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Route Feasibility for Container Transportation: Panama Canal New Route vs. U.S. Intermodal System (USWC – USEC)

By

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Abstract

The container freight transportation has grown substantially in the last decade with a considerably deployment of Post-Panamax vessels in the main trade routes. In this thesis we will make an analysis in terms of costs toward the shippers of one of the main trades, Asia to East coast of the United States. To do so, we will develop some scenarios in which our final customer is situated in Chicago, Illinois and the routes to compare in terms of costs are: A) Shanghai to Chicago (through the U.S. Intermodal System) and B) Shanghai to Chicago (through the Panama Canal). The entrance gateway for the first route previously mentioned is the port of Los Angeles, and for the second route is the port of New York. The cost comparison analysis will be done with the help of the Logit Model, which calculates the probabilities or preferences of a shipper in choosing between the alternatives based on certain criteria's as the transport costs, value of time and transit time. With the outcomes of the created scenarios we will make a sensitivity analysis based on the criteria's previously mentioned. Furthermore, we will analyze the impact of the Panama Canal expansion in terms of the costs a shipper has to pay compared to the U.S. Intermodal System route.

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Chapter 1 Introduction

Container transportation has become one of the pillars in the shipping industry. As a result, it has brought new technology and innovation to the transportation business. Due to high oil prices, restrictions and max capacity utilization, liner shipping companies are looking the best ways to undertake their logistics operations in transporting goods from origin to destination. The container transportation mode has grown enormously, with a large number of vessels (i.e. Panamax and Post-Panamax) and TEU capacity deployed among carriers. However, this growth has been limited by restrictions and max capacity utilization. For example the Panama Canal, which currently is limited to handle Panamax size vessels with limited capacity in a market in which 493 Post-Panamax operate with an upcoming fleet of 344 vessels (3.2 million TEU's) (Clarksons Report 2010). Although, is this study we are not going to focus in the number of transits after the expansion is completed, but we can see that a higher amount of container could cross through the Canal and shipping lines would enjoy economies of scale, thus reducing their costs. As mentioned before the constraint in regards with the limited size of the Panama Canal is being relaxed with the expansion project by constructing a third set of locks that will allow Post Panamax vessels (5000+ TEU) to pass through the Canal.

The United States is one of the major importers around the world and their main imports come from Northeast Asia and Europe (Transpacific Route and Transatlantic Route respectively).The country is divided into Business Economics Areas (BEAs), and the most important are Chicago-Gary-Kenosha, followed by Memphis, Dallas Forth Worth and Kansas City; Los Angeles-Riverside-Orange County in the West Coast; New York-Long Island in the East Coast and Houston-Galveston-Brazoria in the Gulf Coast (Fan, L. et al., 2009). For the aim of this study we will only focus in Chicago's economic area. Moreover the United States logistic network have faced some issues, i.e. the reliability of the port of Los Angeles/Long Beach and Seattle/Tacoma have been affected due to the difficulty of handling fully loaded large ships (8000+) and the inefficient rail infrastructure for high volume flows (Fan, L. et al., 2009). In the case of the U.S. east coast, some of the ports are restricted by not having enough depth in their access channels, lack of equipment or port infrastructure; therefore the unavailability of handling large ships (Fan, L. et al., 2009). This is of relevance for this study, since the reliability is a criterion to be measured. How the reliability does affect the choice of using the Intermodal system or an alternative route (i.e. the Panama Canal)? If a shipper imports high value cargo or time sensitive, which needs less time as possible to get to its destination, he would rather to pay more for a faster route in order to have the cargo on time. However due to the difficulties the United States logistic system may face, the cargo transit time is triggered and thus, not satisfying customer needs.

For the purpose of this study we will analyse the logistics costs for shipments going through the two main routes for the imports in the Transpacific trade lane, which are: a) Northeast Asia – U.S. West Coast –Railroad to BEAs (West Coast, Interior market), and b) Northeast Asia – Panama Canal- US Gulf or East Coast. It is important to note that the entrance gateways we have chosen are the port of Los Angeles and the port of New York, since they have the highest TEU throughput in their respective regions (West region for Los Angeles and East region for New York). This analysis is subject to the final customer, which is in Chicago. So having these two routes options and bearing in mind the constraints each route faces, which is the optimal route in terms of cost for a customer in the U.S.? Is it through the Panama Canal or U.S. Railway?

Scope

As mentioned in the previous part, the purpose of this thesis is to analyze which route is the best to the customer in terms of costs, which comprises all related transport costs (operating cost at sea, operating cost in port stay, railway shipping cost, surcharges, and Panama Canal fees). To do so, two scenarios will modelled in which the first one is a customer “A” that trades in high volume and secondly a customer “B” that trades in lower volume. On the other hand, these scenarios will be analysed the two main routes which are Northeast Asia – Port of Los Angeles (West Coast) – Railroad Corridor (Class I – BNSF railroad company) – BEA (Chicago) and Northeast Asia – Panama Canal (all water transit) – Port of New York (East Coast) – BEA (Chicago). The time a good is expected to be received is a relevant aspect to take into consideration in this study, since customers need to evaluate their stock constantly in order for not having over stock or run out of it. Moreover, the reliability is another point of relevance which will be analysed in a qualitative way.

The model to develop has the aim to choose the most feasible route in term of costs and transit time for container transportation in the transpacific route from Northeast Asia to Chicago, taking into consideration the transport costs, value of time and transit time. To do so, we have chosen one of the Binary Choice Models called the Logit Model, which its outcomes are the probabilities of choosing among alternatives routes. In our case, the two alternatives we have are either using the U.S. Intermodal System or The Panama Canal and our individuals would be then the two chosen companies “A” and “B”. With the probabilities collected in the model we will make a sensitivity analysis, by creating 8 sub-scenarios within the two main scenarios, in which 4 of the sub-scenarios are based on the changes in the transit times and the last 4 sub-scenarios are based on the changes of the costs of the routes. With these 16 outcomes we can analyse how sensitive is the choice of an individual based on certain changes. Furthermore, we will analyse the impact of the Panama Canal expansion towards the shipping lines companies and to the shippers. This analysis will be made in qualitative way and compared to the outcomes collected in the model.

Chapter 2 Container Trade Market Analysis

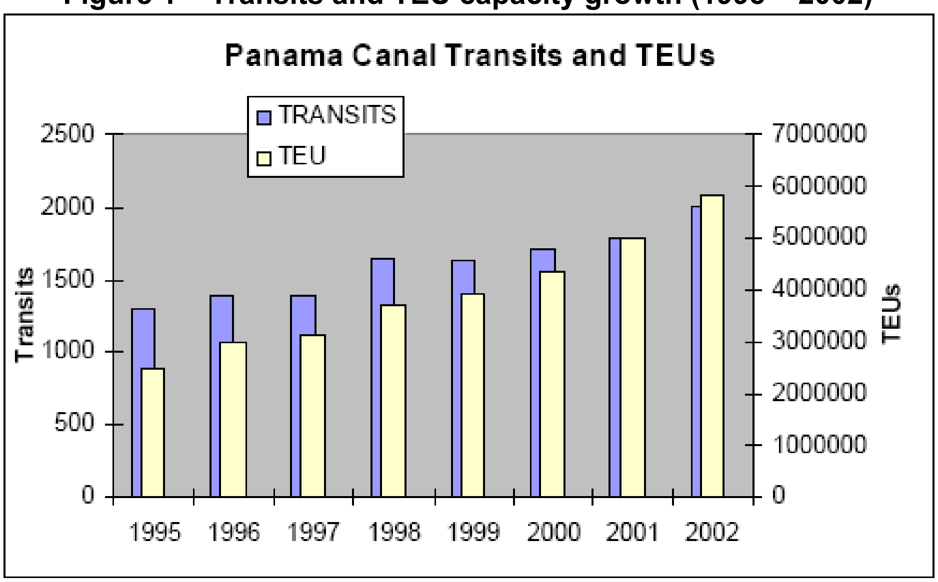
2.1 Introduction

In this chapter we will analyse the scheme of the container trade market of our study scope, which is the Panama Canal and the United States logistic system. With this analysis, we can have an overview of how is the traffic flow in these trades and how is the trade network composed. The parts that compose this analysis are the Panama Canal historic trade flows, Panama Canal main competitors and the U.S. intermodal system. Most of the data for this analysis is available and published by the Panama Canal Authority.

2.2. Panama Canal Historic Trade Flows

The Panama Canal is one of the most important waterborne routes in the world by the fact that facilitates the connection between the main exporters and importers worldwide. Among the different types of shipping markets, the container segment appears to be the one with a fastest and steady growth. This growth has occurred because of the globalization, the high concentrated markets, process standardization (introduction of containerization) and the high demand level of consumption. As a result of this, the container segment is of a great importance for the Panama Canal in both terms of number of vessel transits and in the TEU capacity of the vessels using the Canal (Panama Canal Authority, 2002). Panama Canal Authority data indicates that the number of container vessel transits across the Panama Canal increased at an average annual growth rate of 6.4% while at the same time TEU capacity of these specialized vessels transiting the Canal grew by 12.9% (Panama Canal Authority, 2002). (See figure 1).

Figure 1 – Transits and TEU capacity growth (1995 – 2002)



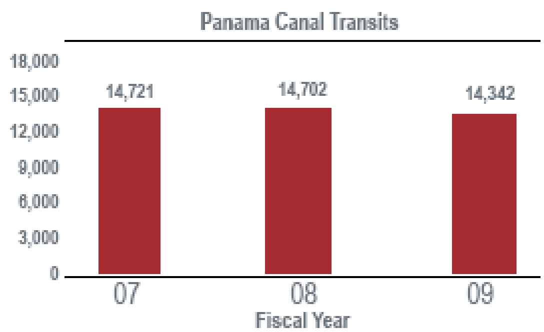
Source: (Panama Canal Authority, 2002)

The fiscal year 2009 faced a period of recession in the worldwide economy, as a consequence of the economic crisis in the most developed countries as United States, Japan, England and the European Union. However, the Panama Canal took the necessary measures to face this recession and even to gain more participation in the relevant routes. The Canal had 14,342 transits in the FY 2009, representing 2.4% less than in the previews FY 2008 (14,702 transits). (See Figure 2) (Panama Canal Authority Annual Report, 2009).

Moreover, 299.1 millions tons PC/UMS (Panama Canal / Universal Metric System) were registered in the FY 2009, representing 3.4% less than in the FY 2008. (See Figure 3) (Panama Canal Authority Annual Report, 2009).

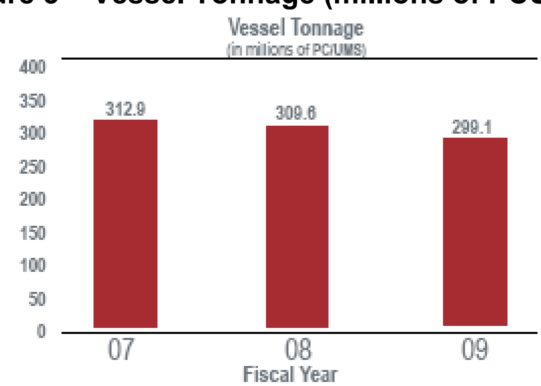
The toll revenues in the FY 2009 totaled $ 1,438.2 million, which represents an increase of 9.2% ($120.7 million) of income compared to the previews FY 2008 (Panama Canal Authority Annual Report, 2009) (See Figure 4). Even though the Panama Canal faced a decrease in vessel transits and tonnage, the toll revenues were not affected, but increased. It is important to mention how much toll revenues is accounted from the container vessels segment, totaling 11.9 million TEU, which represent $ 793.1 million (55% of FY 2009 total toll revenues) (Panama Canal Authority Annual Report, 2009).From this extent we can state that the container segment is the one of most relevance for the Canal.

Figure 2 – Panama Canal Transits



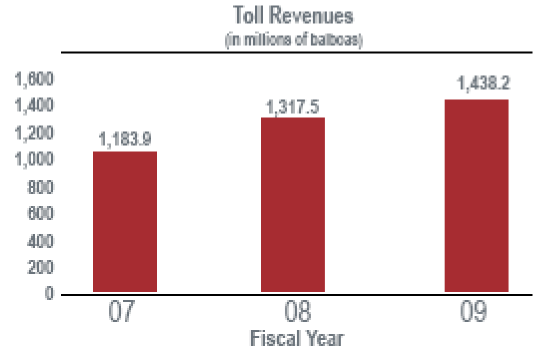
Source: (Panama Canal Authority, 2009 Annual Report)

Figure 3 – Vessel Tonnage (millions of PCUMS)



Source: (Panama Canal Authority, 2009 Annual Report)

Figure 4 – Panama Canal Toll Revenues (millios of dollars)



Source: (ACP 2009 Annual Report) **Figure 4**

The relevant container flow market for the Panama Canal has been divided into 12 routes for the Panama Canal, whereas the North South – East Asia and United States are the most important (See table 1).

Table 1 - Relevant Trade Flows and Canal Shares for 2001 (´000s TEU)

Trade Flow				2001 Trade Volume ('000s TEU)			Percent
No.	Origin	Destination	US Region	Total	Relevant	Canal Share	Share
US Based Trade Routes							
1	NE Asia	US	East	2.183	2.183	647	29,7%
			Gulf	807	807	24	3,0%
			West	2.942			
2	SE Asia	US	East	407	407	72	17,8%
			Gulf	151	151	0	0,0%
			West	528			
3	US	Oceania	East	134	134	134	100,0%
			West	36	36	0	0,0%
4	US	NC/EC SA	East	326			
			West	87	87	44	50.0%
5	WC SA	US	East	192	192	192	100,0%
			West	51	51	0	0,0%
6	Europe	US	East	1,790			
			West	476	476	476	100.0%
Non-US Based Trade Routes							
7	WC SA	Caribbean		6	6	6	100,0%
8	NE Asia	EC SA		144	144	0	0,0%
9	Europe	WC SA		169	169	169	100,0%
10	NC/EC SA	WC SA		94	94	47	50,0%
11	Asia	NC SA		42	42	42	100,0%
12	Asia	WC SA[3]		171	171	27	15,6%
Total				10.736	5.150	1.880	36,5%

Note: All figures are one-way, in the dominant direction.

Source: PIERS, ACP data, consultant analysis.
Legend: WC= West Coast; NC= North Coast; EC= East Coast; SA= South America

Source: (Panama Canal Authority, 2002)

From Table 1 we can see the predominant let of North East Asia to the United States (East, Gulf and West). Although the data from this table is from 2001, it is of relevance for the purpose of this study, since it gives us a clear overview of the main markets for the Panama Canal. As mentioned before, the NE Asia – U.S. is the predominant leg, which will be the focus of our study. According to the Panama Canal Authority, until May 2005 there were 34 liner services crossing the Canal and the before mentioned leg (Asia to United Sates East coast) is the primary one for the Canal with 14 services.

The Traffic through the Panama Canal depends on the maritime freight demand. As a result, this traffic is determined by three components: the tolls, cargo throughout crossing the Canal and the location of origin and destination. Since the market of the east coast of the United States has a significant importance for the cargo volume crossing this water way, the growth of the traffic flow volume through the Canal can be related to the U.S. personal consumption expenditures (PCE). According to the Panama Canal Authority, the PCE in the United States is expected to growth from $7.1 trillion in 2002 to $14.7 trillion in 2025, with a growth factor of 2.06. As a result, this represents an annual growth of 3.2% per year. In conclusion, a growth in the traffic flow through the Canal is expected, as long as the demand or PCE of the United States East coast growth.

