
SC	FLORENCE-SC
SC	GREENVILLE1
SC	GREENVILLE2
SC	MYRTLEBEACH
SC	NORTHCHARLESTON
SC	ROCKHILL
SC	SPARTANBURG1
SC	SPARTANBURG2
OR	BEND
OR	PORTLAND1
OR	PORTLAND2
OR	SALEM-OR
OR	SPRINGFIELD-OR
PA	BETHELPARK
TX	AMARILLO
TX	ARLINGTON1
TX	ARLINGTON2
TX	AUSTIN1
TX	AUSTIN2
TX	BAYTOWN
TX	BEAUMONT
TX	BROWNSVILLE
TX	BURLESON
TX	CEDARHILL
TX	CEDARPARK
TX	COLLEGESTATION
TX	CONROE
TX	CORPUSCHRISTI
TX	DALLAS1
TX	DALLAS2
TX	DALLAS3
TX	DENTON
TX	ELPASO1
TX	ELPASO2
TX	FARMERSBRANCH
TX	FLOWERMOUND
TX	FORTWORTH1
TX	FORTWORTH2
TX	FORTWORTH3
TX	FRISCO
TX	GEORGETOWN
TX	GRAPEVINE
TX	HOUSTON1
TX	HOUSTON2
TX	HOUSTON3
TX	HOUSTON4
TX	HOUSTON5
TX	HOUSTON6
TX	HUMBLE
TX	HURST
TX	IRVING1
TX	IRVING2

SD	RAPIDCITY	TX	KATY
SD	SIOUXFALLS	TX	KILLEEN
TN	ANTIOCH	TX	LAREDO
TN	BRENTWOOD	TX	LEWISVILLE
TN	CHATTANOOGA	TX	LONGVIEW
TN	CLARKSVILLE-TN	TX	LUBBOCK
TN	JACKSON-TN	TX	LUFKIN
TN	JOHNSONCITY	TX	MANSFIELD
TN	KNOXVILLE	TX	MCALLEN
TN	MADISON	TX	MCKINNEY
TN	MEMPHIS1	TX	MESQUITE1
TN	MEMPHIS2	TX	MESQUITE2
TN	MEMPHIS3	TX	MIDLAND
TX	ABILENE	VA	RESTON
TX	PASADENA-TX	TX	NORTHRICHLANDHILLS
TX	PEARLAND	VA	RICHMOND
TX	PLANO	VA	ROANOKE
TX	ROUNDROCK	VA	SPRINGFIELD-VA
TX	SANANGELO	VA	STERLING
TX	SANANTONIO1	VA	VIENNA
TX	SANANTONIO2	VA	VIRGINIABEACH
TX	SANANTONIO3	VA	WOODBRIDGE
TX	SANANTONIO4	VT	WILLISTON
TX	SANMARCOS-TX	WA	BELLEVUE
TX	SELMA	WA	BELLINGHAM
TX	SHERMAN	WA	BURLINGTON-WA
TX	SPRING1	WA	EVERETT
TX	SPRING2	WA	FEDERALWAY
TX	SUGARLAND	WA	KENNEWICK
TX	TEXARKANA	WA	LYNNWOOD
TX	THEWOODLANDS	WA	OLYMPIA
TX	TYLER	WA	PUYALLUP
TX	VICTORIA	WA	SEATTLE
TX	WACO1	WA	SILVERDALE
TX	WACO2	WA	SPOKANE1
TX	WEATHERFORD	WA	SPOKANE2
TX	WEBSTER	WA	TACOMA
TX	WICHITAFALLS	WA	TUKWILA
UT	LOGAN	WA	YAKIMA
UT	MURRAY	WI	APPLETON1
UT	OREM	WI	APPLETON2
UT	RIVERDALE	WI	BROOKFIELD
UT	SALTLAKECITY1	WI	DELAFIELD
UT	SALTLAKECITY2	WI	EAUCLAIRE

UT	SANDY
UT	WASHINGTON
VA	ALEXANDRIA1
VA	ALEXANDRIA2
VA	ARLINGTON1-VA
VA	ARLINGTON2-VA
VA	CHARLOTTESVILLE
VA	CHESAPEAKE1
VA	CHESAPEAKE2
VA	COLONIALHEIGHTS
VA	FAIRFAX
VA	FALLSCHURCH1
VA	FALLSCHURCH2
VA	FREDERICKSBURG
VA	GLENALLEN1
VA	GLENALLEN2
VA	HERNDON
VA	LEESBURG
VA	LYNCHBURG
VA	MANASSAS
VA	NEWPORTNEWS
WI	FONDDULAC
WI	FOXPOINT
WI	GREENBAY
WI	GREENFIELD
WI	JANESVILLE
WI	MADISON1
WI	MADISON2
WI	MENOMONEEFALLS
WI	MILWAUKEE1
WI	MILWAUKEE2
WI	ONALASKA
WI	PLOVER
WI	RACINE
WI	WAUSAU
WI	WAUWATOSA
WV	BARBOURSVILLE
WV	GRANVILLE