Panama Canal Grain Market Segment Peer Review

By

Stephen Fuller and Tun-Hsiang Yu

For

PB Team
Autoridad del Canal de Panama
Balboa, Ancon
Republica de Panama

June 27, 2003

Table of Contents

Panama Canal Grain Market Peer Review

Introduction

In this report, we offer a review of the Panama Canal Grain Market Segment Study by Nathan Associates. Five volumes were reviewed. Initially, the Terms of Reference as it relates to the identified volume (study) is reviewed. This is followed by review comments that relate directly to various pages of dialogue or sections in that volume. At the end of each of the five studies (volumes), we offer a summary of review comments and ways the study could be improved. Finally, at the end of the report are summarizing thoughts.

Title: Volume 2: Panama Canal's Potential Market

Objective as Stated in Terms of Reference: Requirements 5.1

For each commodity of this segment as described in sub-paragraph 4.2, the contractor shall determine the Canal's yearly potential market by cargo (expressed in terms of metric tons and metric ton-miles) by vessel size and by route.

On Page 1 of Introduction, author's have restated objective as follows: the term "Canal's potential market" represents our estimate of the maximum market share of world trade that the Canal could capture assuming a value of zero for Panama Canal tolls.

Review Comments

Initially, review comments will focus on the methodology used to accomplish the research objective. Then, comments will be offered regarding the estimation of parameters to be incorporated into the developed analytical tool.

Comments on Methodology (Pages 2-4, Appendix H)

1. Forecasts of selected macroeconomic variables reflecting most probable, best case, and worse case are offered by DRI-WEFA by country and world region to 2025. These selected variables are used to estimate annual grain production and consumption by country/region to 2025 for purposes of identifying regions/countries with grain/oilseed surpluses and deficits. These estimates in combination with transportation and logistics costs that link excess supply regions/countries to excess demand regions/countries are incorporated into a least-cost framework for purposes of resolving least-cost grain/oilseed flows. If the model is correctly constructed it should closely approximate actual flows since transportation and logistics costs are central to the determination of flow patterns for comparatively low-valued commerce such as grain, coal, and ores. The least-cost grain/oilseed model can then be used to evaluate improvements to the Canal by appropriately modifying rates/costs on those routes involving the Canal over the 25-year

study period. By examining best case, worst case, and most probable scenarios as outlined by DRI-WEFA, sensitivity of Canal flows to selected macroeconomic variables can be resolved.

It is this reviewer's opinion that this approach is appropriate to accomplish the stated research objective. Although the general approach seems appropriate, it is the specification of the developed model and associated parameter estimates that determine its capacity to correctly reproduce/forecast grain flows via the Canal.

The developed transportation model is outlined in appendix H. The developed model is presumably a multi-commodity, spatial equilibrium model that is solved by a linear-programming (least-cost) algorithm. The model presumably represents a crop year. The developed model minimizes the grain/oilseed production costs and the transportation/logistics costs that link all excess supply regions/countries with excess demand regions/countries. The model includes 26 producing regions and 42 consuming regions. Rail, truck, and barge costs are incorporated into the model as well as ocean shipping costs. Figure 1 (Appendix H) indicates that the model determines grain flows between domestic excess supply regions and domestic excess demand regions and export ports. In addition, flows from exporting ports to importing ports and the final destination within the importing country/region are represented by the model. The cost-minimizing model apparently reflects a regional grain/oilseed supply relationship that is the shape of a backward L, where the horizontal portion is the unit cost of grain production and the vertical section is an upper bound on region supply. Apparently, crop production in each region is optimized (Equation 2) subject to the availability of arable land in the region. In addition, the model includes a minimum regional production constraint for included crops. Remaining constraints are on port capacities and flows into and out of network nodes.

In general, the model seems adequate, however, the manner in which supply is represented may represent a problem.