2.2.1 Main Competitors

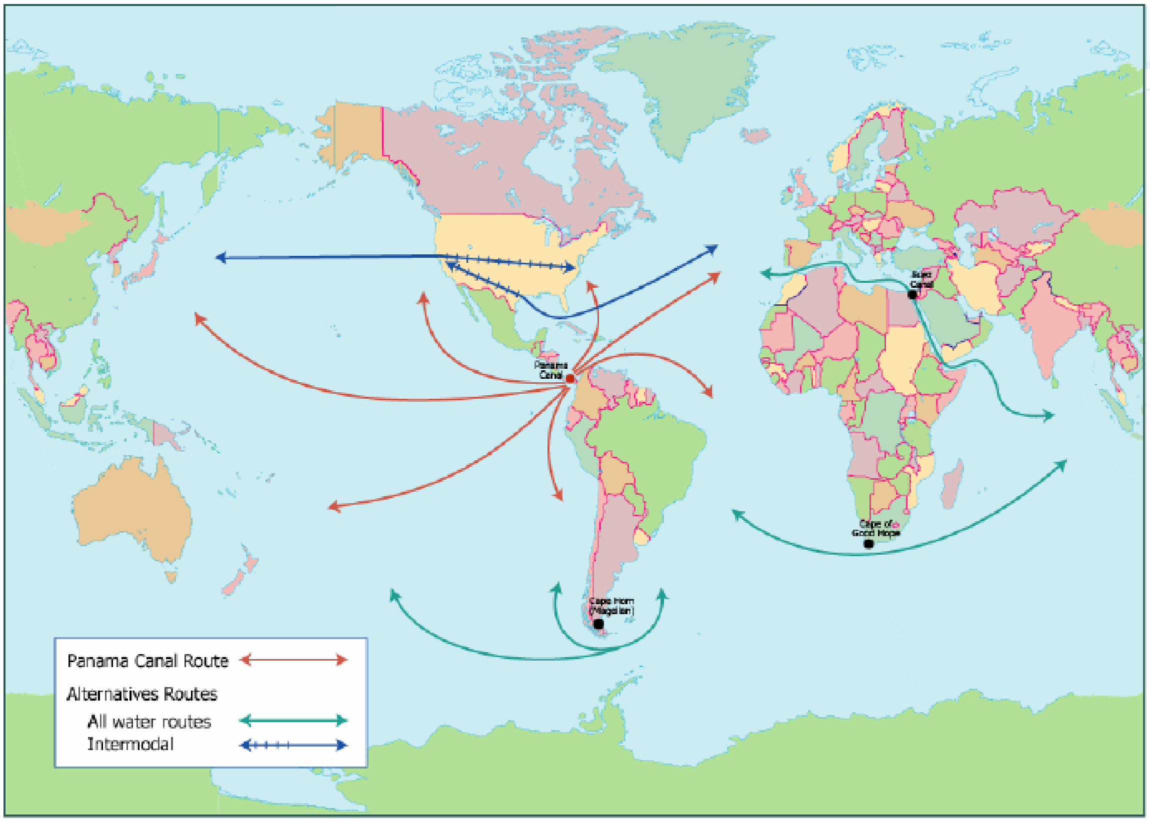
There are alternative routes that represent competitiveness for the Panama Canal. The geographic location of origin and destination and the alternatives routes lead to tradeoffs in transport cost, time, and level of service (The Panama Canal Authority, 2002). As a result of these tradeoffs, the Panama Canal has to have a strong marketing strategy and pricing policy in order to capture share from this market. These alternative routes are classified as follow:

- All water Routes (AW)
    - Via the Suez Canal
    - Around the Cape Horn
    - Around the Cape of Good Hope

- Intermodal Routes (U.S. IM)
    - From Asia to the West Coast of the US connected through the U.S. Rail System

Figure 5 graphically shows above mentioned routes for cargo relevant to the Canal.

Figure 5 – Relevant Panama Canal and Alternative Trade Routes



Source: (Panama Canal Authority, 2002)

The identified routes represent different degrees of competition to the Panama Canal. Furthermore, the Canal route has a strong competitive advantage that is its geographical location. As we can see in figure 5, the Panama Canal Route has more market alternatives compared as an example the Cape Horn all water route or the U.S. Intermodal route. It is important to mention the cluster conglomeration or maritime related activities of each route, which represents competitiveness. As an example the comparison of bunker prices and services in Los Angeles and in the Panama Canal ($445.50 IFO380 and $453.00 IFO380 respectively,), which makes the Panama Canal more attractive to the carriers (Bunker World web site). Since this information changes in a daily basis, is important to state that the aforementioned prices were collected in 19 of August, 2010

So, the relevant trades have been categorized as captive to the Panama Canal, meaning there is no reasonable alternative route but just the Canal route, and divertible, meaning the Canal route must compete with the alternatives routes. Categorizing these relevant trades, the future demand can be analyzed and put in practice an appropriate marketing strategy with the aim of capturing the highest possible share from this market. In Table 2 the relevant trades are categorized (The Panama Canal Authority, 2002).

Table 2 – Captive and Divertible Trade

Trade (Origin – Destination)	US Region	Relevant to Canal	Divertible, Captive or Not Relevant
US Trade Flows			
1. NE Asia – US	East, Gulf	Yes	Divertible
	West	No	Not Relevant
2. SE Asia – US	East, Gulf	Yes	Divertible
	West	No	Not Relevant
3. USA - Oceania	East	Yes	Captive
	Wes	Yes	Divertible
4. USA - NC/EC SA	West	Yes	Divertible
	East	No	Not Relevant
5. WC SA – USA	East	Yes	Captive
	West	Yes	Divertible
6. Europe – USA	Wes	Yes	Divertible
	East	No	Not Relevant
Latin America Trade Flows			
7. WC SA	Caribbean	Yes	Captive
8. NE Asia	EC SA	Yes	Divertible
9. Europe	WC SA	Yes	Captive
10. NC/EC SA	WC SA	Yes	Divertible
11. Asia	NC SA	Yes	Captive
12. Asia	WC SA	Yes	Divertible

Source: (The Panama Canal Authority, 2002)

In the Latin American trade flows, there is a 50% of captive routes and 50% of divertible routes. As it can be seen in above table, three of the South American routes are completely captive to the Panama Canal: WCSA – Caribbean Basin; Europe – WCSA; and Asia – NCSA. On the other hand, trades between Asia and the East and West Coast of South America are represented as diverted to the Panama Canal route from competing with all water services. In regards with the other 6 trades, the U.S. market (imports and exports) is the predominant. Hence, is important to determine the competitiveness of the Panama Canal with the other route, which is the U.S. Intermodal System.

The two main Panama Canal competitors are the U.S. Intermodal System and the Suez Canal among the above mentioned. The Suez Canal route in particular, competes with the Panama Canal in the South and Southeast Asia – U.S. East Coast route due to its shorter navigation time of 21.1 days and its capacity to handle Post-Panamax vessels (Delmy L. Salin, 2010). Although the Suez Canal is competitive to the Panama Canal as one of the alternative routes for the United States East coast, for the relevance of this study, we will not focus in that route, since its competitiveness is mostly represented in the trade from South Asia to United States East coast and this study is being focused on the trade from North Asia to the United States. In the next part the U.S. intermodal system will be analyzed with more details.

2.3 U.S. Intermodal System

In 1970 a land bridge was explored in order to serve Asia and Europe by the time the Suez Canal was closed, with the transpacific and transatlantic vessels joined by a transcontinental rail movement (The Panama Canal Authority, 2002). However, this idea was triggered by the fact that the idea was not economically feasible and due to the reopening of the Suez Canal. Nevertheless rail movement became popular among inland terminals, allowing the container transportation from the coasts (West and East) to the internal or central part of the United States. Another attractiveness of the rail corridor it was the internal repositioning of the empty containers.

With the introduction of the Post-Panamax in the U.S. west ports, the double stack rail movement was accelerated in the late 1980´s (The Panama Canal Authority, 2002). Moreover, it is important to mention that in the 1990´s there was no price differentiation between all water routes and railway corridors. As a result of this, the railway corridors were more attractive for customers by the fact that it only took 16 days for a cargo to be moved from Asia to U.S. East coast, whereas through the all water way the cargo took 30 days. However, with the Ocean Shipping Reform Act (OSRA), the all water way was boosted due to allowance of confidentiality between the lines and customers. Thus, all water ways gained share and became a rate/service alternative to the intermodal system (The Panama Canal Authority, 2002).

The intermodal system remained as a powerful alternative among customers since there were some shipment specific lines, in which cargoes with higher value or time sensitive were more likely to be transported by rail, whereas the lower value or non time sensitive cargo by all water route through the Panama Canal. On the other hand the reliability of the rail service is affected by the large number of containers moving within the country, incurring in congestion. The opening of Prince Rupert and the expansion of the Panama Canal are alternative logistical channels that can affect the competitive environment. In this study, the two routes will be evaluated in terms of logistical cost. These routes are: a) Los Angeles to Chicago, (through the Union Pacific Railroad), and c) New York to Chicago through CSX Railway company. These two routes have been chosen, by the fact that in these ports is represents the major container traffic flow (See Figure 10). The data needed to perform this evaluation will be transportation cost for two types of commodities: "*Footwear and Apparel"* and *"Home Furniture*". This data is collected by a confidential source. Although the rail costs are available in the tool prices of each selected railroad companies web page, we will use the data collected from the confidential source, since in our main objective we need to calculate the transport cost for the customer as a whole and not separated. To the cost of transportation a fuel surcharge needs to be added. This fuel surcharge changes depending on the fuel market price, which fluctuates in a daily basis and is charged to the customer per mile traveled. The travel time is relevant in this study, since we need to take in consideration that in the two scenarios one of the commodities is high value or time sensitive, meaning this that a customer would rather to pay more money as long as the cargo arrives as soon as possible. The reliability of the service will be analyzed as the third criteria in a qualitative way, based on the current situation of the system.

2.3.1 Network Configuration

2.3.1.1 Railroad Corridors

As mentioned in the previews point, the two rail corridors to take into consideration in this study are the Union Pacific Railroad (UP) and CSX Transportation, since these are two of the main rail road corridors in their specific region (West region and East region respectively). Moreover, these were chosen since the information of transport cost is available. It is an important point that these costs are average costs, based on certain commodities, meaning that the real costs are confidential between the rail company and the customer. In the following points the two rail corridors will be briefly analyzed:

Union Pacific Railroad (UP)
The Union Pacific Railroad is one of the most important in the United States and is an operating subsidiary of the Union Pacific Corporation. UP covers 23 states across the western two thirds of the United States (Union Pacific Railroad Company). The network covered by the UP is reasonable extensive. It links the major ports of the Gulf and the West to the east through Chicago, St. Louis, Memphis and New Orleans. Moreover, performs transportation of the most diversified commodities. In the figure 6 we can see the UP Network.

Figure 6 - Union Pacific Railroad Network

Source: (Union Pacific Railroad Company)

The calculation of the transportation costs were made through a price tool and the mileage calculation through a mileage calculator, both available in the Union Pacific web page. In the Table 3 we can see the price details for the two of the three routes to analyze in this study (note that the origin chosen is the harbor and the destination is Chicago, Illinois):
-Los Angeles Harbor, CA – Chicago:

Table 3 - Union Pacific Railroad Freight Rates (LA to Chicago)

Union Pacific	Commodity	Rate	Fuel Surcharge (Per Mile)	Mileage	Total Cost
Los Angeles - Chicago	Apparel	$5,027	$0.17	2186	$5,398.62
Los Angeles - Chicago	Furniture	$5,027	$0.17	2186	$5,398.62

Source: (Union Pacific Railroad Company)

This information was collected through the Union Pacific Railroad web site in July 20, 2010.

CSX Transportation

CSX Transportation is a subsidiary company of CSX Corp. It has 21,000 route miles that serves the major population centers in 23 states east of the Mississippi River, the District of Columbia, and Quebec and Ontario in Canada (CSX Transportation Company). On below Figure 7 we can see the CSX network.

Figure 7 - CSX System Map

Source: (CSX Transportation Company)

As in the Union Pacific routes, the calculation for the CSX route was made through the price tool in the CSX web page. In Table 4 we can see the prices in details of the second route to be analyzed in this study:

Table 4 – CSX Transportation Freight Rates (New York to Chicago)

CSX	Commodity	Rate	Fuel Surcharge (Per Mile)	Mileage	Total Cost
New York - Chicago	Apparel	$2,747	$0.27	946	$3,002.42
New York - Chicago	Furniture	$2,747	$0.27	946	$3,002.42

Source: (CSX Transportation Company)

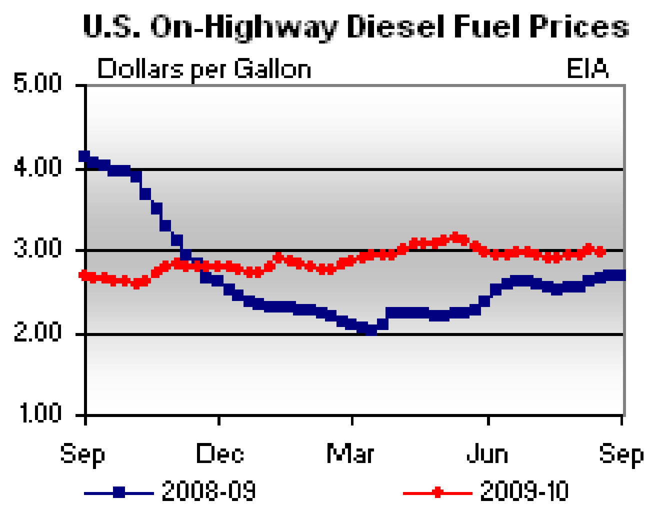
This information was collected through the Union Pacific Railroad web site in July 20, 2010.

-Fuel Surcharge

The Fuel Surcharge is calculated in a monthly basis, based on the average price of the Highway Diesel Fuel (HDF) reported by the U.S. Department of Energy (DOE). The HDF average price is determined by adding the weekly HDF prices reported by the U.S. Department of Energy. This charge should be applied to each shipment having a waybill. For the purpose of the study this aspect is of relevance by the fact that the cost for a customer depends on the fluctuation of the fuel and thus on the percentage of the fuel surcharge. Both companies, Union Pacific Railroad and CSX Transportation have their own way to calculate the surcharge based on the price reported by the U.S. Department of Energy.

In the following Graphic 1 we can see the trend the HDF has had during the period of 2008 to 2010. It is important to note that this information was collected on the 19 of August, 2010 and the same changes in a regular basis.

Graph 1 - U.S. On Highway Diesel Fuel Prices ($ per Gallon)



Source: (U.S. Energy Information Administration)

From this graph we can see the fluctuation of the diesel fuel price in the last two years. Since the fuel surcharge is one of the major components of the logistic costs, the fuel price fluctuation above showed is of relevance for our study. In the following we can see the calculation of the fuel surcharge for the both selected rail companies of our study.

Union Pacific Railroad starts adding a mileage based fuel surcharge, which begins at $0.05 to freight charges at the moment the HDF average price (per gallon) equals or exceeds $2.30. In Table 5 we can see that UP for every $0.05 of increase above $2.30 per gallon, the surcharge applied will increase by $0.01 per mile. If the HDF price is reported below $2.30, then no fuel charge shall be applied. (Union Pacific Railroad Company)

Table 5 - Union Pacific Railroad Surcharges

HDF Average Price (Per Gallon)	Fuel Surcharge (Cents per Mile per Car)
$0.00 to $2.299	$0.00
$2.30 to $2.349	$0.05
$2.35 to $2.399	$0.06
$2.40 to $2.449	$0.07
$2.45 to $2.499	$0.08
$2.50 to $2.549	$0.09
$2.55 to $5.599	$0.10
$2.60 to $2.649	$0.11
$2.65 to $2.699	$0.12
$2.70 to $2.749	$0.13
$2.75 to $2.799	$0.14
$2.80 to $ 2.849	$0.15
$2.85 to $2.899	$0.16
$2.90 to $2.949	$0.17
$2.95 to $2.999	$0.18

Source: (Union Pacific Railroad Company)

In the case of CSX Transportation, the mileage based fuel surcharge starts at $0.01 in the event that the HDF price is reported as equal or exceeding $2.00 per gallon. The fuel surcharge increases by $0.01 per mile per railcar for every $0.04 per gallon increase. See Table 6.

