Sensitivity Analysis of Panama Canal Traffic Demand

Final Report

Prepared for:
Panama Canal Commission

Prepared by:
ICF Kaiser International, Inc.
in association with:
Louis Berger International, Inc.

July 31, 1996

Table of Contents

SECTION 3: MEASURING THE ELASTICITY OF DEMAND FOR CANAL TRANSIT

SECTION 4: IMPACT OF ANNUAL VERSUS LESS FREQUENT TOLL INCREASES

SECTION 5: IMPLICATIONS OF CANAL USERS' EXPECTATIONS

SECTION 6: FEASIBILITY ASSESSMENT OF ON-DECK CARGO FEES

Table of Contents

Executive Summary

Introduction

The Panama Canal Commission (PCC) selected the team of ICF Kaiser International and Louis Berger International in an open competition to conduct a sensitivity analysis of Canal traffic demand to changes in transit costs. It was not the objective of this study to: analyze toll policy at the PCC; suggest alternative, new toll policies in order to generate increased revenues for the PCC; or provide trade forecasts.

Previous studies of toll sensitivity have been carried out including the following three in the last thirteen years.

Report Title	Author	Date
A Sensitivity Analysis of Panama Canal Trade, 1984-2010	Temple, Barker & Sloane, Inc. (now Mercer Management Consulting, Inc.)	1986
Financial Scheme, Financial Analysis and Management Arrangements Component Study (FSFAMAC)	Robert Nathan Associates with Daiwa Institute of Research and others	1993
Tolls Policy Considerations for the Future Canal Organization	Louis Berger International, Inc. and Louisiana State University National Ports and Waterways Institute	1993

The approach used in each of the studies above can be described as "cost of the next best alternative" in which the cost of Canal transit by route and commodity type was compared to the cost of using a by-pass alternative; when the cost of Canal transit reaches a high enough level, operators will select an alternative routing. The increases that were examined were 25, 50 and 100 percent. No statistical models, utilizing PCC data, were involved in these earlier studies.

In this study, the team analyzed and measured the sensitivity of Canal users (vessel operators) to changes in Panama Canal transit costs using both quantitative and nonquantitative approaches. The quantitative method included using actual PCC transit and cost data. The nonquantitative data, derived from a marketing tool, a PCC user questionnaire, provided the views and opinions of actual PCC customers. From these a detailed model was developed; it incorporated PCC commodity data (29 commodity groups), route designation (28 major routes), and transit costs. Then, using a sophisticated estimation approach, actual elasticities of demand were calculated. These elasticities reflect the likely reaction of vessel operators to increased tolls. The survey of Canal users was completed for input into the analysis of their expectations with regard to Canal tolls and the transition. Also examined were the advantages and disadvantages of charging additional fees for on-deck cargo on containerships and other vessels transiting the Canal.

The most recent Canal data available to the Consultants was FY1995, and the tonnage flows through Canal are depicted in the following two charts, ES-1 and ES-2. The first chart indicates the dominance of the trade route between East Asia and the East Coast of North America (44 percent of total tonnage), while the second chart clearly shows the predominance of bulk commodities through the Canal.

Chart ES-1

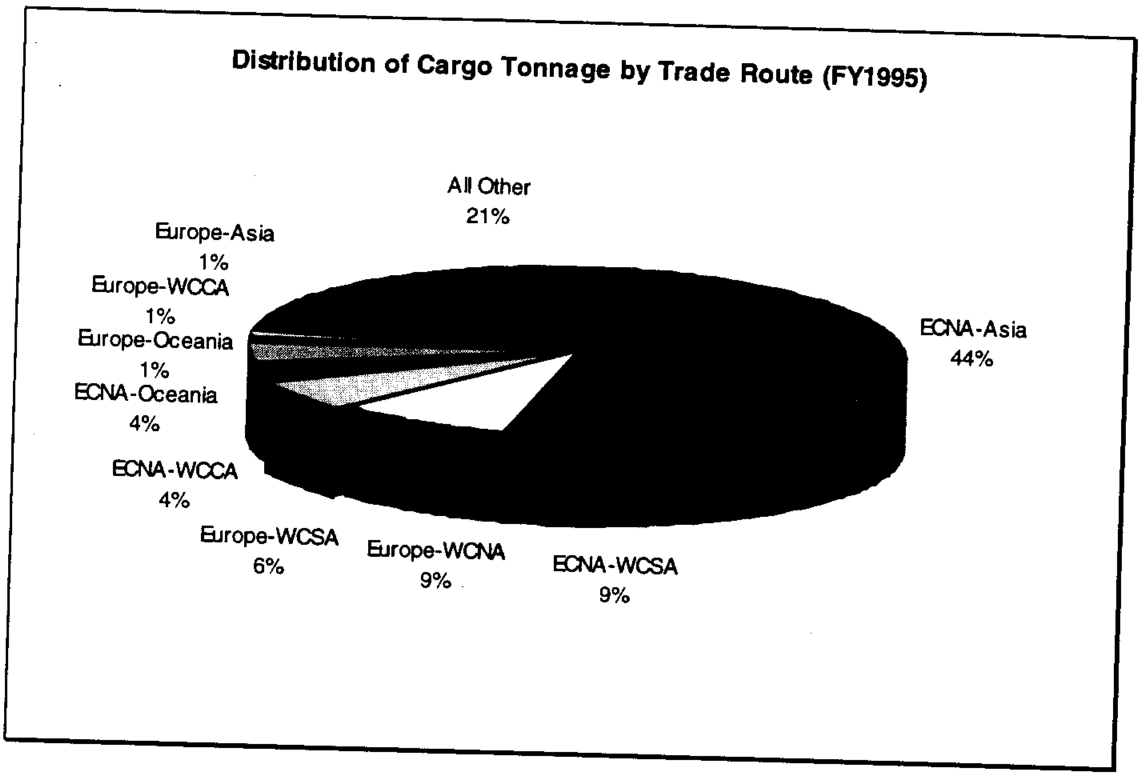
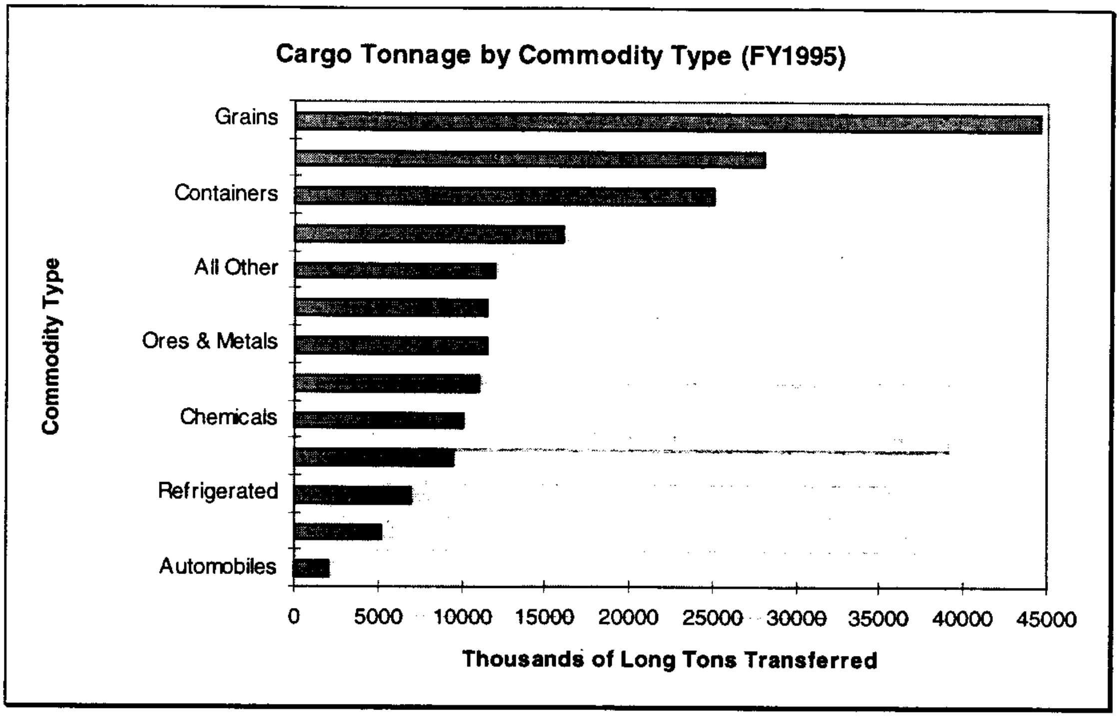


Chart ES-2



Canal revenues in FY1995 reflected the dominance of bulk commodities as shown above. Table ES-1 shows that dry and liquid bulk carriers together generated 49 percent of the Canal's revenue.

Table ES-1
Percentage of Tolls Collected from Commercial Vessels-1995

Vessel Type	*1995 Canal Tolls (% share)*
Dry Bulk	36%
Full Container	15%
Tanker	13%
Vehicle Carrier	11%
Reefer	8%
General Cargo	5%
Passenger	3%
Ro/Ro	2%

Source: PCC

In work such as this, it is important to note that there are sufficient exogenous events that affect the behavior of vessels that can potentially transit the Canal and that no statistical model or approach can simulate with certainty. Shifts in patterns of trade, policy decisions (such as China's to cease export of grain to Asia), applications or removal of subsidies (such as in the European Union), weather conditions or simply commodity price speculation (as happened recently with U.S. oil companies) can all combine to create changing patterns of vessel operations, independent of Canal toll increases. The sensitivity analysis should be seen as one of the tools for assessing the impact of toll increases. It will need to be tempered with short term events for a more accurate assessment.

Summary of Results

Based on the analysis of PCC data using a model developed by ICF Kaiser, the results generally indicate that bulk cargo carriers and shippers are more sensitive to increases in Canal transit costs than containership (liner) operators.

Bulk Shipping

The toll sensitivity for bulk commodities, both liquid and dry, is higher than for liner cargo for a number of reasons:

- Bulk operators tend to be independents operating without set schedules. They, and the products they carry, tend to be sensitive to small changes in prices. While transportation costs may be small relative to total costs, smaller differences in price may differentiate suppliers. Thus, transportation costs can reduce market penetration for suppliers that are geographically disadvantaged in their key markets.

- Since bulk operators follow supply, and since they cannot sustain higher costs in their own margins and must pass these on to the buyers of their services (see Table ES-2 below), the demand for Canal transits will fall quickly when prices are increased even slightly. In response, bulk operators will then move their ships to a location where opportunities are greatest. As a result, this flexibility is driven by small changes in costs and larger swings in supply.

Table ES-2
Average Daily and Hourly Values of Ships' Time By Vessel Type
U.S. Dollars in FY 1995

Vessel Type	Cost Per Day (000s)	Cost Per Hour
Containers	$25-$41	$1000-$1700
General Cargo	$11-$14	$460-$580
Combos	$12-$26	$500-1090
Dry Bulk	$12-$30	$500-$1250
RoRo	$20-$32	$830-$1330
Vehicle Carriers	$25	$1040
Reefer Ships	$24	$1010
Gas Tankers	$57	$2380
Product Tankers	$14-$30	$580-$1250
Tankers	$12-$36	$500-$1500
Other Vessels	$11	$460

- Bulk products, when compared to manufactured goods, tend to be less differentiated. Due to the "sameness" across such commodities, suppliers and buyers can act quickly. These sudden distribution shifts create a higher price elasticity for ships carrying bulk cargoes. Thus, we should expect bulk carriers to react to changes in toll rates rather quickly

An example of this ability to shift supply between suppliers may be found in the coal market. While there have been some new suppliers entering the market, notably Colombia, the largest suppliers today are the United States, Canada, Europe, Indonesia/India/China, and Australia. In the case of Europe, most European coal (including that of Eastern Europe), is sold within Western Europe. Bulk shipments by European railroads maintain this relationship between supplier and buyer. The United States and Australia compete as major suppliers of coal to both Europe and Asia. But, other sources are emerging-such as South Africa. After the end of the trade embargo, South Africa's coal business has climbed from $800 million in 1980, $1.7 billion in 1990, and is forecast to climb to $2 billion by the year 2000. Other new sources include Canada (west) and China.

Liner Shipping

Liner shipping companies, on the other hand, operating on fixed, published time schedules, are less sensitive than bulk operators to moderate increases in Canal transit costs in the near term. The daily operating costs of a typical liner vessel, carrying containers and breakbulk cargoes, are very high, (see Table ES-2 above) so that such operators are more sensitive to delays that disrupt their schedules than to increases in the cash cost of a Canal transit. In the user survey, these operators indicated that they would even be willing to pay more for a Canal transit in exchange for improved service and a guarantee of transit time.

For containerized cargo, where the model estimated a minimal amount of elasticity, the results indicated that a toll increase would have a very small negative effect on cargo volumes, and it was decided to hold the change to 0 (zero). Since container ships travel on regular, fixed schedules and routes, advertised well in advance of actual service dates, vessel utilization varies over time and a marginal decline in cargo will not alter the sailing pattern of the ships, at least not in the near term. However, if volumes decline over a long period of time below acceptable revenue levels, then of course, operators will take remedial action. The Consultants conservatively assumed that toll increases at reasonable levels will not cause reduced transits in the short to medium term even if cargo volumes drop marginally. Decisions on liner vessel routing can generally be assumed to be a function of vessel utilization, total voyage costs, of which the Canal transit charge represents between 2 and 7% of the total, and other operating parameters such as feeder options, demand centers and conforming to strategic alliance agreements. The determination of whether or not to transit the Canal is a longer term decision based on a combination of the above factors. It is exceedingly difficult to establish at what point a toll rate increase will combine with the other operating factors to force a change in vessel routing. If a bypass decision is reached by a liner shipping operator, however, it will have a multiple effect on Canal revenues due primarily to the shipping alliances which combine two or more carriers into one service. Over the long term, then, one would expect the results of the elasticity model to apply.

Reefer Vessels

For refrigerated vessels and their cargoes, where negative price elasticities were observed, the Consultant limited the effect to a maximum -0.5. It is possible that reefer vessel operators, and more importantly, producers, have little choice in some cases but to transit through the Panama Canal. In cases such as Ecuador to Europe, it is likely that higher tolls will ultimately be borne by growers in the form of slightly lower income rather than losing the entire market in Western Europe, hence a relatively low sensitivity to toll increases.

After taking into consideration the variation in responses to a toll rate increase by ship type, and, hence, by cargo, one important rule of thumb that stemmed from the statistical analysis of the complete 1980-95 data is:

every 1 percent increase in tolls generates about 0.55 percent increase in revenue in the long term across all ship types, everything else being unchanged.

The Consultants' modeling showed that, if the PCC were to impose a 15 percent hike in tolls in 1997 and 1998 (Scenario 1), then, over the full 1997-2000 period, cargo would fall by almost 119 million tons and revenues would increase by $292 million compared to what might have otherwise occurred under a zero-increase base case scenario.

Concerning the imposition of fees for on-deck cargo, the team measured the potential increase in revenue that could accrue if Canal users were charged higher transit tolls in proportion to the on-deck tonnage compared to below-deck tonnage. The increases are substantial, and primarily incurred by container and RoRo vessels. However, it was not the objective of this study to examine PCC toll-setting policies. This report considers several options for imposing on-deck cargo fees and describes the likely response of vessel operators. In short, the current PC/UMS-based charging scheme appears to compensate the PCC as much as would a tonnage-based fee structure that included on-deck cargo charges.

The detailed elasticities of Canal demand by commodity, route, and ship type are contained in the main body of the report. A summary of the main highlights of the modeling and the user survey are presented below, along with a short review of the feasibility and impact of assessing on-deck cargo fees.

Model Results

The transit cost sensitivity model developed by the ICF Kaiser team used 16 years (FY1980-95) of Canal transit data by commodity and route, processed by the study team and put into a flexible database to permit easy access and flexibility for modeling purposes. During the period covered, there were three Canal toll rate increases, shown in the table below, and, in order to capture the effect of these increases on Canal traffic and revenues, the model also incorporates many other key variables, besides the cost of Canal transit, that affected trade through the Canal during that period.

Table ES-3
Canal Toll Rate Changes

Date of Adjustment	Toll for Laden Voyage per Panama Canal Net Ton	Increase (Percent)
1915-1938	$1.20	
1938	$ .90	
1974	$1.08	19.7%
1976	$1.29	19.5%
1979	$1.67	29.3%
1983	$1.83	9.8%
1989	$2.01	9.8%
1992	$2.21	9.9%

Source: PCC

These other variables include: global trade demand by commodity and country, development of bypass routes (e.g. mini-landbridge), the cost of ship's time based on the route and type of cargo carried, and various exogenous factors such as a change in trade agreements or policies (e.g. China's decision to stop exporting corn to the Far East). Only by including all such variables can the model accurately assess the pure cargo and revenue effects of increases in Canal transit costs. Concerning model accuracy, to the best of the Consultants' capability, this model captures the statistically-defined historical performance, the above additional factors, plus shipping industry behavior based on the Consultants' past work in the field. Therefore, while there are always exogenous shocks that can affect future performance, the Consultants feel strongly that this model is the most accurate and complete ever built to deal with the issue of sensitivity to the cost of transiting the Canal.

Chart ES-3
Transit Cost Elasticity by Ship and Product Carried

Ship Type	Transit Cost Elasticity	Product Characteristics
Bulk	⇧ Very Elastic (< -1.0).	Many Sources/Homogeneous
Tanker	⇗ Slightly Less Elastic (= -1.0)	Homogeneous
General/Reefer	⇩ Inelastic (> -1.0)	Fewer sources/Differentiated
Container	⇩ Inelastic (= 0)	Differentiated

Cargo Demand - Baseline

Additionally, the study team developed a new forecast of cargo demand through the year 2015, based on the ICF Kaiser global trade model. A baseline forecast was developed that assumed no toll increase at all through the end of the forecast period (2015). Developing a new cargo demand forecast was necessary in order to measure the tonnage and revenue effects of an increase in Canal transit costs against a consistent base case.

The cargo demand forecast incorporated the outlooks for key economies (U.S., Europe, Far East, Latin America by country, etc.) which drive the world seaborne trade outlook. The Canal's share of global seaborne trade, by commodity and route, was then modeled and projected based on the general outlook for world economic and trade developments.

The baseline projection calls for tonnage to grow to 215 million tons in 2000, and then to 303 million tons by 2015. This represents a 2.4 percent average annual growth through 2000, followed thereafter by slightly slower growth. Containerized cargo is the fastest growing portion of the cargo picture, averaging 4.7 percent annually through 2000 and 4.1 percent thereafter. Bulk commodities, both liquid and dry, accounted for 70 percent of the Canal's tonnage in FY1995 but are forecast to grow more slowly than containerized tonnage, and the baseline projection calls for this segment to fall slightly to 66 percent by 2015 as containerized cargo and other general cargo grow faster.

In terms of route structure, the U.S. East Coast to/from East Asia route accounted for over 38 percent of Canal tonnage in 1996, and this route will decrease in significance, to less than 36 percent, by the year 2015 as other routes grow faster, such as the U.S. East Coast to/from South America West Coast.

Scenario Results

While the results of the modeling are statistically significant and intuitively correct, several of the higher elasticities were adjusted downward in view of international shipping practices such as long-term service contracts, long-term ship charters, and round-the-world services. In particular, several bulk elasticities, and a small number of containership elasticities were "capped" in the modeling exercise.

The study team analyzed four different toll increase scenarios, agreed in a meeting with PCC representatives on May 31, 1996, and detailed in Table ES-4 in percentage terms.

Table ES-4
Four Alternative Toll Increase Scenarios Were Evaluated
Percentage Increase in Canal Transit Cost

Scenario	1997	1998	1999	2000	After 2000
1	15	15	0	0	0
2	10	10	0	0	0
3	5	5	5	5	0
4	2.5	2.5	2.5	2.5	2.5/year

The net effect of these scenarios on total Canal tonnage and tolls revenue is shown in the following Table ES-5. Here, the effect on Canal tonnage and tolls revenue of each scenario is shown as a percentage difference from the base case (no toll increase) scenario.

Table ES-5
Change in Tons and Revenue for Each Toll Increase Scenario
millions of long tons and dollars ($)

Scenario	1997		1998		1999		2000		2005	
	Tons	$	Tons	$	Tons	$	Tons	$	Tons	$
1	-11.7	37.5	-33.2	83.6	-33.7	86.2	-34.3	89.0	-37.9	103.4
2	-11.8	26.0	-22.7	56.4	-23.1	58.1	-23.5	60.0	-25.9	69.5
3	-5.9	13.5	-11.7	28.5	-17.3	45.3	-22.9	63.8	-25.3	73.8
4	-2.7	7.4	-5.4	15.4	-8.1	24.1	-10.9	33.5	-25.3	92.8

It is clear from this table that Scenario 1 produces the largest drop in Canal tonnage in the near term, with sizable increases in revenue compared to the baseline case. In the following Table ES-6, the cumulative tonnage lost and the corresponding revenue gains for the 1997-2000 period are shown for each scenario. The alternative of small annual increases (2.5%) in Scenario 4 yields a cumulative increase of $80 million in tolls revenue on 27 million fewer cargo tons. Table ES-3 also shows the year 2000 expected tonnage and revenues for each scenario.

Table ES-6
Comparison of Toll Increase Effects on Canal Tonnage and Revenues Over The Next Four Years (1997-2000)

	Cumulative (1997-2000)		Year 2000	
	Decreased Tonnage (Millions of Long Tons)	*Increased Revenue (Millions of U.S. Dollars)*	*Tonnage (Millions of Long Tons)*	*Revenue (Millions of U.S. Dollars)*
Scenario 1	118.9	296	180.4	614.8
Scenario 2	85.3	201	191.3	585.8
Scenario 3	57.8	151	191.8	589.6
Scenario 4	27.2	80	203.8	559.3

This table shows that, with a 15 percent increase in tolls in 1997 and again in 1998 (Scenario 1), tonnage will fall by almost 124 million tons; however the PCC will gain more than $272 million in revenue, compared to what would otherwise have occurred based on the ICF Kaiser cargo demand model projections with no toll hikes.

Effects on Key Commodities and Routes

Of course, such changes in tonnage and revenues are not spread evenly over all commodities and routes. Indeed, the team's analysis shows that there are important commodities that exhibit higher elasticities than others, and, similarly, there are Canal routes that have higher elasticities because of the more immediate availability of alternative bypasses.

Under Scenario 1, of the 1997 drop of 13.8 million tons through the Canal, down 7 percent, nearly one quarter of the decline will occur in the important U.S.-East Asia route (both directions). Also, other routes dominated by bulk commodities such as Canada (West) to Europe will decline significantly in the face of the simulated toll hike.

In particular, as shown in Table ES-7 below, dual toll increases of 15 percent will have a greater effect on the dry bulk and tanker commodities than on containerized cargo. Indeed, most containership operators are willing to pay the higher tolls as long as transit times and service levels can be assured.

Table ES-7
Scenario 1 Effects on Canal Tonnage by Vessel Type for 1997

Comparison of 1997 Tonnage				
Commodity Group	Scenario 1 *(millions of long tons)*	Base Case *(millions of long tons)*	Difference *(millions of long tons)*	Difference (%)
Bulks	94.8	105.6	-10.8	-10.2%
Tanker	31.7	35.8	-4.1	-11.5%
General Cargo/Reefer	8.8	9.3	-0.5	-5.4%
RoRo/Vehicles	1.7	1.7	0.0	0.0%
Containerized	24.0	24.0	0.0	0.0%

The additional $37.5 million in expected revenues in 1997 under Scenario 1 (up 10 percent over 1996 to $528 million) comes mainly from containerized cargoes and Ro/Ro vessels ($17.9 million additional revenue) and less from dry bulk cargoes ($4.2 million). This reflects the difference in estimated toll sensitivities. The full $272 million additional revenue over 1997-2000 that could be realized under Scenario 1 is split generally in the same manner. In the year 2000, Canal tolls revenue is $615 million under Scenario 1. These estimates incorporate both the expected response of the Canal's customers to the higher tolls and the resulting lower tonnage compared to the baseline forecast.

Chart ES-4 shows the baseline cargo forecast assuming no change in Canal tolls, together with the Scenario 1 cargo forecast. Figure ES-5 shows the baseline tolls revenue forecast along with the Scenario 1 revenue simulation. Clearly, such an increase in tolls over the next two years will decrease cargo through the Canal and increase revenues.

Chart ES-4

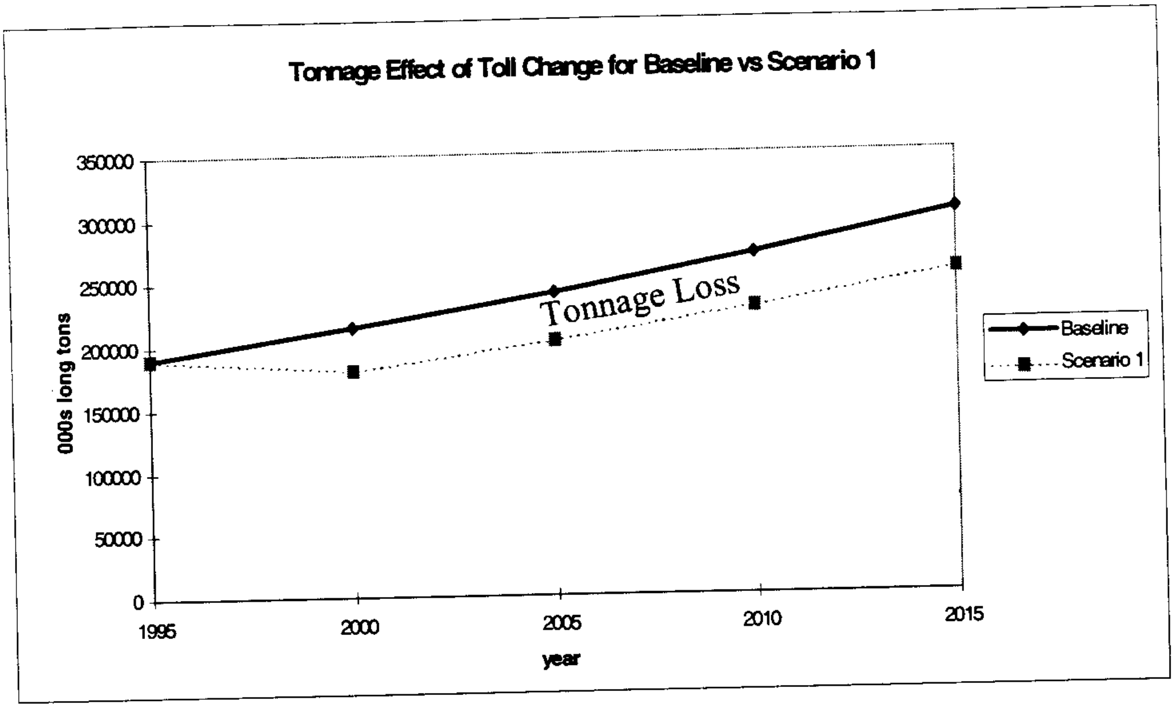
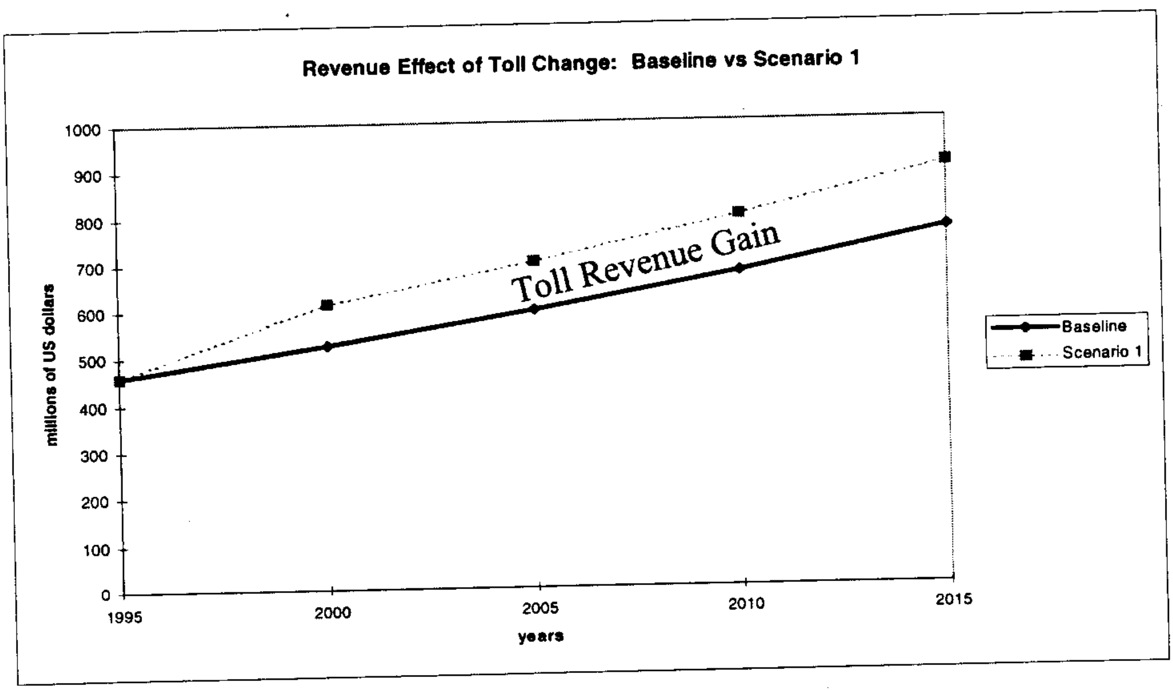


Chart ES-5



User Survey Results

Eighteen Canal customers were interviewed using a structured questionnaire, which was faxed to each respondent and followed up with some face-to-face and telephone interviews. The user survey confirmed the results of the statistical modeling and highlighted several important, but not unexpected, areas of interest and concern.

Following are the key points arising from the user survey.

- The reliability of Canal service and transit time are the major concerns that most container operators currently have. Transit time, in particular, directly affects their competitiveness. The cost of transit ranks third among this group of Canal customers. Just-in-time demands and the growth of the land bridge are placing increased pressure on the Canal to be able to provide quality service without risk of delays. For container ships, the cost of using the advance booking system is very small in comparison to the cost of delay through the Canal or of having to eliminate a port call.

