Sensitivity Analysis of Panama Canal Traffic Demand

Análisis de Sensibilidad de la Demanda de Tráfico del Canal de Panamá

ICF Kaiser International Inc.
En asociación con
Louis Berger International, Inc.

31 de julio de 1996

Resumen Ejecutivo

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Final Report

Prepared for:
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Prepared by:
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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

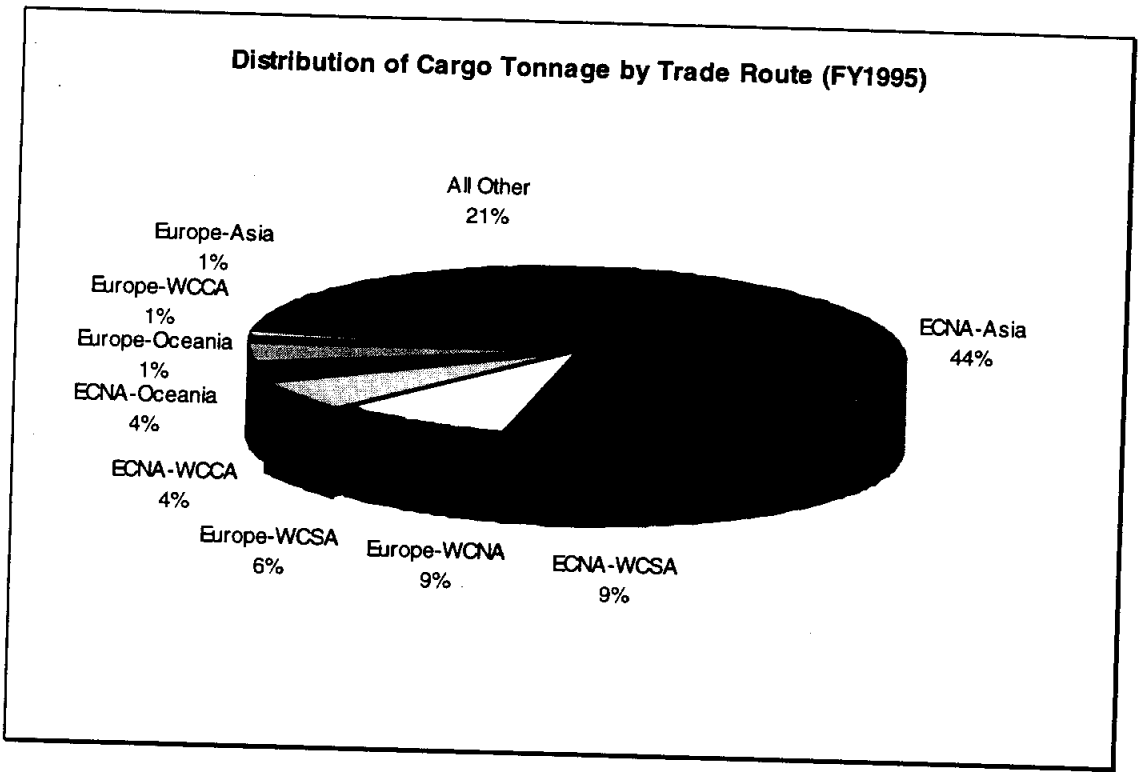
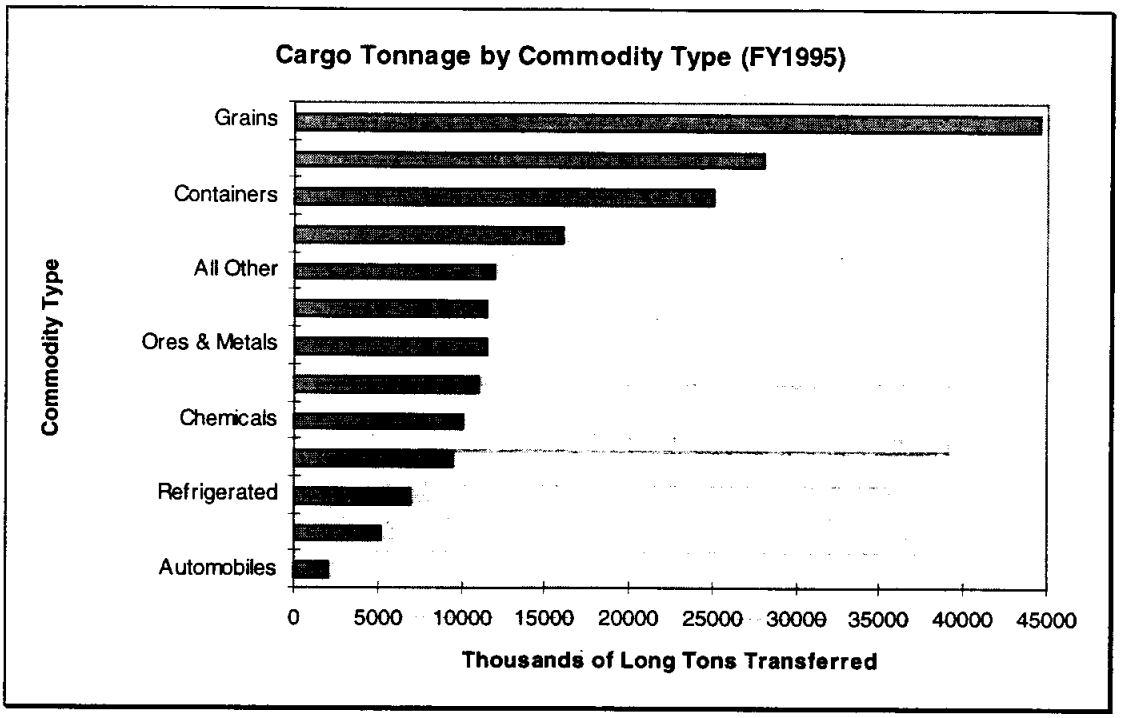