Table 6 – CSX Transportation Surcharges

HDF Average Price (Per Gallon)	Fuel Surcharge (Cents per Mile per Car)
$0.00 to $1.999	$0.00
$2.00 to $2.039	$0.01
$2.04 to $2.079	$0.02
$2.08 to $2.119	$0.03
$2.12 to $ 2.159	$0.04
$2.16 to $2.199	$0.05
$2.20 to $2.239	$0.06
$2.24 to $2.279	$0.07
$2.28 to $2.319	$0.08
$2.32 to $2.359	$0.09
$2.36 to $2.399	$0.10
$2.40 to $2.439	$0.11
$2.44 to $2.479	$0.12
$2.48 to $2.519	$0.13
$2.52 to $2.559	$0.14

Source: (CSX Transportation Company)

Based on Table 5 and 6, we can see that the price for railroad transportation depends on the price of the fuel. This is of relevance for our study, since a change in the price of the fuel changes the total transport cost. Hence, it can influence in the determination of which route should be used based on the type of commodity (whether is time sensitive or not).

2.3.1.2 North American Ports and Business Economic Areas (BEAs)

The North American rail network for international traffic is a composite of the individual rail systems as well as being tied to the development of the west coast ports (The Panama Canal, 2002). The most important and relevant North American ports for this study will be analyzed as follow:

<u>Los Angeles / Long Beach</u>

These ports (also known as the San Pedro Bay ports) are the most important in the U.S. west coast, by several factors as the geographical position, hinterland connection and large vessels channel accessibility. These are, however, the busiest ports in the nation, being Los Angeles the first followed by Long Beach. The ports are the gateway to international commerce and are located in the San Pedro Bay. The LA Basin contains the major population center on the US west coast that absorbs great amount of import cargo (The Panama Canal Authority, 2002). The port of Los Angeles and Long Beach has what is called a Near-dock connection with the Intermodal Container Transfer Facility (ICTF), which is approximately 5 miles from the port. This intermodal facility has an average productivity of 100 lifts per man-hour, leading to accommodate 70 eastbound and 70 westbound trains every week (The Port of Los Angeles). Moreover, they have connection with the Alameda Corridor, which is a 20 mile long rail cargo expressway that links both ports to the transcontinental rail network near downtown Los Angeles (Alameda Corridor Transportation Authority). The Alameda corridor is composed of a series of bridges that separates freight trains from street traffic and passenger trains, leading to a more efficient transportation network. Furthermore, the corridor has three main components:

1. North End Corridor: has the aim to enhance traffic conflicts and to separates cargo trains, passenger trains and street traffic.
2. Mid Corridor Trench: improves ease of traffic congestion.
3. South End Project Area

Moreover, the port of Los Angeles has specialized dedicated On - Dock Rail yards in some of their terminals. For example APL On – Dock Rail yard, Maersk On – Dock Rail yard (operated by APM Terminals) and Evergreen / NYK On – Dock Rail yard.

For the purpose of this study, Los Angeles / Long Beach will be the gateway for the transpacific route that will be analyzed, with the port of Shanghai as the origin.

According to the American Association of Port Authorities, both ports have a throughput of 11,816,592 TEU's (6,748,995 TEU's for Los Angeles and 5,067,597 TEU's for Long Beach) (American Association of Port Authorities).

<u>New York / New Jersey</u>

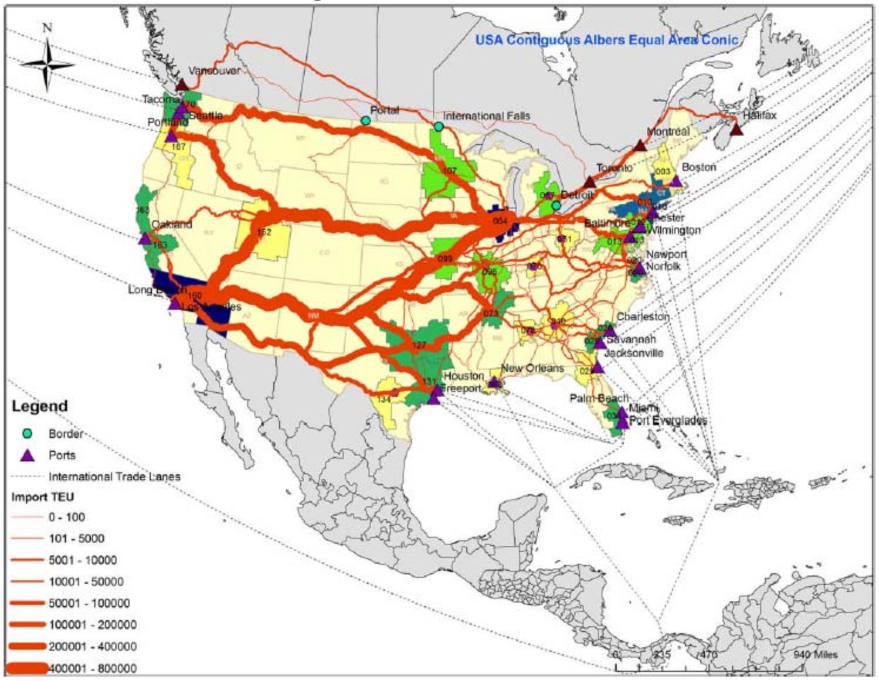
This port is listed as the third biggest container port in the U.S. with an annual throughput of 4,561,527 in 2009. As a result is categorized as a big player in the North Atlantic trade with a market share of 61.5% (Port of New York and New Jersey). The strategic position of the port in the East Coast offers a good connection with the internal U.S. market, i.e. Chicago, Illinois. Because of this, we chose this port for the purpose of this study, by the fact that is one of the main gateways in the U.S. East Coast. Figure 8 shows the location of the port.

Figure 8 – New York / New Jersey Location

Source: (Port of New York)

These ports were chosen by the fact that they represent the highest imports gateways in the United States. In Figure 9 we can see a computational traffic flow for containers imports within the country.

Figure 9 – Traffic Flow

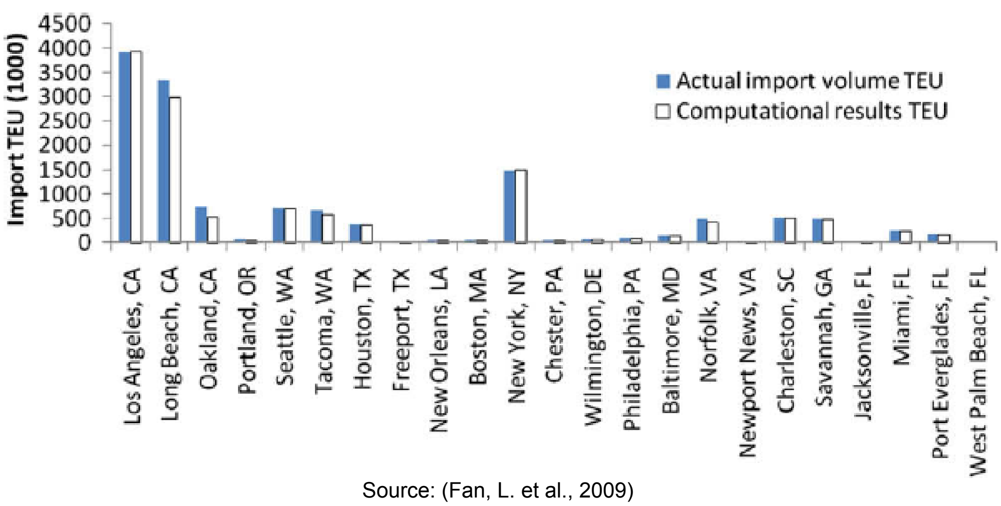


Source: (Fan, L. et. al. 2009)

From Figure 9 we can see a strong connection from Los Angeles to Chicago. Although the connection from New York to Chicago is not as strong as the one with Los Angeles, it is shown that has the strongest one in the East coast. Moreover, from this we can state again our choice of comparing these two routes (Los Angeles to Chicago & New York to Chicago).

Moreover, Figure 10 shows the import volumes for container imports of the most important US ports (Fan, L. et al., 2009).

Figure 10 - U.S. Import Volumes



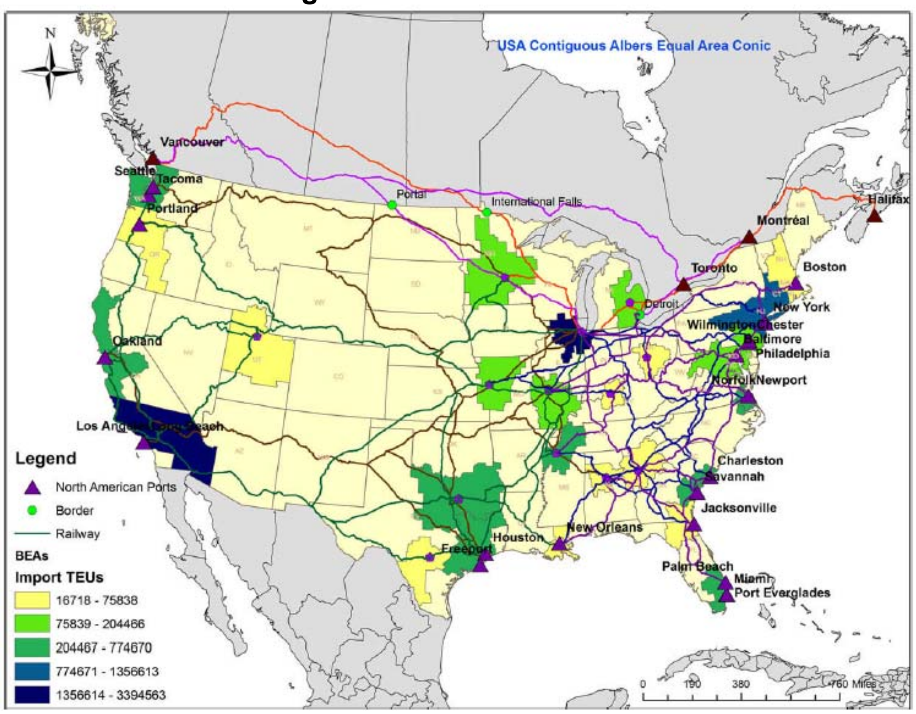
Source: (Fan, L. et al., 2009)

From Figure 10 we can appreciate that the port of Los Angeles / Long Beach and the port of New York have the highest throughput. Once again, we can state that these ports were chosen by just mentioned fact.

Business Economic Areas (BEAs)

The Business Economic Areas (BEAs) are the specific areas where the demand for containers is the highest. This demand is the sum of shipments through all US and Canadian ports to the BEAs The country is divided into Business Economics Areas (BEAs), and the most important are Chicago-Gary-Kenosha, followed by Memphis, Dallas Forth Worth and Kansas City; Los Angeles-Riverside-Orange County in the West Coast; New York-Long Island in the East Coast and Houston-Galveston-Brazoria in the Gulf Coast (Fan, L. et al., 2009). Figure 11 shows the location of the most important BEAs with their respective intermodal connections with the ports of the East and West coast.

Figure 11 - BEAs Location



Source: (Fan, L. et al., 2009)

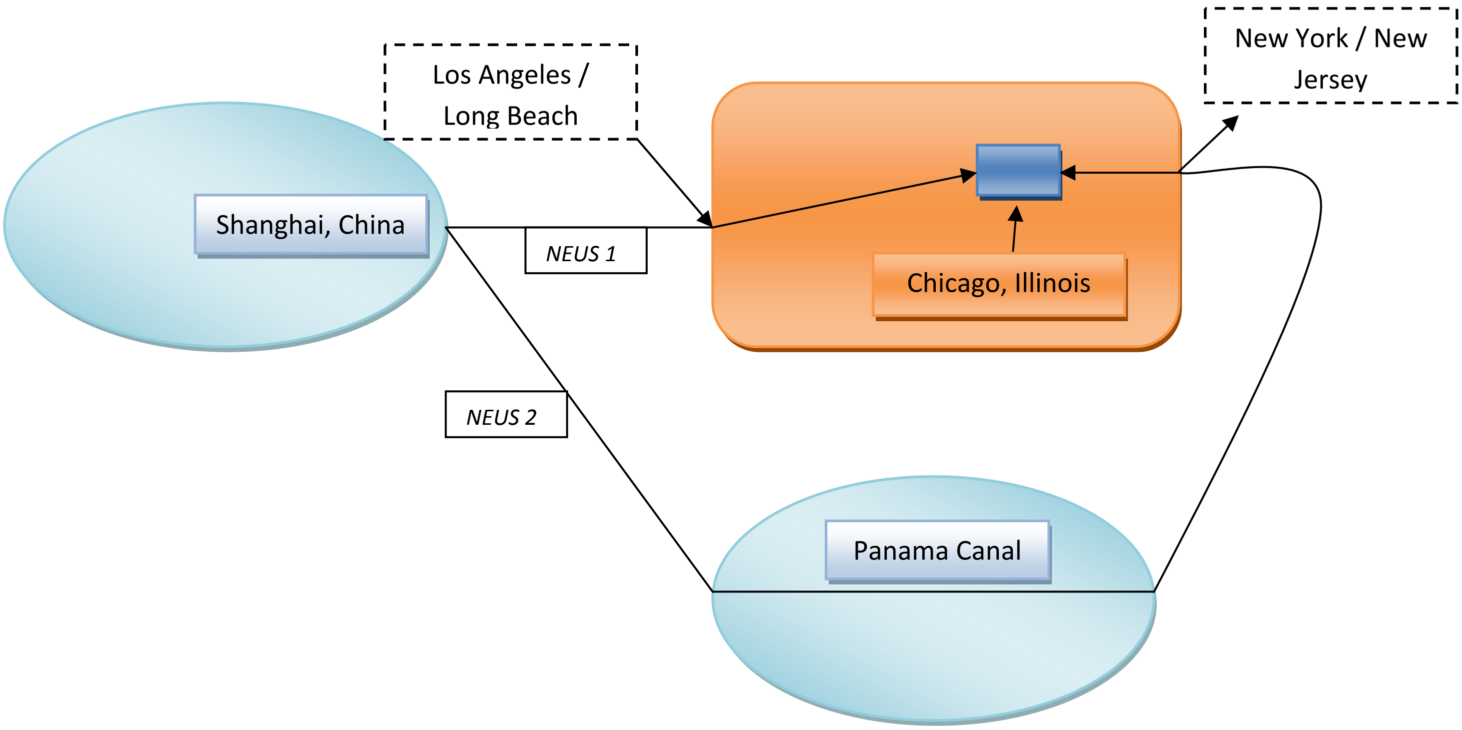
For the aim of this study, we will focus only in Chicago’s Economic Area, since is the one that represents the highest demand for containerized cargo in the centre of the country. Among the other connection points (i.e. Kansas City, St. Louis and Memphis), Chicago is the major gateway and is considered as the third largest port, since 11 million TEU transit annually (The Panama Canal, 2002).

Regarding intermodal terminals in Chicago we can mention that the Joilet Intermodal Terminal is currently under construction, which will be focused on both, domestic and international traffic from the West Coast. This terminal is will expand Union Pacific coverage since provide access to all major traffic lanes.

2.4 Asia – U.S. Service Patterns

First of all a service pattern is a specific route which serves a certain trade. This can be noted as the rotation of the vessels. In this study, the rotations of the vessels to be analyzed are: A) Shanghai International Port (China) – Los Angeles / Long Beach, United States; B) Shanghai International Port (China) - Panama Canal, Panama – New York / New Jersey, United States. In this study, the first service will be named as the *"NEAUS 1"* and the second service as the *"NEAUS 2".* The NEAUS 1 is a TPD service (Transpacific Direct) and the NEAUS 2 is an AW (All water). The transit time of these services are 13 days for the NEUS 1 and 25 days for the NEUS 2. It is important to remember that the transit time is by sea. Moreover, for the analysis of this study we need to add 8 days to the NEUS 1 and 2 days to the NEUS 2, which represent the days that takes to transport the cargo to Chicago BEA. Figure 12 shows the configuration of the two services.

Figure 12 – Service Pattern



From this scheme, we can see the two logistics routes that will be analyzed in this study.