- Although vessel sizes continue to increase and a great many Panamax and post-Panamax vessels are on order, the size limitation posed by the Canal does not by itself appear to threaten loss of business to the Canal. Furthermore, the most important factors that affect the decisions of users to opt for competitive alternatives to the Canal seem to be beyond the ability of the Canal to control, such as world trade patterns and time requirements of users. Nevertheless, the increasing sensitivity of users to delays and increases in Canal costs pose a threat of market share loss in the long run.

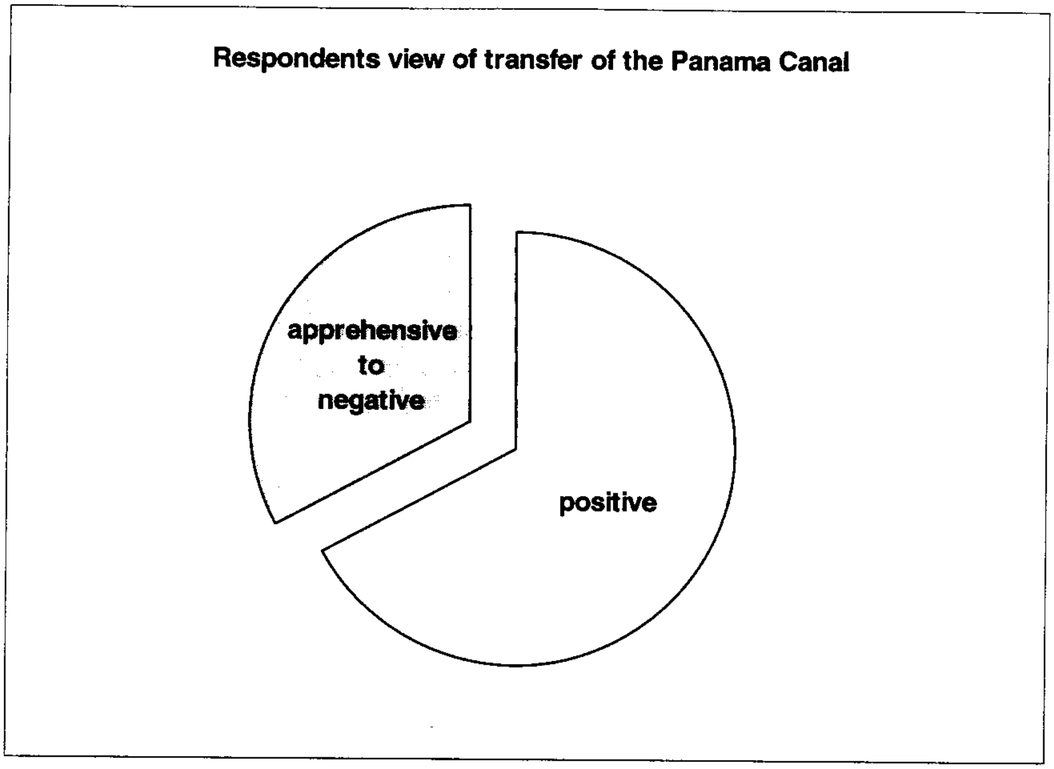
- Bulk operators are more price sensitive, although transit time and reliability are also important.

- Most users opt to use the booking system, find it useful, and would even be willing to pay more for it, if it would guarantee them transit. A wide range of criticisms were offered, however, ranging from those who would like to see it abandoned to those who think it should be offered during times of high congestion.

- Most users do not have a negative view of the effects of the transfer of the Canal to Panama by 2000. Expectations on service level and toll changes are mixed. It seems that most users are not highly aware of the transition process and not overly concerned about its possible effects on the Canal. Users are not actively making fleet deployment plans based on expectations of changes in Canal service level and costs after the transfer.

Concerning the transfer of the Canal to Panama, over 2/3 of the responses indicated a generally positive view that the Canal will be operated with the same or an improved level of service after the transfer.

Chart ES-6



The other 1/3 of the responses ranged from apprehensive to negative. These results were independent of the size of the customer or his market segment. There appeared to be no consistent view on whether the transfer would bring higher tolls with it, although within the 1/3 "negative" group, there was the perception that not enough attention would be paid to maintenance and service and that toll revenues would be siphoned off to fund other programs in Panama.

For bulk operators, competition stems from other operators, not from alternative bypass routes. Therefore, if a particular bulk commodity can be sourced at a point not requiring Canal transit to reach its end market, even though Canal costs range from 6 percent to 12.5 percent of total transportation cost for most bulk commodities transiting the Canal, the cost was placed on an equal basis with Canal transit time and reliability. Because bulk operators are not so time-sensitive, they do not use the advance booking system as much as container operators

On-Deck Cargo Fees

On-deck stowage of cargo is most common on full container and RoRo vessels. In 1995, about half of such vessel transits reported deckload tons to be nearly fifty percent of below deck tons. On the other hand, only about 20 percent of general cargo and container/breakbulk vessel transits reported such a ratio of on-deck to below-deck cargo tonnage. Therefore, the full container and RoRo ships would be the most affected by any toll increase. In this study, the team assumed that on-deck cargo was included in the total PC/UMS calculation for each vessel transit, thereby implying a higher toll for those vessels carrying on-deck cargo.

If such an on-deck cargo fee were charged, the net effect would be an increase in Canal revenues with full containerships and RoRo's bearing most of the increased financial burden. Using 1995 PCC data on ship types, cargo, and numbers of transits, the team's analysis shows that full containerships would have provided an additional $30 million in revenue as a result of an average on-deck charge of $26,000 per transit. RoRo vessels, on the other hand, while paying an additional $28,000 per transit, would have contributed an additional $4.5 million due to the smaller number of transits for such vessels. Similar calculations were carried out for all vessels carrying on-deck cargo, and the results, in Table ES-8 below, show that total Canal revenues in FY1995 would have increased by a total of $41 million if this type of on-deck fee had been imposed.

Table ES-8

Increased Canal Toll Revenues From On-Deck Cargo Fees

Vessel Type	1995 Tolls Paid	Deck Tolls (est.)	Increase
Full Container	$65,630,000	$30,000,000	46%
RoRo	$ 7,927,000	$ 4,500,000	57%
General Cargo	$13,385,000	$ 3,500,000	26%
Container/BB	$ 6,239,000	$ 2,000,000	32%
Dry Bulk	$ 6,794,000	$ 1,000,000	15%
Total	$99,975,000	$41,000,000	41%

It is very important to realize that the current PC/UMS net ton measurement of vessel capacity captures most, if not all, of the total cargo tonnage carried by all vessels. In fact, nearly 95 percent of full container ships have PC/UMS tons that exceed the total reported cargo tons. Most other vessels with on-deck cargo have a similar relationship between billing tons based on PC/UMS and actual cargo tons. Therefore, we conclude that the PC/UMS net ton prescription of vessel capacity charging more appears to accommodate for vessels with deck cargo. In essence, the current basis of calculating and charging tolls at the Canal is fair from the standpoint of basing tolls on vessel ton capacities.

Table of Contents

Section 1: Introduction

Purpose of Study as Outlined in Scope of Work

Study Objective

The Panama Canal Commission (PCC) selected the Team of ICF Kaiser International and Louis Berger International in an open competition to conduct a sensitivity analysis of Canal traffic demand to changes in transit costs. The results of this study will assist the PCC as it considers changes in Canal tolls in the coming years.

The PCC directed the ICF Kaiser Team to perform the following as part of this sensitivity analysis:

- Provide elasticity of demand estimates to characterize the extent to which changes in toll rates will affect the volume of Canal traffic over the forecast period, 1996 to 2015.

- Estimate the value (or opportunity cost) of ship Canal transit time to determine the costs of delays.

- Survey Canal users to understand their views on possible future toll changes, overall Canal service quality, and the transition of the Canal to the government of Panama in 1999.

- Evaluate the advantages and disadvantages of the possible introduction of a toll system for on-deck cargo.

- Evaluate the advantages and disadvantages of a more predictable toll increase.

To address these study objectives, the ICF Kaiser Team conducted a range of activities which are described in the report and listed briefly below:

Elasticity Analysis

- Analyze PCC data to develop quantitative relationships between the key commodities, ship types, and trade routes.

- Develop a world commodity trade forecast by region and trade route for 1996 to 2015 based on macroeconomic forecasts and the application of an international trade model.

- Estimate transportation costs for trade routes involving the Canal as well as bypass routes.

- Estimate the Canal transit time based on historical data and estimate the opportunity cost of this time.

- Develop an econometric model to provide the elasticity of demand estimates by commodity, route, and ship type.

- Apply the econometric model to forecast Canal commodity flows and toll revenues under different toll rate scenarios for the forecast period.

- Analyze the sensitivity of changes in Canal traffic to changes in Canal transit time.

- Compare the ICF Kaiser forecast of commodity flows through the Canal developed for this study with the 1995 Mercer forecast (under a Base Case where tolls remain at the 1995 level)

Canal User Expectations

- Develop and administer a questionnaire to obtain information from Canal users about their reactions to possible toll changes, overall level of current service, and the transfer of the Panama Canal to the Republic of Panama.

On-Deck Cargo Tolls

- Estimate the revenue generating potential of tolls for on-deck cargo by analyzing PCC data on cargo volumes by ship type

- Consider other factors affecting the feasibility of imposing on-deck cargo fees.

Toll Changes Assessments

- Evaluate and assess changes to the Canal's current tolls based on a consideration of the results from the elasticity analysis survey of user perceptions, and other activities

Previous Toll Changes

Tolls rates for the Canal have increased just six times, in the waterway's history with increasing frequency since 1974. During the 1980's Canal traffic and toll revenues fluctuated. Earlier downward trending periods were based on:

- The 1982 opening of the Trans-Panama oil pipeline, significantly affecting previous Alaska North Slope oil shipments through the Canal

- Worldwide recession

However, from 1985 to 1988, traffic and revenues improved due to increasing trade in the automobile and container markets.

Due to operating costs and expected limited growth in Canal traffic, tolls were raised again in 1989. From 1990 to 1991, Canal revenues got a boost during Operation Desert Storm, increasing revenues 10 percent. This growth in traffic was related to increasing insurance rates at the Suez Canal during the conflict. In 1992, the Board of Directors approved the introduction of the Panama Canal Universal Measurement System (PC/UMS) and Canal rates were increased 9.9 percent. In 1994, the PC/UMS system was implemented.

Table 1-1
History of Panama Canal Toll Increases

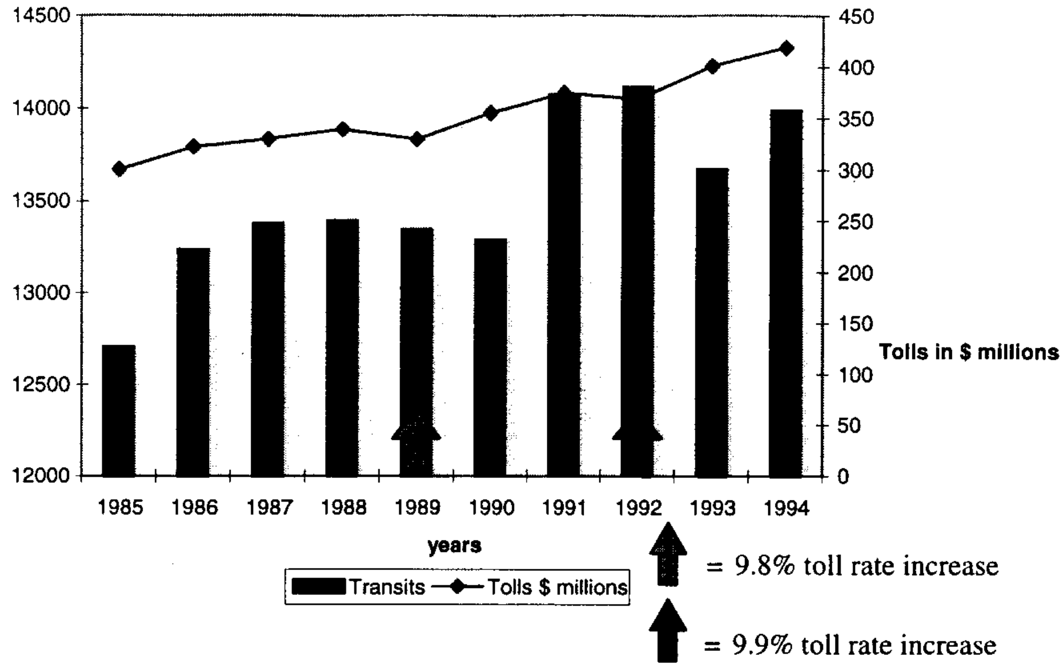
Year	*Percent Increase*
1974	19.7
1976	19.5
1979	29.3
1983	9.8
1989	9.8
1992	9.9

Thus, over the 18 year time period (1974-1992), the average annual increase was 4.4%, with the most recent average annual increase at 3.26%. The six increases total to nearly 100% of the original rates in the early 1970's.

When annual transits and their corresponding toll revenues are compared with each toll increase, a direct relationship may be derived. Chart 1-1 on the following page shows the number of commercial vessel transits and toll revenues from 1985 to 1994. The arrows in 1989 and 1992 denote the recent toll increases. Toll receipts seem to increase after the 1989 change. In 1992, revenue fell; then in 1993, with the toll increase, revenue increased. Recent toll increases seem to have a consistent effect on transits; during the years immediately following a rate increase, the number of transits appear to drop. From this limited illustration, it would seem reasonable to assume that increases in toll rates were the only reasons for transit reduction.

Chart 1-1

Comparison of number of Commercial Transits and Tolls Collected per Year (1985-1994)



However, transit decisions are based on a multitude of factors: daily operating costs, cargo costs, market shares, port costs, canal waters time, non-ocean transportation costs, as well as the random fluctuations of the value of commodities carried. This study and the related elasticity model captures the influence of these other factors.

Review of Past Canal Studies

The ICF Kaiser Team reviewed past studies that addressed the issue of toll rate increases and the likely response by the ocean shipping community. These reports are listed below. A short review of these studies is provided.

Report Title	Author	Date
A Sensitivity Analysis of Panama Canal Trade, 1984-2010	Temple, Barker & Sloane, Inc. (now Mercer Management Consulting, Inc.)	1986
Financial Scheme, Financial Analysis and Management Arrangements Component Study (FSFAMAC)	Robert Nathan Associates with Daiwa Institute of Research and others	1993
Tolls Policy Considerations for the Future Canal Organization	Louis Berger International, Inc. and Louisiana State University National Ports and Waterways Institute	1993

"A Sensitivity Analysis of Panama Canal Trade, 1984-2010" by Temple, Barker & Sloane, Inc, (TBS)

TBS focused on the principal commodities and trade routes for the Panama Canal, and examined the final, landed cost of each commodity in its end market. This cost reflected the total transportation cost for delivery of each commodity to its final market, with the Canal tolls representing some portion (large or small) that is a function of the length of the trade route. Also, export prices at various alternative sources were examined for each Canal commodity, thereby providing a look at the degree to which commodities, especially the major bulks, were exported at roughly the same price.

The study assumed that increased transportation costs, caused by an increase in Canal transit costs (most of which are tolls), would potentially cause certain commodities to shift away from the Canal as long as:

- Transportation costs are a substantial portion of the final landed cost, and
- Export price differentials between alternative sources are small.

Each commodity was analyzed, along with its route structure, in the light of all possible ways in which the commodity might reach its final destination by not using the Canal (route substitution or by-pass), or substitute products might be used in the place of commodities whose landed costs are increased sufficiently by higher transportation costs for the market to seek alternatives (e.g. coal for oil, or vice versa).

While the methodology used in this study was robust and considered most options for commodities to reach their final destinations using the cheapest route, and it incorporated the response time by carriers in the face of a toll increase, the methodology did not involve the calculation of toll elasticities of demand using actual Canal transit data. Rather, the focus was on the alternative options available to shippers, carriers, and purchasers on key routes. The study examined three large increases in transit costs: 25 percent, 50 percent, and 100 percent. The overall results of the study indicated that demand is relatively inelastic to changes in transit costs.

"Financial Scheme, Financial Analysis and Management Arrangements Component Study" (FSFAMAC) by Robert Nathan Associates

This study used the WEFA Group (Wharton Econometric Forecasting Associates) study of traffic demand as the starting point for an analysis of how Canal usage might shift under varying assumptions of transit costs.

In this study, a methodology similar to that used in the TBS study was employed. In short, after the data were appropriately formatted, comparisons of alternative diversion costs were developed. These costs were then compared to the cost of transporting the same commodities on the same routes through the Canal. Then, a diversion rule was imposed on the data: if the Canal costs are less than 90 percent of the diversion costs, then the cargo would remain captive to the Canal, and if the canal costs are higher than the diversion costs, then the cargo would divert. This "trigger point" approach to diversion of cargo is reasonable but there remains the question of why the 90 percent threshold was used as opposed to some other percentage.

This study showed, as in the TBS study, that cargo transiting the Canal is relative price inelastic. At 50 percent and 100 percent toll rate increases, cargo would fall by 2-5 percent and 4-6 percent, respectively. The effect of smaller prices increases was not reported.

"Tolls Policy Considerations for the Future Canal Organization" by Louis Berger International, Inc.

This 1993 study did not develop new estimates of toll elasticities. Rather, the study reviewed previous work, including the above two studies, and then developed recommendations for additional work to be carried out in order to enrich the PCC understanding of the relationship between toll increases and Canal demand. Additionally, the study recommends that a study be undertaken to determine the feasibility of linking the Canal's toll rates to economic development plans in Panama.

Overview and Organization of This Report

Following the (first section) information on previous toll increases and general trends in Canal cargo volumes, and a review of past studies on the relationship between Canal traffic and changes in toll rates; a roadmap for the remainder of the report is provided below:

- Section 2 - describes the underlying outlook for trade and the world economy
- Section 3 -- describes the approach for developing the econometric model to generate the elasticity of demand estimates
- Section 4 -- provides an evaluation of the advantages and disadvantages of more frequent and predictable toll increases.
- Section 5 -- summarizes the activities for obtaining user expectations on Canal service quality and responses to possible toll increases
- Section 6-- discusses the advantages and disadvantages of the introduction of on-deck cargo fees

Additionally, supporting information is provided in appendices which are referenced throughout the report as applicable.

Table of Contents

Section 2: Economic Environment

Introduction

There are several significant factors that comprise the basis of an analysis of Canal users' sensitivities to changes in Canal costs. This section will present the three critical factors in determining elasticity. These are transportation costs and value of ships' time, trends in fleet acquisition and deployment, and their implications for analysis and traffic demand.

The characteristics of the existing world fleet and the value of each ship's time are critical to the understanding of the market and of the costs of the environment facing vessel operators.

Additionally, to interpret the elasticities of each commodity moving via the Canal, the review of current world trade flows is essential. To understand the future impacts of cost changes, the a forecast was developed predicting the future flows of the same commodities transiting via the Canal. This forecast, the details of which are found in the appendices, was a critical foundation on which to build the elasticity model. However, providing a new forecast for the Panama Canal is beyond the scope of this study, and the forecast provided is simply a mechanism for use in this sensitivity analysis.

Following are separate sections treating the trends in fleet acquisition and deployment, along with transportation costs and value of ships' time.

Transportation Costs and the Value of Ships' Time

A clear understanding of the value of ships' time is important to any analysis of sensitivity to the costs of using the Canal. The "Costs" for vessel operators regarding the use of the Canal is defined as: tolls and the operating costs of the vessels related to that portion of each voyage in Canal waters. In this section we summarize the value of ships' time with respect to overall voyage costs by vessel type and by route.

This analysis required a quantification of cost components of vessel operating costs from data provided by a number of sources including the Panama Canal Commission. For comparability in this exercise, all costs were standardized to fiscal year 1995 levels. No attempt was made to analyze forecasts of operating costs in this task. For an understanding of how ships' time relates to customer sensitivity to increases in tolls it is not necessary to forecast costs levels. It is important, however, to understand the relative size and significance of ships time with respect to overall voyage costs. These costs obviously vary greatly by route and by vessel type and size.

Previous studies that examined the value of Panama Canal vessel time have used data on the use of the advanced booking system as a measure of willingness to pay. For the Consultants' analysis of the value of ships' time, data from the vessel operators use of the PCC advanced booking system was of limited use. This is because calculations of ships' time must importantly include periods of delay and the advanced booking system is suspended in times of sustained delays.

In addition to vessel classification and operating route, there are two additional dimensions that ship's time analysis must take into account:

1) The type of vessel service: regularly scheduled liner vessel operations versus irregularly scheduled vessels; and,
2) The time horizon: short run versus the long run.

The predominant regularly scheduled liner vessels are Containerships, Reefers, and Vehicle Carriers. These vessels sail regular routes seeking to maintain a fixed sailing schedule as announced and published for the shippers who are their customers. To be successful, these ships must adhere to their published schedules, reefer ships must move their cargoes quickly to maintain commodity quality, and vehicle carriers must move their high value cargo reliably.

Most major liner operators plan their schedules by the hour. Unexpected delays in vessel arrival at the next port can mean substantial costs in terms of longshore labor standby time and overtime. When a ships' schedule slips, it can create such a deterioration in service schedules, that some port calls may even be dropped. The efforts to get back on schedule result in loss of revenues or additional costs to move cargoes to other locations. The movement of refrigerated perishable cargo on reefer ships is obviously very sensitive to unexpected delays. The value of these vessels' time tends to be higher also due to the fact that most are expensive to build and operate. This means the daily or hourly fixed costs are high, whether the ship is underway at sea or delayed.

In the short run, regularly scheduled vessels will seek to meet voyage schedules by speeding up or slowing down in order to reach the next port on time. Thus, the primary variable cost for these ships in the short run is the fuel cost, as these vessels try to recover any time lost at the Canal by faster steaming on the leg immediately following a delayed Canal transit. The fixed vessel costs can also be estimated for short run delays. The principal short run costs are the sum of the variable fuel costs plus the fixed vessel costs. Under present toll policy, Canal tolls are the same with or without delays (ignoring the advanced booking charges) so they are not included in delay cost calculations. However, tolls are included in the total voyage cost calculations.

The long run situation is somewhat different with regard to costs of delay. The long term reaction of vessel operators to delays will obviously be to minimize the cost impact of delays. The value of ship's time is the sum of the fixed capital and operating costs of the vessel. In the long run, predictable delays are taken into consideration just as if the voyage time or the route had increased by whatever the delay time is. The most important characteristic of time associated with delays is whether delays are predictable or not. If delays are predictable then the expected value of delay time is used in operations planning and pricing by carriers. It is the unexpected delay that has the potential for the most disruption. Whether or not delays are predictable, an expected value for total Canal Waters Time is estimated in all planning and pricing decisions made by carriers using the Canal. If the variance of Canal Waters Time is increasing, vessels will treat this as an increased cost on the route, valuing the time at their normal operating cost for the vessel on that route.

In the long run, service and voyage schedules, fleet size, vessel deployment, and port rotations can be varied to accommodate predictable delays. Long term planning for liner vessel schedules would only be effected when a voyage leg had a particularly tight schedule and included a Canal passage. Based on this, the use of vessel fixed costs and the variable fuel costs for valuing regularly scheduled vessels' time are appropriate in the long run, as well as in the short run.

Irregular schedule vessels are most commonly tankers, bulk carriers, general cargo vessels, and various tramp ships. The irregular schedule vessels seek to work close to a fixed schedule maximizing cargo carried per year. Vessel schedules for these operators are less restrictive than for liner operators. Voyages are typically planned to the nearest day or days, and the Canal Waters Times are computed to the nearest day for planning purposes. Costs from faster steaming are less because irregular vessels steam at slower speeds and do not have as much opportunity to use extra fuel by speeding up as older liner vessels. The flexibility under the charter party at the discharge end can also run several days prior to demurrage, a flexibility uncommon for liner service vessels.

What constitutes the short run for a vessel operator depends on what type of service they are engaged in and their ability to react to changed delay situations. For an irregularly scheduled vessel, each voyage presents a new opportunity to change operating practices to allow for new delay time expectations. Even for many liner vessel operators changes can be announced and put into place in as little as a month. The liner vessel operators may have several vessels on a route in this period however, so several vessels could suffer from delays before adjustments can be made. In the extreme case of the addition of new vessels onto a route up to two or four years could be considered the long run period of adjustment to changes in delay.

It is expected that at current operating cost levels, vessel operators will react to recurring Canal delays only if these delays become more frequent. Shippers will respond when they have actually experienced increased transit times and possibly increased variation in transit times. Thus, it is assumed that the value of ships' time is stable only for periods of up to at most two to four years. ***If more than two years of frequent delays occurs then it is assumed that the increase in average Canal Waters Time will force operators to react with changes in vessel sailing patterns and service offerings.***

The costs of Canal transits were analyzed by route and be vessel type for the components of total voyage costs including: Canal Tolls, and the Operating and Fixed Vessel Costs. Separate cost formulas for various cargo vessel types were used for vessels sizes measured in terms of deadweight tonnage. A detailed listing and explanation of the cost categories appears in the appendix.

For comparison and estimation of the elasticity for Canal transit demand, the cost of bypass was estimated by route and vessel type. The all-water bypass cost estimation used the route distance, the vessel speed on the route, the vessel type, and formulas for vessel operating costs and capital costs for vessels by type and size range. The bypass route cost estimation for mini land bridge adds costs for the water and land portions of the movements. The cost factors used include the variable cost of fuel per day at sea and in port, and all fixed costs for the vessels, as detailed in the appendix.

There are 36 commercial cargo vessel categories used in this analysis including several size ranges within each vessel type. The size classifications for cellular containerships are defined in terms of the container capacity of the ship measured in TEUs. The size classifications for all other types of vessels were defined in terms of the deadweight tonnage of the vessels. The detailed vessel size class categories are listed in the tables in the appendix.

Summary of Value of Delay Time Estimates by Vessel Class

In Table 2-2, the detailed estimates of the value of ships' time are summarized by vessel class both in terms of the cost per day and the cost per hour. These costs are for vessels using the Canal so all post-Panamax vessels are excluded from this analysis. As expected, Containerships have one of the highest costs per day with a range of from about $25,000 to over $41,000 a day. This works out to over $1,000 for each additional hour of Canal Waters Time for each transit. The other vessel categories carrying high value cargoes such as RoRos, Vehicle Carriers, and Reefer vessels also incur a large cost from increases in Canal Waters Time. Gas Tankers, as specialized vessels with high operating costs, suffer the greatest costs from increases in Canal Waters Time.

Table 2-2
Average Daily and Hourly Values of Ships' Time By Vessel Type
U.S. Dollars in FY 1995

Vessel Type	Cost Per Day (000s)	Cost Per Hour
Containers	$25-$41	$1000-$1700
General Cargo	$11-$14	$460-$580
Combos	$12-$26	$500-1090
Dry Bulk	$12-$30	$500-$1250
RoRo	$20-$32	$830-$1330
Vehicle Carriers	$25	$1040
Reefer Ships	$24	$1010
Gas Tankers	$57	$2380
Product Tankers	$14-$30	$580-$1250
Tankers	$12-$36	$500-$1500
Other Vessels	$11	$460

To best illustrate the significance of ships' time to vessel operators, the value of ships time as a percent of the total voyage cost was calculated for each vessel class on each route. A summary of this exercise is presented below in Table 2-2 with the detailed vessel class and route tables presented in the appendix. Note that one day of additional Canal Waters Time can be as much as 8% of the total voyage cost to a vessel. Given common operating margins for the maritime cargo business, this can be very significant. All the profit from a voyage can be lost due to the cost of such a delay.

Table 2-3
Value of One Day of Ships' Time as a Percent of Total Voyage Cost
Range Across All Routes By Ship Type
FY 1995

Vessel Type	Percent
Containers	2.1-7.2
General Cargo	1.9-6.9
Combos	1.9-6.9
Dry Bulk	2.0-6.6
RoRo	2.3-8.0
Vehicle Carriers	2.3-6.4
Reefer Ships	2.1-5.0
Gas Tankers	2.4-6.5
Product Tankers	2.0-7.4
Tankers	1.9-5.8
Other Vessels	2.0-4.3

The range of these shares is obviously related to the length of the route, and therefore the total voyage cost of each transit. The vessels operating on shorter routes stand to lose the most in terms of percent of total voyage cost from one day of delay.

The value of ships' time for delay time impacts is one measure of the cost to the vessel operator. The variance in delay time is probably even more significant for vessel operators in the short run. Time definite service is increasingly important. In fact, it may be the case that the average Canal Waters Time is less important than the variance around the average Canal Waters Time. The variance depends on several factors for any particular vessel operator including not only the size and type of vessel operating on a specific route, but also the time of year and the direction of sailing. Further research in this direction may be warranted in the future.

Trends in Fleet Acquisition and Deployment

The Canal is utilized by a wide range of ship types and due to their direct and indirect relationships with the world market place, it is important to understand each vessel type's characteristics. The chart below presents the distribution of toll revenue by vessel type for FY1995:

Table 2-1
Percentage of Tolls Collected from Commercial Vessels-1996

Vessel Type	*1995 Canal Tolls (% share)*
Dry Bulk	36%
Full Container	15%
Tanker	13%
Vehicle Carrier	11%
Reefer	8%
General Cargo	5%
Passenger	3%
Ro/Ro	2%

Source: PCC

The following is a short review of the leading shipping segments at the Canal: dry bulk, tankers, containerships and refrigerated vessels.

Dry Bulk Vessels

Dry bulk vessels are usually grouped into four categories:

Category	*DWT Capacity*
Handy size	20,000-30,000
Handymax	30,000-50,000
Panamax	60,000-70,000
Capesize	about 150,000

The main worldwide employment of these vessels is transportation of coal with a total seaborne trade this year approaching 400 million tons, followed by grain at about 200 million tons.[1]

[1] (1) *Shipbuilding Industry Outlook*, IMA Associates, 1996; (2) *Marine Reporter / Engineering News*, several issues, especially March 1996; (3) *Clarkson Data Base* as reported in *International Bulk Journal*, March 1996; (4) *Marine Log*, several issues; and (5) Shipping Statistics and Market Review, World Bulk Fleet, ISL.