Chart ES-2



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 ($)

	1997		1998		1999		2000		2005	
Scenario	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

Commodity Group	Comparison of 1997 Tonnage: 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

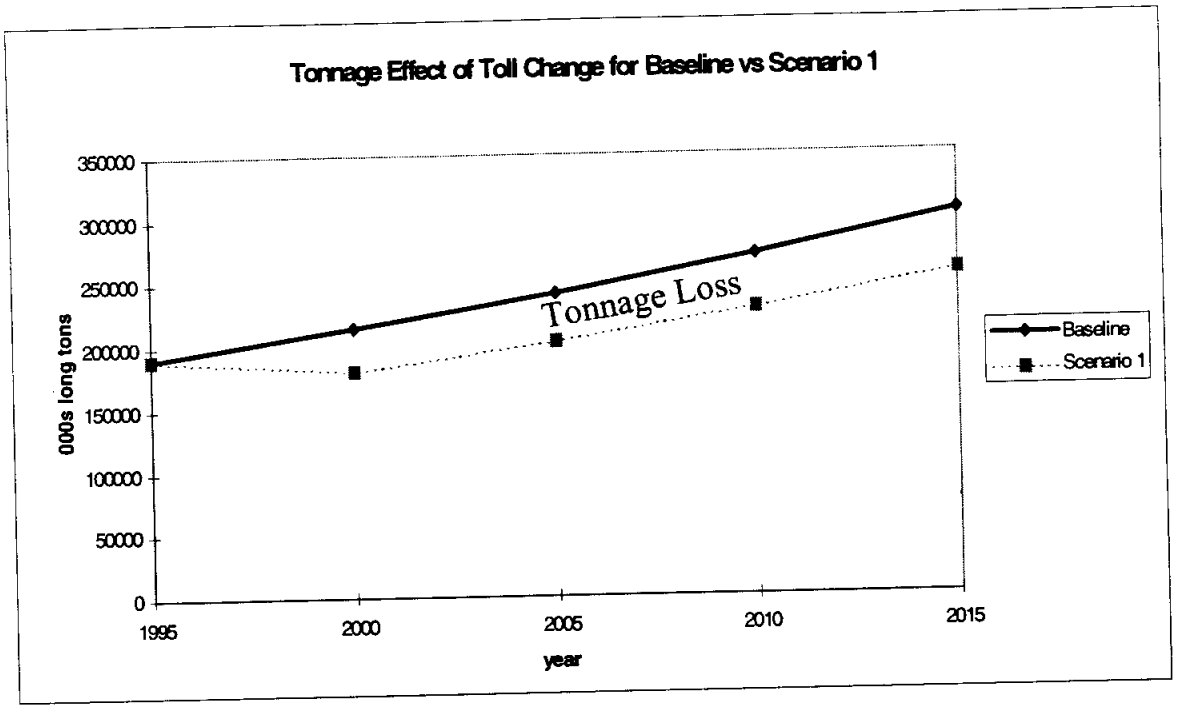
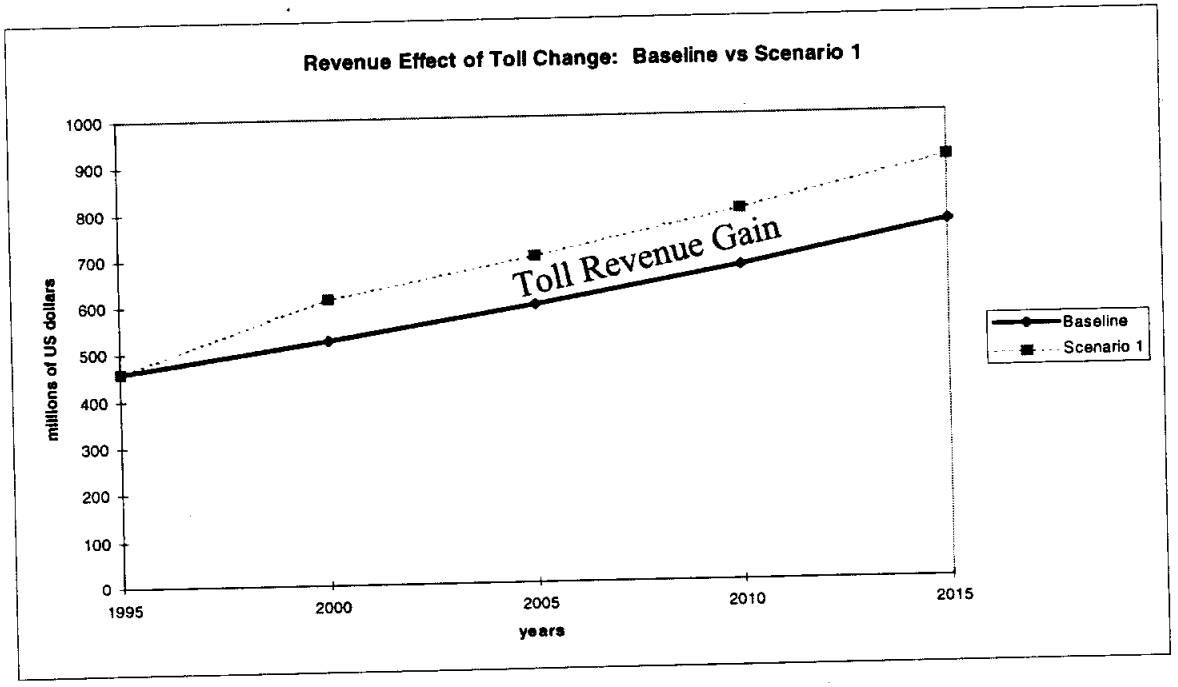