2.5 Conclusion

Concluding with this chapter, we have a clear overview of the parameters that compose each route in our study. We have noticed that the vessel transits and TEU volume through the Panama Canal has increased gradually throughout the years (Figure 1). Moreover, the container trade route of major relevance for the Canal is from North East Asia to the East coast of the United States. As a result of this, the Panama Canal has to control their pricing policy in order to remain their strong position within the market. However, the tolls are not the only criteria for a well positioning, but the consumer demand is of great important. The demand is related to the consumer expenditure and according to the Panama Canal Authority; the water way can have an annual growth of 3.2% per year (forecast made until 2025). Furthermore, with the expansion of the Canal, shipping lines will enjoy of economies of scale, leading to a potential decrease in prices for final customer (cargo owners). On the other hand, this might be an issue if we face another economic recession, by the fact that in order for a container vessel to cross the Canal, it has to pay a toll based on the TEU capacity and not on the cargo carried on board. As a result of this, Post - Panamax vessels with 8000 TEU capacity will incur in high operation expenses.

Regarding the main competitor for the Panama Canal, the U.S. Intermodal system takes the first place. By the fact that the Panama Canal nowadays is limited to handle Panamax vessels (5000 TEU) and with the geographical advantages (location and depth) of the ports of the West coast of the United States (i.e. Los Angeles / Long Beach), which are able to receive larger vessels than the Panamax, the U.S. Intermodal system is handling a substantial volume of cargo with destination intra – United States. However, the intermodal system has faced challenges that have affected their service reliability (i.e. max capacity utilization, labor forces, etc.). For the aim of this study, we have chosen two routes which comprise rail corridors. The selected rail corridors are the Union Pacific Railroad Company and the CSX Transportation Company. Both were selected because their connections with the chosen ports to Chicago, Illinois. Moreover, the data regarding the rail transportation costs was available in both companies' web sites.

In the next chapter we will analyze the container freight rates of relevance for our study.

Chapter 3 Container Freight Rate Analysis and Trends

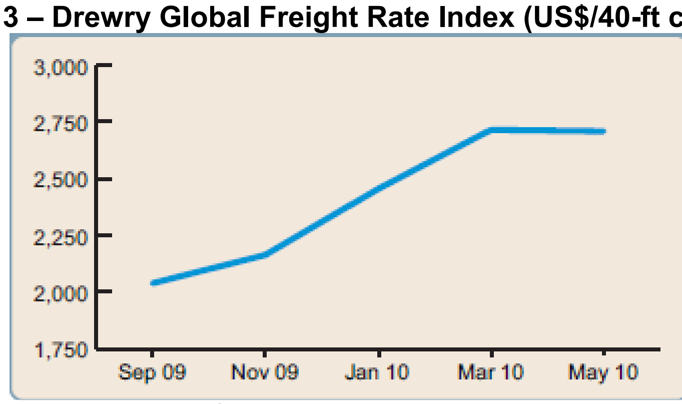
3.1 Introduction

In this chapter we will take a look to the trend of the freight rates. The data collected is from based in the recently (June 2010) reported Drewry Global Freight Index. The relevance of this information is to have an insight of the state of one of the most important part of the of the total logistic transport cost. Besides the average freight rates reported by Drewry Publishing, we will discuss the container freight rates from Asia to the United States, which are the relevant rates for our study. Moreover, we will describe the surcharges and charges included in the total freight rate. To have a brief idea and according to TSA (Transpacific Stabilization Agreement) the surcharges are floating charges that are adjusted constantly (in a regular basis), which reflect the costs that are regularly fluctuating (i.e. exchange rates and bunker fuel prices) and charges are associated to the fixed or more stable costs (i.e. origin and destiny port handling operation charges).

3.2 Freight Rate Trend (Changes)

The container freight rate analysis is based on the pricing benchmark made by Drewry Global Freight Rate Index. At the end of 2008 and in 2009 the container freight rates dropped as a result of the economic downturn. However, the rates have shown a steady growth of 76.4% from May2009 – May 2010. In Figure 13 we can appreciate the strong upward trend the freight rates of a 40-ft container have had.

Figure 13 – Drewry Global Freight Rate Index (US$/40-ft container)

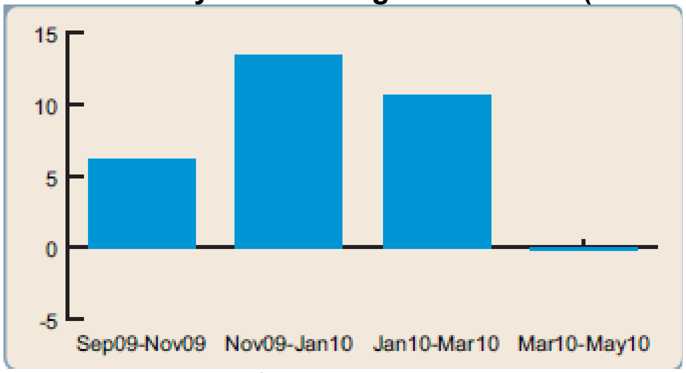


Source: Drewry Publishing

The line describing the freight rates in above Figure 13, shows us how is the trend and for the purpose of this study we can have an insight of the costs involved in the container transportation.

Figure 14 shows the % change of the Drewry Global Freight Rate Index based on the freight upward trend displayed in figure 13.

Figure 14 – Drewry Global Freight Rate Index (% change)



Source: Drewry Publishing

From above figure (13) we can see the index changes from September 2009 to May 2010. From Nov 2009 to Jan 2010 the index changed (upward – 13.4%) dramatically. However, from Mar 2010 to May 2010 there was a symbolic 0.2% decline. In Figure 15 we can see in more detail the index history from May 2009 to May 2010.

Figure 15 – Drewry Global Freight Rate Index History

May 09	$1,536
% change Mar 09-May 09	-1.3%
Jul 09	$1,726
% change May 09-Jul 09	12.4%
Sep 09	$2,040
% change Jul 09-Sep 09	18.2%
Nov 09	$2,165
% change Sep 09-Nov 09	6.1%
Jan 10	$2,456
% change Nov 09-Jan 10	13.4%
Mar-10	$2,716
% change Jan 10-Mar 10	10.6%
May 10	$2,709
% change Mar 10-May 10	-0.2%
% change May 09-May 10	76.4%

Source: Drewry Publishing

Concluding the analysis of the freight rate trend, recently reported by Drewry Publising, we can say that the worldwide trade is in a period of recovering by the fact that the prices have gone up as a result of a growth in the demand for trade. However and according to the Container Freight Rate Insight report made by Drewry the rates in some routes are facing a decline (as is shown in last month of Figure 14) and that they have reached the peak. This was confirmed in some routes to Europe and some routes from the U.S. On the other hand the rates of the transpacific route (Asia to U.S.) have continued to increase (Container Freight Rate Insight – Drewry Publishing)

3.3 Asia to U.S. Freight Rates

In the post-recession the container trade have faced an increase in its rates, being around 70-80% more higher than in 2009 and close to the rates we had in the pre-recession of 2008 (Container Freight Rates Insight – May 2010 – Jun 2010, Drewry Publishing). Moreover, the imports in the West Coast of the United States have increased substantially almost exceeding $2,500 (for 40-ft container). Next Table 7 shows the some of the region pair's rates for the types of container size from January 2010 to May 2010.

Table 7 - Asia to US Rates Benchmarks (until May 2010)

					% change		
Port/region pairs	*Container size*	**Jan 10**	**Mar 10**	**May 10**	**Jan 10 to Mar 10**	**Mar 10 to May 10**	**May 09 to May 10**
South China to US East Coast	20ft container	$2,520	$2,500	$3,150	-1%	26%	41%
South China to US East Coast	40ft container	$3,240	$3,240	$3,870	0%	19%	36%
South China to US West Coast	20ft container	$1,710	$1,810	$1,990	6%	10%	38%
South China to US West Coast	40ft container	$2,210	$2,310	$2,560	5%	11%	38%
South China to US Gulf Coast	20ft container	$3,030	$3,200	$3,200	6%	0%	38%
South China to US Gulf Coast	40ft container	$3,850	$4,040	$4,040	5%	0%	37%
Central China (Shanghai) to US East Coast	20ft container	$2,480	$3,180	$3,090	28%	-3%	-
Central China (Shanghai) to US East Coast	40ft container	$3,110	$3,700	$3,560	19%	-4%	-
Central China (Shanghai) to US West Coast	20ft container	$1,640	$2,220	$2,020	35%	-9%	-
Central China (Shanghai) to US West Coast	40ft container	$2,080	$2,620	$2,400	26%	-8%	-
Central China (Shanghai) to US Gulf Coast	20ft container	$2,790	n.a.	n.a.	-	-	-
Central China (Shanghai) to US Gulf Coast	40ft container	$3,510	n.a.	n.a.	-	-	-
North China (Tianjin) to US East Coast	20ft container	$2,620	$2,720	$3,070	4%	13%	-
North China (Tianjin) to US East Coast	40ft container	$3,310	$3,310	$3,810	0%	15%	-
North China (Tianjin) to US West Coast	20ft container	$2,570	$2,140	$2,140	-17%	0%	-
North China (Tianjin) to US West Coast	40ft container	$3,210	$2,660	$2,660	-17%	0%	-
Hong Kong to US East Coast	20ft container	$2,790	$2,750	$3,460	-1%	26%	46%
Hong Kong to US East Coast	40ft container	$3,470	$3,370	$4,010	-3%	19%	36%
Hong Kong to US West Coast	20ft container	$1,930	$1,900	$2,090	-2%	10%	32%
Hong Kong to US West Coast	40ft container	$2,380	$2,300	$2,560	-3%	11%	31%

Source: Drewry Publishing

As mentioned before, in this study we will focus on the trade of Shanghai to the West/East Coast of the United States, so as we can see in above figure the rate for a 40-ft container have had a substantial increase, although from March to May 2010 we can see there was a considerable decrease for 20-ft containers and 40-ft containers of 28% and 19% respectively. It might seem to be contradictory to the statement previously mentioned in which Drewry expects a continuously increase in the rates for the transpacific route from Asia to the U.S., but taking a look at the other region pairs we can foresee a potential increase.

3.4 Surcharges and Charges

In the previews part of this study we could see how the freight rates have been increasing in the period of post-recession. Moreover, in the transport costs we need to take into consideration the surcharges, which play an important role in the benchmark of the rates due to some of them fluctuates in a daily basis. The United Nations describes surcharges as "general rate increases applied to all commodities transported on a particular liner tariff" (Wang, D.-H., et al.2010). According to TSA (Transportation Stabilization Agreement) these surcharges are floating charges intended to recover rising or constantly fluctuating costs that are out of the carrier's control and to cover their operation costs. It is important to mention that regular charges address fixed costs, unlike surcharges are addressed to fluctuating costs. According to Wang, D.-H., et al.(2010) the shipping lines are subject to 22 different surcharges, however they have managed to transfer some of the costs to the shippers as the variable costs, i.e. BAF and CAF (Currency Adjustment Factor). In the next part of this study we will examine some of the most relevant maritime transport surcharges and charges. In our point of view the BAF (Bunker Adjustment Factor) plays the most important role when benchmarking the rates. So because of this the BAF will be analyzed in a broad way, based on the study (The rationale behind and effects of Bunker Adjustment Factor) made by Wang, D.-H., Chen C.-C. and Lai C.-S.

-BAF Surcharge (Bunker Adjustment Factor): the BAF is the surcharge associated to the vessel fuel cost and it was introduced after the first oil crises in the early 1970´s when the OAPEC (Organization of Arab Petroleum Exporting Countries) made an oil embargo as a result of the United States decision in re-supplying the Israeli military during the Yom Kippur War (also known as the Arab – Israeli War). Due to the implementation of the BAF and even more before the economic downturn (2003), the freight rates were increased in order to cover the bunker consumption costs. As a consequence, the relationship between carriers and shippers was affected, since it turned as an obstacle in the negotiation between them (Wang, D.-H., et al., 2010). Nowadays the bunker costs for shipping lines account for 40-60% of total vessel operation costs (Wang, D.-H., et al., 2010). As a result of this, the carriers have had to take action in order to reduce their cost and try to maintain the relationship between with them and the shippers. However the shippers have supported the idea to include the cost of the bunker to the freight rate at the beginning of a contract. On the other hand the carriers are not in the same position, due to most of the shipping lines want to keep the pricing elements separated by the fact that in surcharge system only the base-rate portion is subject to negotiation (Wang, D.-H., et al.2010). With this statement we can confirm that the carrier / shipper relationship can be or is affected due to an increase in the BAF surcharge.

Nowadays in the shipping line industry there are two kind of contract between the carriers and the shippers which are the "all in freight" and the "ocean freight with BAF", whereas with the first mentioned the carriers need to decide whether to raise the rates or not, due to the daily fluctuation of the bunker prices. So in this case carriers evaluate the bunker fluctuation in a long term in order to set the rates. In the case of ocean freight with BAF the carriers set the prices according to the BAF formulas. Wang, D.-H., et al. (2010), compare the two types of contracts between shippers and carriers with a demand and supply curves for each contract. For the purpose of this study we won´t enter in details regarding the examination of the contracts, however is important to note that this plays an important role in the rates.

The increase of the fuel prices were seen within the period of 2003 – 2008. According to Wang, D.-H., et al. (2010) between February 2004 and July 2008 there was a substantial increase in the prices of the bunker and this is reported by monitoring the prices in more than 70 of the major ports of the world. The paper also shows that in February 1st, 2004 the price for IFO 380 CST (60% of world bunker volume) recorded it was $128 per metric ton. The price rose 423% by July 1st, 2008 when the recorded price was $669.5 per metric ton. In Table 8 we can confirm the previews statement and states that the total average growth rate of fuel prices is about 1.75% from January 2003 to July 2008

Table 8 – Bunker Fuel Prices (US$ - per metric ton)

Fuel prices	2003	2004	2005	2006	2007	2008
January 1	157.5	133.0	140.0	261.0	252.0	472.0
February 1	172.5	128.0	163.5	293.0	247.5	423.0
March 1	158.5	149.0	185.0	297.0	267.0	472.0
April 1	140.0	143.0	216.5	316.5	300.0	461.5
May 1	131.5	161.5	239.5	334.5	331.0	472.0
June 1	149.0	172.0	221.0	314.5	313.0	542.5
July 1	158.0	152.0	237.0	304.0	338.5	669.5
August 1	163.0	171.0	245.0	318.0	381.0	
September 1	153.5	154.0	289.5	297.5	361.5	
October 1	150.0	165.5	285.0	270.5	385.5	
November 1	151.5	170.5	260.5	262.0	477.0	
December 1	136.0	134.5	254.5	263.0	431.0	

Source: (Wang, D.-H., et al. 2010)

More over in Table 9 we can see the increase in the BAF surcharge announced by the Far East Freight Conference (FEFC) throughout the period of 2003 to 2008. In the table we can notice that the price in January 1st, 2003 recorded $56 per TEU and in July 1st, 2008 recorded $610 per TEU. The previews statement represents an increase of 2.97% per month from January 2003 to July 2008.