The total fleet of dry bulk vessels, at the end of 1995, stood at 5,034 vessels of 20,000 DWT and higher, with total capacity of 238 million DWT. Newbuildings delivered during 1995 amounted to 16.6 million DWT, or about 7% of the fleet. The total order book to the end of 1997 reached 33.1 million DWT, or about 14% of the current fleet. The majority of the newbuildings are reportedly destined for construction in Korea's shipyards, however Japanese yards will also be awarded several contracts. This large addition of vessels could put pressure on freight rates, at least in the near future. However, since some 20% of world fleet is currently over 20 years old, a large level of scrapping is mandated in the coming years. The rate of scrapping might be accelerated following a pending agreement by the International Association of Classification Societies (IACS) to impose restriction on use of the existing fleet. Hence, a recent report by Drewry, *Panama Bulk Carriers: Market Prospects and Profitability, 1995 - 2000,* urges owner to invest in the dry bulk vessels.

In terms of fleet composition, the Capesize category, measured in DWT, accounts for the largest share, with about 30% of the total tonnage. This category is also the fastest growing with about 50% of all expected deliveries until the end of 1997. Since the Capesize vessels are of relatively young age, while the smaller tonnage vessels, especially those smaller than Panamax are relatively old, it is expected that within several years the Capesize tonnage will reach close to the 50% market. This ensures ample supply of large vessels, but also implies limited supply of smaller ones, with corresponding respective implications for the future ratio between these two size categories and those ships available that can transit the Canal.

Tankers

The size of large tankers has stabilized at 300,000 DWT. Many tankers, built during the oil crisis of 1973 and immediately after it, are now about twenty years old and rapidly approaching scrapping age.

The two latest MARPOL 13F and 13G regulations of the IMO for all vessels delivered after 1966 requires double hulls. According to 13G, existing vessels approaching twenty five years, must operate with empty tanks sufficient to fulfill the requirement of a 30% side or bottom protection, or they must have hydrostatic cargo or sea balance. As a result, from 1998 on, these ships may lose the equivalent of about 20% of their capacity. At the age of 30 years, they must be retrofitted with double-bottoms which will likely make them uneconomical. Double-hulls result in a reduction of 5% - 6% in cargo capacity compared to single hulls, and doubles also increase construction costs by about 5% - 10%. Additionally, double-hulls also increases ongoing maintenance costs.

Containerships

The introduction of the Regina Maersk began the second phase of post-Panamax containerships. These vessels, with nominal capacity of 6,000 TEUs have the following characteristics: 318 x 42 x 14 m (LOA x Beam x Draft). The most important functional characteristics of these *Post II* vessels, is their ability to accommodate 14 rows of containers underdeck with 17 rows across on-deck. In comparison, Post I, with capacities of 4,500 - 5,500 TEUs accommodate 15 rows, and a Panamax only 13 rows. Except for the beam, the other dimensions, including the draft are almost identical. Draft is dictated by the water depth in the existing ports of call.

The post-Panamax trend, beginning in 1988 with the American President Lines fleet, gained momentum following the restructuring many shipping lines' organization and operating systems. Most of the global carriers formed alliances, establishing joint operations and vessel sharing agreements. The alliances are expected to extend their agreements to terminals and equipment and eventually to even pursue mergers. The formation of alliances has already resulted in the redesign of services worldwide, including rationalization and elimination of duplicate services. The formation of alliances is also expected to drive newbuildings of even larger ships- perhaps up to 8,000 - 10,000 TEUs per vessel according to a recent forecast.[2]

Another feature that typifies the new post-Panamax ships is their large reefer capacity. The Regina Maersk, maintains 700 plugs, making it 20% larger than the largest dedicated reefer vessel. (Maersk's Post II, will operate on the Trans-Pacific).

The latest known orders for new containerships include: five 5,700-TEU, 23 knot vessels by NYK to be deployed on the North Europe/Asia service during 1997/8 and sources indicate that P & O has committed itself for four 6,200-TEU containerships.[3]

Unlike other cargoes, which are carried usually by tramp shipping, containers are carried on liner terms operating on a set, multi-port itinerary. The revival of the all-water express services (Panama Express) is threatened by Suez Express.

In the container market, the influence of the alliances is increasing--not just in numbers of transits, but also in the volume of containers, since the vessels are increasing in size. There are now 5 alliances operating in the USEC/FE trade route. There are a total of 13 lines in the 5 alliances (listed below) plying that trade, to which must be added the three major independents (Evergreen, Cosco and Zim). Obviously, if all those large lines had served the trade independently, that would have doubled the operating capacity--and the number of transits. So carriers' urge to rationalize has made for an economically sensible and superior service--but a reduction in PCC revenues.

[2] A 15,000-TEU vessel was discussed in the recent TOC 96 by P & O line.

[3] Containerization International, March 1996.

Chart 2-1
Major alliances and independent container carriers

Major Container Carriers Transiting The Canal

CARRIER ALLIANCES

Grand Alliance (NOL, Hapag-Lloyd, P&OCL, NYK)
Global Alliance (APL, OOCL, MOL, Nedlloyd)
Sea-Land/Maersk Alliance
Tricon Alliance (Hanjin, DSR-Senator, Cho Yang)
Yang Ming (K-Line)

MAJOR INDEPENDENTS

Evergreen
Cosco
Zim

By 1997, Hanjin is anticipated to have joined the Tricon group in a full alliance. Its then ex-partner Yang Ming will want to continue in the trade and it is quite possible that it will have persuaded K-line, its partner in the Transpacific and Europe/Asia trades, to re-enter the USEC/FE trade via the Panama Canal. If so, the number of transits made by those lines would be unaffected

One important development is the Global Alliance's inauguration of an all-water FE/USEC service via the Panama Canal. This signaled the re-entry to the trade of OOCL, the entry of APL and Nedlloyd, and the enhancement of MOL's frequency and volumes. This was one reason for the recent increase in transits and volumes on that route, despite Cosco's shift to the Suez route. It is expected that in 1996 the major Alliances will perform around 80% of the Canal transits on the major trade route (USEC/FE).

Multipurpose

No change in fleet tonnage is expected, with the largest vessel up to 40,000 DWT. Main features of the multi-purpose vessels is their specialization in the forest-product segments, typified by the Totally Covered Open-Hatch Carrier (TCOHC).

Reefer

The increase in size of refrigerated vessels seems to have tapered off in recent years, with the largest vessels at about 12,000 DWT. The main feature of the newer vessels is the increase in number of containers (up to 160 TEUs in recent models). Another trend relates to higher speed and automated loading/unloading system, both of which are aimed at increasing productivity (lowering cost per ton-miles). These vessels require quick Canal transits.

Chart 2-2

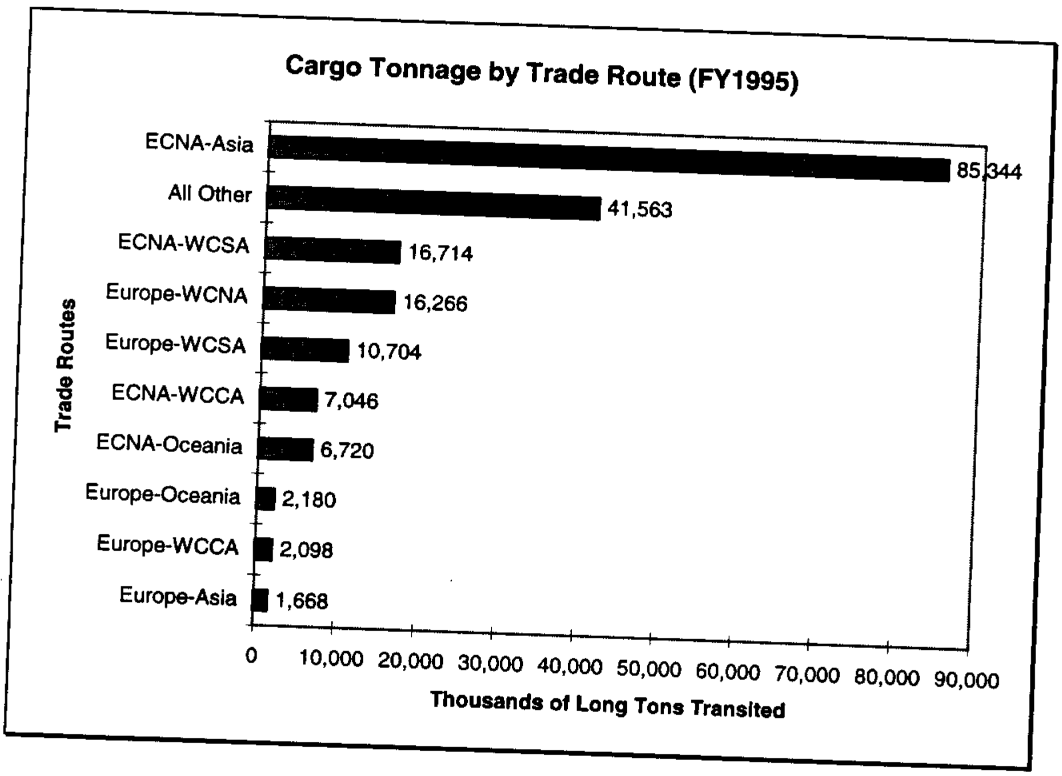


Chart 2-3

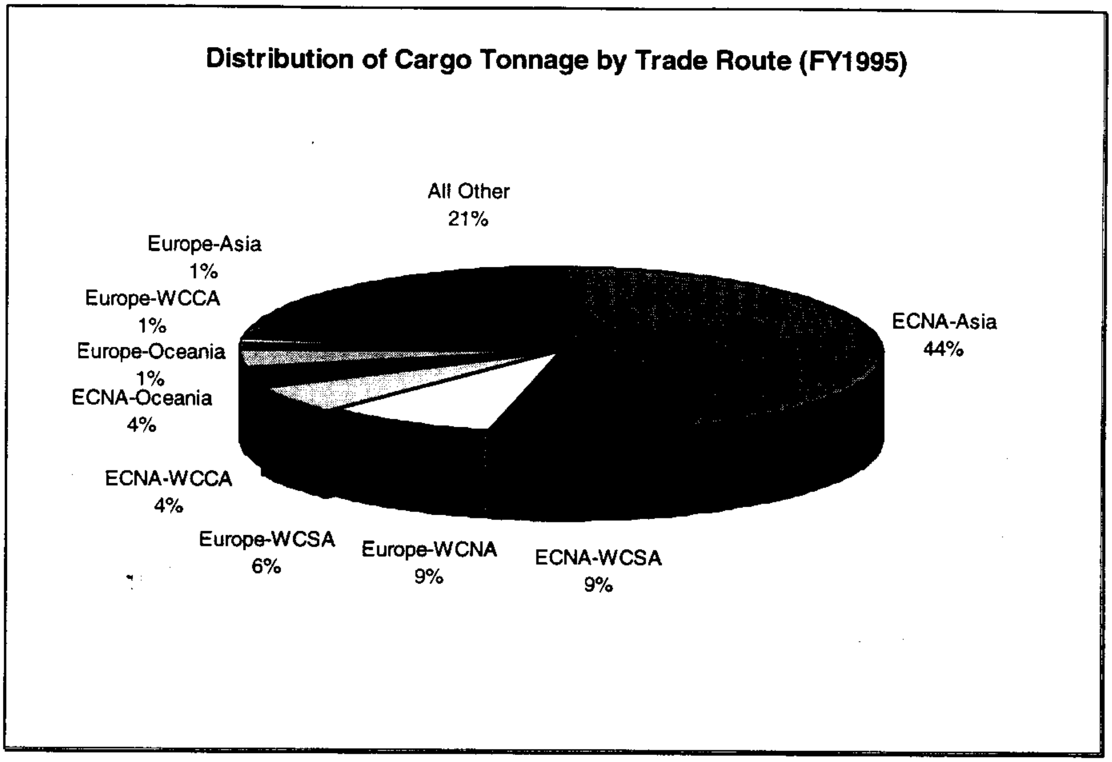


Chart 2-4

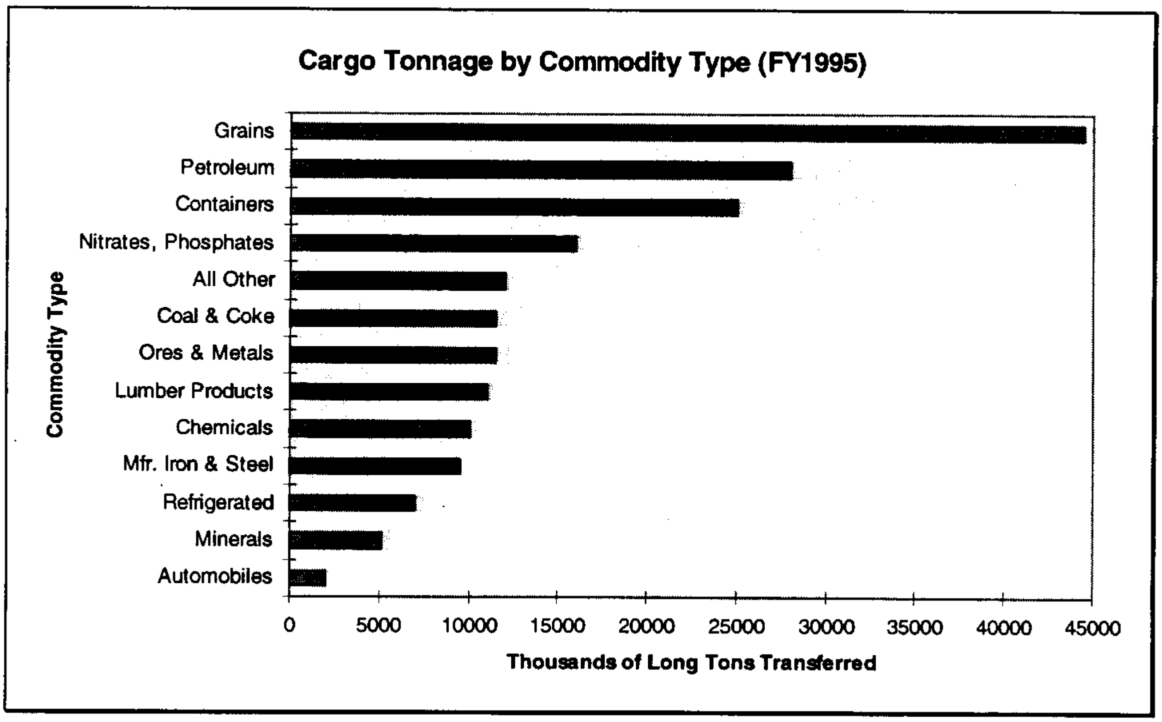
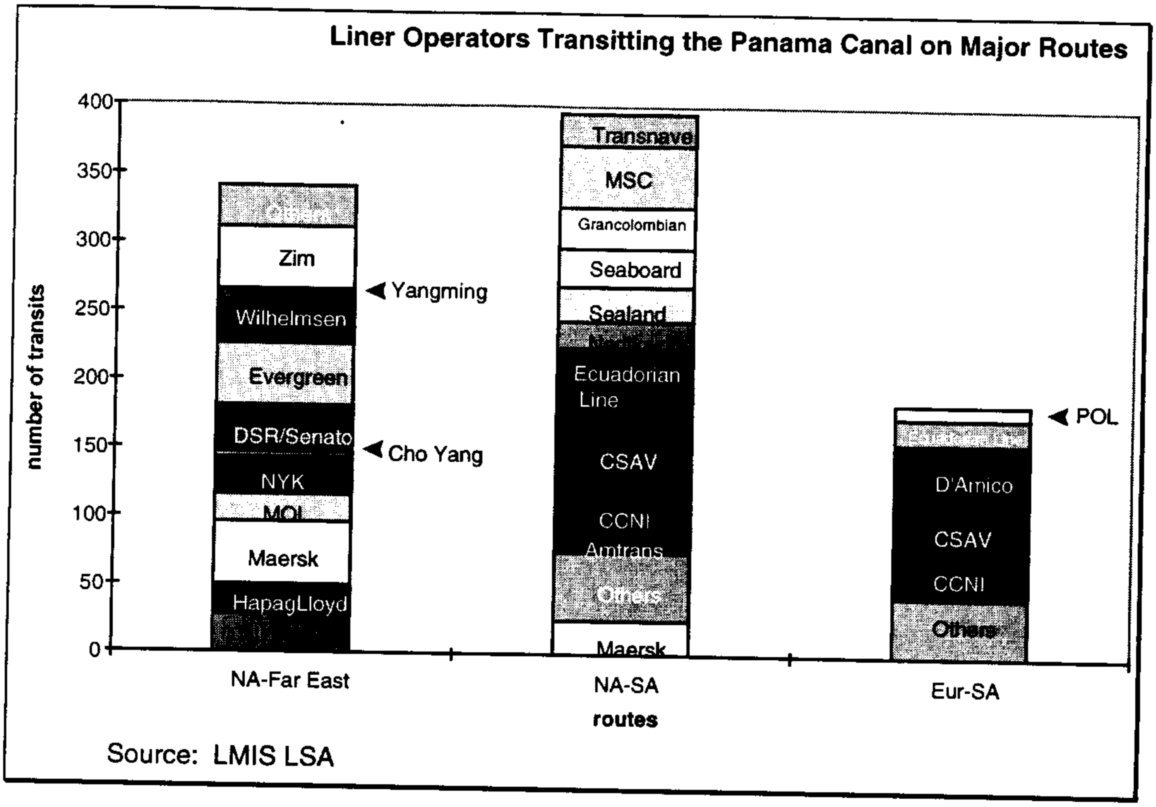


Chart 2-5



Liner Operators Transitting the Panama Canal on Major Routes
number of transits
400
350
300
250
200
150
100
50
0
Zim
Wilhelmsen
Evergreen
DSR/Senato
NYK
MOL
Maersk
HapagLloyd
Yangming
Cho Yang
Transnave
MSC
Grancolombian
Seaboard
Sealand
Ecuadorian Line
CSAV
CCNI
Amtrans
Others
Maersk
POL
D'Amico
CSAV
CCNI
Others
NA-Far East
NA-SA
Eur-SA
routes
Source: LMIS LSA

Summary - Analysis of Traffic Demand Elasticity

The value of delay time for vessels transiting the Canal has a measurable impact on the elasticity of demand for Canal transits. As demonstrated in the elasticity discussion in Section 3, changes in average Canal Waters Time affects vessel owners and shippers decisions and therefore the traffic and tonnage that will transit the Canal. The main discussion of these impacts is included in the elasticity discussion.

The elasticity for bulk is high for a number of reasons:

- Bulk operators tend to be independents operating without set schedules. They, and the products they carry, tend to be sensitive to small changes in prices. While transportation costs may be small relative to total costs, smaller differences in price may differentiate suppliers. Thus, transportation costs can reduce market penetration for suppliers geographically disadvantaged in their key markets.

- Since operators follow supply, and as their own margins are small (they cannot sustain higher costs in their own margins and must pass these on to the buyers of their services), this may mean that demand for Canal transits will fall faster when prices are increased even slightly. In response, bulk operators will then move their ships to a location where opportunities are greatest. As a result, this flexibility is driven by small changes in costs and larger swings in supply.

- Bulk products when compared to manufactures, tend to be less differentiated. Due to the "sameness" across each bulk line, suppliers and buyers can act quickly. These sudden distribution shifts create a higher elasticity to price for ships carrying bulk cargoes. Thus, we should expect bulk carriers to react to changes in toll rates rather quickly

- As an example of this ability to shift supply between suppliers may be found in the coal market. While there have been some new suppliers entering the market-notably Colombia-the largest suppliers today are the United States, Canada, Europe, Indonesia/India/China, and Australia. In the case of Europe, most European coal (including that of Eastern Europe), is sold within Western Europe. Bulk shipments by European railroads maintain this relationship between supplier and buyer. The United States and Australia compete as major suppliers of coal to both Europe and Asia. But, other sources are emerging-such as South Africa. After the end of the trade embargo, South Africa's coal business has climbed from $ 800 million in 1980, $1.7 billion in 1990, and is forecast to climb to $ 2 billion by the year 2000. Other new sources include Canada (west) and China.

- The fastest growing markets for coal are in Asia, largely for power production. This growth in coal has implications for Canal traffic, as higher toll rates for Canal transits will likely fuel continued export opportunities in Australia, South Africa, and Western Canada, as suppliers seek to reduce transportation expense.

The table 2-4 below illustrates the movement of market share away from the United States to the new coal production entrants.

Table 2-4

COAL EXPORTERS' SHARE OF WORLD MARKETS

Country	1990	2000
United States	23%	14%
Australia	20%	21%
Asia	6%	12%

United States coal producers exporting off the eastern seaboard to Asia will continue to see a decline in their market share. Producers in Australia, India, and China are likely to pick up share. Thus, with changes in toll rates, the United States share of the world coal forecast may decline at an accelerated rate, while Asia's climbs from 6% to 12%.

Table of Contents

Section 3: Measuring the Elasticity of Demand for Canal Transit

Introduction

We have approached the problem of measuring the impact of Canal tariff adjustments on trade using an empirical and statistical approach. Elasticities developed using this approach are based on actual Canal traffic data combined with information on tolls paid and Canal waters time. Results, despite the complexity of the model, are consistent with *a priori* expectations about the general price sensitivity of shipping to transit costs and the availability of alternative (bypass) routes or sources of supply. In the following pages we lay out the basic approach taken in modeling this complex relationship and the econometric results observed.

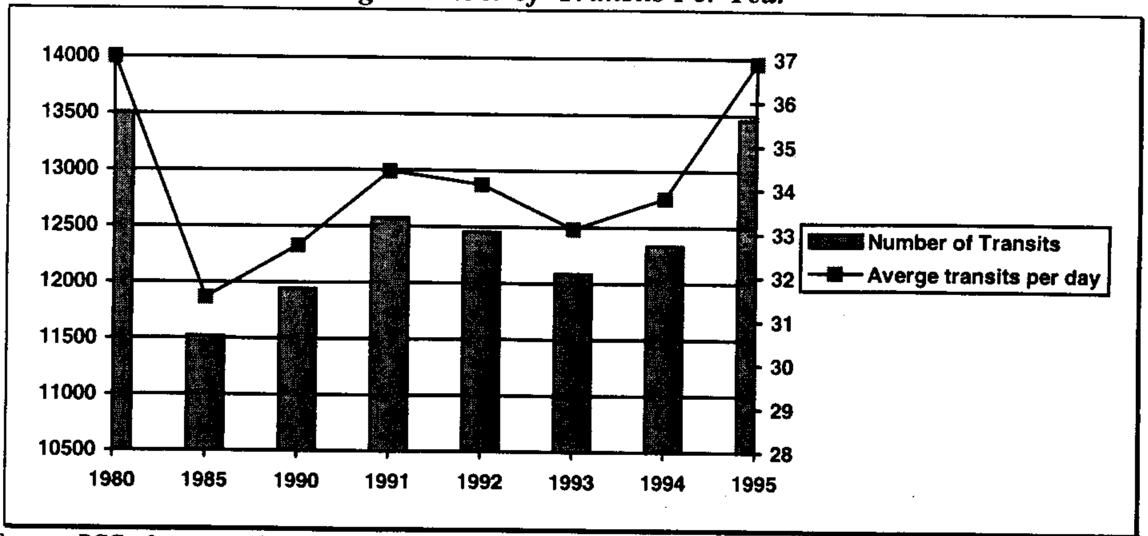
An elasticity is a mathematical relationship between the change in quantity of traffic through the Canal to a change in the price or cost of transit. For this study, relationships were identified between the percentage change in transit costs and the percentange change in traffic through the Canal. An elasticity less than -1.0 is considered very elastic while an elasticity greater than -1.0 is inelastic. When the relationship is "elastic", an increase in price yields a loss in total revenues, thus the revenue from higher in toll rates would be overwhelmed by the loss of traffic paying tolls. If the relationship is "inelastic" to price, than an increase in transit costs would also yield an increase in total revenues.

A Difficult Problem

While there exists a long historical record of traffic moving through the Canal, more detailed Canal traffic data was available for this study starting in 1974, but due to limitations on available trade and macroeconomic data, elasticity models were estimated using data starting in 1980 through 1995. There were three adjustments in Canal tolls during this period, (see Table 3-1 for a history of tolls). Our measures of the "price of transit" take into account a variety of factors that affect costs (and ship profitability) on specific routes carrying a given group of commodities. Additionally, traffic coming to the Canal has been generally constrained over the past several years by the total throughput capacity of the Canal.

As the chart below illustrates the number of ship transits averages about 13,000 annually for the five year period 1990-1995. On a daily basis this works out to an average of about 35 transits per day.

Chart 3-1
Average Number of Transits Per Year



Source: PCC - for oceangoing commercial vessels only.

Over the past year, however, traffic has surged as grain shipments to the rapidly growing East Asian nations and China have pushed the transits nearly 38 ships per day. Complicating the picture is the fact that the mix of ships differs from smaller, bulk carriers to Panamax ocean liners. Given that the Canal is generally capacity constrained and Canal tolls are collected on a per transit, rather than per cargo, basis, this suggests that cargo growth cannot be substantial without a significant increase in either Canal efficiency or the efficiency of shippers (moving to larger vessels or filling vessels to their maximum capacity). The exception is a continuing increase in vessel size closer to Panamax size. This can be observed from reported Canal traffic data. In 1970, the average long tons per transit were 8,366. By 1980, the tonnage size increased, growing to 12,380 and in 1995 it reached 14,139. Over the 25 year period this translates into a factor of 1.69, explaining growth in volumes of cargo well in excess of numbers of transits. This growth in vessel size also explains, in part, why normal pressures of supply and demand, or price elasticities are difficult to quantify. As vessels grow closer to Panamax size, supply constraints are effectively reduced in importance. It is not clear at what point demand becomes constrained by supply (the maximum number of transits), but as Canal waters time increases, this point comes nearer.

Table 3-1

Canal Tolls Adjustments

Date of Adjustment	Toll for Laden Voyage per Panama Canal Net Ton	Increase Percent
1915-1938	$1.20	
1938	$ .90	
1974	$1.08	19.7%
1976	$1.29	19.5%
1979	$1.67	29.3%
1983	$1.83	9.8%
1989	$2.01	9.8%
1992	$2.21	9.9%

Source: PCC

When a resource that is fully utilized, as is nearly the case of the Canal today, economic theory suggests the optimum behavior is to allow market prices to rise and thus ration supply between buyers. For Canal transit, the assumption of price or cost rationing affects individual transits on a ship-by-ship basis. Thus increases in transit costs will tend to limit Canal use by some operators whose profit margins on voyages are small or when the costs of an alternative routes (for ships or cargoes) becomes lower.

Economists quantify such sensitivity to prices through a measure called elasticity which is calculated as the percentage change in demand for a percentage change in price. These price elasticities are typically negative. A value less than -1.0 is called elastic to price while a value greater than -1.0 (0 is greater than -1.0) is inelastic. If the elasticity value is greater than -1.0 then a given percentage increase in price will lead to a smaller percentage drop in demand and the total revenues collected will be greater than before. If the price elasticity is less than -1.0 (say -1.2) then the price increase will lead to a fall in total revenues as the higher price will be offset by an even larger percentage loss of traffic.[1] Depending then upon the elasticities for each type of cargo and each route any adjustment in tolls will translate into some determinant adjustment (based on this model of traffic demand) in total toll revenue collected.

[1] The general calculation is the elasticity of price, which is typically negative, leads to a smaller volume through the Canal. Thus Total Revenue = Volume * Price. If the elasticity is less than 1.0 (absolute value), a 5% increase in the price, would decrease volume by less than 5%. If the elasticity is greater than 1.0, then a 5% increase in price would decrease volume by more than 5%.

A third difficulty with this type of analysis is that some traffic through the Canal is a function of routing and the economics of ship sizing. Decisions of traffic routings, including frequency of pendulum service and round-the-world service also impact the Canal traffic projections. Sensitivity of Canal traffic in the short run to changes in tolls may be less if the cost of alternative routings for cargoes remain above the costs associated with Canal transits. In the longer term, however, ship operators will seek and may find bypass routes that are economically more efficient so that the potential to use alternative routings may be greater. Decisions by ship owners to deploy ships on some services also impact Canal transits. Interestingly, despite the higher cost of the land bridge for containers relative to the all water routing, the shorter transit time has been sufficient to allow shippers to justify this added expense. The cost viability of the "land bridge" from Asia to East Coast destinations varies by product. Land costs for moving bulk products are often high. Our estimate of the landed costs for automobiles moving from East Asia by the Canal is $858 thousand dollars compared to a routing through the US West coast and transit by rail of about $ 3.7 million.

While the problem of projecting the traffic growth in the face of toll changes is complex, it is not impossible. Any model thus represents a particular view of reality that may change during the forecast period. Our model is a compromise between "complexity" and simplicity of form. There are implicitly four key variables in the model:

- Canal Transit Related Revenue per Ton by Commodity by Route
- Canal Waters Time by Commodity by Route
- Ship Costs Per Day by Type adjusted by Fuel and Other Price Changes
- Growth in Trade by Commodity by Route.

The model uses these variables to estimate the Canal transit cost elasticity, described below.

The Canal Baseline Traffic Forecast: No Change in Toll Structure

Using the model we have developed a baseline forecast both for Canal traffic by product (all routes) and for all routes (all products). Detailed forecast tables are in Appendix B. Appendix B Tables 1 and 2 provide a summary of the flow through the Canal that may be expected, assuming there are no changes in average tolls per ton of cargo. The results reflect the fact that Canal waters times are reduced by 10% beginning in 2004 due to the expected completion of the Gaillard Cut. Appendix Tables 3 and 4 show expected tolls by product over this same time period. This is the Baseline Traffic forecast, other alternative scenarios will follow, comprising a review of four different cost applications.

Some observations on the forecast

The 1990-95 growth of 3.9% in traffic (11.6% in 1995 alone) will likely not be repeated. We can see that the majority of this surge came from increased United States exports of grain (mainly corn) to Asia (up 43% between 1994 and 1995). The likely shortages in available supplies and the high level of current trade suggests that growth will be difficult to achieve. We expect traffic to decline slightly in 1996 and then grow at about a 1 or 2% rate in the later years.

Our forecast suggests a modest growth in traffic of about 2.3% over the 1995-2000 period, 2.3% between 2000-2005 (helped by the shorter Canal Waters Time associated with the finishing of the Gaillard cut), and about 2.4% thereafter.