Chart ES-5



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.

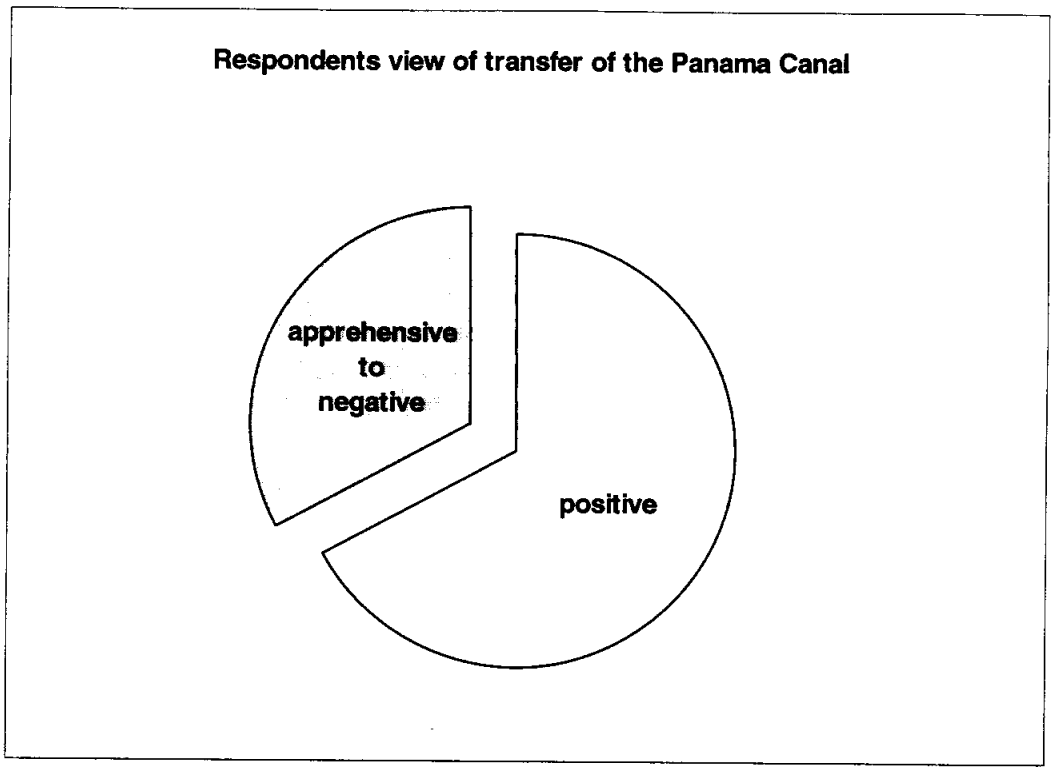
- Bulk operators are more price sensitive, although transit time and reliability are also important.

- 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.