Table 9 – FEFC BAF (US$/TEU)

BAF	2003	2004	2005	2006	2007	2008
January 1	56	79	128	240	240	482
February 1	70	74	111	233	235	456
March 1	97	84	116	257	227	456
April 1	112	84	131	270	247	456
May 1	99	84	171	276	256	509
June 1	71	90	205	301	296	546
July 1	69	109	199	313	307	610
August 1	69	104	199	296	312	
September 1	87	104	219	305	350	
October 1	82	120	230	300	345	
November 1	72	120	270	264	359	
December 1	79	142	270	248	394	

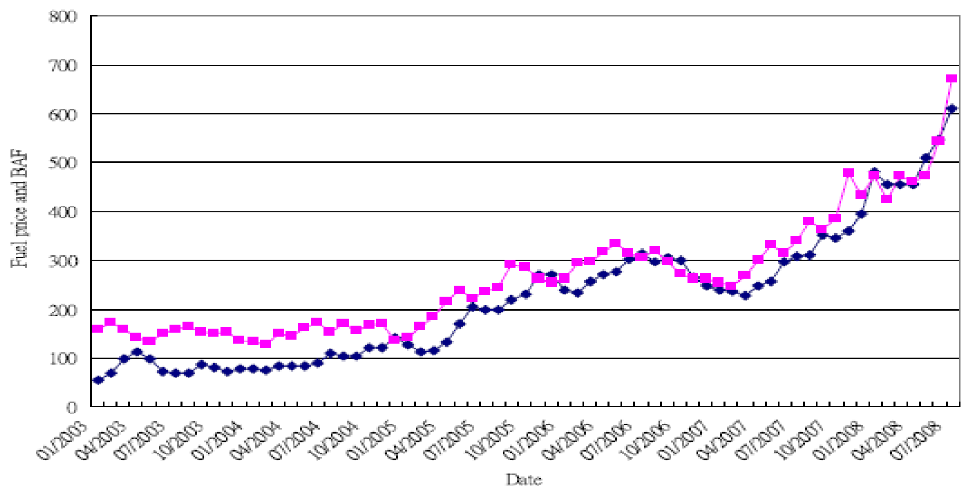
Source: (Wang, D.-H., et al. 2010)

As we can see from these two above tables (8 and 9), there a proportional increase in the BAF when the fuel price increases. For example, in July 1st, 2003 the cost of one metric ton was $158.00 and the BAF in the same date was reported to $69.00, which gives us a ratio of 2.29. Moreover in July 1st, 2008 the cost of one metric ton was $669.50 and the BAF was reported to $610.00, giving us a smaller ratio of 1.10. From this, we can say that the BAF is affected by getting a higher value with the increase of the fuel price. As a result, we have increases in the freight rates.

For the purpose of this study we do not take in consideration the inflation, but this might be another reason of the increases in the value of the BAF. So let's say we take in consideration the inflation rate, and then we will see a substantial increase in the BAF. For example, the inflation rate from January 1st, 2003 to July 1st, 2008 is 21.06% (InflationData.com), so this means that the BAF reported in first month of 2003 which was $56 will then be $67.79 in July 2008 [$56.00 + ($56.00 * 0.2106) = $67.79].

Next Figure 16 shows the trend of the bunker prices and the BAF have had from January 2003 to July 2008

Figure 16 - Fuel Price and BAF Trend



Source: Wang, D.-H., et al. (2010). Where indicates the fuel prices and the icates the BAF

-PSS (Peak Season Surcharge): the peak season surcharge is the charge associated with the incremental operational costs incurred during the peak season. According to Drewry publishing, the most prominent carriers have announced the peak season surcharge around $400 for a 40-ft container. On the other hand some carriers are willing to raise the PSS to $700. On May 14, 2010 members of the Transpacific Stabilization Agreement (TSA – group of 15 major liner shipping companies in the Pacific Ocean) announced increases on the U.S. inbound cargo. In Table 10 it is shown the PSS rates announced by TSA.

Table 10 – TSA Far East to U.S. PSS Surcharge

20-ft. container	$320
40-ft. container	$400
40-ft. high cube container	$450
45-ft. container	$506

Source: Transpacific Stabilization Agreement

It is important to mention that these prices were reported on May 14, 2010.

-CAF Surcharge (Currency Adjustment Factor): this is the charge associated with the fluctuations in the world currencies and it was developed by the fact that carriers were incurring in costs due to the constantly fluctuation of exchange rates between the U.S. dollar and other currencies. According to TSA and for the purpose of our case study this charge is intended to cover increased local currency operating costs in Asian countries relative to U.S. dollar denominated freight charges and revenues and is calculated as a percentage surcharge on the basic ocean freight rate. As an example of a CAF calculation let's assume a BAS (Basic Ocean Freight) is $2100, BAF (Bunker Adjustment Factor) is $380 and the CAF is recorded to 12%.

- BAS: $2100
- BAF: $380
- CAF: 12%
- Total ocean freight = $2100 + $380 + ($2100 * 0.12) = $2732

It is important to note that this is a simple example of ocean freight, by the fact that in order to calculate the total ocean freight rate some other charges need to be included.
-CCD Charge (Submission of Cargo Declaration Data Fee): this is a fee assessed for submitting cargo declarations electronically. This fee is charged to shippers because carriers are required to submit cargo declaration data for all cargo on board the vessels that make calls into the United States to the U.S. Custom Services. It is important to note that this cargo submission needs to be done 24 hours before the cargo is loaded onto the vessel in the port of loading. If the case one single container is not declared the carrier will incur in fines. This declaration includes the description and weight of the cargo, shipper's complete name and address, consignee, owner or owner´s complete name and address, internationally recognized hazardous material code (if the case of hazardous material) and seal numbers assigned to the containers.

-ODF Charge (Documentation Fee at Origin): this is the charge associated with documentation processing at origin.

-OHC Charge (Handling Charge at Origin): this is the charge associated with specific costs at origin terminals. More clearly, OHC reflects land side handling costs at the container facilities and the handling costs at the water side (loading operations). This charge varies by port.

-PAE Charge (Port Additional / Port Dues – Export): this is a charge assessed for port additionals of when carriers' are collecting port dues from the customer on behalf of the port.

-PSE Charge (Port Security Charge – Export): this a charge associated with export security costs.

-SER Charge (Carrier Security Charge): this a charge associated with the carriers' compliance to the ISPS code (International Ship and Port Facility Security – an amendment to the Safety of Life at Sea - SOLAS) on vessel and container security arrangements for ships and ports.

-BAS Charge (Basic Ocean Freight): this charge is associated with ocean transportation.

-DHC Charge (Handling Charge at Destination): this is the charge associated with specific costs at discharge terminals.

-EMF Charge (Equipment Management Fee): this is a fee applicable for all full export containers, which cover services as:

- Cost for the high security bolt seal issued to all export shippers, including procurement, storage and handling of them.
- Transport setting to approved truckers for empty container pickup.

- Costs for checking seal status and condition on all full containers, when loading and discharging from vessel.

If the case the carrier is vertical integrated and performs all logistics arrangements on behalf of the cargo owner there are two charges regarding the rail road transportation. These are:

-IHI Charge (Inland Haulage Import): this is the charge associated with arranging intermodal transportation for imports.

-IFS (Inland Fuel Surcharge): this is the charge associated to the rail fuel costs. The fuel surcharge was previously discussed in Chapter 1. Refer to Table 5 and 6.

3.5 Conclusion

From this chapter we could see the outlook of the freight rates (or the period of September 2009 to May 2010) based on the Drewry Publishing. Moreover, we described the freight rates from Shanghai to the East and West coast of the United States, which are the routes of relevance for this study. As we have seen in this analysis, the freight rates fluctuate in a daily basis and within the period of September 2009 and May 2010, there have been a gradually increase of it. There are many factors that contribute to the freight rate fluctuation, but from our point of view the main reason is the constant changes of the oil prices. As we can see in Table 7 and 8 there is a substantial increase in the bunker fuel prices and in the Bunker Adjustment Factor (BAF surcharge). Taking a look at the relation between the fuel price and the BAF surcharge, we notice that when the fuel price increases the BAF gets a higher value, which then leads to an increase in the freight rates. Furthermore we described the surcharges and charges that comprise the total transport cost.

Chapter 4 Scenarios and Transportation Costs

4.1 Introduction

As mentioned before, the transpacific container trade is one of the main important in the world. Since the purpose of this study is to look for the most feasible route subject to the certain customer, we have had to develop two scenarios which comprise two companies (which represent the final customers) that have different import throughput into the United States from Asia. The companies that will be used in this study are fictitious by the fact that the data collected from the companies is confidential. The source of the data for each company is interviews made by the Panama Canal for their study "The Panama Canal Impact on the Liner Shipping Industry". The type of data collected refers to the amount of containers they import, the value of the cargo in each container (container measure unit is the FEU), the type of commodity, whether the goods are sensitive to the time. Regarding whether the cargo is time sensitive or not, it refers to the specific time the cargo owner needs the shipment; i.e. summer clothes is a certain commodity that is need it for summer season, so this makes it a cargo of a high value or sensitive to the time, by the fact that if the cargo arrives in the last weeks of the summer it might not be sold making the companies to incur in losses. Another example is fruits that need to be refrigerated. According to my previous experience, this last example of refrigerated cargo is one of the top priorities for a liner shipping company, due to the short life time the commodity has and the vulnerability reefer containers have. However, in this study the type of commodity does not require reefer containers. As an example of cargoes not being sensitive to the time or low value we can mention electro domestic products (i.e. coffee maker machines, toaster machines, microwaves, etc.), which are note made for a specific season or for an especial event, but are products that customers are willing to buy any time of the year.

The two companies are settled in Chicago, Illinois, since it is one of the most important economic areas in the country. As is already known, the two routes to be analyzed are: A) Shanghai, China to Chicago, USA (through Los Angeles and then via intermodal to Chicago), B) Shanghai, China to Chicago, USA (through the Panama Canal, calling the Port of New York / New Jersey and intermodal to Chicago). In the following part of this chapter we will explain the scenarios (the company's outlook) and relevant criteria's that should be taken into account. Moreover, in the next chapter we will discuss the model we used and its outcomes, based on empirical data.

Moreover, the transport costs will be displayed in this chapter. The source of data costs was collected by a confidential source (this source is used due to the expertise they have in the container trade business) and by Drewry Publishing. The costs comprise ocean freight (all charges discussed in the previews chapter), surcharges and rail transportation cost.

4.2 Scenario 1 – Company "A"

This company referred to as Company "A" has its main distribution center settled in Chicago, Illinois as the point to redistribute the cargoes within its scope region. It is important to mention that not all the cargo goes to Chicago distribution center, but to Memphis as well. According to the data collected from the company, 80% of the cargo is for Chicago and the remaining 20% for Memphis as the second main redistributing point in the East of United States. For the purpose of this study, we will only focus on the 80 % of imports to Chicago. Regarding the retailing points where the cargoes need to be redistributed from Chicago's distribution center are: A) Milwaukee, Wisconsin; B) Lansing, Michigan; C) Indianapolis, Indiana; D) Columbus, Ohio.

Furthermore, the company imports Home Furniture's as the commodity. It is important to mention whether the commodity is sensitive to time or not. For this type of cargo and according to the data collected, 90% of the cargo is low value or not sensitive to time and the remaining 10% is sensitive to the time. As mentioned before 80% of the cargo is for Chicago and 20% for Memphis, so we will only focus on the 80% making the share split for each route.

Regarding the import throughput, Company "A" imports 5,500 FEU per year with a cargo value of $17,500 per container. In the next Table 11 we can see the relevant data we need for the study regarding Company "A".

Table 11 – Company "A" Outlook

Company "A"	
Type of Commodity	Home Furniture's
Yearly Throughput	5,500 FEU/year
Throughput to Chicago (80%)	4,400 FEU/year
Cargo Value (per FEU)	$17,500
Total Cargo Value (to Chicago)	$77,000,000
All Water Route Shares (90%)	3,960 FEU/year
Value of All Water Route Cargo	$69,300,000
Intermodal Route Shares (10%)	440 FEU/year
Value of Intermodal Route Cargo	$7,700,000

Source: Panama Canal Authority

Due to data unavailability, we couldn´t collect the split imports per month, based on the yearly throughput. So for the aim of the study we will assume the company's split imports on a monthly basis, which leads us to have 367 FEU each month from January to August and 366 FEU each month from September to December in Chicago. In the next Table 12 we will see the import split for Company "A"

Table 12 – Import Split for Company "A"

Company "A" Import Split (per month)	
January	367 FEU
February	367 FEU
March	367 FEU
April	367 FEU
May	367 FEU
June	367 FEU
July	367 FEU
August	367 FEU
September	366 FEU
October	366 FEU
November	366 FEU
December	366 FEU

4.3 Scenario 2 – Company "B"

This company referred to as Company "B" has its main distribution center in Chicago, Illinois as a point to redistribute the cargoes within its scope region. However, this company has 2 more distribution centers, which are Los Angeles in the West coast and Houston in the Gulf. According to the data collected, the shares of each distribution center are as follow:

- 70% for Chicago, Illinois
- 20% for Los Angeles, California
- 10% for Houston, Texas

The retailing points where the cargoes need to be redistributed from Chicago distribution center are: A) Minneapolis, Minnesota; B) Madison, Wisconsin; C) Cincinnati, Ohio.

We will only focus in Chicago's share (70%). Moreover, this company imports Footwear and Apparel. Regarding the import throughput, Company "B" imports 6,500 FEU per year with a cargo value of $50,000 per Container. In the next Table 13 we can see the relevant data we need for the study regarding Company "B".

Table 13 – Company "B" Outlook

Company "B"	
Type of Commodity	Footwear and Apparel
Yearly Throughput	6,500 FEU/year
Throughput to Chicago (70%)	4,550 FEU/year
Cargo Value (per FEU)	$50,000
Total Cargo Value (to Chicago)	$227,500,000
All Water Route Shares (45%)	2,048 FEU/year
Value of All Water Route Cargo	$102,400,000
Intermodal Route Shares (55%)	2,502 FEU/year
Value of Intermodal Route Cargo	$125,100,000

Source: Panama Canal Authority

Due to data unavailability, we couldn´t collect the split imports per month, based on the yearly throughput. So for the aim of the study we will assume the company's split imports on a monthly basis, which leads us to have 380 FEU each month in January and February and 379 FEU each month from March to December in Chicago. In the next Table 14 we will see the import split for Company "B"

Table 14 – Import Split for Company "B"

Company "B" Import Split (per month)	
January	380 FEU
February	380 FEU
March	379 FEU
April	379 FEU
May	379 FEU
June	379 FEU
July	379 FEU
August	379 FEU
September	379 FEU
October	379 FEU
November	379 FEU
December	379 FEU

4.4 Transportation Costs

In order to make the cost comparison analysis of the two routes chosen in this study, we will base it on the transport cost data collected and the two scenarios previously mentioned. For these two scenarios there are certain criteria's to take in consideration, which are the transport cost, the value of time and the transit time. These criteria's can be explained as follow:

-Transport costs: This involves ship voyage cost, port handling cost, rail transport cost and Panama Canal tolls (for the AW route) charges and surcharges. It is important to note that the data collected for transport cost comprises all costs discussed in the previous chapter in which the source is confidential. In the next two Tables 15 and 16 we will display the transport costs.

Table 15 – Transport Costs for Route 1

Route 1			
Shanghai - Los Angeles - Chicago			
Sea Transportation			
40 / DRY	ODF	BoL	$25.00
40 / DRY	CDD	BoL	$29.51
40 / DRY	BAS	Container	$2,533.00
40 / DRY	BAF	Container	$390.00
40 / DRY	DHC	Container	$390.00
40 / DRY	EMF	Container	$7.38
40 / DRY	OHC	Container	$110.64
40 / DRY	PAE	Container	$38.36
40 / DRY	PSE	Container	$4.43
40 / DRY	PSS	Container	$800.00
40 / DRY	SER	Container	$9.00
Rail Inland Transportation			
40 / DRY	IHI	Container	$3,128.00
40 / DRY	IFS	Container	$372.62
Total Costs			**$7,836.94**

Table 16 – Transport Costs for Route 2

Route 2			
Shanghai - Panama Canal - New York - Chicago			
Sea Transportation			
40 / DRY	ODF	BoL	$25.00
40 / DRY	CDD	BoL	$29.51
40 / DRY	BAS	Container	$3,735.00
40 / DRY	BAF	Container	$630.00
40 / DRY	DHC	Container	$390.00
40 / DRY	EMF	Container	$7.38
40 / DRY	OHC	Container	$110.64
40 / DRY	PAE	Container	$38.36
40 / DRY	PSE	Container	$4.43
40 / DRY	PSS	Container	$800.00
40 / DRY	SER	Container	$9.00
40 / DRY	PCC	Container	$200.00
Rail Inland Transportation			
40 / DRY	IHI	Container	$1,187.00
40 / DRY	IFS	Container	$255.42
Total Costs			**$7,421.74**

Both tables (15 and 16) represent the transport costs by sea and by rail. As mentioned before, the costs collected are from a confidential source. However, IFS (Inland Fuel Surcharge) was calculated according to the distance in mileage times the fuel surcharge reported by each company, Union Pacific Railroad and CSX Transportation.