Tolls revenues are forecast to grow slightly faster than traffic (2.7% in the 1995-2000 period versus 2.3% for traffic). Overall the toll revenues will be rising at about 0.2 to 0.3 percent faster than traffic growth. This is due mainly to the growth in containerized commodities since tolls on container ships are higher than on bulk carriers.

The surge in tolls which occurred in 1993, up 8.9%, can be attributed to the change in the tariff charged since overall traffic declined by about 1% (tolls were increased by 9.9%). This suggests that the price elasticity is close to zero but in reality the measurement is flawed because the effect of toll changes varies considerably by product and by route and there was a rebound in world trade as Europe gained momentum. Thus there is no non-quantitative approach that can measure elasticity of demand to price at the overall level even crudely.[2] The strong growth in tolls collected, however, can be attributed in part to the strong demand for food grains in Asia coming from the United States, the surge in US import demand (up 11%), and the strong growth in Asian demand.

[2] Any weight measure, as is the case of total tons through the Canal, is flawed because of the differences in weight between low and high value products. Moreover, Canal tolls vary by ship characteristics further complicating the calculations.

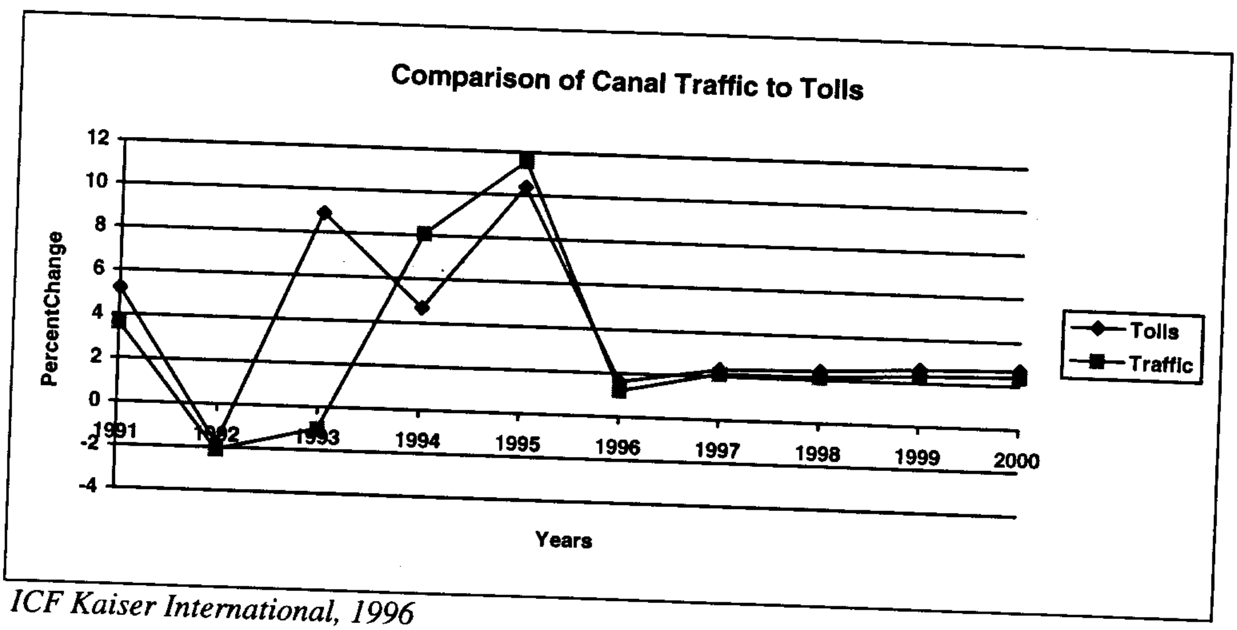
While this suggests that in 1993 price elasticities were lower than those estimated using the econometric approach it should be recognized that the elasticity is a measure of both the trade and the price effect. The Transit Cost Per Ton measure used varies significantly and the effect of price on volume also varies, thus there is no clear relationship except at the individual product and route level as to effect of a change in tolls.

Bananas grew strongly between 1990-1995 as bananas from Ecuador discovered markets in Western Europe (for a five year period, the overall Ecuador to Western Europe grew at an annual rate of 12.7%). New markets for bananas in Europe should allow for growth in this product category, but at a mere reduced rate of just over 2% per year.

Trade in general non-containerized manufactures as well as container traffic should remain strong. This higher value cargo is expected to grow over 4% per year. Growth should be about 1% per year, more then the 3.5% achieved in the 1990-95 period. The container traffic share for tolls on all major routes will increase from 12% in 1995 to about 15% in 2015.

Without changing the toll structure the PCC can expect total toll revenues to increase at a rate of about 2.5% over the period. The larger increase comes from the widening of the Canal allowing more traffic (and average Canal Waters Time to remain about 24 hours). By 2015 tolls reach $ 765 million per year and assuming other revenues of about $ 140 million, the overall budget for the Canal could rise to $ 900 million.

Chart 3-2



ICF Kaiser International, 1996

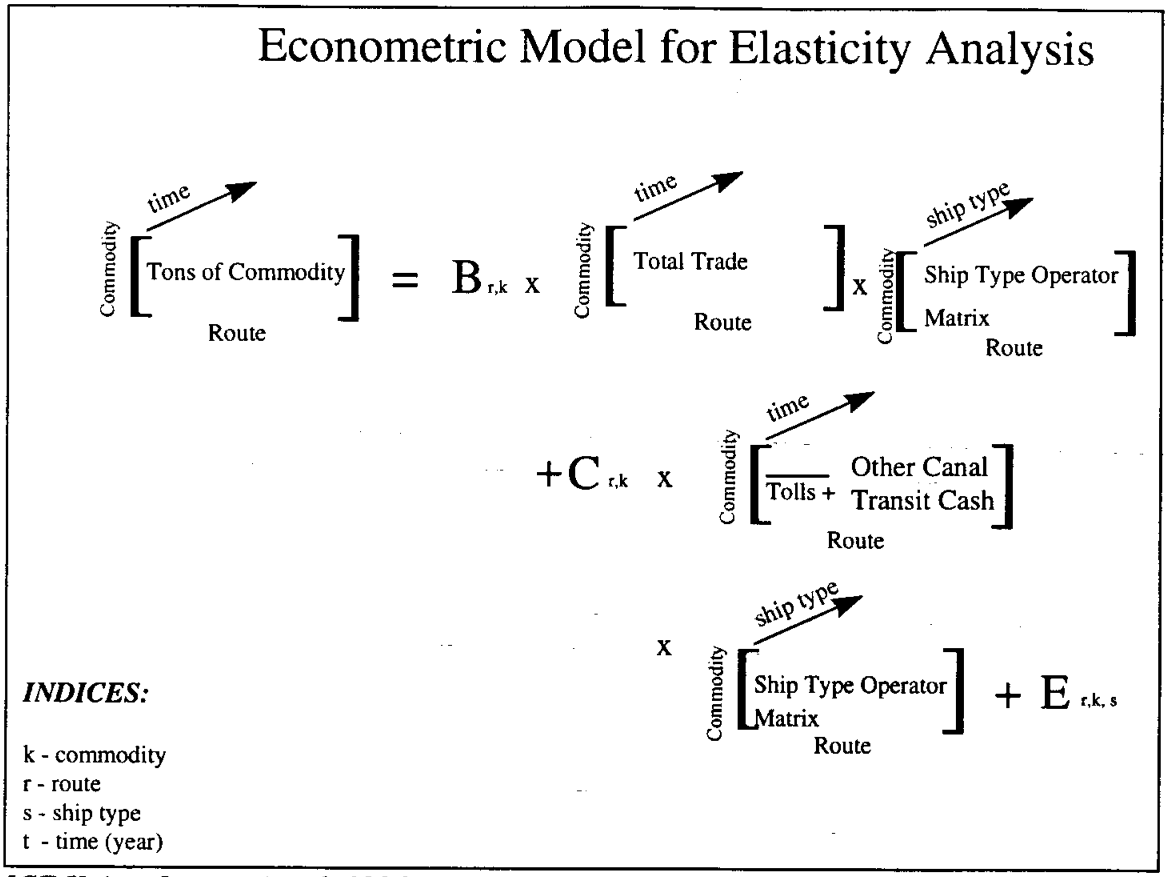
ICF Canal Traffic Model : Methodology

The Canal Traffic Model assumes that shippers are sensitive to price. Thus they base their shipping decisions, in part, on the cost of transit as measured by the toll charges passed through by vessel operators. The differential in price between various routes for the movement of containerized cargo to the East Coast from Asia suggests there is also a "value" placed on timeliness of delivery. As inventories are reduced the "timeliness and regularity of delivery" may become even of greater importance. Thus, in assessing the impact of small variations in price on Canal traffic, it is important to study all factors affecting the cost of transit on a commodity and route specific basis.

We have modeled traffic growth through the Canal by commodity and by route. Like the earlier studies, traffic volume is judged by volume of commodities moving through the Canal. Twenty-nine product categories, including four grain products, are organized in the model into groups of products carried by similar type ships (see List 3-A at the end of this section for identification of products and ship types). While it is difficult to characterize each of these products only in terms of the type of ship, we have based our decision on PCC transit data detailed by product and ship type. Each product has been classified into a ship type based on the type that predominates, i.e. has the highest share of total Canal traffic for the product category.[3] Chart 3-3 provides a schematic of the model used in this study.

[3] The only exception to this general rule is for the two categories of reefer cargoes. Recognizing that there may be a misclassification of ships for reefer cargo in refrigerated containers (a growing trade) we have allowed reefer products (bananas and other refrigerated) to be in both General Cargo/Reefer and in Containerized. We have also included automobiles in containerized cargo category on the assumption that our aggregate ship type includes vehicle carriers and Ro/Ro ships.

Chart 3-3



ICF Kaiser International, 1996

A pooled-cross-sectional-time series model specification was used to predict market behavior on a route-by-route basis. It is assumed that shipper behavior may be measured statistically by the changes in volume through the Canal for groups of products shipped in similar type vessels relative to changes in trade and transport cost (of the Canal). As we can see from the model results this approach has been well validated by the size and sign of most of the coefficients developed using this model specification.[4].

The pooled-time series model allows efficient estimation of coefficients even when the available data is less than complete. The sixteen years of data on each product flow is considered insufficient for purposes of estimation using only time series techniques. By pooling data across all 29 commodities we have increased the degrees of freedom and the statistical significance of the findings there are over 450 degrees of freedom in each model.

[4] This increases the number of observations on which the estimation is performed. Thus the elasticity is based on the variation in traffic to average tolls for the entire sample (all products) rather than on the yearly flow for a single product.

The chart above shows the basic model specification. It provides a functional specification of the model including the differential filters used to separate effects between ship types.

Chart 3-4
Panama Canal Traffic Sensitivity Model

$$\text{Tons via Canal}_{ktr} = [\text{Cost of Transit}_{ktr}, \text{Trade Flow}_{ktR}, \text{Shiptype Filters}_{sh}\ \text{Product Intercepts}_{k}]$$

$$\text{Cost of Transit}_{ktr} = \left[\frac{(\text{Cost per Ton}_{ktr} \times \text{Avg.Tons}_{kr}) + (\text{Canal Waters Time}_{ktr} \times \text{Daily Ship Cost}_{st})}{\text{Avg.Tons}_{kr}}\right]$$

$$\text{Trade Flows}_{ktr} = \left[\begin{array}{l}\text{Trade Intensity}_{ti}, \text{Traded Goods Share}_{ti}, \text{Population Size}_{ti}, \text{Percapita Personal Consumption}_{ti}, \\ \text{Investment}_{ti}, \text{Exchange}_{ti} / \text{Export Price}_{tj}, \text{Relative Wage Index}_{tij}, \text{Relative Productivity Index tij}, \\ \text{Relative Manufacturing Share}_{tij}, \text{Importer Country Intercepts}_{i}\end{array}\right]$$

$$\text{Avg Tons}_{kr} = (\sum_{k} \text{TonsviaCanal}_{ktr}) / 6$$

$$\text{Cost per Ton}_{ktr} = \sum_{sk} \left(\frac{\text{Tons via Canal}_{sktr}}{\sum_{sk} \text{Tons via Canal}_{sktr}} \times \frac{\text{Cost}_{str}}{\text{Tons All Cargoes}_{str}}\right)$$

$$\text{Canal Waters Time}_{ktr} = \sum_{sk} \left(\frac{\text{Tons via Canal}_{sktr}}{\sum_{sk} \text{Tons via Cana}_{sktr}} \times \text{Canal Waters Time}_{str}\right)$$

$$\text{Daily Ship Cost}_{st} = [\text{Average Daily Fuel Cost}_{st}, \text{Average Daily Non-fuel Operating Costs}_{st}]$$

where:

k is the PCC Commodity category;
t is the time period;
s is the ship transit;
r is the trade route;
i is the importer (sums to routes r); and
i is the exporter (sums to routes r).

sh is the ship type (Bulk, Container, Tanker & General Cargo.

ICF Kaiser International, 1996

Ship type filters allow for the differentiation of effects between types of cargo vessels. This is critical to understand the economics since different products have different price points, i.e. the point where the landed cost of the good (price plus transport cost) will make the sale uneconomic.

Cost of Transit is the critical variable that represents the price of moving through the Canal. While distance and availability of alternative routings and even the number of post-Panamax versus Panamax ships in the world will not change in the short run, there has been some adjustment both in tolls and other costs associated with transit and canal waters time, i.e. the time spent waiting and transiting the Canal. We need only observe how this single measure of cost has varied against the traffic since we can assume that other traffic associated with total demand (as measured by trade flows between the seller and the buyer) will have traveled by some form of a bypass. Thus, small changes in this

Canal specific variable can be judged against small changes in Canal activity (traffic by cargo and by route).

Chart 3-5

ICF Kaiser Global Trade Model
Equation Specification

$$X_{i,j,k} = [Con_{i,t},\ INV_{i,t},\ CG\ Share_{i,t},\ MGShare_{i,t},\ CON_{i,t} * D_{i,t},\ INV_{i,t} * D_{i,t}\ CGShare_{i,t} * D_{i,t},\ MGShare_{i,t} * D_{i,t},\ POP_{i,t},\ CEXH_{i,j,k,t},\ CEXH_{i,j,k,t} * A_{i,g},\ RelWage_{i,j,t},\ RelProd_{i,j,t},\ RelManufShare_{i,j,t}]$$

X_{ij} is exports in real 1987 US $ to region I from region j

A is the set of importing region intercepts for all regions *i* in the sample for product *k*

D is a dynamic adjustment variable, which is equal to 1 minus the importing region's per capita GDP divided by $20,000

CON_i is personal consumption expenditures of importer i

INV_i is gross fixed investment of importer i

POP_i is the population of importer i

A_{ig} is a country/regional instrumental variable used to separate individual effects of price. The regions we used were the US, Japan, Europe, NIEs, and Other OECD

CEXH is the cross exchange rate price relationship. We use the exchange rate of the importer *i* and the partner region *j* for the commodity *k* and time *t* multiplied by the commodity price term

CGShare is the consumption share of traded goods to output for region *i* and time *t*
MGShare is the import share intensity (imports over apparent consumption of traded products) for region I and time t

RelProd is based on total factor productivity measures. The average output per employee for region i at time period t is compared to that of the exporting region j.

RelWage is the hourly wages for region i over that for the exporting region j

RelManufShare for country *i* is the absolute share of the manufacturing sector in the country's total output relative to that of the exporting region

ICF Kaiser International, 1996

The results of the estimations confirm our original hypothesis that traffic is affected by changes in operating costs. The actual cost of moving goods through the Canal has varied as the volume of cargo per ship transiting the Canal has changed over time. The variance in the average cost per ton of cargo is reflective of several different factors:

- Efficiency of cargo utilization through the Canal by ship transit;
- Changes in the mix of ships available for service on the All Water Route;
- Changes in average ship costs (fuel and other);
- Canal tolls charged;
- Canal Waters Time (delay time).

The measure of Canal transit is based on a calculated weighted average of total transit charges per ton carried by each ship transiting with that cargo. For instance, the cost for bananas is measured as the average cost of transit in any one year per ton of bananas based on all ship costs per ton that carried bananas through the Canal (both container and reefer vessels thus are counted for that single commodity). In a similar fashion the *canal waters time* for each ship is accounted for in terms of the commodity itself. This represents the cost of Canal transit for each ton of cargo by cargo type and route. For example,, the cost of transporting bananas between the West Coast of South America and Europe is independent of the ship type (reefer or refrigerated container) and reflects the average cost of shipping on all types of vessels.

"Transit cost" is measured by the average of tons of bananas over all sixteen years multiplied by the yearly average cost of one ton moving through the Canal, plus the average canal waters time multiplied by the average daily ship operating cost (on a per day basis). This represents the total cost of transiting bananas through the Canal in any one year. This is then divided by the average tons of bananas over the period to get an average cost per ton of bananas shipped through the Canal.

The Results of Model Estimation

We developed the model using a Generalized Least Square Estimator for the pooled variables. This approach reduces the underlying variance in the series and allows the estimation of more consistent price and demand elasticities. The statistical significance of the variables was generally considered to be satisfactory and the unadjusted fits were typically in the upper 90% range based on R-squared estimators which measure the variance explained by the independent variables in the equation. The generalized least squares estimation procedures improve the fit while making the coefficients generally more consistent with our *a priori* expectations.

The elasticities presented in the Table 3-2 and Table 3-3 are for major routes represents almost 70% of total Canal traffic in tons, while the model itself was estimated based on approximately 90% of Canal traffic volume. As can be observed the elasticities are generally of the correct sign although there are several that reflect the uneven nature of Canal traffic. Where elasticities were judged to be too far out of line with expectations, they were excluded. In these cases, alternative methods were used to develop our forecasts. The Canal Traffic Baseline forecast, however, assumes that traffic will not grow faster than the underlying growth in the total trade on the route for each product group. Nor do we allow it to decline faster than the decline in international trade. When international trade is growing but PCC traffic is falling then we limit the decline to 5% in that one year.

Trade elasticities should be positive but when they are negative this may reflect the fact that Canal traffic has declined as overall trade has grown strongly. This is especially true for the Far East to US East Coast/All Water route. Today the largest volume of this cargo moves through the West Coast. Price elasticities, however, for container traffic tend to be less than 1.0 suggesting that this trade is inelastic and that a toll increase would yield an increase in Canal revenues. Alternatively, bulk price elasticities tend to be greater than 1.0 so that any toll increase will reduce bulk cargo movements through the Canal.

Reefer cargoes were assumed to be indeterminate as to shiptype. We assumed that they traveled both in reefer vessels on some routes and in refrigerated containers on others. To take account of this data on reefer cargoes (bananas and other reefer) were included in both the containerized/automobile category and the general cargo category. The elasticity used for these cargoes is the average of both elasticities estimated (container and general cargo). We have also assumed that on routes between the East Coast of the United States (this includes the Gulf coast ports) and Asia for food grains and other food products have little alternative but to move on routes through the Canal. As a result we have split the filter between general bulk type cargoes and food cargoes carried by bulk vessels. Therefore, our *a priori* assumption is that the elasticity against Canal transit cost for food should be close to zero.[5]

Finally, in developing estimates of impact we have assumed that if the elasticity of price to traffic is positive then a small change in the Canal transit costs will have no impact on traffic; in these cases traffic growth is held to our baseline forecast and toll increases to the full value of the adjustment of tolls. This is a better assumption than adjusting traffic upward when tolls rise. Positive price elasticities, although usually small, are often measures of the inelastic nature of a product flow to changes in price. Thus price is not important to the flow, and of course, higher prices do not lead to more traffic growth.

[5] In actual fact, historically the elasticity for tonnage to transit is -.24 over the long period, but positive .03 for the period 1990-1995 when demand for US grain to Asia soared.

Table 3-2

Estimated Price Elasticities for Canal Transit Costs Per Ton of Cargo

	Coal & Coke, Lumber, Pulpwood, Iron & Steel, Phosphates, Fertilizers, Misc. Minerals, Alumina/Bauxite, Other Ores, Metal Scrap, Sugar, Paper	**Wheat, Corn, Soybean, Other Grain**	**Chemicals, Petroleum Chemicals, Petroleum, Petroleum Residual, Petroleum Coke, Petroleum Products, Food & Agriculture**	**Other Metals, All Others**	**Automobiles, Containerized Cargo**	**Bananas, Other Reefer**
US East to East Asia	-.752	-.243	0	-.247	0	-.186
East Asia to US East	-.888	-.888	-0.254	0	0	-.500
South Am. West to US East	-.993	-.993	-1.300	-.934	0	0
Canada to Europe	-1.3	-1.300	-1.300	-.818	0	-.065
South Am. West to Europe	-1.3	-1.300	-0.835	-.545	0	-.134
US West to Europe	-.357	-.357	-1.152	-1.300	0	-.500
US East to South & SE Asia	0	-1.300	0	-.218	0	0
US East to South Am. West	-.402	-1.300	-.264	-.814	0	-.500
US East to Central Am./Carib.	-.630	-1.300	0	-.400	0	0
South Am. West to Central Am./Carib.	-.259	-.259	-.819	-.122	0	-.500
South Am. East to South Am. West	-.680	-.680	-1.300	-.249	0	-.102
US East to Oceania	-.777	0	-.196	-.470	0	0
Europe to US West	-.810	-.810	-1.054	-.541	0	-0.496
South Am. East to US West	-1.300	-1.300	-1.300	-1.300	0	-0.500
South & SE Asia to US East	-.993	-.993	-1.023	-.188	0	0
Centl Am./Carib. to Centl Am./Carib.	-1.300	-1.300	-1.300	-1.180	0	-0.500
Oceania to US East	-.107	-0.107	-.986	0	0	0
South Am. East to Central Am./Carib.	-1.300	-1.300	-1.043	-.815	0	-0.233
Central Am./Carib. to US East	-.460	-.046	-1.037	-.975	0	-0.477
Europe to South Am. West	-.930	-.930	-.938	-.480	0	0
South Am. East to East Asia	-1.300	-1.300	-1.300	-.947	0	-.500
Central Am./Carib. to East Asia	-1.300	-1.300	-.194	-.105	0	-.500
Central Am./Carib. to South Am. West	-1.099	-1.099	-1.059	-.798	0	-.500
East Asia to Central Am./Carib.	-1.002	-1.002	0	-.832	0	-.500
South Am. West to South Am. East	-0.721	-0.721	-1.070	0	0	-.294
US West to South Am. East	-1.300	-1.300	-1.300	-1.059	0	-.099
East Asia to South Am. East	-1.300	-1.300	-.777	-1.300	0	-.199
Central Am./Carib. to South Am. East	-1.077	-1.077	-1.300	0	0	0

ICF Kaiser International, 1996

Analysis of results

The initial study results to assess price elasticity were derived from numbers which were statistically and econometrically correct. While the results were within an often acceptable range of potential change, the Consultants felt that in some cases certain the data could overstate the statistical significance and the overall impact of the toll changes on shippers and shipowners. These initial unadjusted estimated elasticities of demand for Canal Transit are presented in Table 3-3 for major trade routes for the periods 1980-1995 and 1990-1995.

It was considered prudent to take account of shipping behavior and vessel operating patterns which could have further external effects on the toll's elasticity. As a result, some of the output was adjusted. The marketing survey further substantiated by at least some of these assumptions. Based on this review, the following controls were installed:

1. For containerized cargo where the model reflected a minimal amount of elasticity, this is, the results indicated that a toll increase would be a marginal negative effect on cargo volumes, it was decided to hold the change to 0 (zero). As container ships travel on a regular, fixed schedule and routes are advertised well in advance of actual service dates, Vessel utilizations vary over time and a marginal decline in cargo will not alter the sailing pattern of the ships. If volumes decline over a long period of time below acceptable revenue levels, then of course, operators will take remedial action. For example, operators on major routes experiencing excess capacity often solve this problem via the introduction of voluntary "theoretical" reductions in capacity. The Trans Pacific trade experienced such a reduction several years ago. Based on this and other examples, the Consultant conservatively assumed that toll increases moving at reasonable levels will not cause reduced transits even if cargo volumes drop marginally.[6] Decisions on liner vessel routing can generally be assumed to be a function of vessel utilization, total voyage costs, of which the Canal transit charge represents between 2 and 7 percent of the total, and other operating parameters such as feeder options, demand centers, and conforming to strategic alliances. The determination of whether or not to transit the Canal will be a longer term decision and will also be based on a combination of the above factors. It is exceedingly difficult to establish at what point a toll rate increase will combine with the other operating parameters to force a change in vessel routing. If a bypass decision is made, however, it will have a dramatic effect on Canal revenues due primarily to the shipping alliances as they combine two or more carriers into one service. Over the long term it could be expected that the results of the elasticity model would apply.

---

[6] The average of the elasticities for containerized cargoes was -0.053, the median -0.004. Some routes, however are significantly more sensitive. For example, East Asia to US East Coast shows an elasticity of -2.188 (1980-1995) and -0.925 (1990-1995). Others are insensitive such as the West Coast of South America to the US East Coast (1.011 for the 1980-1995 period, but -1.165 during the 1990-1995 period), suggesting that there are alternative shipping methods today.

Table 3-3

Unadjusted Raw Price Elasticities for Canal Transit Costs Per Ton of Cargo 1980-1995 & 1990-1995

	Coal & Coke, Lumber, Pulpwood, Iron & Steel, Phosphates, Fertilizers, Misc. Minerals, Alumina/Bauxite, Other Ores, Metal Scrap, Sugar, Paper		Wheat, Corn, Soybean, Other Grain		Chemicals, Petroluem Chemicals, Petroleum, Petroleum Residual, Petroleum Coke, Petroleum Products, Food & Agriculture		Other Metals, All Other General Cargo		Automobiles, Containerized Cargo		Bananas, Other Reefer	
	90-95	***80-95***	**90-95**	***80-95***	**90-95**	***80-95***	**90-95**	***80-95***	**90-95**	***80-95***	**90-95**	***80-95***
US East to East Asia	-1.291	*-0.752*	0.030	*-0.243*	-0.794	*0.298*	-0.764	*-0.247*	-0.469	*-0.125*	-0.617	*-0.186*
East Asia to US East	0.270	*-0.888*	0.270	*-0.888*	-0.628	*-0.254*	-0.391	*0.015*	-0.925	*-2.188*	-0.658	*-1.087*
South Am. West to US East	-1.659	*-0.993*	-1.659	*-0.993*	-1.465	*-2.165*	-0.073	*-0.934*	-1.165	*1.011*	-0.619	*0.038*
Canada to Europe	-5.906	*-1.332*	-5.906	*-1.332*	-0.059	*-1.946*	0.583	*-0.818*	1.960	*0.689*	1.272	*-0.065*
South Am. West to Europe	-1.844	*-1.759*	-1.844	*-1.759*	-2.074	*-0.835*	-1.312	*-0.545*	0.029	*0.277*	-0.642	*-0.134*
US West to Europe	0.941	*-0.357*	0.941	*-0.357*	0.246	*-1.152*	-0.976	*-1.347*	-0.037	*-0.029*	-0.507	*-0.688*
US East to South & SE Asia	0.356	*0.127*	-2.075	*-2.277*	0.933	*1.482*	-0.011	*-0.218*	0.279	*1.235*	0.134	*0.509*
US East to South Am. West	-0.737	*-0.402*	-2.856	*-1.991*	-0.662	*-0.264*	-0.485	*-0.814*	-0.139	*-0.471*	-0.312	*-0.643*
US East to Central Am./Carib.	-1.246	*-0.630*	-1.593	*-2.310*	-0.772	*0.460*	-1.882	*-0.400*	1.588	*1.731*	-0.147	*0.666*
South Am. West to Central Am./Carib.	-0.626	*-0.259*	-0.626	*-0.259*	-1.723	*-0.819*	-0.135	*-0.122*	0.369	*-0.881*	0.117	*-0.502*
South Am. East to South Am. West	-0.018	*-0.680*	-0.018	*-0.680*	-2.435	*-1.808*	-0.726	*-0.249*	1.105	*0.046*	0.190	*-0.102*
US East to Oceania	-0.735	*-0.777*	0.763	*0.899*	-1.178	*-0.196*	-1.238	*-0.470*	0.437	*0.624*	-0.401	*0.077*
Europe to US West	-0.498	*-0.810*	-0.498	*-0.810*	-3.557	*-1.054*	-0.784	*-0.541*	-1.042	*-0.451*	-0.913	*-0.496*
South Am. East to US West	0.902	*-1.718*	0.902	*-1.718*	-0.381	*-1.381*	-5.391	*-2.823*	-0.597	*-1.426*	-2.994	*-2.125*
South & SE Asia to US East	-2.644	*-0.993*	-2.644	*-0.993*	-2.703	*-1.023*	0.175	*-0.188*	-0.836	*1.224*	-0.331	*0.518*
Centl Am./Carib. to Centl Am./Carib.	-1.831	*-1.705*	-1.831	*-1.705*	-2.511	*-2.302*	-1.104	*-1.180*	-1.156	*-0.988*	-1.130	*-1.084*
Oceania to US East	-0.069	*-0.107*	-0.069	*-0.107*	-1.309	*-0.986*	0.815	*0.693*	0.169	*0.024*	0.492	*0.359*
South Am. East to Central Am./Carib.	-1.019	*-1.915*	-1.019	*-1.915*	-1.400	*-1.043*	1.053	*-0.815*	-0.459	*0.350*	0.297	*-0.233*
Central Am./Carib. to US East	-2.115	*-0.460*	-2.115	*-0.460*	-1.792	*-1.037*	-1.162	*-0.975*	0.304	*0.022*	-0.429	*-0.477*
Europe to South Am. West	-1.292	*-0.930*	-1.292	*-0.930*	-1.427	*-0.938*	-0.580	*-0.480*	-0.251	*0.694*	-0.416	*0.107*
South Am. East to East Asia	-1.719	*-2.187*	-1.719	*-2.187*	-3.501	*-2.057*	-0.815	*-0.947*	-0.544	*-0.827*	-0.680	*-0.887*
Central Am./Carib. to East Asia	-3.361	*-1.967*	-3.361	*-1.967*	-2.540	*-0.194*	-0.686	*-0.105*	0.358	*-1.019*	-0.164	*-0.562*
Central Am./Carib. to South Am. West	-1.114	*-1.099*	-1.114	*-1.099*	-1.227	*-1.059*	-0.866	*-0.798*	-0.896	*-0.496*	-0.881	*-0.647*
East Asia to Central Am./Carib.	-1.256	*-1.002*	-1.256	*-1.002*	1.400	*0.259*	-1.191	*-0.832*	1.400	*-0.977*	0.105	*-0.905*
South Am. West to South Am. East	-0.624	*-0.721*	-0.624	*-0.721*	-1.156	*-1.070*	-0.264	*0.383*	0.131	*-0.970*	-0.067	*-0.294*
US West to South Am. East	1.486	*-1.668*	1.486	*-1.668*	-2.745	*-2.238*	-3.878	*-1.059*	-0.095	*0.862*	-1.987	*-0.099*
East Asia to South Am. East	-0.606	*-1.619*	-0.606	*-1.619*	-1.261	*-0.777*	-2.013	*-1.321*	1.293	*0.924*	-0.360	*-0.199*
Central Am./Carib. to South Am. East	-0.635	*-1.077*	-0.635	*-1.077*	-2.805	*-2.010*	0.389	*0.549*	-1.173	*-0.341*	-0.392	*0.104*
Simple Average	-1.032	-1.024	-1.106	-1.149	-1.412	-0.932	-0.847	-0.592	-0.013	-0.053	-0.430	-0.323
Median	-0.878	-0.962	-1.067	-1.040	-1.355	-1.030	-0.745	-0.543	-0.066	-0.004	-0.396	-0.216
Standard deviation	1.441	0.605	1.524	0.767	1.214	0.911	1.313	0.684	0.873	0.925	0.771	0.587

2. For refrigerated vessels and their cargoes, where negative price elasticities were observed, the Consultant limited the effect to a maximum -0.5. While somewhat arbitrary, it is possible that reefer vessel operators, and more importantly, producers, have little choice in some cases but to transit through the Panama Canal. In cases such as Ecuador to Europe, it is likely that higher tolls will ultimately be borne by growers in the form of slightly lower income rather than losing the entire market in Western Europe.

3. For the major East-West grain trade out of the US Gulf to East Asia, the elasticity generated by the model was -0.24 (it was positive using the shorter sample period). For US Gulf to Southeast Asia, however, an all water alternative is viable. We have limited bulk for all other bulks the negative price elasticity to -1.3 whenever the estimated elasticity is greater than this maximum. This suggests that there will be a diversion either to alternative routes or to alternative suppliers. Again, this is consistent with our assumption that for bulk products, price changes may be significant in determining supplier, given the nature of the cargo carriers.

The overall results indicate that in aggregate, the elasticity to toll increases is negative, as one would suspect, however, the ratio of toll increases to cargo decline is within levels of tolerance that can be related to past activities. Given the uncertainty of international trade, temporary shortages of supply, (as seen recently in the United States with petroleum products) and political decisions (such as China's decision to halt grain exports and increasing imports of American grain in late 1994), it is very difficult to suggest with 100 percent accuracy that any limited number of factors can be related statistically to changes in toll policy. Yet, the model developed for this project provides strong evidence of significant linkages that help to determine the results of toll increases.

Other observations include:

- The price elasticity for bulk type products excluding food grains tend to be less than -1.0. The average for all bulks is -1.024 and the median at -.962

- On bulk routes where there are few alternative routes that are feasible tend to have elasticities less than -1.0: South American East to Central America (-.259), US West coast to/from Europe (-.357), South America East to South America West (-.68), Oceania to/from US East (-.107). For US East coast to Southeast Asia (includes India) the elasticity indicated is positive suggesting that other factors may be important in explaining transportation choice. [7]

[7] The total miles is about equal for bulk shipments going via Suez or the Panama Canal. Tolls are higher on the Suez.

- Food Grain from East Coast ports have few options but to transit through the Canal due to the cost of shipping grain through alternative means. Thus US East Coast to East Asia the elasticity for shipments through the Canal is close to zero (slightly positive during the 1990-1995 sample period by -.24 for the longer period). There was a similar finding of zero sensitivity for East Coast to Oceania (although there is only a limited shipment of US food grains to Oceania). For US East Coast to Southeast Asia (where the route through Suez is slightly less then through Panama) the indicated elasticity is -2.3 confirming our theory that bulk shipments are very sensitive to small changes in price.

- Tanker type products (Chemicals, Petroleum products, etc.) are equally sensitive to changes in canal transit costs. One exception is that for the major flows coming out of the East Coast chemical industries and moving to East Asia (the cost of bypass is significant given the difficulty of moving these type of products by rail due to their nature and their weight). The elasticity is greater than -1.0 suggesting that any increase will lead to a reduction in traffic, but an increase in total revenues. Source substitution is a more likely scenario here.

- For tanker products out of South America West (mainly crude out of Ecuador) higher tolls lead to significantly less traffic and an overall lower total revenue. Similarly on traffic to Europe from South America West coast a 10% increase in canal costs leads to a decline in traffic and a net loss in revenues.

- Where there is no conceivable alternative routing, i.e South America West to the Caribbean the elasticity is -.7 so that same 10% increase yields only a 7% decline and a net increase of 3% in revenues.

- It is likely that for routes where the elasticity is greater than 2 (in the case of many smaller routes through the Canal) any toll increase would force a significant portion of the liquid bulk trade to find alternative routings, i.e. around the Cape Horn or alternative suppliers.

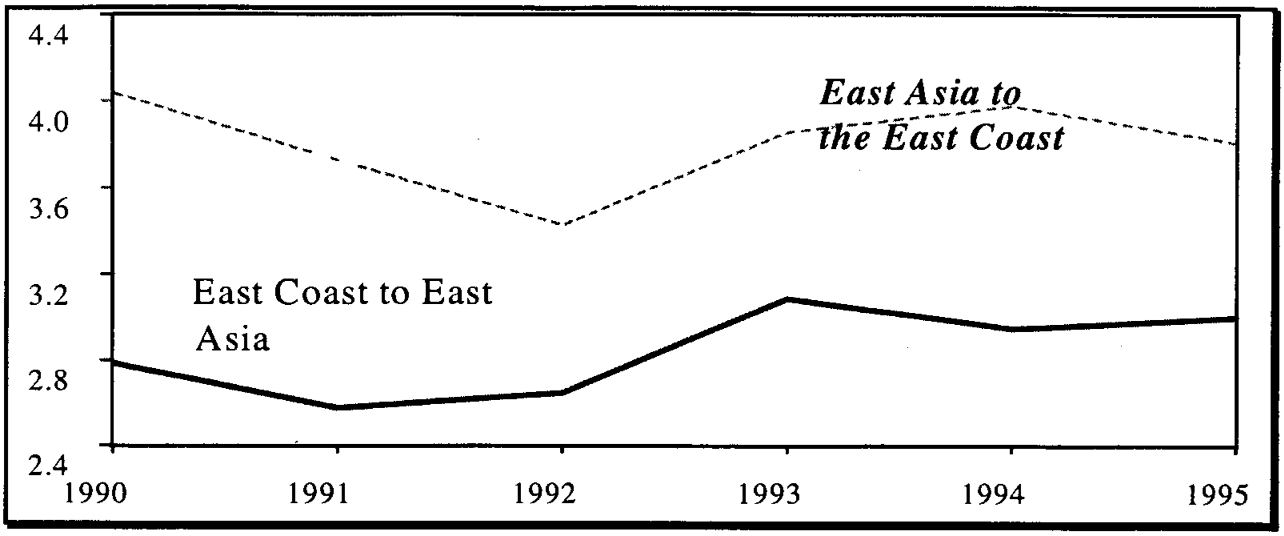
- For cargoes that move on general cargo vessels – including oversized cargoes as well as reefer cargoes, traffic is generally inelastic to price changes. This means that for the US East Coast to East Asia route the elasticity is .25 (but -.7 using the shorter sample period). Thus, a 10% increase yields 7.5% in additional revenues (10% higher rates and 3% lower volume). Similarly for East Asia to the US the other alternatives are not enough to force this type of oversized cargo off ships and onto rail cars since the cost by rail may be far greater than any conceivable adjustment in costs of transit through the Canal. Also time may be important for these products. Oversized and jumbo cargoes that move on these type ships that are "industrial" may be very costly and carry inventory costs greater than the transit costs or they may be perishable. Thus the elasticity is positive and 10% yields about 10% in added revenues.

- In general for these oversized and heavier cargoes the price elasticity is closer to zero then to -1.0. The mean is -0.59, with some routes showing no sensitivity to toll changes. For ships carrying unique cargoes, the Canal is the best route. Yet even as revenues go up, traffic declines since some of this trade might be made non-economic or alternative sea routings, perhaps through Suez or around Cape Horn or Cape of Good Hope found.

- For liner trade, including refrigerated cargoes carried on liners in boxes and automobiles, the cost of transit through the Canal is less important than the time associated with the transit (and the certainty of making a schedule). We measure both of these variables but the transit related revenue per ton is the more dominant and the canal waters time the less dominant value. This type of cargo is less sensitive to price charges and likely more sensitive to delays. In general liner elasticities as calculated are less elastic than others. They range from a very elastic East Asia to US East Coast (due to the development of a reliable intermodal connection through the West Coast to a large number of routes with positive price elasticities.

- Sensitivity in our model is product determinant. Higher value products and a superior (but more costly) alternative routing explains the two East Asia routes. In the case the US East to East Asia route, the elasticity is -.125, suggesting only a slight sensitivity to price for transit costs. Low value goods (in higher volumes) are shipped from the US East to East Asia, and since the ships are already traveling on the route this flow is less sensitive to toll changes. But on the Eastbound leg from East Asia to the US East Coast the elasticity is close to -2.18 (-.925 for the 1980-1995 period so a 10% toll increase yields a 1% increase in revenues.) The effect of mini land bridge through US West Coast is evident here.

Chart 3-6
Ship Transit Costs Per Ton of Containerized Cargo
East US to East Asia & East Asia to East U.S.



ICF Kaiser International, 1996

- Historically, i.e. over the longer period (1980-1995), for South America West to the US East Coast the elasticity is positive. Yet, as alternatives for cargo have developed, including transhipment cargoes via the US West Coast to Midwest/US East Coast, the elasticity has become very negative and elastic: greater than -1.0.

- Where there is no close alternative route choice such as West Coast South America to Europe the elasticity is positive, but near zero.

- Bananas and Other Reefer Cargoes show some sensitivity to price. For example, West Coast South America to Europe, a major route for bananas and fruits. The elasticity is -0.13 for the longer period and -0.6 for the shorter one.

- Where there is no alternative--such as South America West to Central America/Caribbean or between East and West Latin America the elasticity is generally negative and closer to zero than to -1.0.

Chart 3-7
Comparison of Elasticity by Ship and Product Carried

Ship Carrier	Transit Cost Elasticity	Product Characteristic
Bulk	⬆ Very Elastic (< -1.0).	Many Sources/Homogeneous
Tanker	⬈ Slightly Less Elastic (= -1.0)	Homogeneous
General/Reefer	⬇ Inelastic (> -1.0)	Fewer sources/Differentiated
Container	⬇ Inelastic (= 0)	Differentiated

ICF Kaiser International, 1996

While we can examine the relative cost differential based on distance between points via the Canal and by a well chosen bypass route, differential in cost of transits may not explain the significance of the negative price elasticities calculated. Canal tolls could rise substantially before these differences are wiped out. Our model suggests, however, that there is for many products an extreme sensitivity to small adjustments in the transit costs.

Table 3-4
Ship Owners Perspective

Route	Cost via Canal ($ 000)	Cost via All Water (bypass canal) ($ 000)	Cost via Land Bridge (MLB) ($)	Differential All Water ($ 000)	Differential LandBridge ($ 000)
US E.Coast from N.Asia	$ 578	$ 771 (Cape Horn)	$1759	$193	$1181
US E. Coast from S.Asia	$ 719	$ 624 (Suez)	$2053	- $95	$1315

ICF Kaiser International, 1996

The elasticity for container traffic on the US East Coast to and from East Asia route varies from -.125 for the Westbound direction and -2.2 for the Eastbound one (-0.47 and -0.92 when the sample is shortened to the last six years. The Westbound direction, however, tends to be lower valued unfinished raw materials including waste paper and pulp, while the Eastbound direction tends to be finished products of a higher value. The transit cost elasticity for US East Coast to and from South Asia (including Southeast Asia) is over 1.0, thus liner traffic is not impacted on this route by price adjustments. This suggests the ships that make this transit (likely the Around the World Ships) are indifferent to tolls and are sensitive only to judgments of their owners as to viability of this type of ship routing. Of course, the success of this strategy would be called into question if tolls were raised to a point where this type of long distance service becomes noneconomic. Again, the cargoes carried may represent low value waste products from the East Coast and the ships may call on the West Coast ports to pick up more higher value cargoes. Southeast Asia is marginally closer via Suez than through the Canal, but Suez tolls may be higher than those through the Canal.

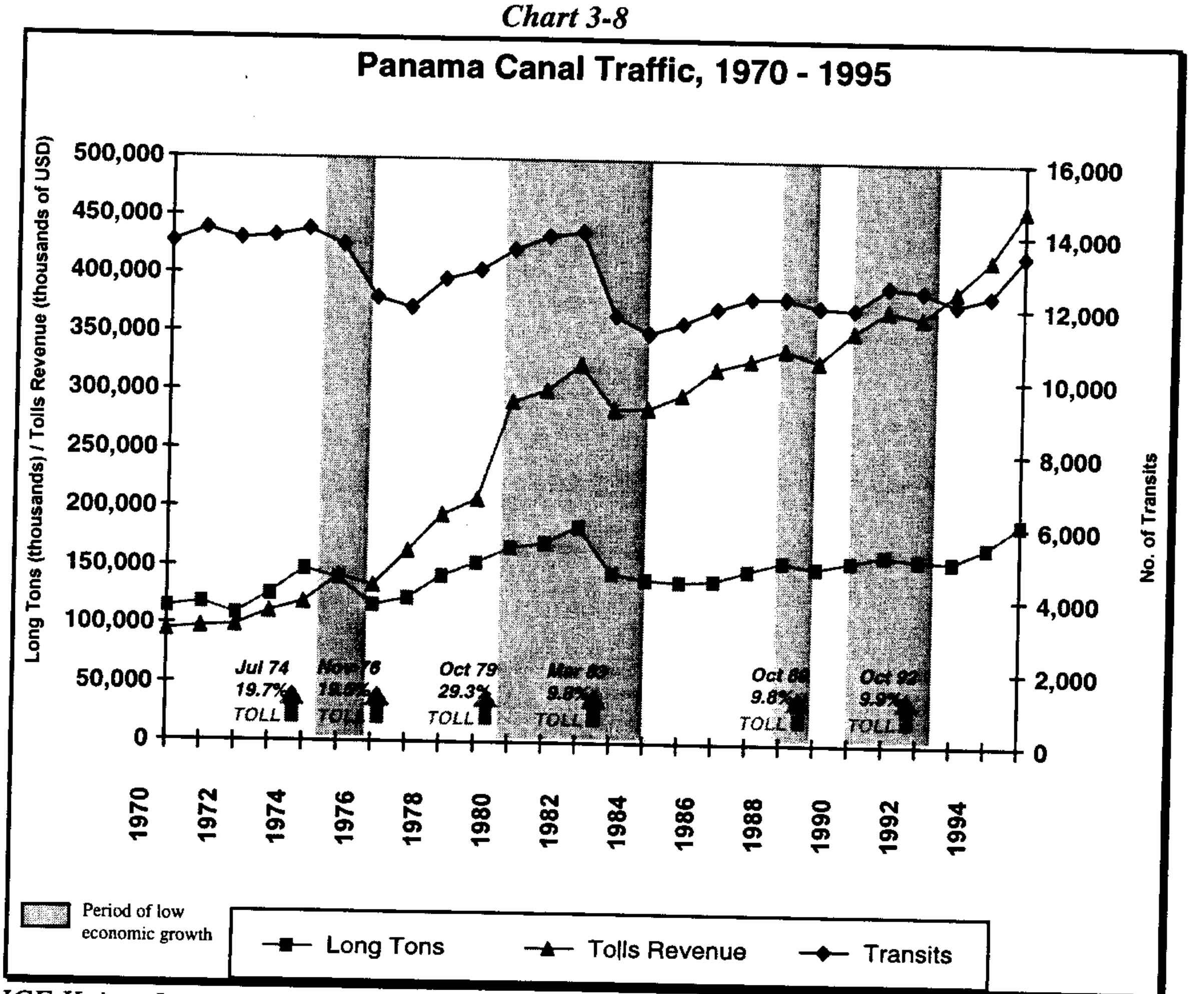
Given that a large volume of US bound cargoes currently travel by the fastest means this suggests that the time value of money can play a role in determining volume through the Canal. While we have not measured this effect it is clear, given the sizable differential in price between the Landbridge and the All Water route to Asia, that shippers are willing to pay this differential to gain time of delivery. With the increased use of "Just-in-time" inventory control (within industry) the regularity of service may play an even larger role. Thus the unpredictability of Canal waters time may influence decisions since a delay of several days can lead to a costly shut down of manufacturing plants that is dependent on the prompt supply of parts and materials.

Summary

It should again be pointed out that we have approached the sensitivity of toll increases from an empirical and statistical point of view with some adjustments for expected vessel owner and cargo owner behavior, however this does not fully account for historical patterns of events during times of toll increases. A review of transits, toll revenues and long tons of cargo through the Canal since 1970 provides some interesting insights. These are:

- the average long tons per voyage increased by 69% over the period and by 7.5% since 1990. Therefore the number of transits on its own is not a clear measure for growth or decline. It does however indicate that shipowners and charterers are trying to maximize the economies of scale in order to achieve the minimum unit cost of transportation possible within Canal constraints.

Chart 3-8

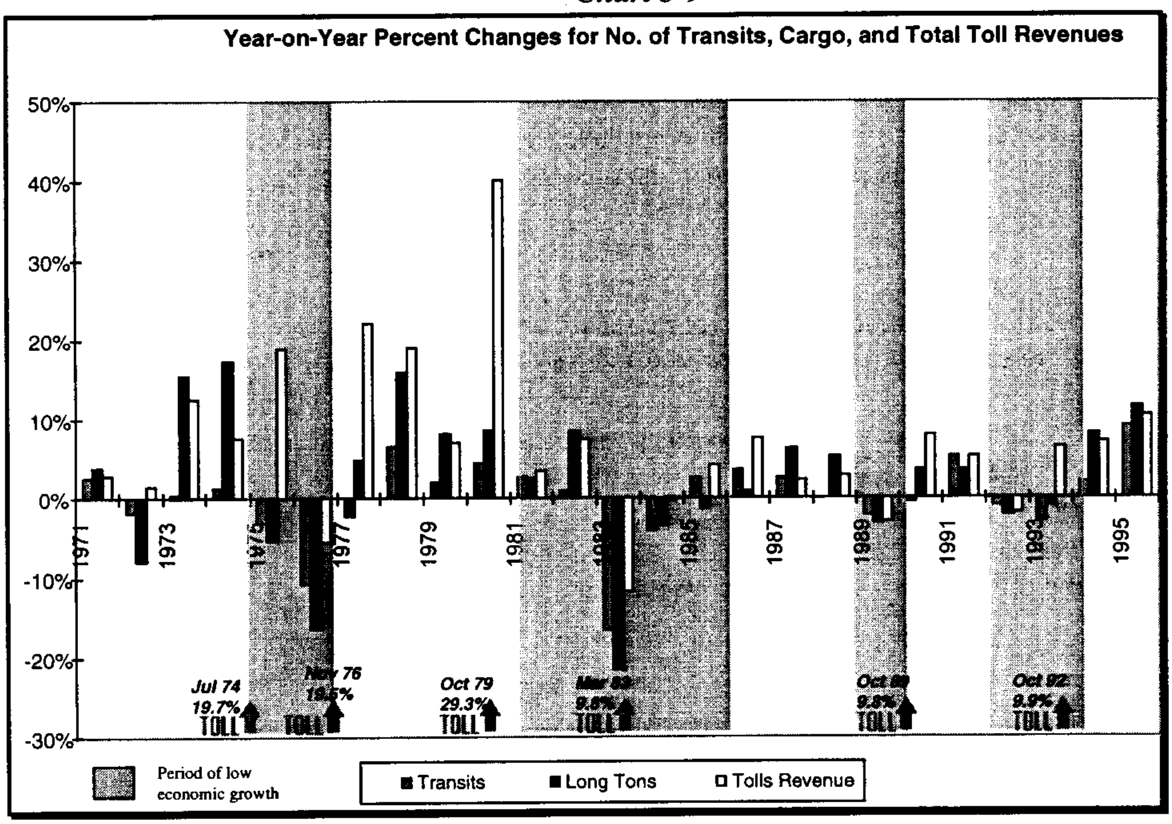


ICF Kaiser International, 1996

- At least four of the past toll increases came during a period of recession and low economic growth.

    1. The July 1974 increase of 19.7% corresponded with an average toll revenue increase of 7% over a three year period. Cargo tonnage declined by an average of 1.4% over the same period.
    2. The March 1983 increase of 9.8 % corresponded with an average toll revenue decrease of -2.45% over a three year period. Cargo tonnage declined by 8.8 over the same period. This decline was due largely to the shift of Alaskan North Slope crude from moving via the Canal to the PTP pipeline.
    3. The October 1989 increase of 9.8% took effect just prior to the 1991-93 global downturn in trade. The average toll revenue increase over three years was 3.8%. The cargo tonnage increased on average 1.7% during this period.
    4. The October 1992 toll increase of 9.9% resulted in an average increase over three years of 7.8% while cargo tons increased by 6.3%.

Chart 3-9



ICF Kaiser International, 1996

- Based on comments from individual discussions with ship owners and responses from the market survey carried it is not clear that the current cost of transit for certain ship types is at a level to create an immediate adjustment in the demand curve. This is substantiated in the results of the elasticity model to some extent. The effect of increasing Canal Waters Time is far more critical to shifts in the demand curve.

There are sufficient exogenous events that impact on the behavior of vessels that can potentially transit the Canal that no statistical model or approach can mirror the actual results with certainty. Shifts in patterns of trade, policy decisions (such as China's to cease export of grain to Asia), applications or removal of subsidies (such as in the European Union), weather conditions or simply commodity price speculation (as happened recently with U.S. oil companies) can all combine to create changing patterns of vessel operations independent of Canal toll increases. The sensitivity analysis should be seen as one of the tools for assessing the impact of toll increases. It will need to be tempered with short term events for a more accurate assessment.

List 3-A
PCC Cargo Categories

PCC Cargo Categories	Ship Designation Based on actual Canal Transit data	PCC Traffic Cargo Splits (Average All Routes and All Years)	Comments
1. Banana	Container & General Cargo	37% Container & 59% Reefer	Cargo split between reefer and container
2. Reefer Other	Container and General Cargo	37% Container & 59% Reefer	Assume all commodities requiring refrigeration would go into reefers
4. Petroleum Chemicals	Tanker	98% Tanker	Covers all organic chemicals
3. Chemicals	Tanker	4% Bulk & 92% Tanker	All other chemicals are containerized. Ninety-eight percent shipped in tanker vessels.
5. Coal & Coke	Bulk	100% Bulk	
8. Wheat	Bulk	92.9% Bulk	
29. Corn	Bulk	99% Bulk	
7. Soybeans	Bulk	98% Bulk	
6. Grains Other	Bulk	88% Bulk & 9% General Cargo	Includes oil seeds
9. Lumber Products	Bulk	91% Bulk & 6% Container	
10. Pulpwood	Bulk	67% Bulk & 27% Container	
11. Automobiles	Container/Auto carrier	92% Vehicle Carrier	
12. Iron & Steel	Bulk	78% Bulk, 6% Container & 15% General Cargo	
19. Metals Other	General Cargo/Reefer	42% Bulk, 13% Container & 43% General Cargo	
14. Phosphates	Bulk	95% Bulk	
15. Fertilizers	Bulk	73% Bulk, 18% General & 4% Tanker	
13. Minerals Misc.	Bulk	91% Bulk, 5% Container	
16. Alumina/Bauxite	Bulk	94% Bulk	
17. Ores Other	Bulk	84% Bulk, 6% Container & 10% General Cargo	
18. Scrap Metal	Bulk	96% Bulk	
20. Sugar	Bulk	71% Bulk & 27% General Cargo	
21. Petroleum	Tanker	99% Tanker	Includes natural & manufactured gas
22. Petroleum Residual	Tanker	96% Tanker	
23. Petroleum Coke	Bulk	98% Bulk	
24. Petroleum Products	Tanker	5% Bulk & 94% Tanker	
25. Paper	Bulk	42% Bulk, 19% Container, 24% General Cargo & 13% Reefer	

26. Food & Agriculture	Tanker	20% Bulk, 20% General Cargo & 52% Tanker	Mainly oil seeds—52% in tankers
27. All Other	General Cargo/Reefer	27% Bulk, 14% Container, 37% General Cargo, 11% Tanker, & 10% RORO/Vehicle.	Further split into: 30. Leather and rubber and products 31. Resins 32. Textiles 33. Machinery, other vehicles & transport equipment 34. Other
28. Containerized	Container	85% Container, 5% General Cargo & 5% Vehicle/RORO	Further split into: 35. Food, beverages and tobacco 36. Pharmaceutical, cleansing and other chemical products 37. Computers, electrical and electronic products 38. Clothing 39. Footwear 40. Photographic eq., watches and clocks 41. Scientific eq. 42. Other containerized cargo

ICF Kaiser International, 1996

Table of Contents

Section 4: Impact of Annual Versus Less Frequent Toll Increases

Introduction

Given the market and elasticity analysis conducted in the previous sections, the sensitivities of changes to Panama Canal tolls are now reviewed in this section.

Current tolls use a full cost recovery system such that toll rate increases cover the capital and operating costs of the Canal. These costs include recovery of prior years' losses, and working capital requirements. Currently, toll rates are not specifically tied to the commercial value of the commodity mix carried. The Panama Canal toll rates are administered by computing the PC/UMS Net Ton for each vessel Panama Canal toll rates vary depending on ship and carrier type. It is beyond the scope of this study to consider possible changes to the structure of tolls beyond current treaty requirements. Thus, this study focuses only on the potential change in frequency and amount of toll increases using the current system of toll assessment. (A separate analysis of a proposed on-deck cargo tolls system is discussed in Section 6).

Impact of Raising Canal Tolls

We can observe the impact of Canal tolls by using the elasticity model developed to project the baseline scenario. Some routes and products were excluded when developing these alternatives because the size of the implied elasticity and the sign appeared questionable. In these cases, the baseline forecast was substituted. While this may overstate the effect since there was no allowance for a decline in traffic, the risk of using faulty elasticities is greater. In any case, the Consultants do not believe that this action biases results significantly. Additional variances and exogenous factors are discussed in Section 3.

Revenue growth is dependent on the projected strength of key routes and the impact of a scenario (with a given percentage increase in tolls) on the Transit Cost Per Ton for that route and that product. This varies significantly as it is dependent upon the price charged by type of ship (the ship characteristics). Thus, while the overall tonnage may fall, the tolls collected could be larger allowing the aggregate to be higher. However, given the elasticities, it is clear that a 10% increase in tolls will not result in a direct relationship to increases in revenue on a 1 to 1 basis.

It is not surprising to see that traffic will potentially decline when tolls increase. Revenues are higher and the amounts are significant. The most significant increase is attained when tolls are increased each year. Here the increased revenues are significantly higher than in the baseline. The traffic is, however less.

If the Canal did not raise tolls (baseline scenario), the revenue forecast indicates that by 2015, total toll revenue would be $765 million. However, this assumes that the Canal can handle traffic that is over 100 million tons greater than in 1996, that is, an increase in volume of over 60 percent.

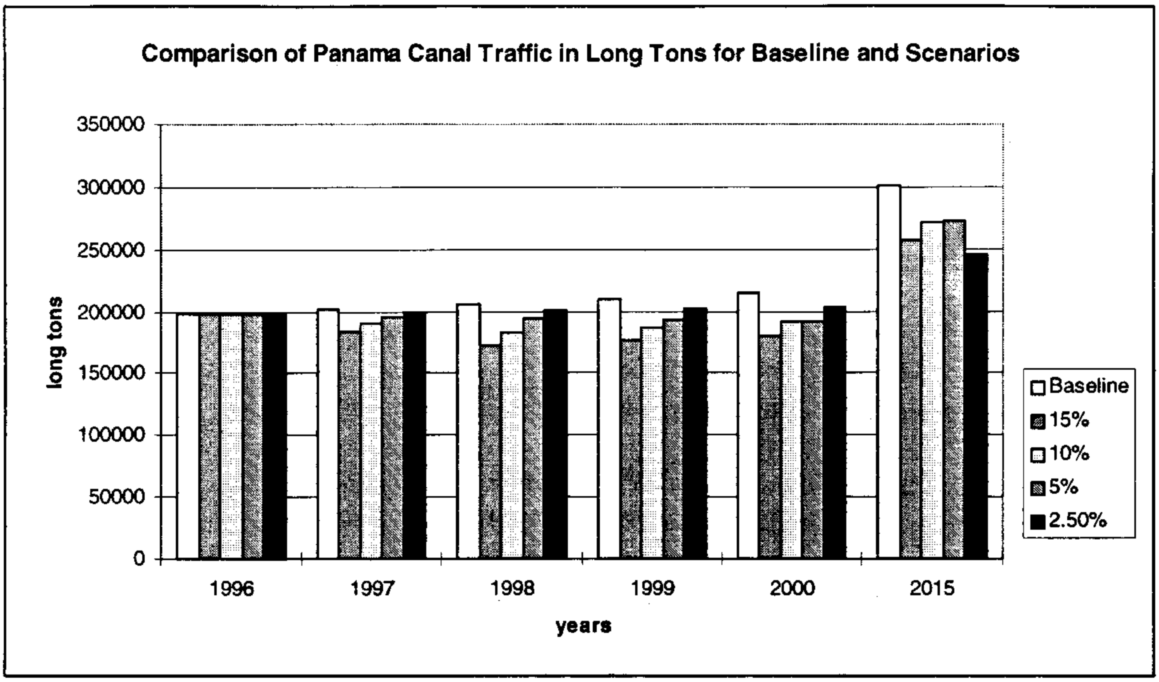
If tolls are raised by 15% in the first two years and then held steady (Scenario 1), then revenues in 2015 will be over $900 million dollars—almost $140 million dollars above the baseline at the same point in time. However, overall traffic growth from 1995-2015 is expected to be only about 60 million tons in the first Scenario as compared to a projected growth in the baseline of 104 million tons. When tolls are raised by 10% for two years (Scenario 2), the net impact by 2015 is $46 million dollars less than the $900 million dollars in the 15% scenario. Given the model's structure, there is little difference between the second and third scenarios (for 5% increase with two 10% increases back to back). The last scenario, 2.5% growth every year, yields a greater pay off at the end of the period and may be the best alternative since it spreads the impact over a longer period.