-<u>Value of Time:</u> This criterion, can be denoted as the holding costs and it refers to the value of the time or the value of the cargo while is in the transit time. In order to calculate it, we need to know the interest cost of capital based on its value plus the insurance rate. With this information we can calculate the cargo value per day of transit. The value of time vary by trade flow, cargo type (and its value), inventory and the costs of financing and the opportunity cost of the cargo not reaching on time its destination (The Panama Canal Authority). This last aspect refers to the reliability of the services (at sea and inland) which is one of the most important factors that influence directly the value of time, since a day of delay will affect the overall costs for the customer. On the other hand, faster delivery time may reduce render payments and increased profits.

As mentioned before the value of time will be calculated based on the interest cost of capital and the insurance rate. To do so, the interest cost of capital will be based on the LIBOR rate (London Interbank Offered Rate), which is an international referential interest rate based on the average interest rates in which a large number of international banks in London lend money to one another (HomeFinance.nl). These rates are calculated every UK business day by the international media company Thomson Reutter in association with the British Banker's Association (BBA), in which its find out the rate at which each bank in the London wholesale money market could borrow Eurodollars from other banks, for specific maturities (The Fed (U.S.) Prime Rate) The LIBOR maturities time ranges from overnight to 12 month. In the next table 17 we can see the LIBOR rates for the different period of maturity.

Table 17 – LIBOR Rates

US dollar LIBOR	8/20/2010	8/19/2010	8/18/2010	8/17/2010	8/16/2010
US dollar LIBOR overnight	0.22725 %	0.22725 %	0.22600 %	0.22663 %	0.22875 %
US dollar LIBOR 1 week	0.25656 %	0.25831 %	0.25875 %	0.25875 %	0.25994 %
US dollar LIBOR 2 weeks	0.25938 %	0.26063 %	0.26109 %	0.26122 %	0.26413 %
US dollar LIBOR 1 month	0.26438 %	0.26469 %	0.26625 %	0.26656 %	0.26938 %
US dollar LIBOR 2 months	0.29594 %	0.29969 %	0.30000 %	0.30344 %	0.30875 %
US dollar LIBOR 3 months	0.32922 %	0.33906 %	0.34547 %	0.35219 %	0.36188 %
US dollar LIBOR 4 months	0.40150 %	0.40931 %	0.41738 %	0.42563 %	0.43713 %
US dollar LIBOR 5 months	0.47250 %	0.48031 %	0.48963 %	0.49756 %	0.50869 %
US dollar LIBOR 6 months	0.54563 %	0.55594 %	0.56844 %	0.57650 %	0.58731 %
US dollar LIBOR 7 months	0.60781 %	0.61500 %	0.62700 %	0.63631 %	0.64756 %
US dollar LIBOR 8 months	0.66319 %	0.67006 %	0.68363 %	0.69381 %	0.70506 %
US dollar LIBOR 9 months	0.71688 %	0.72500 %	0.73750 %	0.75031 %	0.76406 %
US dollar LIBOR 10 months	0.77625 %	0.78831 %	0.80088 %	0.81375 %	0.82731 %
US dollar LIBOR 11 months	0.83938 %	0.85188 %	0.86350 %	0.88031 %	0.89194 %
US dollar LIBOR 12 months	0.90638 %	0.91919 %	0.93094 %	0.94619 %	0.96094 %

Source: Home Finance

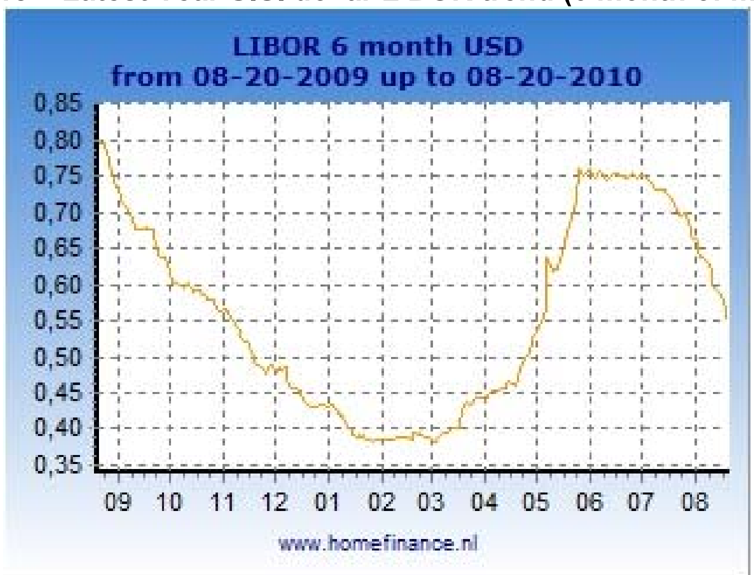
For the aim of this study, we have chosen the LIBOR 6 month, because is a rate which average shows a good remuneration. Moreover, the clients in this study have a well performance when it comes to the rates remuneration, which make them applicable for this maturity rate (General Bank Interview). In the next Figure 17 we will see the historical trend of the U.S. dollar LIBOR (6 months of maturity).

Figure 17 – U.S. dollar LIBOR Historical Trend (6 month of maturity)

Source: Home Finance

From this Figure 16 we can see the trend of the LIBOR (6 month of maturity) from 1987 to 2010. As we can see there has been downward trend throughout this period. However, in the period from 2000 to 2004 we can see a substantial decrease in the rates followed by a substantial increase until 2008. Moreover, the downward trend kept going until these days. According to Grace Chen (2009), a LIBOR rate fall indicates that there is enough capital to borrow and loan between banks and some speculative bankers can show a profit by borrowing low and lending high. For the aim of this thesis, we will not focus on the historic trend, but we want to show that a decrease or increase in the LIBOR rate will affect the value of time. Furthermore, in Figure 18 we can appreciate the trend of the U.S. dollar LIBOR (6 month of maturity) for the latest year.

Figure 18 – Latest Year U.S. dollar LIBOR trend (6 month of maturity)



Source: Home Finance

In the next Table 18 we will see the first LIBOR rates (6 month of maturity) per month for the period from November, 2009 to August, 2010.

Table 18 – Monthly LIBOR Rates (6 month of maturity)

LIBOR Rates (per month)	
2-Aug-10	0.65994%
1-Jul-10	0.75100%
1-Jun-10	0.76113%
4-May-10	0.54578%
1-Apr-10	0.44156%
1-Mar-10	0.38375%
1-Feb-10	0.38375%
4-Jan-10	0.43438%
1-Dec-09	0.48188%
2-Nov-09	0.56688%

Source: Home Finance

In the next Table 19 we will see the LIBOR rates (6 month of maturity) on a daily basis for the month of August, 2010.

Table 19 – Daily LIBOR Rates (6 month of maturity)

LIBOR Rates (August, 2010)	
20-Aug-10	0.54563%
19-Aug-10	0.55594%
18-Aug-10	0.56844%
17-Aug-10	0.57650%
16-Aug-10	0.58731%
13-Aug-10	0.59188%
12-Aug-10	0.59406%
11-Aug-10	0.60250%
10-Aug-10	0.62031%
9-Aug-10	0.62750%

Source: Home Finance

As mentioned before, we have chosen the LIBOR 6 month for the aim of this study, so the rate to use for the value of time calculation is 0.65994%, because is the average LIBOR rate for the month of August. The rate is presented in Table 18. Moreover, to the LIBOR rate we need to add 2.00 %, which is an average spread rate for international banks.

Another criterion to take into consideration for the value of time calculation is the insurance rate. The rate to be used is 2.25% which is based on the average shipping insurance (Shipping Insurance).

4.5 Conclusion

In this chapter we have explained the two scenarios developed for this study, which concerns two companies based in Chicago, Illinois with different commodities and amount of import volumes. Moreover, we showed the criteria's to take into consideration in order to calculate the Total Transport Cost, which involves the transport costs for each company that comprise ship voyage cost, port handling cost, rail transport cost and Panama Canal tolls (for the AW route) charges and surcharges and the Value of Time (VoT) that involves the interest cost of capital and the insurance rate. The value of time and the transit time are two of the main important aspects for the calculation of the total transport costs, since as we have explained; the VoT can vary depending on the cargo type, trade flow, inventory and costs of financing and the time it takes for the cargo to reach its destination. A delay in the transit time will affect the total transport cost. In the next chapter we will explain the model chosen in order to make the cost comparison analysis of the two container transportation routes.

Chapter 5 Model / Methodology

5.1 Introduction

In this chapter we will explain the chosen econometric model for this study. The cost comparison analysis of the two chosen routes will be done with the help of the *"Logit Model"*, which is one of the Binary Choice Models. First we will review the literature of such model, explaining the parameters to take in consideration for the further calculation. Moreover, we will proceed to show the outcomes collected from the calculations. The logit model gives probabilities that an individual will make a certain choice (Pindiyck R. -S. et. al. 1991, Page 258). So for the aim of this study, we will compute this model in order to get the probabilities for the two companies "A" and "B" of choosing one of the two routes for their freight transportation. It is important to note that the probabilities will be calculated based on the criteria's explained in the previous chapter. Now we start by defining the model, its parameters and what outcomes we are expecting from it.

5.2 The Logit Model

A Binary Choice Model assumes that individuals are faced with a choice between two alternatives and that their choice depends on their characteristics (Pindiyck R. -S. et. al. 1991, Page 248). According to Pindiyck R. -S. et. al. 1991, these type of models also respond to qualitative data, i.e. a choice of an individual in voting yes or voting no in a president election or choosing among different transport mode..

The *logit model*, which is one of the Binary Choice Models, gives probabilities that an individual will make a choice among alternatives. In our case, the two alternatives we have are either using the U.S. Intermodal System or The Panama Canal and our individuals would be then the two chosen companies "A" and "B". So for the purposes of this research we assume that the customers have decided to transport the goods from Asia to the East coast of the United States and to use ocean transport. With this model we are trying to model the relationship between an independent and a dependent variable. So in our case, the independent variable will be the Total Transport Costs, which include transport costs, value of time and transit time and the dependent variable will be the route of preference, which are P1 and P2.Getting more in detail, the model is based on the cumulative logistic probability function and can be specified as following Equation 1 (Pindiyck R. -S. et. al. 1991, Page 248):

Equation 1:

$$\mathbf{P_i = F\ (Zi) = F\ (\alpha + \beta Xi) = 1\ /\ 1 + \mathit{e}^{-(\alpha + \beta Xi)}}$$

In above formula the Pi is the probability that an individual makes a certain choice, so in our case it refers to the decision between the using the U.S. Intermodal System or the Panama Canal route. Moreover, **α** and **Xi** refers to the total transport costs (TTC) of each route. To compute this model subject to the data collected in this study, we will describe the equations as follow:

Equation 2:

$$\mathbf{TTC = TC + [\ Vot * (Transit\ Time)\ ]}$$

TTC stands for the Total Transport Cost which involves the transport costs (TC), the Value of Time (VoT) and the Transit Time.

Moreover, to calculate the value of time as is explained in the previous chapter, we need to calculate the value of the cargo per day based on the interest cost of capital and the insurance rate. In the following we will see the Equation 3, which represent the value of time:

Equation 3:

VoT = LIBORCC + IRCC

Whereas the LIBORCC stands for the LIBOR rate of the Cost of Capital and the IRCC stands for the Insurance Rate of Cost of Capital. Both the LIBORCC and the IRCC are calculated based on each rate (LIBOR rate and insurance rate) times the cost of capital and divided by 360 days, which gives us the value of time per day of transit. It is divided by 360 and not by 365 due to standard bank policies, since the remuneration is higher dividing by 360 than by 365. The next step is the calculation of the Beta (β) based on the TEU throughput of each port gateways (Los Angeles and New York). In the next Equation 4 we will see the Beta calculation:

Equation 4:

Beta (β) = -[{ln (T1/T2)} / (CR1 – CR2)]

For the accuracy of the model the Beta should be estimated based on historical data of the flows imports of each company. Unfortunately, we were not able to collect these data from the companies, so instead it was estimated based on the logarithm of the ratio of the TEU throughput of the two gateways selected (ports of Los Angeles and New York), which represent the containerized flows in each U.S. coast (West and East) and then divided by the cost difference of the two routes. In Equation 4 the T1 and T2 represent the TEU throughput for the ports of Los Angeles and New York respectively. Moreover, CR1 and CR2 stand for Cost of Route 1 and Cost of Route 2 respectively and they refer to the transportation costs at sea and inland rail, excluding the value of time.

Lastly we calculate the probabilities of choosing one of the two routes with next Equation 5:

Equation 5:

$$(P1/P2) = e^{-\beta\ (TTC1 - TTC2)}$$

Above equation was derived from Equation 1, in which P1 is equal to 1 – F[**β** (TTC1 – TTC2)] and P2 is equal to F[**β** (TTC1 – TTC2)].

In the next part of this chapter, we will make a sensitivity analysis based on the *Logit Model* outcomes, in order to know how sensitive the decision of the customers in choosing between the two routes is. To do so, we have created 8 sub-scenarios within the main two scenarios previously described. In the 8 sub-scenarios we will change the transit time of the routes with the purpose of getting different outcomes and make the sensitivity analysis.

5.2.1 Model Outcomes

In this part of the chapter we will describe the model outcomes for the 8 sub-scenarios within the two main scenarios. Moreover, we will calculate the preferences of the individuals based on the import of 1 FEU per month, in order to look at the impact per container. The sensitivity analysis will be done based on the changes of transit time (for the first 4 sub-scenarios) and on the changes of the costs of the routes (for the last 4 sub-scenarios). We now proceed to present the outcomes and in the last part of the chapter we will present the analysis of the outcomes. Next Table 20 shows the transit times we will use for the modeling of the first 4 sub-scenarios. Furthermore, these transit times were chosen according the interviews made by the Panama Canal Authority to some companies that use both routes for their imports in the East coast of the United States, for the aim of the study "The Panama Canal impact on the liner shipping industry".

Table 20 – Transit Times

Transit Times		
	Route 1	**Route 2**
Sub-Scenario 1	21	25
Sub-Scenario 2	27	25
Sub-Scenario 3	21	31
Sub-Scenario 4	28	22

Table 21 shows the costs of the routes we will use for the modeling of the last 4 sub-scenarios, which are based on different types of contracts with the shipping line company.

Table 21 – Costs of the Routes

Transport Costs		
	Route 1	**Route 2**
Sub-Scenario 5	$7,836.94	$7,421.74
Sub-Scenario 6	$7,836.94	$7,190.74
Sub-Scenario 7	$7,200.94	$7,421.74
Sub-Scenario 8	$6,900.94	$7,321.74

In the following we will show the outcomes of the model:

<u>-Scenario 1 (Company "A")</u>

In the Sub-Scenario 1 we will add the tables with the company's information, (Table 22) and the results of the value of time, which is the same for all scenarios. Moreover, we will display in two tables the outcomes results for the 8 sub-scenarios (table 26 & 27).

- *Sub-Scenario 1*

The next Table 22 we will see the items that we took in consideration for the modeling of scenario of Company "

Table 22 – Company "A"

Yearly Throughput	5,500 FEU/year
Throughput to Chicago (80%)	4,400 FEU/year
Cargo Value (per FEU)	$17,500
Monthly Import (FEU)	1
Value of Cargo - Monthly Import	$17,500
Cost of Route 1	$7,836.94
Cost of Route 2	$7,421.74
LIBOR 6 Month	2.65994%
Bargaining Commission	0.125%
Insurance Rate	2.25%
Transit Time Route 1 (days)	21
Transit Time Route 2 (days)	25
Throughput Import - Los Angeles (TEU)	6,748,994
Throughput Import - New York (TEU)	4,561,831

Since the beginning our study was based on the throughput to Chicago, which is the 80% (4,400 FEU / year), but, however, for the accuracy of the modeling we will use 1 FEU as the monthly import. Moreover, the costs for both routes are explained in the previous chapter. The LIBOR Rate is 2.65994%, which is the sum of the LIBOR 6 month of August plus the spread (0.65994% + 2.00%). A bargaining commission needs to be added to the LIBOR rate, which vary depending on the client. According to the source (Anonymous Industry Expert) where this rate was collected, for this kind of customers the bargaining commission would be 0.125% of the total value. Furthermore the insurance rate is of relevance for the calculation of the value of time. Last but not least, we mentioned the throughputs of the gateways. In the next Table 23, we will show the outcomes of the calculation of the Value of Time.