Table 4-1
Results of Simulations

	Tonnage (000s long tons)					
	1996	**1997**	**1998**	**1999**	**2000**	**2015**
Baseline	197912	201788	205740	210175	214747	301119
Scenario 1	197912	184122	172544	176415	180428	257220
Scenario 2	197912	190011	183014	187057	191252	271678
Scenario 3	197912	195899	194080	192815	191799	272425
Scenario 4	197912	199084	200324	202012	203849	246091
	Revenue (Millions US dollars)					
	1996	**1997**	**1998**	**1999**	**2000**	**2015**
Baseline	480	490	501	513	526	765
Scenario 1	480	528	585	599	615	904
Scenario 2	480	516	557	571	586	858
Scenario 3	480	504	530	559	590	864
Scenario 4	480	498	516	537	559	1062

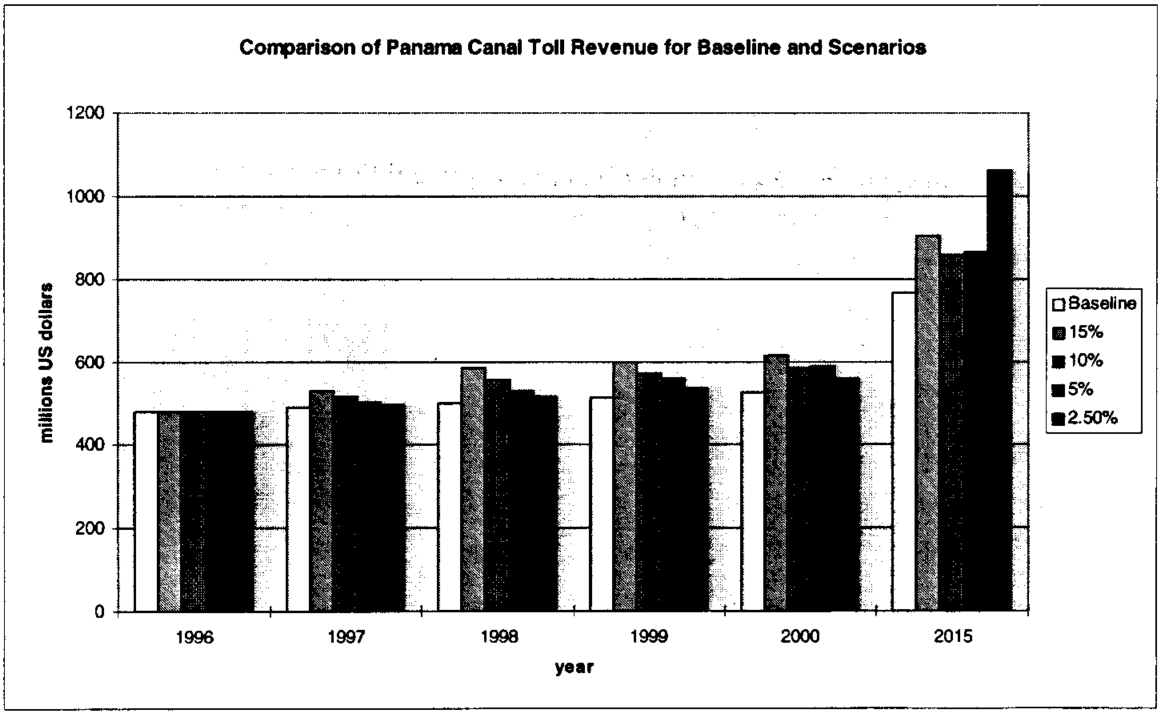
The following bar charts illustrate the projected response for each scenario. The first chart illustrates changes in tonnage, the second bar chart presents changes in revenues.

Chart 4-1



Source: ICF Kaiser International, 1996

Chart 4-2



Source: ICF Kaiser International, 1996

The table below identifies the varying effects of toll changes on revenues by ship type for the baseline and each of the scenarios for 1996 to 2015.

Table 4-2
Comparison of Revenues Under Four Toll Increase Scenarios By Shiptype

(Millions US Dollars)						
BULK	**1996**	**1997**	**1998**	**1999**	**2000**	**2015**
Baseline	143.3	145.4	147.4	149.6	152	193.1
15%	143.3	149.6	156.7	159.0	161.4	203.5
10%	143.3	148.7	154.4	156.8	159.1	201.2
5%	143.3	147.3	151.3	155.8	160.4	202.8
2.5%	143.3	146.6	149.8	153.4	157.1	229.2
(Millions US Dollars)						
Containers	**1996**	**1997**	**1998**	**1999**	**2000**	**2015**
Baseline	82.2	85.6	89.1	93.1	97.3	175.5
Scenario 1 (15%)	82.2	98.4	117.8	123.2	128.6	232.1
Scenario 2 (10%)	82.2	94.1	107.8	112.7	117.7	212.3
Scenario 3 (5%)	82.2	89.9	98.2	107.8	118.2	213.3
Scenario 4 (2.5%)	82.2	87.7	93.6	100.3	107.4	280.5
(Millions US Dollars)						
Tankers	**1996**	**1997**	**1998**	**1999**	**2000**	**2015**
Baseline	49.1	50.2	51.3	52.6	54.0	84.5
Scenario 1 (15%)	49.1	50.9	53.4	54.9	56.5	91.6
Scenario 2 (10%)	49.1	50.9	53.0	54.4	55.9	89.6
Scenario 3 (5%)	49.1	50.6	52.3	54.3	56.4	90.3
Scenario 4 (2.5%)	49.1	50.6	52.3	54.1	56.0	107.5
(Millions US Dollars)						
RORO	**1996**	**1997**	**1998**	**1999**	**2000**	**2015**
Baseline	38.1	38.3	38.5	38.9	39.3	46.1
Scenario 1 (15%)	38.1	44.1	51.0	51.5	52.0	61.0
Scenario 2 (10%)	38.1	42.2	46.6	47.1	47.6	55.8
Scenario 3 (5%)	38.1	40.8	43.5	46.5	49.7	66.7
Scenario 4 (2.5%)	38.1	39.3	40.5	41.9	43.4	73.8
(Millions US Dollars)						
General Cargo & Reefer	**1996**	**1997**	**1998**	**1999**	**2000**	**2015**
Baseline	31.9	32.5	33.3	34.1	35.0	50.0
Scenario 1 (15%)	31.9	35.9	40.7	41.7	42.8	61.1
Scenario 2 (10%)	31.9	34.9	38.2	39.2	40.2	57.4
Scenario 3 (5%)	31.9	33.7	35.7	38.0	40.4	57.7
Scenario 4 (2.5%)	31.9	33.6	35.3	37.3	39.4	86.2

Advantages of Predictable Increases

- **Canal users can plan their routing and vessel deployments into the future; the Commission can probably expect a neutral response from the market.**

Predictable systematic increases in tolls will ensure that Canal users can apply strategic methods in their own future operational planning. Carriers that know they will be facing an increase in tolls will be better able to re-deploy their fleets to minimize the negative effects associated with a toll increase. A neutral to positive response from the market can be expected from such a toll change. This assumes the rate hike would be limited and coupled with improved service.

- **Better fiscal planning**

Vessel operators' fiscal planning will be improved by predictable increases in tolls because the risk and uncertainty of the expense will be reduced. With prudent management practices, reduced uncertainty can lower total vessel costs through reductions in the risk premium that is embedded in calculations of future returns to vessel and service commitments made in the present. It may also be true that for the PCC, financial planning for Operations and Maintenance would also benefit from more predictable increases in Canal tolls,

- **Must be coupled to good service and reliability of service by PCC**

To be well received by the market, predictability of toll increases also requires predictability in service. As seen in the market study results, regular annual increases can support the perception that the Commission is organizing to operate more as a successful business. Predictability of price changes are one characteristic of organizations that are responsive to their market and are managed for growth.

Increasing toll rates will likely affect transits due to the immediate diversion of some non-scheduled vessels. However, there is a near-term benefit from these diversions due to the capacity constraints of the Canal for transit. The Commission will be better able to service the vessels transiting the Canal while receiving increased toll revenue. We are assuming some reduction in vessel transits for those with the greatest elasticity of demand for transit in the immediate period after the toll increase takes effect. Previous traffic shifts indicate the advantage of increasing tolls despite expected reductions in market share. The adverse impacts on transits may be acerbated by sensitivity that increases over time.

Disadvantages of Predictable Increases

- **Potential customer resistance**

Carriers that are aware of upcoming increases in Canal user fees can opt to avoid using the Canal in the future or start experimenting with new routes or introducing landbridge options prior to the implementation of the increase. Pre-announcement will therefore allow ship operators to plan alternative strategies well in advance of the expected toll increase thereby causing a potentially stronger downward effect on revenues than has been experienced in the past.

- **Increased customer service expectations**

Carriers expect incremental improvements in service with increased tolls. The cost of improvements is one justification for increases in tolls and carriers expect to see resulting increases in service in return. If improved service does not appear to be forthcoming, customer perceptions of the Canal may suffer potentially resulting in diversion of cargo to alternate routes.

Criteria for Evaluating Toll Charges

In order to study reactions to toll changes, a number of issues need to be considered. These can be grouped around a set of criteria for evaluating various toll change options in order to assess their viability. These are:

- Time to take effect (legislative and other delays)
- Studies required (by law) to justify increases
- Market/Customer response questionnaires/research
- Cost increases (as justification)
- Applying the criteria to change options
- Profit vs. Non profit operation of the Canal
- Demand elasticity

It may be deemed necessary to consider all the criteria when evaluating toll increases, but one would expect, in normal circumstances, that a mixture of legal and financial criteria would be of paramount importance. Vessel operators' route choice alternatives must also be considered because for every existing route through the Canal there are other alternatives. Even though the cost differential rounding Cape Horn, using the Suez Canal or, in the case of containerized cargo, utilizing land-bridge options may be great, they can become a logical possibility an operational point of view. Transportation cost increases may, however, alter the commodity origin for bulk cargoes are concerned by eliminating the actual movement on a particular route as a result of delivered price sensitivity and alternative sourcing.

Toll Options

In summarizing the results of the sensitivity analysis, we concluded that a number of toll change options exist that could be used to provide required revenues to cover increasing operating expenses over time. These are:

- Annual toll increases with pre-announcement of years two and three increases
  - Linked to inflation/PCC costs
  - Linked to maintenance and development requirements

- More frequent toll hikes than in the past; e.g. annual

- Surcharges for on-deck cargo or specific cargoes

These options were represented for quantitative analysis by several toll increase scenarios which are:

- Scenario 1 assumes that tolls increase 15% in 1997 and 1998, with no change in the following years.

- Scenario 2 assumes a 10% increase in these two years with no change in the following 16 years.

- Scenario 3 is a milder increase of 5% for four years in a row and then no change for the following years.

- Scenario 4 increases tolls 2.5% each year from 1997 through 2015. It is the most aggressive and yields the greatest increase in revenues but the deepest drop in traffic.

These scenarios cover changes in tolls that can be considered to reflect PCC costs or expenditures, maintenance and development requirements, and more frequent toll increases than in the past. Contrasted with previous increases, scenarios one through four reflect a shift to more frequent increases. Scenario five has been structured for the analysis of the potential for on deck cargo surcharges.

Other possible variables for analysis of toll increases could include changing the toll structure based on commodity, route, ship type and size. However, analysis of such changes and are beyond the scope of this study.

These toll change options can be evaluated by applying the seven evaluation criteria listed previously. The chart below shows that these options, especially one in which an entirely new toll structure is envisaged, would involve greater time and expense to implement (compared to the existing toll increases and periodicity) based on either information requirements mandated by law or support studies to be undertaken to justify the change.

Table 4-3
Time and Cost to Implement Toll Changes Compared to Current Effort

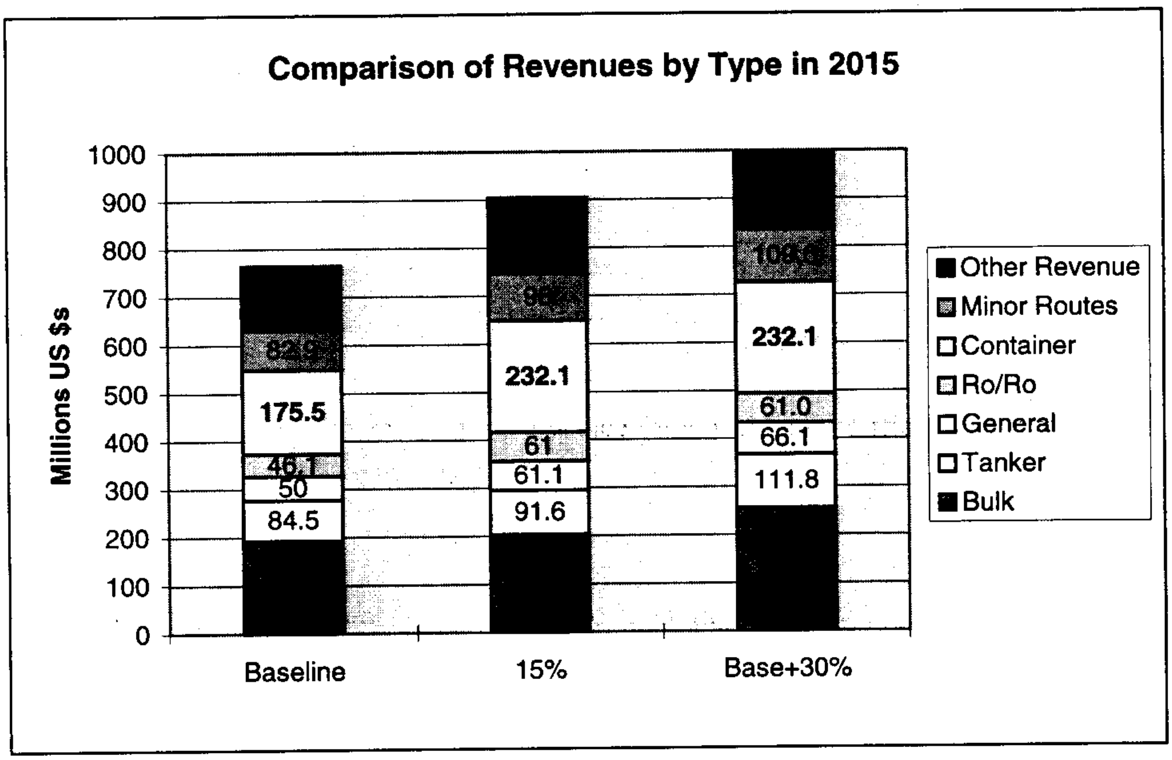
	Time to Take Effect	Required Studies	Market Response (surveys)	Required Cost Analysis	Demand Elasticity Studies	*Composite*
Annual Toll Hikes	○	◑	○	◑	◑	◑
Changes in Toll Structure	●	●	●	◑	◑	◕
Annual Changes with Pre-Announce	○	◑	○	◑	◑	◔
Surchages for on-deck cargo	◑	◑	◑	○	◑	◑

LEGEND
○ Little change from current procedures/costs
◔ Modest change from current procedures/costs
◑ Moderate change from current procedures/costs
◕ Larger change from current procedures/costs
● Large change from current procedures/costs

Summary

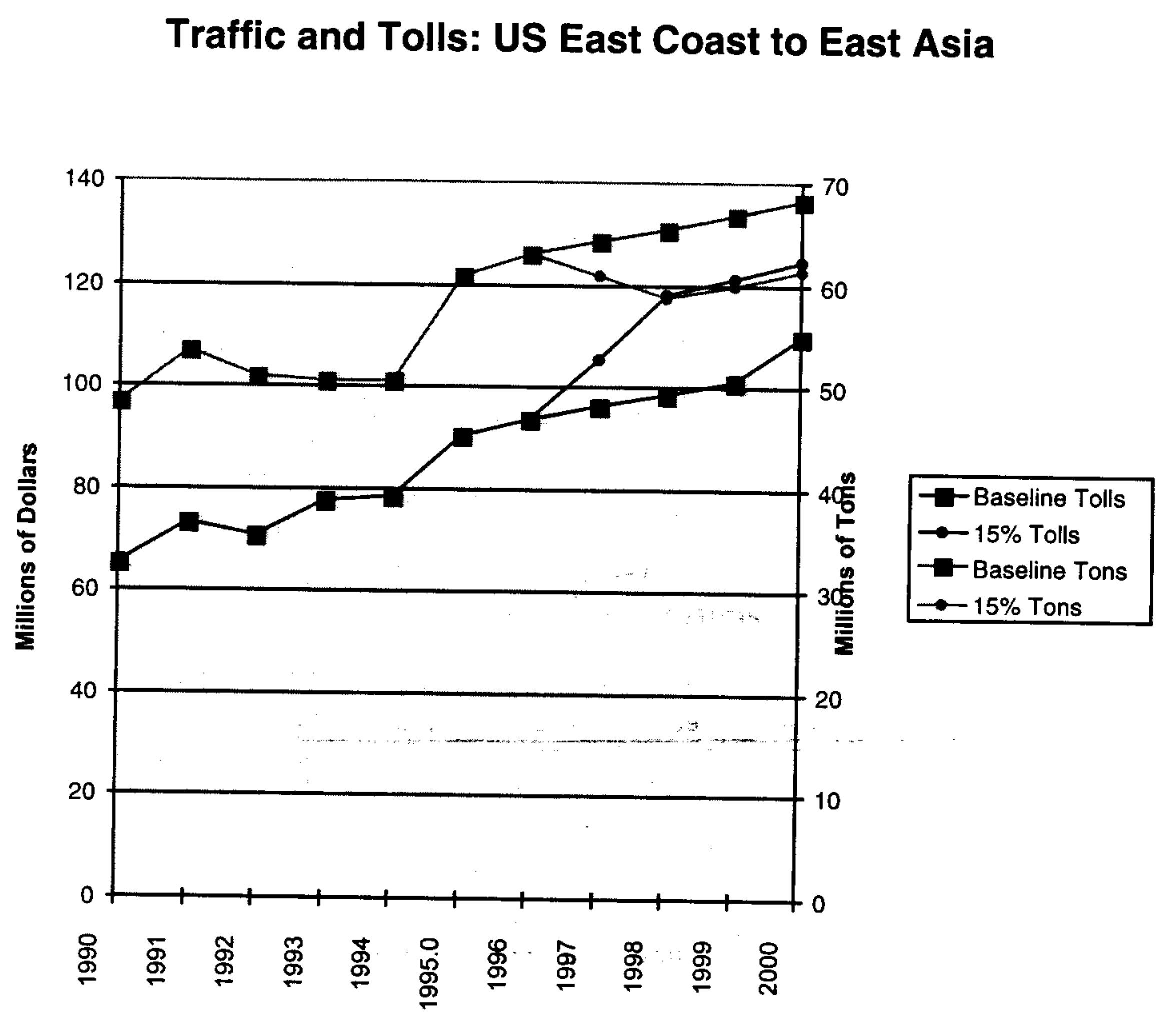
We can see the effect of toll adjustments on revenues by looking closely at the chart below. In 2015 tolls collected from the bulk operators in the baseline scenario would be equal to \$ 193 million and account for about 25% of total revenues of the Canal in that year. But with the 15% increase and the adjustment in traffic tolls are only about \$ 203.5 million. If traffic had remained at the baseline traffic but with a 32% increase in tolls then total revenues from bulk operators would have increased to \$ 255 million. The Canal lost about 20% of potential revenues or on a 32% increase in tolls (over the two years 15% each year) it gained just 5% (5% out of 32% potential increase) or just 15% of the potential increase in bulk. For container cargoes the gain was 100% of the increase on the assumption that there was no loss due to routing decisions. This, of course, is a very strong assumption and it is likely that there would be some losses as the elasticities suggest for containerized cargoes.

Chart 4-3



Thus while each of the scenario offers a potential for improving the revenue performance of the Canal, each will have a differential impact on individual routes and revenue streams. The detailed tables at the end of this document highlight for traffic and for revenues collected the impact of these different toll options. The chart below illustrates this for the major East-West flow through the Canal. The impact on a route depends upon the mix of products and the sensitivity of each to changes in price.

Chart 4-4



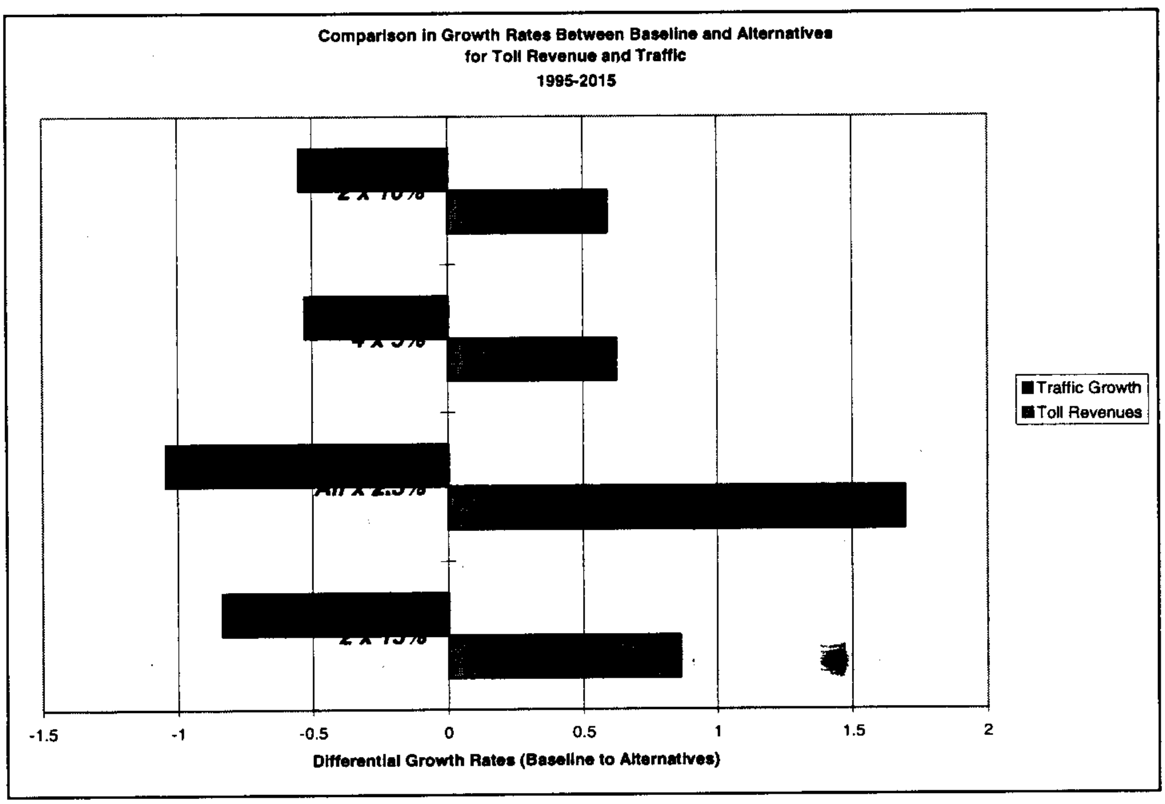
Changing Tolls and their Effect on the Canal

Shipper behavior depends upon a number of different factors. Our assumption that there will be marginal impact on liner operators is an effect to be expected in the short term following a toll hike. The detailed statistical modeling showed there is at least some impact associated with a change in the transit cost through the Canal. But determining the break point at which few ships pass through the Canal is more difficult. Liner vessels rarely operate fully laden through the Canal and the model has been based on the marginal changes in cargoes themselves.

There will likely be diversions of cargoes when tolls increase. It is likely that some operators, especially bulk operators, may shift capacity and routes quickly, but there is no way to ascertain how quickly these changes will occur. Our models assume that the major impact is the year following the price adjustment. This has generally been the case in the past.

Chart 4-5 shows the absolute difference between the four scenarios and the baseline as of 2015. The revenues in the 2.5% scenario is in this year are almost $300 million higher than in the baseline in 2015 but tonnage through the Canal is 55 million tons below the baseline. An alternative approach to the problem of measuring the impact is to measure the differential in the absolute rate of growth between the baseline and the four scenarios. In the baseline projection we expect that total revenues will grow about 2.5% in line with traffic growth of about 2.3% over the period 1995 through 2015. Assuming a 20% increase, the impact is to increase the average rate of growth by about .6% over this period but the rate of growth in traffic is about .5% less. Two 15% increases yield about a .9% increase in the average rate of revenue growth and a decline of about .8% in the rate of growth in traffic. On the other hand, an increase in tolls of about 2.5% yearly adds about 1.7% to the rate of growth of the toll revenues and cuts traffic growth by about 1% per year.

Chart 4-5



A Final Word

The model developed here reflects the past, not the future. It reflects the behavior of ship operators, freight forwarders, and shippers, while taking into account the changing pattern of global consumption and production. Panama Canal tolls are but a single variable in a larger matrix of factors that drive the decision to transit the Canal or not.

There appears to be no doubt that traffic will be impacted by changes in Canal tolls. An assumption that price to traffic elasticities are zero, as is the case with respect to liner trade, is not confirmed by the statistical data we have developed from PCC traffic and toll records. There is, as detailed in Section 3, a strong relationship between traffic growth and changes in transit costs (tolls and Canal waters time combined). It appears, however, that liners are less affected by toll changes than are bulk ships. Therefore, one benefit of raising rates is that the rate of growth through the Canal will slow and that this should reduce the average delay time associated with transit. This may be beneficial since the current rate of growth in tonnage is not likely to be sustained.

As the ships transiting have become larger and closer to the maximum length, width and draft allowed, tonnage through the Canal can increase. But eventually we must reach a point where all ships are at their maximum or near maximum. The model developed does not take into account these limits. It assumes the Canal can sustain about a 2.4% growth in tonnage through 2015. This is less than the 3.5% achieved over the 1990 through 1995 period. It is clear, however, that with the Canal limited to a maximum number of ships per day eventually tonnage through the Canal will be constrained by capacity. Raising tolls and slowing the growth in tonnage will postpone this day farther into the future.

Table of Contents

Section 5: Implications of Canal Users' Expectations

Introduction

This section of the report presents the approach and results of the Consultant's work to assess the implications of users' expectations and perceptions regarding Canal tolls and the transfer of the Canal to Panamanian control on December 31, 1999. The section presents the approach and methodology, as well as the results and conclusions.

Approach and Methodology

To assess the implications of Canal users' perceptions with respect to the Canal transfer on traffic levels, the consultant team used a market survey-based approach. This means the degree to which selected users will be influenced by the Canal transfer in making decisions that affect their use of the Canal was inferred from their responses to questions presented on a survey form and/or discussed during interviews. The survey was designed to employ two techniques. First, interviewees are asked directly how they perceive the transition process and expect it to affect their future use of the Canal. Second, they were also asked to respond to a series of questions designed to help explain the nature of their business and the key factors that affect their decisions on whether or not to use the Canal.

The methodology has been developed in recognition of the common limitations of surveys. When presented with a remote or hypothetical situation, it is often difficult for an interviewee to accurately predict his response. Confronted with a scenario that is difficult to visualize, the respondent often orients his responses in a way that he feels give the answers he thinks will best serve his interests or are what he thinks the interviewer wants to hear. In the specific case of the present study, the Canal transfer is now over three years away and many users may not yet be planning around it. The risk is that responses will not reflect the degree to which they will truly "perceive" the transfer and act in accordance, but rather how they might influence the Panama Canal's decisions on issues that affect them. Their **stated** expectations about the transfer and how it might affect traffic will therefore be tempered by what is **revealed** by their responses to other questions that seek to characterize the importance of aspects of Canal service to their business.

Canal traffic was first categorized into various market segments. A list of key industry representatives was developed including representatives of all major market segments, and a survey questionnaire was designed to obtain input about both the role of the Canal in each company's operations and its competitiveness. Questions were also included about important issues or problems that concerned them, including their perceptions as to the Canal transfer at the end of the decade.

Summary Description of Interviewees

The questionnaire was faxed to the representative group of key industry executives in the major market segments. This group was assembled form the leading types of vessels currently using the canal-as indicated in Table 5-1 below.

Table 5-1

Key Market Segments Based on Toll Revenue

Ship Type	Transits	Tolls
Dry Bulk	3,753	162,162
Full Container	1,311	71,073
Tanker	1,854	62,324
Vehicle Carrier	624	50,225
Reefer	2,580	38,118
GC/BB/RORO	2,082	44,572
Passenger	311	15,215
Other	1,116	18,923
Small Crafts	1,504	172
Total	15,135	462,784
Ship Type	**Percent Transits**	**Percent Tolls**
Dry Bulk	24.8%	35.0%
Full Container	8.7%	15.4%
Tanker	12.2%	13.5%
Vehicle Carrier	4.1%	10.9%
Reefer	17.0%	8.2%
GC/BB/RORO	13.8%	9.6%
Passenger	2.1%	3.3%
Other	7.4%	4.1%
Small Crafts	9.9%	0.0%
Total	100.0%	100.0%

Source: PCC

This survey was supplemented with in-person interviews with some industry representatives in the US. The list of companies that were sent a copy of the questionnaire is provided in Table 5-2 . The information obtained through the survey was analyzed to reach conclusions on the Canal users' perceptions and expectations. (A sample questionnaire may be found in the Appendix.)

Table 5-2

List of Companies Sent Surveys

Vessel Type	Company	Location
General Cargo 5% of toll revenue	Pan Ocean Shipping Star Shipping Flota Mercante Grancolombiana Corp. Noboa and Transportes Maritimos Bolivarianos Gearbulk	Seoul Bergen Bogota Ecuador Surrey KT, England
Reefer 8% of toll revenue	Cool Carriers J. Lauritzen Wallem Group Dole Fresh Fruit Scaldis Reefer	Danderyd Copenhagen Hong Kong Costa Rica Antwerp
Dry Bulk 35% of toll revenue	Tokai Shipping K-Line Navix Daiichi Shinwa Pacific Carriers, Ltd. China Ocean Shipping Co. (COSCO) Cho Yang Greenwich Marine Sanko Steamship Co., Ltd.	Tokyo Tokyo Tokyo Tokyo Tokyo Singapore Hong Kong Seoul New York Tokyo
Tanker 13% of toll revenue	Flota Petrolera Ecuatoriana Stolt Parcel Tankers	Quito Connecticut
Full Container 15% of toll revenue	A.P. Moller Mitsui OSK Line (MOL) Yangming Evergreen Orient Overseas Container Line (OOCL) Hanjin Hapag-Lloyd Hamburg-Sud Zim-American Israeli Shipping	Copenhagen Tokyo Taiwan Taiwan Hong Kong Seoul Hamburg Hamburg New York
RO/RO 2% of toll revenue	Willhelmsen	Norway
Vehicle Carrier 11% of toll revenue	Wallenius Lines NOSAC NYK Hyundai	Stockholm Oslo Tokyo Seoul
Passenger 3% of toll revenue	Princess Cruises Holland American Lines	Los Angeles Seattle

These interviews were used to obtain information regarding the various factors that affect industry fleet deployment and acquisition plans, the size of those vessels, and other fleet related strategies of the user groups. In addition, these interviews were structured to obtain information on the perceptions of the users on the current Canal situation and how the transfer might affect their fleet plans and/or their use of the Canal under different future scenarios.

The intent of the proposed interviews was not to carry a comprehensive survey of Canal users, but to contact key knowledgeable industry people in the major market segments. This effort provides a means to obtain users' views on the role of the Canal in their business now and how this role may be changing. Also, questions were designed to study how the Canal affects each users' overall competitive position and to identify the critical issues regarding the Canal transfer.

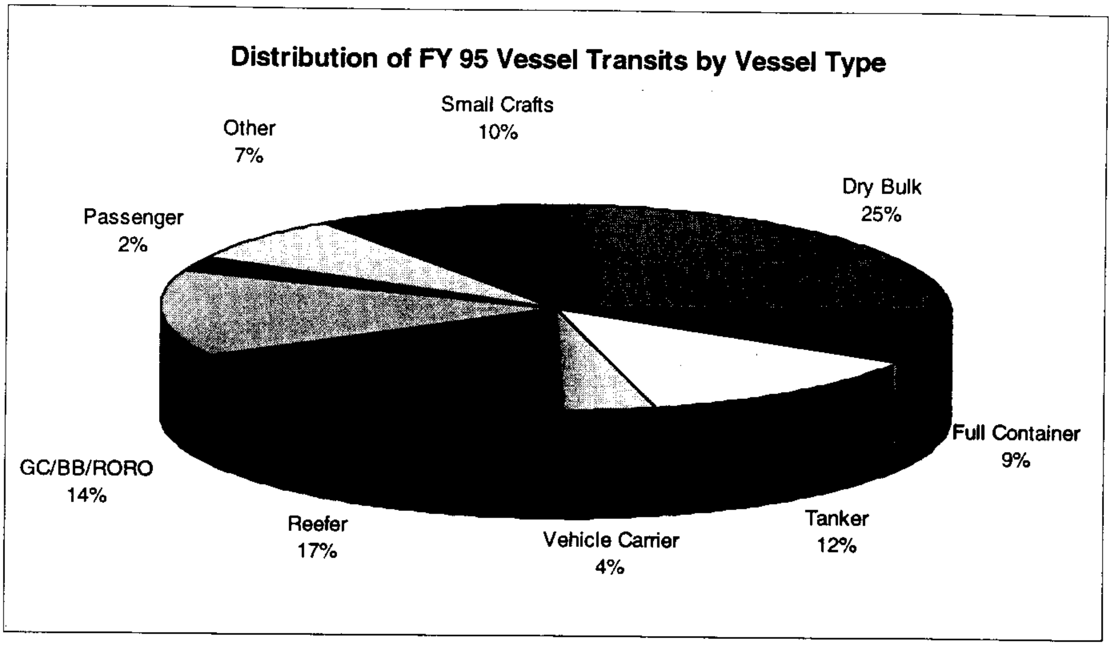
Market Segments

The major market segments targeted for the interviews were defined based on their share of traffic-both from the perspective of total transits and toll revenue generated. The Canal's major markets can be defined broadly to include both maritime cargo and passenger flows as a combination of three basic attributes: vessel type; trade route and commodity/cargo type.

Although there are many combinations of these characteristics, a small subset of dominant segments can be identified for each that both enables one to focus on the most important segments of Canal users and identify the aspects of the transit service that are most valuable and help explain the Canal's share of the overall market within each segment.

Chart 5-1 summarizes the distribution of FY1995 traffic across the most important market segments, in both number of transits and toll revenue. The largest market segment is dry bulk, accounting for 25% of transits and 35% of tolls revenue. Other important segments are full container ships and tankers, especially when considered in terms of tolls revenue. It is interesting to note that the combination of dry bulk, containerships, tankers and vehicle carriers account for 75% of tolls revenues versus only 50% of transits. This reflects the larger carrying capacity of these vessel types. Reefers, general cargo vessels, break bulk and other smaller cargo vessels represent 33% of transits and just 22% of revenues.

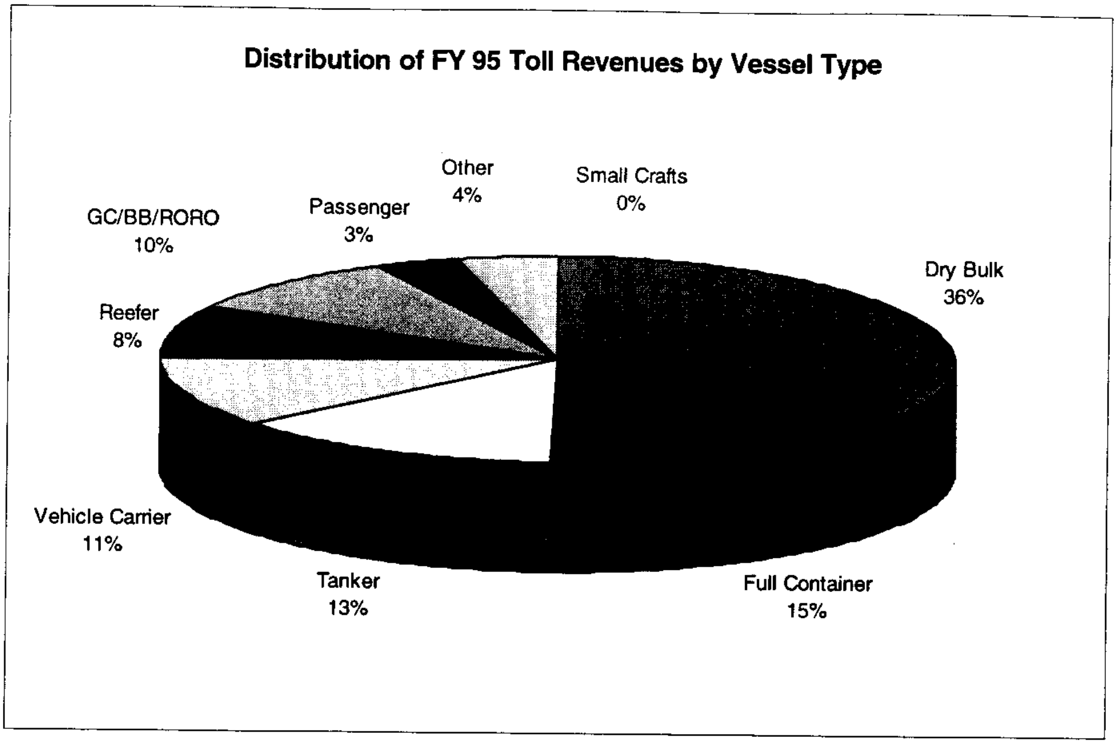
Chart 5-1



Passenger cruise vessels account for only 2% of transits and 3% of revenues. Although not as significant in terms of toll revenues as other market segments, cruise vessels can have a substantial economic impact and related tourism potential if vessels stop in Panama. Small crafts less than 300 tons account for 10% of transits and produce little or virtually no revenue.

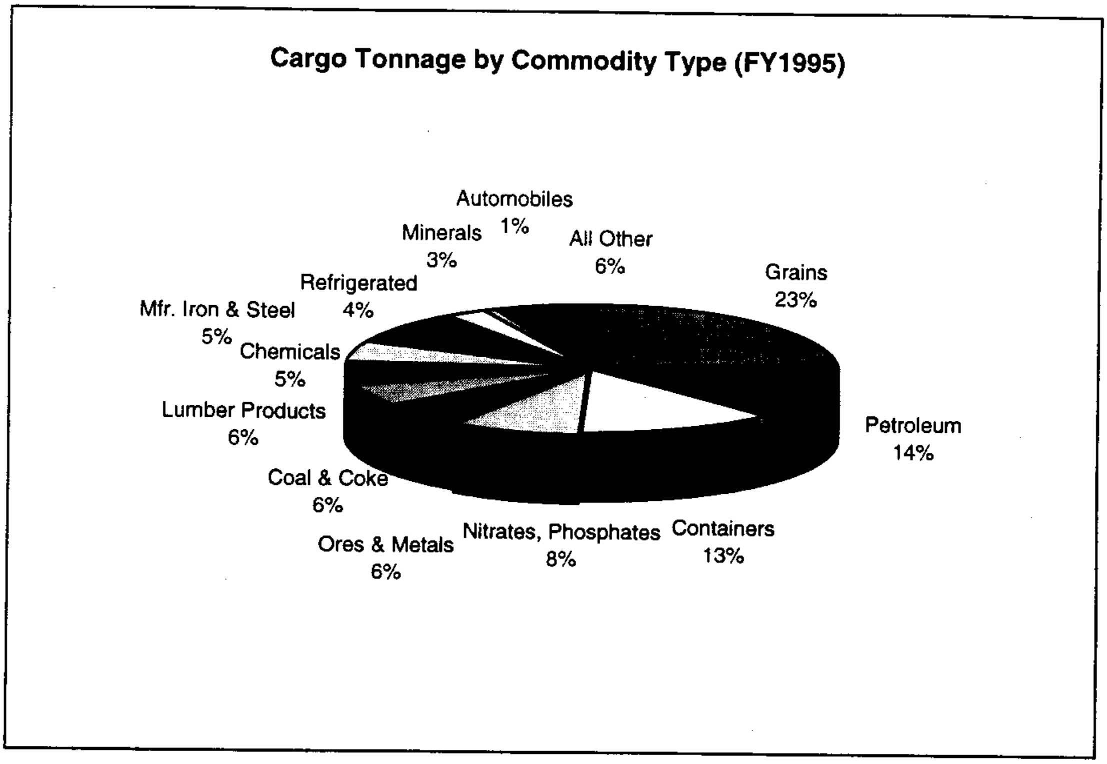
A similar pattern can be observed with respect to the distribution of traffic by trade route. Five major trade routes, or origin-destination pairs, account for 76% of cargo tonnage, with just one, between East Coast North America and Asia, making up 44% of cargo tonnage in FY 1995. The other major routes link the East Coast of North America with other Pacific locations and Europe with the West Coast of the Americas. The Canal is particularly important to trade in the hemisphere. About 64% of Canal business originates or is bound for the US and about 14% of total seaborne US trade makes use of the Canal. The Canal is the major trade route also for some countries in Latin America.

Chart 5-2



Segmented by commodity type, cargo is similarly concentrated in a few major classes, with grains making up 23% of total cargo, followed closely by petroleum products including crude oil at 14% and containers at 13% (see Figure 5-3). The majority of the cargoes are low-value bulk commodities which typically are influenced more by low transport cost than time and reliability of service. Nevertheless, some important segments such as containers and other fast-growing high-value cargo segments (edible oils, perishable food products, automobiles, etc.) place a premium on transit time and reliability as the time value of the cargo and the cost of delays are often far greater than the direct cost of additional transport time.

Chart 5-3



Analysis of the Interviews

Assessment of Companies Surveyed

Of the 38 companies to whom questionnaires were sent, 21 responses were received, representing a significant volume of traffic in each of the major market segments. The survey list was not developed with the intent of achieving a statistically significant sample of all Canal traffic, but rather to gauge the perspectives of key users in major segments. The responses received from many frequent Canal users and the diversity of market segments surveyed adds to its validity for developing general conclusions.

The responses are summarized in the following table, broken down by vessel type.

Table 5-3

Vessel Type	Percent of 1995 Tolls Revenue by Segment	1995 Transits by Segment	Number of Companies Surveyed	Transits in 1995 by Companies Surveyed	
				Number	As % of Total 1995 Transits
Dry Bulk	35%	3,753	4	401	10.7%
Full Container	15%	1,311	5	479	36.5%
Tanker	14%	1,854	4	171	9.2%
Reefer	8%	2,580	3	550	21.3%
General Cargo/ Breakbulk	8%	1,850	2	179	9.5%
RO/RO	2%	232	1	66	28.4%
Vehicle Carrier	11%	624	2	99	15.9%
Passenger	3%	311	2	73	23.5%

Note that the total number in the Companies Surveyed column is greater than the 18 surveyed, since several companies operated vessels in more than one segment.

It is also worth noting that in each of the major market segments, the number of transits by the companies who responded represents a significant share of the total number of vessel transits during 1995, at least 9% in each category and as high as 36.5% for containerships.

The sample also covered a sufficient range of transit routes and commodity types. In the analysis of results the consultant weighted the responses by the number of transits of each company, but in the end conclusions were drawn by synthesizing comments from all companies. Also, the relative size of each company in terms of its use of the Canal was an important factor to consider in understanding their perspective and principal concerns.

Analysis of Results

The analysis of the results of the surveys is divided in two main sections: the users' requirements and concerns about current Canal costs and services; and their perceptions about the impending transfer of the Canal to Panamanian control. In the first section, each major market segment is analyzed independently based on the marked differences in perspective and service requirements observed in the survey reults, followed by general conclusions. In the second section, perceptions about the transfer are considered for the entire survey sample, since no apparent trend was observed across market segments.

User Requirements and Concerns

Dry Bulk Vessels

By far the most common route among the surveyed companies was the East Coast US to Asia route, with the East Coast US including the Gulf of Mexico ports. This is consistent with the overall distribution of vessels by transit route. Other significant routes are Europe to West Coast South America and Oceania, and East Coast US to the West Coast of South and Central America. Cargoes include all major commodities shipped in dry bulk such as grains, ores and phosphates, with most being considered "low value" by respondents. No respondents characterized cargoes as highly time-sensitive or just-in-time.

All respondents view their competition as other companyies' vessels who also transit the Canal and none as intermodal operators. During an interview, one major company did comment that for some commodities the transport component is sometimes high enough to make rail transport to West Coast US ports continuing on to Asia by ship competitive with the all-water route leaving from Gulf ports. This is particularly notable for corn during the season when prices are low and freight rates are high, in which the transport component can be as high as 25% of the value of the commodity. Improvements in rail service and increases in Canal costs could make the intermodal route increasingly competitive. In terms of competition to the Canal by other all-water routes, the Suez or Cape of Good Hope routes were viewed as more competive for ECUS to Asia cargo than the Strait of Magellan.

Canal costs were a relatively high component of the cost of the transportation service offered by the companies surveyed, ranging from 6% to 12.5%. For most companies this did not represent a change as compared with previous years, although one company indicated that Canal costs were a rising component.

All respondents except one indicated that transit time, cost and reliability were equally important factors afecting their competitiveness, although they interact with each other to affect total cost to the user. One company highlighted transit cost as most important. The direct impact of transit delays on costs was also emphasized. However, none indicated that improvements in these areas would increase their use of the Canal.

The delays caused by congestion were highlighted as a recent trend affecting the companies' use of the Canal. One company stated that bulk raw material prices and worldwide shipping prices have a far greater effect on use of the Canal than the cost and service level of the Canal transit.

Despite the large quantity of post-Panamax vessels on order, none of the companies viewed the size restriction as a threat to the future use of the Canal. As an example, they point out that most ports in Japan do not have the grain-handling facilities or draft to handle post-Panamax vessels. They do not anticipate the need to switch to larger vessels on alternative routes.

All respondents indicated that they do use the advance booking system when they hear congestion might be a problem, however, only one company used it all of the time. One company noted that vessels travelling from Gulf ports do not have enough time to arrange pre-booking and suggested that the ground rules be changed to allow for it. One company expressed willingness to pay up to $3,000 more for pre-booking, others did not do so explicitly, but expressed satisfaction with level of fees.

Full Container Ships

The most common route served among respondents is the US East Coast to Asia. Europe to Asia and East Coast US to West Coast South America were also represented. Almost all companies characterized their cargoes as "high value" with most being time-sensitive or JIT.

The major recent change in customer requirements that seems to have affected use of the Canal has been the demand for faster service without delays that has led to diversion of traffic to the mini land bridge and Suez Canal. Most see both operators who use the land bridge and the Canal as their competition.

Reliability was unanimously the most important aspect of the Canal service that affects the companies' competitiveness. Customers do not accept delays and the cost of delays is so high as to make them unacceptable. This requirement is increasing. As reliability continues to be important and delays persist, the alternative routes and modes become more attractive.

The two companies who responded, estimated the value of Canal transit costs as a percentage of total transportation costs at 3% and 5%. Only one respondent indicated that Canal costs were an increasing component of their cost structure.

Service reliability and transit restrictions were criticized as recent trends affecting the companies' use of the Canal. The growth of alliances has increased pressure to reduce all costs to liner operators. Larger companies thought they should be given special rates and preferential services.

All respondents use the pre-booking services, and only one uses it only when congestion is reported. This reflects the importance given by container lines to reliability and their intolerance of delays. This was further supported by many companies' stated willingness to pay more to guarantee transit. Recommendations for improvements to the system included that the system not be suspended during periods of high congestion such as during lane outages and that frequent users be given preferenctial rates.

Tankers

Although responses were received from 4 companies that operate tanker ships, one respresented a significantly larger share of the total number of transits in the sample than the other three. This company transports specialty chemicals and the primary trade route is US East Coast to Asia. The other major trade route served is US East Coast to West Coast South America. It is important to note that the characteristics and requirements of this company are not necessarily the same as those that transport other commodities in liquid bulk such as crude oil and other petroleum products.

All shippers classified their product as bulk and hazardous, although only edible oils and specialty chemicals were referred to as time sensitive or JIT. Competition is perceived as other carriers who also transit the Canal.

Transit time, cost and reliability were all perceived as equally important aspects of the Canal transit service that affect the companies' competitiveness, although it was pointed out that reliability directly affects cost. Reliability is an absolute requirement and in recent years congestion has worsened. Edible oils and specialty chemicals are similar to containerized cargoes in that they are high value and customers do not tolerate delays. Most contracts are long term.

All respondents use the advance booking system when congestion is anticipated or the client's schedule delivery requirements are heightened. A small tanker operator proposed eliminating the system and operating on a first-come, first-served basis. Nevertheless, this operator and other would still be willing to pay up to a few thousand dollars more to guarantee transit.

Reefers

Of three companies surveyed, the dominant trade routes are West Coast South America to Europe and the East Coast of the US. All goods were classified as perishable and products include bananas, other fruits and other food products. Other companies also transiting the Canal are perceived as the competition.

Transit time and reliability were singled out as the important factors affecting the companies' competitiveness. Most sources for bananas are close to Panama making time and reliability of the utmost importance. During peak seasons this can a critical factor in determining which operators get the business. The perishable nature of the products and time pressures of customers explain this. Transit cost was given less importance.

Carriers use mostly long term contracts and one transports its own products. Canal costs are not perceived as rising as a percentage of the companies' total transportation costs.

Major trends that are affecting banana transporters' use of the Canal are the EU quota policy and banana companies seeking alternative sources that do not require a transit of the Canal. The respondents criticized the fact that lane outages for locks overhauls seem to coincide with the peak banana export season, January to April.

The companies always use the advance booking system. Some see the system as fair and in no need of improvement, while others suggested that reefer vessels in ballast also be allowed to use it. Companies expressed willingness to pay more for it if necessary for guarantee, ranging from about $3,000 to 100% of current fees.

Vehicle Carriers

The two companies who responded to the survey serve a variety of routes, including East Coast US to Asia, Oceania and West Coast South America, and Europe to West Coast US and Oceania. The trade route is the only factor that affects the carriers' decision to use the Canal. All cargoes are high value and time-sensitive.

Both see the competition as other operators who also use the Canal, although one company saw intermodal operators as a growing source of competition. Transit time, cost and reliability were perceived as equally important factors to the respondents, however, the impact of reliability on both other factors was noted.

Most cargoes are shipped under long-term contracts of more than a year, and Canal costs represent a relatively high component of total transport costs at 8 to 9%. The companies do not perceive these as a rising share of total costs.

Recent trends that may affect use of the Canal are the increased need for logistics and JIT delivery by customers and the improvements in the mini land bridge. Companies are increasing their fleet size to use more Panamax vessels. Users do not see improvements that could increase their use of the Canal, but rather think that better reliability and service is needed for them to continue to serve their clients well while using it.

Users almost always use the advance booking system. One company suggested increasing the prior booking time as an improvement and would be willing to pay up to $10,000 more per tranist. The other thinks the system should be abolished altogether.

Passenger Vessels

The two companies that responded to the questionnaire operate through the Canal from the Caribbean and to/from the West Coast of North America. Other cruise vessels are perceived as the competition.

Canal costs are nearly 10% of total costs of the cruise service for one of the operators. Since cruise vessels make many crossings annually, cost is viewed as the most important factor. If costs were reduced, demand could be stimulated, as there is great intereest in cruises to transit the Canal. Reliability is second in importance, but since passenger vessels get priority for transit, it is not a major concern. Transit time is also considered an important factor, as cruise vessels are on a tight schedule. One of the operators emphasized the importance of allowing afternoon arrivals and night cruises for large vessels.

It was suggested that consideration should be given to fee reductions based on the total number of crossings by the fleet of a company (the more crossings, the lower the fee per crossing). For example, one operator suggested a 50 percent reduction for cruise ships that enter at Cristobal to sail for the day across Gatun Lake and later depart via the same port of Cristobal.

Perceptions about the Canal Transfer

Roughly two-thirds of the respondents (12 out of the 19 who responded to the questions directed at the the issues related to the Canal transfer) have a generally positive view that the Canal will be operated with the same or an improved level of service after the transfer. The other one-third ranged from aprehensive to negative, and expressed the expectation that service will deteriorate. Both views were shared by companies ranging widely in size and market segment.

The principal fear among those with a negative perception was that not enough attention would be paid to maintenance and service and that toll revenues would be siphoned off from the Canal to fund other programs in Panama. Nevertheless, all companies perceived the transition process as having progressed smoothly to date. The companies with a positive view did not see the transfer as having any noticeable effect on Canal operations.

Opinion diverged widely among both camps over how the transfer will affect toll rates. About half of the respondents expect tolls to increase faster than the historical rate over the long term, mostly due to Panama's use of the Canal as a revenue generator. The remaining half was divided evenly among those who foresee no change and those predicting a decline in tolls. The only reasons offered for declining tolls were improved efficiency and lower labor costs.

Most companies view congestion and reliability as growing problems and that service level will continue to decline, although many did not view the transfer as root cause. The transfer does not seem to be at the forefront of the minds of most companies surveyed. None indicated that the transfer was affecting its current fleet deployment plans or anticipated any effect on its future use of the Canal.

Summary Conclusions

The major conclusions that can be drawn from the results of the survey are summarized as follows:

- The reliability of Canal service with respect to transit time is the major concern that most users currently have and that directly affects their competitiveness. Customer demands and the growth of the land bridge are placing increased pressure on the Canal to be able to provide quality service without risk of delays.

- Although vessel sizes continue to increase and a great many Panamax and post-Panamax vessels are on order, the size limitation posed by the Canal does not by itself appear to threaten loss of business to the Canal. Furthermore, the most important factors that affect the decisions of users to use options competitive with the Canal seem to be beyond the ability of the Canal to control, such as world trade patterns and time requirements of users. Neverhteless, the increasing sensitivity of users to delays and increases in Canal costs poses a threat of market share loss in the long run.

- Most users opt to use the booking system, find it useful and would be willing to pay more for it, if it guarantees them transit. A wide range of criticisms were offered, however, ranging from those who would like to see it abandoned to those who think it should be offered during times of high congestion, there should be greater flexibility in arrival times, and/or preference should be given to high volume customers.

- Passenger cruise operators expect increasing demand for voyages through the Canal, as well as cruises from the Caribbean up to Alaska via the Canal. If transit costs were reduced, this could result in an increase in demand for Canal transits.

- Most users do not have a negative view of the effects of the transfer of the Canal to Panama by 2000. Expectations on service level and toll changes are mixed. It seems that most users are not highly aware of the transition process and not overly concerned about its possible effects on the Canal. Users are not actively making fleet deployment plans based on expectations of changes in Canal service level and costs after the transfer.

-

Table of Contents

Section 6: Feasibility Assessment of On-Deck Cargo Fees

Introduction

Currently, the Panama Canal Commission's toll rate system does not contain an explicit assessment of transit fees for on-deck cargo (deck cargo). Transit fees are based on the PC/UMS net ton equivalent for the enclosed cargo carrying space beneath the deck. The practice of not having any explicit provision for transit fee assessment for deck cargo appears to be a historic phenomenon related to the evolution of general cargo shipping. The absence of deck tolls does not reflect modern container ships, which often have as much cubic space devoted to containers above deck as below deck.

A summary of the Panamax world container fleet size characteristics is contained in Table 6-1. The data indicate that deadweight tons (dwt) as a conventional measure of vessel capacity per twenty foot equivalent unit (TEU) is roughly between 16 to 17 tons. Ship dwt capacity is proportional to the cube of the vessel. Other things being equal, larger container vessels carry proportionately more cargo both above and below deck.

Table 6-1
Summary of Panamax World Container Fleet

LOA	482	541	591	636	676	713	764	795	839	853*	886*	950*
Beam	73	80	85	90	94	98	103	106	111*	112*	116*	105*
Draft	26.7	29.1	31.1	32.9	34.4	35.8	37.7	38.9	40.5	41.0	42.2	38.3
DWT(000)	12	16	20	24	28	32	38	42	48	50	55	58
TEU (000)	0.6	1.0	1.2	1.4	1.6	2.0	2.2	2.5	2.8	3.0	3.5	4.0
DWT/TEU	20.0	16.0	16.7	17.1	17.5	16.0	17.3	16.8	17.1	16.7	15.7	14.5

Source: adopted from FY 1994 Planning Guidance, *Deep Draft Vessel Costs* (October 1, 1993) U.S. Army Corps of Engineers Notes: * indicates that length or beam exceed maximum Panama Canal dimensions

Table 6-2 contains examples of two modern Panamax container vessels with respect to size and container capacities below and above deck. The more conventional design represented by the Lykes vessel can accommodate 433 TEU above deck and 670 TEU below deck. Accordingly, nearly forty percent of TEU capacity is represented by above deck stowage. The "box ship" design can hold a total of 2480 TEU with some rows stacked six high on the main deck or 2386 TEU with rows stacked up to five high on the main deck. Under these conditions deck loads would be 1416 or 1322 TEU compared to 1064 TEU in the hold, respectively. Deckload TEU cubic capacity would range from nearly 55 to 57 percent of total capacity.

All indications are that container vessel transits through the Canal will experience slow growth consistent with new alliances and some alternative services to the PC (landbridge and Suez routings). However, the number of boxes carried by the vessels can be expected to increase, both as a function of continued orders for new Panamax vessels that are near maximum dimensions as well as continued commercial pressures to increase vessel utilization.[1]

Consider for example the spate of Panamax new buildings compared to Post-Panamax. For example, if all probable orders materialize by the end of the decade, Panamax vessels will increase by 82 compared to Post-Panamax increasing by 81. This means that by 1998 there will be some 92 Post-Panamax vessels operating, possibly up to 119 by 2000 and there will be some 136 Panamax containerships operating by 1998, possibly up to 157 by 2000. Analysis of recent Panamax orders such Tricon 4545 TEU ships suggests that the lines are maximizing the size the Panamax vessels employed on Canal routes. It follows that maximum vessel utilization will exploit deck loading.

Table 6-2
Container Vessel Cubic Capacities

Name	**MV Charlotte Lykes**	**Ecobox**
LOA	659	665
Beam	80	100.37

[1] The Suez Canal Authority (SCA) unlike the Panama Canal assesses transit fees for deck cargo. The rules for the computations of (Suez Canal) tonnage provide that, "Unfixed and unenclosed loads are not included in the measurement. Closed deck loads including containers on weather deck of cargo ships are to be included in the measurement."[1] SCA regulations concerning container ships prescribe the following:

> The "Containers" are closed space increasing the carriage capacity of the ship when situated over the main deck (weather deck). They are considered as a ship's permanent equipment. It is a matter of fact that those in the cargo holds are included in the underdeck tonnage. A surcharge on Canal dues relevant to the number of tiers on weather deck are taxed.
>
> The SCA provides that the computation of tonnage for vessels carrying containers on deck is as follows:
>
> (1) If the containers on the main deck do not exceed 2 tiers, a ratio of 5% of the vessel's net tonnage is to be added to the ship's net tonnage on the condition that the tonnage of these containers should not exceed 20% of the vessel's Suez Canal Net Tonnes (SCNT).
>
> (2) If the tonnage of the 2 tiers exceeds 20% of the vessel's SCNT, the difference is added to the taxable tonnage.
>
> (3) If there are more than 2 tiers of containers, the tonnage of tiers of containers exceeding the 2 tiers is to be added to the taxable tonnage even if the tonnage of the first 2 tiers is less than 20% of the vessel's SCNT.[1]

Draft	25.64	32.64
TEU Below Deck	433	1416
TEU Above Deck	670	1064
Total TEU	1103	2480
Year Built	1984	1993

Methodology

The investigation of transit fees for on-deck cargo will proceed in four sections as follows: (1) extent of application of deck cargo to particular categories of vessels; (2) extent to which deck cargo tolls would result in increased revenues; (3) anticipated vessel operator response to deck cargo tolls; and (4) different deck toll tariff structures relative to the existing PC/UMS net ton assessment for vessel transit tolls.