Table 23 – Value of Time for Company "A"

Value of Time (VoT)	
Value - Interest Cost of Capital	$1.29
Bargaining Commission	$0.06
Value - Insurance Rate	$1.09
VoT	$2.45

The calculation of the value of time is described in previous point of this chapter. It is important to note the value of time is dependent of the value of the cargo or cost of capital. In the next Table 24 we will present the calculation of the total transport costs (TTC).

Table 24 – Total Transport Cost for Company "A"

Total Transport Costs	
Route 1 TTC	$7,888.34
Route 2 TTC	$7,482.93
TTC1 - TTC2	$405.41

The total transport costs comprise costs of each route mentioned, the transit time (both described in Table 21) and the value of time (described in Table 21). The next Table 25 shows the outcomes of the logit formulation, which gives the individual preference of choosing route 1 or route 2.

Table 25 – Logit Formulation for Company "A"

Logit Model	
β	-0.000943327
e	0.682198877
P1	40.55%
P2	59.45%

From this Table 25 we can see there is a probability denoted as P1 of 40.35% in choosing route 1 (U.S. Intermodal System) and a probability denoted as P2 of 59.45% in choosing route 2 (Panama Canal).

In the next table 26 we compiled the information of company "A" and the results of the model for first 4 sub-scenarios, which as explained before were subject to changes in the transit time. In the last two columns we show the results of the logit modeling

Table 26 - Company "A" Results (changes in transit time)

Company "A" (transit time changes)								
	Transit Times (days)		Route Costs ($)		Value of Time ($) / per FEU / day	Difference in Total Transport Costs ($) (TTC1 - TTC2)	Individual Preference	
	Route 1	Route 2	Route 1	Route 2			P1 (Route 1)	P2 (Route 2)
Sub-Scenario 1	21	25	$7,836.94	$7,421.74	$2.45	$405.41	40.55%	59.45%
Sub-Scenario 2	27	25	$7,836.94	$7,421.74	$2.45	$420.10	40.22%	59.78%
Sub-Scenario 3	21	31	$7,836.94	$7,421.74	$2.45	$390.72	40.89%	59.11%
Sub-Scenario 4	28	22	$7,836.94	$7,421.74	$2.45	$429.89	40.00%	60.00%

The following table 27 displays the results for the last 4 sub-scenarios, which were subject to changes in the transport costs. In the last two columns we show the results of the logit modeling

Table 27 – Company "A" Results (changes in transport costs)

Company "A" (route costs changes)								
	Transit Times (days)		Route Costs ($)		Value of Time ($) / per FEU / day	Difference in Total Transport Costs ($) (TTC1 - TTC2)	Individual Preference	
	Route 1	Route 2	Route 1	Route 2			P1 (Route 1)	P2 (Route 2)
Sub-Scenario 5	21	25	$7,836.94	$7,421.74	$2.45	$405.41	40.55%	59.45%
Sub-Scenario 6	21	25	$7,836.94	$7,190.74	$2.45	$636.41	35.43%	64.57%
Sub-Scenario 7	21	25	$7,200.94	$7,421.74	$2.45	-$230.59	55.42%	44.58%
Sub-Scenario 8	21	25	$6,900.94	$7,321.74	$2.45	-$430.59	60.02%	39.98%

In above tables 26 and 27 the results have been gathered for Company "A", but for more reference please refer to the Appendix 1 in which we can find the tables separated for each sub-scenario. The analysis of the outcomes for Company "A" is presented in the last part of this chapter.

-Scenario 2 (Company "B")

The same as in Scenario 1 we will show the information of Company "B" (table 28) and the value of time (table 29). The difference between the company "A" and "B" is that company "B" transports higher valued goods. Furthermore, the results of the 8 sub-scenarios for company "B" will be displayed in two tables.

- *Sub-Scenario 1*

The next table 28 we will see the items we took in consideration for modeling of scenario of Company "B".

Table 28 – Company "B"

Yearly Throughput	6,500 FEU/year
Throughput to Chicago (70%)	4,550 FEU/year
Cargo Value (per FEU)	$50,000
Monthly Import (FEU)	1
Value of Cargo - Monthly Import	$50,000
Cost of Route 1	$7,836.94
Cost of Route 2	$7,421.74
LIBOR 6 Month	2.65994%
Bargaining Commission	0.125%
Insurance Rate	2.25%
Transit Time Route 1 (days)	21
Transit Time Route 2 (days)	25
Throughput Import - Los Angeles (TEU)	6,748,994
Throughput Import - New York (TEU)	4,561,831

The items for scenario 2 are the same as the items in scenario 1, but the throughput to Chicago, the value of the cargo, monthly import and value of the cargo per month change according to the company specification. In the following we have Table 29 with the value of time for company "B".

Table 29 – Value of Time for Company "B"

Value of Time (VoT)	
Value - Interest Cost of Capital	$1,403.86
Bargaining Commission	$65.97
Value - Insurance Rate	$1,187.50
VoT	$2,657.33

As we can see in above Table 30, the value of time changes from the one of company "A", because of the value of the cargo. The next Table 27 shows the total transport costs.

Table 30 – Total Transport Costs for Company "B"

Total Transport Costs	
Route 1 TTC	$3,033,841.12
Route 2 TTC	$2,886,694.44
TTC1 - TTC2	$147,146.68

The next Table 31 shows the outcomes of the logit formulation, which gives the individual preference of choosing route 1 or route 2.

Table 31 – Logit Formulation for Company "B"

Logit Model	
β	-0.000943327
e	0.694000401
P1	40.97%
P2	59.03%

From this Table 31 we can see there is a probability denoted as P1 of 40.97% in choosing route 1 (U.S. Intermodal System) and a probability denoted as P2 of 59.03% in choosing route 2 (Panama Canal).

In the next table 32 we compiled the information of company "B" and the results of the model for first 4 sub-scenarios, which as explained before were subject to changes in the transit time. In the last two columns we show the results of the logit modeling.

Table 32 – Company "B" Results (changes in transit time)

Company "B" (transit time changes)								
	Transit Times (days)		Route Costs ($)		Value of Time ($) / per FEU / day	Difference in Total Transport Costs ($) (TTC1 - TTC2	Individual Preference	
	Route 1	Route 2	Route 1	Route 2			P1 (Route 1)	P2 (Route 2)
Sub-Scenario 1	21	25	$7,836.94	$7,421.4	$6.99	$387.23	40.97%	59.03%
Sub-Scenario 2	27	25	$7,836.94	$7,421.74	$6.99	$429.19	40.01%	59.99%
Sub-Scenario 3	21	31	$7,836.94	$7,421.74	$6.99	$345.27	41.93%	58.07%
Sub-Scenario 4	28	22	$7,836.94	$7,421.74	$6.99	$457.16	39.38%	60.62%

The following table 33 displays the results for the last 4 sub-scenarios, which were subject to changes in the transport costs. In the last two columns we show the results of the logit modeling.

Table 33 - Company "B" Results (changes in transport costs)

Company "B" (route costs changes)								
	Transit Times (days)		Route Costs ($)		Value of Time ($) / per FEU / day	Difference in Total Transport Costs ($) (TTC1 - TTC2	Individual Preference	
	Route 1	Route 2	Route 1	Route 2			P1 (Route 1)	P2 (Route 2)
Sub-Scenario 1	21	25	$7,836.94	$7,421.74	$6.99	$387.23	40.97%	59.03%
Sub-Scenario 2	21	25	$7,836.94	$7,190.74	$6.99	$618.23	35.82%	64.18%
Sub-Scenario 3	21	25	$7,200.94	$7,421.74	$6.99	-$248.77	55.84%	44.16%
Sub-Scenario 4	21	25	$6,900.94	$7,321.74	$6.99	-$448.77	60.43%	39.57%

In above tables 32 and 33 the results have been gathered for Company "B", but for more references please refer to the Appendix 1 in which we can find the tables separated for each sub-scenario. The analysis of the outcomes of Company "B" is presented in last part of this chapter.

In the next Tables 34 and 35 we have collected all the probabilities for both companies ("A" and "B") mentioned in above tables.

Table 34 – Probabilities – Company "A"

Company "A"		
	P1 (Route 1)	P2 (Route 2)
Sub-Scenario 1	40.55%	59.45%
Sub-Scenario 2	40.22%	59.78%
Sub-Scenario 3	40.89%	59.11%
Sub-Scenario 4	40.00%	60.00%
Sub-Scenario 5	40.55%	59.45%
Sub-Scenario 6	35.43%	64.57%
Sub-Scenario 7	55.42%	44.58%

Sub-Scenario 8	60.02%	39.98%

Table 35 – Probabilities – Company "B"

Company "B"		
	P1 (Route 1)	P2 (Route 2)
Sub-Scenario 1	40.97%	59.03%
Sub-Scenario 2	40.01%	59.99%
Sub-Scenario 3	41.93%	58.07%
Sub-Scenario 4	39.38%	60.62%
Sub-Scenario 5	40.97%	59.03%
Sub-Scenario 6	35.82%	64.18%
Sub-Scenario 7	55.84%	44.16%
Sub-Scenario 8	60.43%	39.57%

In above we have displayed the outcomes for the 8 sub-scenarios of each company. It is important to mention that the sensitivity analysis was made based on the changes in the transit times and the costs of the routes, by the fact that in the model these inputs are fixed, but in the day to day are factors that are subject to fluctuation. For example the transit time, may change because of delays due to labor strikes, low port operation performance, low rail operation performance, not enough capacity to handle the cargo, etc. In the case of the costs of the routes, these may change due to bunker prices fluctuation or exchange rate changes. From tables 35 and 36 we can see that for the sub-scenarios 1 to 4 there are slightly changes in the preference of the customers when it comes to changes in the transit time. On the other hand for the other four sub-scenarios we can see bigger changes in the route preference when it comes to changes in the transport costs. Hence, we can say that the customer route choice is more sensitive subject to changes in the prices rather than in changes in transit time.

5.3 Conclusion

In this chapter we have explained the model (logit model) chosen for the quantitative analysis of this study. As mentioned before, the *Logit Model* is one of the binary choice models, which help us, by making some calculation what is the choice of an individual between 2 alternatives (in our case the two routes) based in certain parameters. Furthermore, in order to make the sensitivity analysis we had to create 8 sub-scenarios for both of the two main scenarios in which the first four were computed based on the changes of transit time and the last four on the changes of the costs of the routes. The aim of these sub-scenarios is have a better look of how sensitive the choice of an individual between the two routes, according to the transit time and the costs of the routes. The parameters we took in consideration to solve the model were the costs of the routes, total transport costs (comprise costs of the routes, interest cost of capital, insurance rate) and the transit time of each route. Moreover, in the logit formula, there is an important item which is the Beta (β) and it was calculated, based on the logarithm of the ratio of the TEU throughput of the two gateways selected (ports of Los Angeles and New York) divided by the costs difference of the routes. It is important to note that the Beta for all the sub-scenarios is a constant factor, which leads us to get the probabilities for both routes. In the next chapter we will make a cost comparison analysis based on the outcomes we collected in this chapter

Chapter 6 Costs Comparison Analysis

6.1 Introduction

Based on the methodology adopted, we have calculated the value of the U.S. Intermodal route and the Panama Canal route, in terms of individual's preferences. We have denoted our individual's as Company "A" and Company "B", with different import characteristics as the type of commodity and value of the cargo. In this chapter we will present the costs comparison analysis for the two chosen routes. To do so, we developed 8 sub-scenarios for each of the two main scenarios. Moreover, we used the Logit Model with the aim of collecting the probabilities based on certain parameters, which are the costs of the routes and the transit time of each route.

6.2 Costs Analysis

In our point of view the competitiveness between the U.S. Intermodal System and the Panama Canal is subject to the pricing policies and the time differential between the routes. However, there are certain factors that are very difficult to quantify in the shipper's route alternative decision (The Panama Canal Authority). Two of these factors are the reliability and the quality of the service, in which a shipper may face delays in cargo that is sensitive to the time or high value or cargo damage when receiving the shipment. These factors are difficult to quantify, by the fact that they depend on the situations the shipper is facing in a daily basis. For the aim of this study, we did not take in consideration these factors, due to the unavailability of data from the shippers. However, we could measure the reliability of the services by creating 8 sub-scenarios in which 4 of them are subject to the changes in transit time.

The factors taken in consideration to make the analysis are:

<u>-Transport costs of each route</u>: these costs include ship voyage cost, port handling cost, rail transport cost and Panama Canal tolls (for the AW route) charges and surcharges.

<u>-Value of Time (VoT):</u> this factor includes the interest cost of capital of the shipment and the insurance rate. For the interest cost of capital, we used the LIBOR rate.

<u>-Transit Time:</u> this factor refers to the time it takes in each route to reach destination.

All these three factors are linked in a way that a change in one of them will affect the Total Transport Costs. A change in the bunker price will affect the BAF surcharge and consequently the ocean and rail freight. Moreover, an increase in the interest cost of capital will affect the value of time, thus an increase in the total transport cost. The same is the case for the transit time, in which a delay in one of the transport modes will affect the value of time, leading to an increase in the total transport cost.

In our study the combination of this factors estimate the difference in the cost of the two routes, which is measured in $ / FEU. In the Tables 26, 27, 33 and 34 presented in the previews chapter, we displayed the results of the probabilities of choices between the U.S. Intermodal route and the Panama Canal route and cost comparison of each route.

These mentioned tables show us the results of the implemented model. For the two main scenarios (Company “A” and Company “B”) we can see that the outcomes (P1 and P2) have relatively the same sequence of changes in their probabilities (see tables 26, 27, 33 and 34). However, we noticed that changing the costs of the routes have a higher impact in the outcomes than the changing the transit time. Moreover, from the results we can say that the probabilities of route preference change according to the differences in the total transport costs, which is a factor affected by both, the transit time and the costs of the routes. An increase in the difference of the total transport costs reflects that the individual is inclined to choose the route 2, whereas a decrease is more likely to go for the route 1. As an example we can see that in both Company “A and “B” the sub-scenarios subject to the changes of the costs of the routes reflect different preferences, in which a high difference of the total transport costs leads to a preference towards the route 2, whereas a small difference leads to a preference towards the route 1. Although this quantitative analysis is not taking in consideration some other factors that affect the preference of a shipper between alternatives choices, we must add that the choice behavior depends as well in the kind of level of service the customer might require, i.e. when someone makes a shipment of summer apparel, he must be sure that the cargo will arrives on time for the summer season and this kind of factors are difficult to quantify.

6.3 Conclusion

In this chapter we have made the cost comparison analysis of the two routes and the impact these costs have in the probabilities of choosing one of the alternative routes. The analysis was made based on the changes in the transit times and in the changes of the costs of the routes. Moreover, the value of time is another factor that we took into consideration, since it represent the value of the cargo over the time is being shipped to destination. The value of time depends on the type of cargo is shipped and the negotiation between the shipper and the party whom is financing the transport costs. Furthermore, we have noticed that in the model outcomes a change in the costs of the routes has a higher impact in the shipper route preference than a change in the transit time. In our perspective, the reason of this is because the costs of a certain route vary in a regular basis, since depends on surcharges which are floating charges intended to recover rising or constantly fluctuating costs that are out of the carrier’s control and to cover their operation costs (Transportation Stabilization Agreement). In the next chapter we will discuss the benefits of the expansion of the Panama Canal towards the shipper.

Chapter 7 Benefits of the Panama Canal Expansion

7.1 Introduction

The Panama Canal is one of the most important alternatives for maritime transport between Asia and the East coast of the United States. As a result of the expansion of the Canal, liner shipping companies will enjoy of economies of scale, leading to lower operational costs versus the TEU volume they would carry. In this chapter we will discuss the benefits of the Panama Canal expansion towards the shipper in term of costs.

7.2 Benefits of the Economies of Scale through the Expanded Panama Canal

Since the opening, the Panama Canal has been limited to handle Panamax vessel. However, this has been an issue in the last years, by the fact that bigger cellular vessels have been deployed to cover the main trades of the world. Moreover, these mega vessels have been restricted; due to there is not enough infrastructure or enough depth in the ports in order to receive them. This is the case of the Panama Canal. Nevertheless, this restriction will be relaxed with the expansion of the Canal, leading to the liner shipping companies to minimize their operation costs in routes with high distances and high cargo volume as the transpacific route from Asia to the East coast of the United States (The Panama Canal Authority). In Table 36 we can see that Post-Panamax vessels with capacity of 6,000 TEU and 8,000 TEU compared to Panamax vessels of 4,000 TEU represent 8% and 16% of costs saving respectively.

Table 36 – Post-Panamax Vessel vs. Panamax Vessels (costs saving)

Costs Saving (%) per Voyage per TEU - Postpanamax Vessels (compared to 4000 TEU Panamax Vessel)		
Route	6,000 TEU	8,000 TEU
Asia - United States East Coast	8%	16%

Source: The Panama Canal Authority

Furthermore, the amount of Post-Panamax vessel deployed in the transpacific route has increased 26% from 2002 to 2006. In 2006 there were reported 291 vessels in the route between Asia and East coast of the United States, in which 168 were Panamax vessels. The income of this last mentioned, recorded for $377,000,000, representing 33.8% of the Canal revenues and 2,119 transits (The Panama Canal Authority). It is forecasted that by 2025 the Panama Canal will receive more than 3,000 annual transits of Post-Panamax vessels, which represent more than 6,000 Panamax vessels in a year. According to the Panama Canal Authority, is it estimated that the with the Canal expanded it will require less transits, but at the same time the volume will increase, since the average container vessel size is estimated to be between 8,000 TEU and 10,000 TEU. Moreover, the number of transits estimated for 2025 is 16,000, which represent a reduction of 14% in the number of transits if the Canal is not expanded. Moreover the studies and market projections show that the vessels PC/UMS (Panama Canal /Universal Metric System) global tons volume will be duplicated in 2025, with an increase of 3% per year (The Panama Canal Authority). In the segment of the containerized cargo that transits the Canal is estimated to increase in an annual rate of 5.6%, from 98 million PC/UMS in 2005 to 296 million PC/UMS in 2025 with the canal expansion. On the other hand, without the expansion is estimated to growth to 185 million PC/UMS in 2025.

The benefits of the expansion of the Panama Canal are not only towards to the shipping lines companies, but to the shipper itself. By the fact that the shipping lines companies may enjoy of economies of scale in the transpacific route from Asia to the East coast of the United States by reducing costs vs. the high cargo volume, the shippers will receive part of this benefit. According to the data collected with regards to the ocean transportation freight, we have that the cost of transporting one 40 – Ft. container from Shanghai to Los Angeles is $4,337.32 and from Shanghai to New York is $5,979.32. So a reduction in the operational costs from Shanghai to New York (through the Panama Canal) fits with our model premise, since it will lead to a higher difference within the two total transport costs, thus a higher probability of choosing Route 2 (all water route through the Panama Canal).

7.3 Conclusion

In this chapter we have reviewed the benefits of the Panama Canal Expansion towards the shipping line companies and the shipper itself. According to the Panama Canal, vessels with capacity of 6,000 and 8,000 TEU represent a cost saving per voyage per TEU of 8% and 16% respectively compared to vessels of 4,000 TEU. Moreover, with the construction of the third set of locks in the Panama Canal the expected average vessel's size is between 8,000 and 10,000 TEU, which will represent fewer transits in a year, but the transiting volume will increase. The Panama Canal expects an increase of containerized cargo volume transiting of 296 million PC/UMS in 2025.

The shipping lines are enjoying the economies of scale, by the fact that more mega vessels are being deployed in the long distances routes as it is the transpacific route from Asia to the East coast of the United States. With the Panama Canal expansion, the shipping lines are able to deploy these mega vessels through the canal, reducing the operational cost versus the TEU volume. Moreover, the shipper itself indirectly enjoy of the economies of scale, since they can ship more cargo at a lower cost.

Chapter 8 Conclusion

Concluding this thesis, we have done a cost comparison analysis of the two main maritime and inland transportation routes from Asia to the East coast of the United States. These two routes comprise sea and rail transportation. We began our research with the aim to conclude with the route feasibility for container transportation of the two routes before mentioned. With the help of our internship in the facilities of the Panama Canal Authority, we started our research and clarifying which aspects and criteria's are of relevance to undertake the study. With the literature review we had a clear overview of the market of these two routes and we started explaining the components of the routes, such as the relevant trades and flows for the Panama Canal, the main competitors and the U.S. Intermodal System network (comprises the Railroad Corridors). Chicago, Illinois was chosen as the cargo destination point, since it is one of the main business economic areas in the east part of the United States. More in detail, the routes we compared in terms of transportation costs are: A) Shanghai to Chicago (through the U.S. Intermodal System) and B) Shanghai to Chicago (through the Panama Canal). The entrance gateway for the first route previously mentioned is the port of Los Angeles, and for the second route is the port of New York.

In order to make the cost comparison analysis we have chosen the "*Logit Model*", which is an econometric model that gives us the probabilities of an individual in choosing between two alternatives. In our case the alternatives are the two routes and our individuals are two customers settled in Chicago, which make imports into the U.S. from Asia. Moreover, the data collected for the modeling comprises all transportation costs and transit time. The transportation costs involve the cost at sea, inland, fuel surcharges, peak season surcharge and currency adjustment factor. The value of time is an important criterion that we added in the costs of transportation and was calculated based on the value of the cargo transported, the interest rate and insurance rate. This last criterion refers to the value of the cargo within the transit time. In the logit formulation there is a constant referred to as Beta (β), which is calculated based on historical data of the flows imports of each company. Unfortunately, we were not able to collect these data from the companies, so instead it was calculated based on the logarithm of the ratio of the TEU throughput of the two gateways selected (ports of Los Angeles and New York) divided by the costs difference of the routes. We believe that our modeling would have been more accurate if the historical flows imports data of the companies would have been available. Due to this and for the accuracy of the modeling, further research is still open to be able to get more interesting results.

For the modeling we created two scenarios which comprises two companies "A" & "B". Moreover, we have 8 sub-scenarios for each scenario, which helped us to make a sensitivity analysis of the costs of the routes. In the modeling we changed the transit times for the first 4 sub-scenarios and the transport costs for the last 4 sub-scenarios. Doing this, we got the probabilities of the individuals in choosing one of the two routes. Looking at the outcomes we concluded that a change in the transportation costs (i.e. freight rates) has a higher impact on the decision of the individuals among the two routes. On the other hand, changing the transit times we got slightly changes in the probabilities and in our case the individuals were more inclined towards the Panama Canal route. Moreover, the difference in the total transport costs between the routes has a high impact on the decision of the individuals, in which based on the model outcomes, a high cost difference leads the route decision towards the route 2 (the Panama Canal) and a small cost difference towards the route 1 (the U.S. Intermodal System).

After modeling we proceeded to briefly analyze the benefits of the Panama Canal expansion towards the shipping line companies and the shipper. According to the Panama Canal Authority, they expect to gain more market when the third set of locks is ready. Is estimated an annual increase of 5.6% leading to have approximately 296 million PC/UMS in 2025, whereas in 2005 it accounted 98 million PC/UMS. Furthermore, the shipper will be benefited from the expansion, since shipping line companies will enjoy of economies of scale through the all water route (Panama Canal route).

At the moment we don't have details of changes in the pricing policies of the Panama Canal route, so it would be accurate for the sake of this study to analyze this in further research. Lastly, it is to be hoped that this thesis will contribute to further studies related to the U.S. Intermodal System and the Panama Canal routes.

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Appendix Sub-Scenarios Results

On below we will find the tables with the results of the sub-scenarios from 2 to 8 for Company "A"

- *Sub-Scenario 2*

Next Table 37 shows the total transport cost based on the transit time of sub-scenario 2 (see Table 20).

Table 37 – Total Transport Costs - Company "A" (Sub-Scenario 2)

Total Transport Costs	
Route 1 TTC	$7,903.02
Route 2 TTC	$7,482.93
TTC1 – TTC2	$420.10

Next Table 38 shows the outcomes of the logit formulation for sub-scenario 2.

Table 38 – Logit Formulation - Company "A" (Sub-Scenario 2)

Logit Model	
β	-0.000943327
e	0.672813543
P1	40.22%
P2	59.78%

- *Sub-Scenario 3*

Next Table 39 shows the total transport cost based on the transit time of sub-scenario 3 (see Table 20).

Table 39 – Total Transport Costs - Company "A" (Sub-Scenario 3)

Total Transport Costs	
Route 1 TTC	$7,888.34
Route 2 TTC	$7,497.61
TTC1 – TTC2	$390.72

Next Table 40 shows the outcomes of the logit formulation for sub-scenario 3.

Table 40 – Logit Formulation - Company "A" (Sub-Scenario 3)

Logit Model	
β	-0.000943327
e	0.69171513
P1	40.89%
P2	59.11%

- *Sub-Scenario 4*

Next Table 41 shows the total transport costs based on the transit time of sub-scenario 4 (see Table 20).

Table 41 – Total Transport Costs - Company "A" (Sub-Scenario 4)

Total Transport Costs	
Route 1 TTC	$7,905.47
Route 2 TTC	$7,475.59
TTC1 - TTC2	$429.89

Next Table 42 shoes the outcomes of the logit formulation for sub-scenario 4.

Table 42 - Logit Formulation - Company "A" (Sub-Scenario 4)

Logit Model	
β	-0.000943327
e	0.666628497
P1	40.00%
P2	60.00%

- *Sub-Scenario 5*

Next Table 43 shows the total transport costs based on the changes of the costs of the routes (see Table 21).

Table 43 – Total Transport Costs – Company "A" (Sub-Scenario 5)

Total Transport Costs	
Route 1 TTC	$7,888.34
Route 2 TTC	$7,482.93
TTC1 - TTC2	$405.41

Next Table 44 shows the logit formulation for sub-scenario 5.

Table 44 – Logit Formulation – Company "A" (Sub-Scenario 5)

Logit Model	
β	**-0.000943327**
e	0.682198877
P1	40.55%
P2	59.45%

- *Sub-Scenario 6*

Next Table 45 shows the total transport costs based on the changes of the costs of the routes (see Table 21).

Table 45 – Total Transport Costs – Company "A" (Sub-Scenario 6)

Total Transport Costs	
Route 1 TTC	$7,888.34
Route 2 TTC	$7,251.93
TTC1 - TTC2	$636.41

Next Table 46 shows the logit formulation for sub-scenario 6.

Table –46 Logit Formulation – Company "A" (Sub-Scenario 6)

Logit Model	
β	-0.000943327
e	0.548623654
P1	35.43%
P2	64.57%

- *Sub-Scenario 7*

Next Table 47 shows the total transport costs based on the changes of the costs of the routes (see Table 21).

Table 47 – Total Transport Costs – Company "A" (Sub-Scenario 7)

Total Transport Costs	
Route 1 TTC	$7,252.34
Route 2 TTC	$7,482.93
TTC1 - TTC2	-$230.59

Next Table 48 shows the logit formulation for sub-scenario 7.

Table 48 – Logit Formulation – Company "A" (Sub-Scenario 7)

Logit Model	
β	-0.000943327
e	1.242992682
P1	55.42%
P2	44.58%

- *Sub-Scenario 8*

Next Table 49 shows the total transport costs based on the changes of the costs of the routes (see Table 21).

Table 49 – Total Transport Costs – Company "A" (Sub-Scenario 8)

Total Transport Costs	
Route 1 TTC	$6,952.34
Route 2 TTC	$7,382.93
TTC1 - TTC2	-$430.59

Next Table 50 shows the logit formulation for sub-scenario 8.

Table 50 – Logit Formulation – Company "A" (Sub-Scenario 8)

Logit Model	
β	-0.000943327
e	1.501083716
P1	60.02%
P2	39.98%

On below we will find the tables with the results of the sub-scenarios from 2 to 8 for Company "B"

- *Sub-Scenario 2*

Next Table 51 shows the total transport cost based on the transit time of sub-scenario 2 (see Table 20).

Table 51 – Total Transport Costs - Company "B" (Sub-Scenario 2)

Total Transport Costs	
Route 1 TTC	$8,025.75
Route 2 TTC	$7,596.56
TTC1 - TTC2	$429.19

Next Table 52 shows the outcomes of the logit formulation for sub-scenario 2.

Table 52 – Logit Formulation - Company "B" (Sub-Scenario 2)

Logit Model	
β	-0.000943327
e	0.667068394
P1	40.01%
P2	59.99%

- *Sub-Scenario 3*

Next Table 53 shows the total transport cost based on the transit time of sub-scenario 3 (see Table 20).

Table 53 – Total Transport Costs - Company "B" (Sub-Scenario 3)

Total Transport Costs	
Route 1 TTC	$7,983.79
Route 2 TTC	$7,638.52
TTC1 - TTC2	$345.27

Next Table 54 shows the outcomes of the logit formulation for sub-scenario 3.

Table 54 – Logit Formulation - Company "B" (Sub-Scenario 3)

Logit Model	
β	-0.000943327
e	0.722019753
P1	41.93%
P2	58.07%

- *Sub-Scenario 4*

Next Table 55 shows the total transport cost based on the transit time of sub-scenario 4 (see Table 20).

Table 55 – Total Transport Costs - Company "B" (Sub-Scenario 4)

Total Transport Costs	
Route 1 TTC	$8,032.74
Route 2 TTC	$7,575.59
TTC1 - TTC2	$457.16

Next Table 56 shows the outcomes of the logit formulation for sub-scenario 4.

Table 56 - Logit Formulation - Company "A" (Sub-Scenario 4)

Logit Model	
β	-0.000943327
e	0.649696897
P1	39.38%
P2	60.62%

- Sub-Scenario 5

Next Table 57 shows the total transport costs based on the changes of the costs of the routes (see Table 21).

Table 57 – Total Transport Costs – Company "B" (Sub-Scenario 5)

Total Transport Costs	
Route 1 TTC	$7,983.79
Route 2 TTC	$7,596.56
TTC1 - TTC2	$387.23

Next Table 58 shows the logit formulation for sub-scenario 5.

Table 58 – Logit Formulation – Company "B" (Sub-Scenario 5)

Logit Model	
β	-0.000943327
e	0.694000401
P1	40.97%
P2	59.03%

- *Sub-Scenario 6*

Next Table 59 shows the total transport costs based on the changes of the costs of the routes (see Table 21).

Table 59 – Total Transport Costs – Company "B" (Sub-Scenario 6)

Total Transport Costs	
Route 1 TTC	$7,983.79
Route 2 TTC	$7,365.56
TTC1 - TTC2	$618.23

Next Table 60 shows the logit formulation for sub-scenario 6.

Table – 60 Logit Formulations – Company "B" (Sub-Scenario 6)

Logit Model	
β	-0.000943327
e	0.558114428
P1	35.82%
P2	64.18%

- *Sub-Scenario 7*

Next Table 61 shows the total transport costs based on the changes of the costs of the routes (see Table 21).

Table 61 – Total Transport Costs – Company "B" (Sub-Scenario 7)

Total Transport Costs	
Route 1 TTC	$7,347.79
Route 2 TTC	$7,596.56
TTC1 - TTC2	-$248.77

Next Table 62 shows the logit formulation for sub-scenario 7.

Table 62 – Logit Formulation – Company "B" (Sub-Scenario 7)

Logit Model	
β	-0.000943327
e	1.264495514
P1	55.84%
P2	44.16%

- *Sub-Scenario 8*

Next Table 63 shows the total transport costs based on the changes of the costs of the routes (see Table 21).

Table 63 – Total Transport Costs – Company "B" (Sub-Scenario 8)

Total Transport Costs	
Route 1 TTC	$7,047.79
Route 2 TTC	$7,496.56
TTC1 - TTC2	-$448.77

Next Table 64 shows the logit formulation for sub-scenario 8.

Table 64 – Logit Formulation – Company "B" (Sub-Scenario 8)

Logit Model	
β	-0.000943327
e	1.527051329
P1	60.43%
P2	39.57%