The data base used for assessment of deck toll application and revenue enhancement was the 1995 fiscal year vessel transits provided by the PCC, representing the most recent time frame available for analysis of deckload cargo transit characteristics. The 1995 "voyage" and "transit" electronic files were matched with the "basic" file of vessel characteristics to generate a listing of vessels containing deck cargo that transited the Canal in 1995. Six vessel types were analyzed for deck cargoes: (1) Full Container; (2) Container Breakbulk; (3) General Cargo; (4) RORO; (5) Dry Bulk; and (6) Tanker. These vessels collectively represented 70 percent of total loaded (laden) commercial Canal transits in 1995.

PCC voyage files report the tons of deck and total cargo by commodity type. The total numbers of containers and empty containers are also reported. The container data does not distinguish box sizes relative to TEU or FEU or stowage patterns relative to above and below main deck. Although the basic ship file contains container capacities above and below deck there was no explicit way to relate unknown size distributions of containers carried by each vessel to stowage utilization above and below deck. Therefore, the data did not permit objective assessment of the extent to which on deck container stowage occurred for the fleet relative to loaded and empty boxes in the hull and on deck as well as actual deck stack configurations with respect to tiers of boxes.

In the absence of other information the reported number of deckload tons for each vessel transit was used as a proxy for both container and non-containerized cargoes as a means to assess the extent to which deck cargo may supplement stowage below the main deck (below deck). The methodology was to compute the below deck stowage cargo tons by subtracting deckload cargo tons from total cargo tons. Deckload cargo tons were divided by below deck cargo tons to obtain the increased proportion of tons that would be achieved for each vessel voyage using deck stowage. The increased billing tons that might ensue from augmenting below deck tons was estimated by multiplying billing tons for each vessel (PC/UMS net tons) by the quotient resulting from dividing deckload cargo tons by below deck tons. The effect of adjusting billing tons by including a deck cargo factor on high cube carrying vessels such as containers was examined by comparing billing tons with total cargo and below deck cargo tons.

Deckload Cargo by Vessel Categories

Table 6-3 contains a breakdown of the number of transits by the six categories of vessels reviewed for deck cargo. The data indicate the total number of vessel transits as well as loaded transits for which total cargo tons were reported. The number of transits reporting deckload tons are also identified.

The data indicate that nearly all container vessel transits were loaded (1304 out of 1311), and almost all of the loaded vessels reported deckload cargo (1189 out of 1304). Most of the loaded RORO vessel transits also reported deckload cargo (182 out of 219). Approximately two-thirds of the loaded transits of container/break bulk vessels reported deckload cargo (204 out of 333) and nearly one-half of the loaded general cargo transits reported deckload cargo (664 out of 1305).

Table 6-3
Panama Canal 1995 Vessel Transits and Deckload Cargo

Vessel	Total Transits	Loaded Transits	Deckload Transits
Full Container	1311	1304	1189
General Cargo	1495	1305	664
Container/Break Bulk	358	333	204
RORO	232	219	182
Dry Bulk	3753	3082	175
Tanker	1854	1310	2

Source: PCC Voyage and Transit files for fiscal year 1995

Twenty percent of total dry bulk transits and one-third of total tanker transits were in ballast as indicated by the numbers of vessels reporting cargo tons compared to transits (3082 out of 3753 dry bulk transits and 1310 out of 1854 tanker transits). Very few of the loaded dry bulk vessels and almost no tankers reported deckload cargo. Only 175 dry bulk transits reported deckload cargo. Two tanker transits reported deckload cargo.

Tables 6-4 and 6-5 indicate the distribution of total and deckload cargo tons for vessels transiting the Canal. Deckload tons on average constitute an average of nearly one-third of full container and RORO vessel total cargo tons compared to only twenty percent for general cargo vessels. Container/break bulk vessels reflected general cargo vessel transits with about twenty percent of total cargo tons reported on average to be on deck.

Table 6-4

Distribution of Total Cargo Tons by Vessel Categories Reporting Deckload Tons

	Total Tons				
Vessel	**Mean**	**Mode**	**Stdev**	**Min**	**Max**
Full Container	16782	1785	9078	67	51771
General Cargo	6491	9211	4734	16	35481
Container/Break Bulk	12759	296	11369	296	40694
RORO	9459	1000	7832	15	28266
Dry Bulk	24007	29622	11258	218	42472
Tanker	-	-	-	-	-

Table 6-5

Distribution of Deckload Tons by Vessel Categories Reporting Deckload Tons

	Deckload Tons				
Vessel	**Mean**	**Mode**	**Stdev**	**Min**	**Max**
Full Container	5538	2100	3350	6	28512
General Cargo	1135	2	1370	2	14477
Container/Break Bulk	2504	10	2903	10	15213
RORO	3796	170	3953	1	15353
Dry Bulk	3017	2	2722	2	14394
Tanker	1807	NA	1275	532	3082

Source: PCC Voyage and Transit files for fiscal year 1995

Increased Billing Tons

Table 6-6 contains the distributions of deckload tons relative to below deck tons for each vessel category. The data indicate that full container and RORO vessels rely substantially more than other vessel categories on deckload stowage. Approximately one-half of full container and RORO vessel transits reported deckload tons to be nearly fifty percent of below deck tons. However, only about twenty percent of general cargo vessels reported deckload tons to be about one-half of below deck tons. Container/break bulk vessels exhibited a similar distribution of deckload to below deck tons as general cargo vessels.

Table 6-6
Distribution of Ratios of Deckload to Below Main Deck Cargo Tons by Vessel Category

	Container		General Cargo		Cont/BB		RORO		Dry Bulk	
Ratio	**No.**	**Cum %**	**No.**	**Cum %**	**No.**	**Cum %**	**No.**	**Cum %**	**No.**	**Cum %**
0.1	47	04	122	27	42	28	20	12	42	40
0.2	82	11	80	45	27	46	21	25	17	57
0.3	189	27	49	56	18	58	10	31	17	73
0.4	252	49	57	68	17	70	13	39	12	85
0.5	215	67	36	76	11	77	9	44	5	89
0.6	136	79	35	84	10	84	9	49	5	94
0.7	93	87	21	88	9	90	19	61	2	96
0.8	42	91	15	92	7	95	12	68	0	96
0.9	28	93	8	94	1	95	14	77	0	96
1.0	75	99	23	99	7	100	37	99	3	99
>1.0	6	100	6	100	0	-	2	100	1	100

Source: PCC Voyage and Transit files for fiscal year 1995

There are very limited observations of deck cargo for bulk vessels. Deckload cargo where it exists is relatively minor. Table 6-6 indicates that nearly one half of dry bulk vessels reported deckload tons to be less than twenty percent of below deck tons.

The estimated impacts of including deckload tons in billing tons are suggested in Table 6-7. The proportion of deckload tons to below deck tons was used to increase PC/UMS net tons (billing tons) for each vessel voyage. The mean increase in full container and RORO vessel billing tons would be nearly 11,000. The increased billing tons data indicate that up to 25 percent of full container transits would reflect increased billing tons by less than 6,000, while up to 75 percent of the transits would reflect increased billing tons by 17,000 or less. For RORO the data indicate that increased billing tons would be less than 3000 per voyage for up to 25 percent of the transits and less than 25,000 tons per voyage for up to 75 percent of the transits.

The smaller sizes of general cargo vessels and less reliance on deckload cargo collectively result in substantially lower increases to billing tons compared to full container vessels. For nearly one-half of the general cargo vessel transits billing tons adjusted by deckload cargo would increase by less than 2000 tons. For nearly 75 percent of the vessel transits billing tons would increase by less than 4000 tons. The container/break bulk vessels had slightly greater adjustments to billing tons based on the proportion of deckload to below deck tons. However, the overall distribution is quite similar to the break bulk results.

The change in billing tons for dry bulk vessels handling deckload cargo would be relatively insignificant compared to container vessels. The data suggest that fifty percent of the dry bulk vessels with deckload cargo would have billing ton increases less than 3000 per voyage.

Increased Toll Revenues

The estimated impacts of incorporating deckload tons into tolls are presented in Table 6-8. The data represents the increased tolls that would be paid by vessel transits. Tolls were increased by the proportion of deckload to below deck tons. One quarter of the full container vessels would pay less than $13,000 more per transit. One-half of the full container vessels would pay less than $25,000 more per transit. Up to 75 percent of the container vessels would pay less than $37,000 more per transit. Increased toll payment for all container vessels would be nearly $30 million annually. The average increased toll per full container vessel transit would be nearly $26,000.

The impact of increased tolls for RORO vessels is similar to that for full container vessels. Increased toll payments for all RORO vessels with deck cargo would be approximately $4.5 million per year. The average increased toll per RORO transit would be nearly $28,000.

The increased tolls for general cargo vessels would be substantially less than for full container and RORO vessels. Nearly one-third of the vessels would pay $2500 or less in increased tolls. One-half of the vessels would pay $5000 or less in increased tolls. Estimated total increased tolls from general cargo vessels would be nearly $3.5 million per year. The weighted average increased toll per general cargo vessel transit would be about $8500. This reflects that there were a small number of general cargo vessel records in the data that indicated very substantial proportions of deckload cargo to below deck tons.

Container/break bulk vessels would pay nearly $2 million more per year under a deck toll structure that related deckload tons to billing tons. The average transit would pay nearly $14,000 more.

Table 6-7
Distribution of Increased Billing Tons to Incorporate Deckload Cargo Tons by Vessel Category

Ratio	Container		General Cargo		Cont/BB		RORO		Dry Bulk	
	No.	Cum %	No.	Cum %	No.	Cum %	No.	Cum %	No.	Cum %
1000	15	01	111	27	24	17	22	13	14	13
2000	38	05	79	46	27	35	16	23	19	30
3000	42	08	64	61	19	49	6	27	25	53
4000	73	14	38	71	15	59	5	30	11	63
5000	56	19	46	82	8	65	6	33	11	73
6000	64	25	19	86	6	69	4	36	9	81
7000	72	31	18	91	8	74	8	41	6	86
8000	73	37	13	94	8	80	4	43	5	91
9000	65	43	3	94	2	81	1	44	5	95
10000	54	47	6	96	1	82	3	45	0	95
11000	44	51	0	96	3	84	5	48	0	95
12000	39	54	1	96	3	86	5	52	1	96
13000	40	58	2	97	1	87	4	54	0	96
14000	35	61	1	97	0	87	2	55	0	96
15000	60	66	0	97	2	88	3	57	0	96
16000	59	71	1	97	1	89	3	59	0	96
17000	52	75	0	97	0	89	3	61	0	96
18000	44	79	3	98	0	89	2	62	2	98
19000	41	83	0	98	1	90	1	62	0	98
20000	59	88	0	98	1	90	2	64	0	98
21000	39	91	0	98	1	91	2	65	0	98
22000	37	94	0	98	0	91	3	67	0	98
23000	18	96	0	98	4	94	1	67	0	98
24000	12	97	0	98	2	95	4	70	0	98
25000	11	98	0	98	3	97	2	71	1	99
26000	7	98	1	98	1	98	2	72	0	99
27000	1	98	0	98	0	98	7	76	0	99
28000	1	98	0	98	0	98	2	78	0	99
29000	2	99	0	98	2	99	2	79	0	99
30000	0	99	0	98	0	99	3	81	0	99
>30000	15	100	8	100	1	100	31	100	1	100

Source: PCC Voyage and Transit files for fiscal year 1995

Table 6-8
Distribution of Increased Tolls Paid by Transits With Deckload Cargo by Vessel Category

	Container		General Cargo		Cont/BB		RORO		Dry Bulk	
Ratio	No.	Cum %	No.	Cum %	No.	Cum %	No.	Cum %	No.	Cum %
2500	21	02	123	31	33	24	19	12	16	15
5000	52	06	76	50	20	38	17	23	29	42
7500	61	11	60	65	21	53	6	26	14	55
10000	71	18	50	78	13	62	8	31	19	72
12500	71	24	29	85	7	67	4	34	8	80
15000	78	30	18	90	9	74	9	39	6	85
17500	79	37	16	94	8	79	4	42	6	91
20000	72	43	2	94	2	81	2	43	5	95
22500	60	48	6	96	3	83	4	45	0	95
25000	42	52	0	96	2	84	5	48	1	96
27500	54	57	1	96	2	86	5	52	0	96
30000	39	60	2	96	1	86	4	54	0	96
32500	59	65	1	97	2	88	3	56	0	96
35000	65	71	1	97	1	89	3	58	0	96
37500	59	76	2	97	0	89	3	60	0	96
40000	44	79	1	98	0	89	3	61	2	98
42500	62	85	0	98	1	89	0	61	0	98
45000	58	90	0	98	2	91	4	64	2	98
47500	38	93	0	98	0	91	1	65	0	98
50000	83	100	9	100	13	100	57	100	2	100

Source: PCC Voyage and Transit files for fiscal year 1995

Dry bulk vessels with deckload cargoes would pay between $5000 to $6000 or less for about one-half of the transits. Up to 75 percent of the dry bulk deckload transits would pay less than about $10,000 in increased tolls. Total increased tolls from dry bulk deckload cargoes would be nearly $1 million per year. The average dry bulk deckload transit would pay about $8500 in increased tolls.

Total transit tolls paid in 1995 by vessels with deck cargo, excluding tankers (two vessels), were compiled to obtain a perspective on the order of magnitude of importance of *maximum estimated* deck tolls for different vessel categories. The data indicate the significance of full container and RORO vessels compared to other categories.

Vessel Type	1995 Tolls Paid ($000,000)	Deck Tolls (est.) ($000,000)	Increase
Full container	65.630	30.0	46%
RORO	7.927	4.5	57%
General Cargo	13.385	3.5	26%
Container/break bulk	6.239	2.0	32%
Dry bulk	6.794	1.0	15%
Total	93.187	41.0	44%

The high proportions of deckload tons to below deck tons suggest that transit tolls for certain categories of vessels, particularly full container vessels, may be understated based on PC/UMS net ton measures. To ascertain this billing tons were divided by total cargo tons for each vessel transit associated with deckload stowage to identify the extent to which PC/UMS net ton measures of vessel capacity coincided with cargo tonnage as augmented by deckloading.

The data in Table 6-9 suggest that PC/UMS net ton prescriptions of vessel capacity capture most if not all of the total tonnage carried by all vessels. Nearly 95 percent of the full container vessels have billing tons based on PC/ UMS net tons that exceed total reported cargo tons. Only five percent of container vessel transits have billing tons that are *less* than reported cargo tons. About fifteen percent of the container transits had billing tons that were more than *twice* the reported total cargo tons. The RORO fleet exhibited a similar pattern of distribution between billing tons and cargo tons.

The relationship between billing tons and total cargo tons for general cargo and container/break bulk vessels is virtually identical and similar in structure to full container vessels. Billing tons exceed cargo tons for nearly 80 and 70 percent of general cargo and container/break bulk vessel transits, respectively. Billing tons are more than twice the amount of total cargo tons for nearly thirty percent of all loaded transits for both vessel categories.

The PC/UMS net ton prescription of capacity for the dry bulk fleet with deckload stowage correlates relatively well with total cargo tons. However, billing tons for dry bulk vessels with deckload cargo are *less* than total cargo tons for 80 percent of the transits. Billing tons exceed the dry bulk cargo voyage tons for only 20 percent of the transits. Nearly 95 percent of all dry bulk transits have billing tons that are less than twice the total cargo tons.

The relationships between billing tons and total cargo tons for different vessel categories suggest that the PC/UMS net ton prescription of vessel capacities more than adequately accommodates vessels with deck cargo from the standpoint of basing tolls on vessel ton capacities. To affirm this the distributions of billing tons relative to below deck tons were computed for each vessel category. The results in Table 6-10 indicate that full container billing tons are greater than below deck cargo tons for over 99 percent of all vessel transits. Moreover, billing tons are more than twice the below deck cargo tons for nearly 60 percent of all vessel transits. Billing tons are greater than below deck cargo tons for approximately 75 to 80 percent of general cargo and container/break bulk vessels. Billing tons are more than two times the amount of below deck cargo tons for about 50 percent of these vessels. However, for dry bulk vessels with deck cargo billing tons are *less* than below deck tons for nearly 75 percent of transits.

Table 6-11 indicates the ratios between billing tons and cargo tons for all loaded bulk vessels transiting the Canal in fiscal year 1995. The data clearly indicate that tolls based on PC/UMS net ton prescriptions of vessel capacity are substantially less than cargo tons. Nearly two-thirds of the loaded dry bulk vessels had ratios of billing tons to cargo tons less than 0.5. Only six percent of dry bulk vessels had ratios of billing tons to cargo tons greater than 1.0. A nearly identical distribution of billing ton to cargo ton ratios exists for tankers.

These results suggest that billing tons based on PC/UMS net tons appear to adequately reflect the low density cargoes handled by vessels that characteristically have deckload cargoes. The relative homogeneity between below deck cargo tons and billing tons based on PC/UMS net tons for bulk vessels is a further harbinger of what could be regarded as equity in the rate structure relative to top loading light density general cargo without explicit prescription of a deck toll.

Table 6-9
Distribution of Ratios of Billing Tons to Reported Total Cargo Tons by Vessel Category

Ratio	Container		General Cargo		Cont/BB		RORO		Dry Bulk	
	No.	Cum %	No.	Cum %	No.	Cum %	No.	Cum %	No.	Cum %
0.4	0	00	0	00	0	00	0	00	0	00
0.5	0	00	10	02	21	10	0	00	46	26
0.6	3	00	39	07	20	20	0	00	56	58
0.7	4	01	41	14	10	25	0	00	24	72
0.8	23	03	39	20	9	30	0	00	8	77
0.9	37	06	28	24	7	33	1	01	5	79
1.0	56	10	41	30	6	36	1	01	3	81
1.1	100	20	23	34	8	40	4	03	6	85
1.2	132	30	24	37	12	46	4	06	2	86
1.3	162	44	32	42	11	51	4	08	5	89
1.4	123	54	34	47	7	55	3	10	2	90
1.5	125	65	32	52	9	59	16	19	1	90
1.6	78	71	21	55	7	63	10	25	0	90
1.7	49	75	17	58	3	64	14	33	2	91
1.8	49	80	23	62	3	66	6	36	0	91
1.9	35	83	12	63	1	66	10	42	3	93
2.0	37	86	19	66	8	70	5	45	0	93
2.1	25	88	12	68	4	72	5	48	1	94
2.2	23	90	13	70	3	73	7	52	2	95
2.3	15	91	19	73	3	75	6	55	0	95
2.4	13	92	15	75	2	76	2	56	0	95
2.5	11	93	9	77	5	78	5	59	1	95
2.6	16	94	8	78	1	79	5	62	2	97
2.7	3	95	7	79	3	80	9	67	0	97
2.8	3	95	10	80	1	81	2	68	0	97
2.9	6	95	7	82	0	81	2	70	1	97
3.0	3	96	6	82	3	82	2	71	0	97
4.0	32	98	40	89	11	88	18	81	0	97
5.0	11	99	26	93	8	92	10	87	0	97
>5.0	8	100	49	100	17	100	23	100	4	100

Source: PCC Voyage and Transit files for fiscal year 1995

Table 6-10
Distribution of Ratios of Billing Tons to Cargo Tons Below Main Deck by Vessel Category

	Container		General Cargo		Cont/BB		RORO		Dry Bulk	
Ratio	No.	Cum %	No.	Cum %	No.	Cum %	No.	Cum %	No.	Cum %
0.4	0	00	0	00	0	00	0	00	0	00
0.5	0	00	7	01	8	04	0	00	46	26
0.6	0	00	22	04	21	14	0	00	56	58
0.7	1	00	37	10	9	19	0	00	24	72
0.8	1	00	39	16	8	23	0	00	8	77
0.9	3	00	24	20	7	26	0	00	5	79
1.0	5	01	21	23	7	30	0	00	3	81
1.1	5	01	27	27	5	32	1	01	6	85
1.2	7	02	13	29	0	32	1	01	2	86
1.3	20	04	19	32	3	34	2	02	5	89
1.4	28	06	16	34	7	37	3	04	2	90
1.5	30	08	12	36	4	39	5	07	1	90
1.6	50	13	13	38	1	39	0	07	0	90
1.7	65	18	11	40	4	41	5	10	2	91
1.8	102	27	20	43	8	45	3	11	0	91
1.9	106	36	3	43	10	50	2	13	3	93
2.0	76	42	8	45	9	55	2	14	0	93
2.1	81	49	18	47	8	59	2	15	1	94
2.2	73	55	26	51	7	62	2	16	2	95
2.3	69	61	25	55	5	65	1	17	0	95
2.4	38	64	25	59	2	66	2	18	0	95
2.5	50	69	20	62	6	68	5	21	1	95
2.6	44	72	21	65	2	69	4	23	2	97
2.7	55	77	13	67	4	71	3	25	0	97
2.8	41	80	11	69	3	73	8	29	0	97
2.9	21	82	9	70	2	74	2	30	1	97
3.0	22	84	10	72	1	74	7	34	0	97
4.0	102	93	61	81	17	83	40	57	0	97
5.0	29	95	27	85	9	87	16	67	0	97
>5.0	58	100	98	100	26	100	58	100	4	100

Source: PCC Voyage and Transit files for fiscal year 1995

Table 6-11
Distribution of Ratios of Billing Tons to Cargo Tons for Bulk Vessels

Ratio	Dry Bulk		Tanker	
	No.	Cum %	No.	Cum %
0.3	1	00	4	00
0.4	103	04	100	08
0.5	1865	64	625	56
0.6	562	82	279	77
0.7	188	88	121	86
0.8	119	92	33	89
0.9	103	95	26	91
1.0	24	94	23	92
1.1	19	96	10	93
1.2	15	97	10	94
1.3	15	98	11	95
1.4	13	98	3	95
1.5	10	99	8	96
1.6	1	99	2	96
1.7	3	99	4	96
1.8	3	99	4	96
1.9	5	99	3	97
>1.9	33	100	44	100

Source: PCC Voyage and Transit files for fiscal year 1995

Anticipated Vessel Operator Response To Deckload Tolls

The implementation of deckload tolls into the existing toll rate structure with no other operational changes will effectively constitute a toll increase. Vessel operator responses to deckload tolls will be a function of the extent to which this form of stowage is integral to cargo handling and price elasticities of demand.

This section will reflect vessel operator deckload stowage alternatives. The implementation of deckload cargo tolls would appear to have little impact on cargo stowage. Deck cargoes are primarily a by-product for bulk vessels. Unless the deck toll mechanism significantly increased the prescription of billing tons, most dry bulk vessels would still have cargo tons that exceed billing tons.

Deck cargoes are more consistent and expected for low density general cargo relative to stowage. Vessel operators have clear incentives to make maximum use of cubic vessel capacity in lieu of ballast. Accordingly, deck cargo would appear to be relatively inelastic to tolls particular to its use.

Unlike the Panama Canal, the Suez Canal Authority (SCA) has long had a pattern of differential toll pricing distinguished by vessel category. For example, a 40,000 PC/UMS net ton container vessel would pay approximately $138,650 Suez Canal toll, excluding deck toll surcharge, compared to nearly an identical amount for a 70,000 PC/UMS net ton dry bulker. A comparative example of SCA and PC transit toll structures for 40,000 PC/UMS net ton container vessel follows.[2] The tolls are computed for PC/UMS net tons, disregarding the relatively small differences between computation of SCNT and PC/UMS net tons that would result for an actual vessel. Three scenarios of deck cargo have been prescribed to reflect the five percent SCA tonnage surcharge for two tiers or less and the addition of deck tonnage for containers exceeding two tiers to SCNT for toll computations. The cargo tons for the deckloads exceeding two tiers were assumed to be 4000 for four tiers and 8000 for six tiers.

Scenario	Suez Canal	Panama Canal	Suez/Panama
No deck cargo	$138,650	$88,400	1.56
2 tiers deck cargo	143,490	88,400	1.62
4 tiers deck cargo	153,170	88,400	1.73
6 tiers deck cargo	162,850	88,400	1.84

The SCA deck toll assessment exists within a differentiated pattern of transit tolls

[2] The comparison of tariff based transit tolls does not include other fees related to transit tolls such as advance booking, tug and line handling or pilotage. Moreover, the comparison of transit tolls does not reflect possible discounts or rebates from the SCA.

compared to the structure of the uniform tonnage assessment levied by the PC. Depending on the amount of deck stowage with respect to height and tons, a container vessel of about 40,000 SCNT might pay a toll between $138,650 to upwards of $163,000 while a 70,000 SCNT dry bulker would pay less than $138,000. The SCA is able in this example to increase tolls per container vessel transit by approximately $5,000 for two tiers or less on deck containers upwards to between $15,000 to $24,000 for more extensive use of deck cargo stowage, corresponding to four and six tiers with 4000 and 8000 incremental tons, respectively.

In 1994 a total of 3713 container vessels transited the Suez Canal. Average vessel size was approximately 25,000 SCNT, indicative of deckload container stacking up to four tiers. This would suggest that the norm of SCA deck tolls for the container fleet might be approximated by up to $15,000 per transit or roughly $50 million annually.

Deck Toll Tariff Structures

Demand for voyages can be linked to the alternatives of using the Canal, whether by voyage route, alternative vessel sizes, or sources of supply of goods. Deckload cargo, other things equal, results in more efficient use of vessel cubic capacity. This in turn can result in fewer voyages other things equal to handle the same volume of cargo, or can lead to handling marginal cargoes relative to rate levels (tariffs) that the traffic will bear

The previous sections indicated that the current cubic space ton equivalent prescription of vessel capacity, expressed as PC/UMS net tons, relates closely to below deck cargo tonnages for bulk vessels. However, the PC/UMS net ton assessment is significantly greater than below deck general cargo tons customarily stowed aboard full container, RORO, and general cargo vessels.

The true value of deckload space to the vessel operator is the opportunity cost of additional cargo measured by the net marginal revenue (marginal revenue minus marginal cost) from additional stowage. The opportunity cost of deckload stowage to the PCC is the expected value of the transit tolls and other revenues net of associated direct costs for transits that *might* be expected to occur in the absence of deckload stowage, other things equal. Where deckload cargo is relatively high in value or volume with respect to stowage space the opportunity cost of deckload stowage to vessel operators or the PCC, respectively, is substantial. Conversely, where the cargo is low in value such as incidental repositioning of empty containers or represents low level of utilization of deckload stowage space, the opportunity cost of deckload stowage will be less to both vessel operators and the PCC.

Other things equal it would appear that deckload cargo tolls should reflect the utility of this form of stowage to both the vessel operator and the PCC relative to the degree to which Canal transit throughput is efficiently used. If deckload tolls are to be used for profit maximization purposes to convert vessel operator consumer surplus to increased revenues for the PCC, the *ideal* situation would be to have a deckload toll that reflected the relative opportunity costs of the cargoes handled. However, administratively this degree of sophistication could be very difficult to efficiently implement on a container commodity item basis.

Of more practical use would be deckload tolls that allowed for a distinction between loaded or empty status of all containers stowed above deck. Beyond this level of differentiation between loaded or only empty shipping containers, distinctions between the value of deckload stowage for different mixes of loaded and empty containers would appear to be difficult to apply unless already done as an extension of an alternative tolls pricing structure. One alternative scheme of the extent of deckloading would be to use tonnage as a factor to adjust PC/UMS net tons analogous to the methodology followed in this analysis.

Deckload tonnage would differentiate well between loaded and empty containers. However, tonnage would not effectively differentiate between the opportunity cost to the vessel operator of different commodity value mixes handled in deckload stowage. Moreover, deckload tonnage would not necessarily be easily ascertained from the standpoint of accurately assessing tons for computation of a deckload surcharge. Therefore, it would appear that the most desirable form of deckload assessment complementary to the existing toll structure using PC/UMS net tons would be a surcharge based on the maximum number of tiers of containers.

The upshot is that deckload tolls cannot be treated in isolation from the rest of the toll pricing structure. This appears to be particularly true for the existing public utility average total cost recovery mechanism of standardized tolls per PC/UMS net ton for all loaded and empty commercial transits. Moreover, the degree to which a deckload toll structure reflects the relative values of alternative stowage configurations will be a function of the extent to which other elements of the toll structure effectively reflect cost of service and demand.

Summary

Deckload cargo is primarily carried by the general cargo trades. The largest vessels and users of deckload cargoes are full container ships. Deckload cubic carrying capacity is usually between 40 to 60 percent of total carrying space (TEU) for these vessels. Therefore, deckload cargo is integral to the operation of full container ships. Except for RORO vessels, other general cargo vessels utilize deckload cargoes less extensively as measured by the proportions of deckload tons to cargo tons below the main deck. Deckload cargoes represent a by-product for dry bulk vessels which normally do not handle large amounts of this cargo. For all practical purposes tankers do not handle deckload stowage.

The extent to which deckload stowage could be used to increase toll revenues is a function of the pricing policies of the PCC and price elasticities of demand of vessel operators. There appear to be little if any increased navigation costs for transiting vessels with deckload stowage.

The deckload toll pricing structure could assume a variety of different forms and applications. The deckload pricing structure could allow for a differential between the volume of stowage relative to cube or weight and the value of stowage relative to cargoes. The cubic stowage are should be related to the change in vessel capacity transiting the Canal with and without deckload stowage and the characteristics of the containers relative to loaded and empty status. More sophisticated pricing mechanisms are possible that could be part of a comprehensive basis for assessing transit tolls based on the value added to the vessel operators. Deckload tolls based on tons of loaded and empty containers could be regarded as a desireable threshold of pricing sophistication in this arena subject to the limitations of administration, including enforcement.

Our analysis suggests that if deck cargo tons were added incrementally to PC/UMS net tons (billing tons) for all vessels in 1995, that the PCC could receive as much as $40 million in increased revenue annually, assuming no loss of vessel transits as a result of price elasticities of demand. The impact of deck tolls in this section does not include price elasticity adjustments to reflect possible cargo or vessel shifts as a result of higher tolls.

The analysis here suggests that increased toll revenues based on adding deck cargo tons to billing tons would appear to reflect a maximum threshold that could be implemented into the current tolls structure. Notwithstanding any tempering of the proportional increases of billing tons the toll revenue increases would average 45% for general cargo vessels, ranging from about 50% for full container and RORO vessels to 25% for general cargo and container/break bulk vessels. Three quarters of the increased revenues would result from full container vessel transits.