Comments on Model Structure and Estimation of Transportation Model Parameters:

Grain Production and Import Demand (Chapter 2, Appendix A)

1. Corn, soybeans, barley, wheat, rice, and grain sorghum are included in the analyses. All evaluated commodities are generally homogeneous except wheat and rice. The U.S. produces hard red winter wheat, hard red spring wheat, soft red winter wheat, durum, and soft wheat. The hard wheat produced in the northern and central plains is a bread wheat while soft wheat is often used for cookies/crackers, durum is used for pasta, etc. **Aggregating all wheat will give rise to inaccurate flows, e.g., soft wheat supplies will fill hard wheat demands and vice versa since flows are based on least-cost production and transportation/logistics costs. This is unfortunate since the study is attempting to accurately represent grain flows via the Panama Canal.**

2. Appendix A defines ten production regions that will comprise the U.S. portion of the model. Typically 3 to 5 states comprise each region. In addition, the ten production regions are also the ten consumption regions. If a region's production of a particular grain/oilseed exceeds its consumption, it will have an excess supply that can be transported to a domestic region whose consumption exceeds its supply or to a port**. It will be very difficult for the researchers to obtain least-cost grain/oilseed flow patterns that approximate reality because of the excessive spatial aggregation---3 to 5 states per production region is excessive**. In essence, it assumes that all shippers in a particular region are confronted with the same transportation rates to various markets. Shippers are confronted with differing rates because of varying distances and shipping arrangements, hence the impossibility of representing a multi-state region with a single set of rates. Consider, for example, that 1999 Waybill data shows railroad rates from Illinois to Alabama and Georgia to vary from about $9/short ton to $29/short ton. Obviously, if several states were aggregated, the range of rates would be even wider. **Hence, the inappropriateness of aggregating large geographic areas when attempting to replicate flow patterns. Because of the excessive spatial aggregation, large quantities of grain/oilseeds are likely to move to a particular market in the least-cost solution, hence the inability of the model to duplicate reality.**

It is generally recognized that spatial detail is required when attempting to forecast spatial flow patterns. The following paragraph is taken from a Transportation Research Board document that was investigating the U.S. Army Corps of Engineers research into the feasibility of expanding lock capacity on U.S. inland waterways:

"Transportation forecasts usually have a high degree of spatial detail. The area served by the transportation facility is usually divided into zones, and estimates of production and uses are provided for each zone. The analyses of the choice of routes and modes and transport congestion and costs are then done separately for each pair of zones that has traffic flowing between them. The more detailed the zone system, the more burdensome it is to calibrate and use the forecasting model. **But, because production, uses, transportation tariffs, and congestion can vary significantly over space, spatial detail is usually required to assure a reasonably accurate forecast.**" This is taken from a document titled, "Inland Navigation System Planning: The Upper Mississippi River and Illinois Waterway." National Research Council, National Academy Press, Washington, D.C., 2001, page 35.

3. It is important that regional grain/oilseed production and consumption be carefully calculated. This is particularly critical because **it is the spatial positioning of regions/countries excess supplies and excess demands that largely determine inter-region flow patterns. If the estimated spatial arrangement of excess supplies and demands is not accurate, it will be impossible for the least-cost model to generate realistic spatial flows.**

a. The researchers give consideration to future ethanol production in the United States and its potential impact on excess supplies of corn for export. For this study, the estimated future consumption of corn for ethanol and the location of ethanol production are important**. It is difficult to project use of corn for ethanol production since its use in fuel is largely based on a political decision.** The researchers analyses and extrapolations are largely based on two studies. One study shows U.S. production of ethanol in 2012 to be 5,500 million gallons or about 2.2 billion bu of corn. **It is difficult to know whether this is a reasonable expectation.**

b. Regional grain/oilseed production in the U.S. portion of the model is projected for each year by multiplying estimated yield and planted area to the 2025 period (Appendix A). Future yields are based on simple trend lines of past yields while the planted areas are based on past acreage and any proportional increases (decreases) that FAPRI at the University of Missouri had shown in their projections to 2010. **The researchers make no attempt to relate the various assumptions that the FAPRI model might have incorporated into the 2010 period.** After 2010, planted area is assumed to be constant.

Regional grain/oilseed consumption was estimated with a formula that reflected production, exports, and grain/oilseed inflows and outflows. In particular,

Consumption = production – exports – domestic out – domestic in

where,
Production is for a particular crop in a specified region
Exports is export rail shipments
Domestic out is rail shipments to other domestic areas
Domestic in is rail shipment from other consumption areas

The researchers indicate they use these estimates to derive a proportion of total U.S. demand that is to be allocated to each of the consuming regions. Total annual U.S. consumption estimates are obtained by crop to the year 2025.

The formula to estimate regional grain consumption seems excessively simple. For example, consider U.S. corn, the primary grain transiting via the Panama Canal. Annually, dairy, poultry, and livestock in the United States consume about 55 percent of corn production, the primary market for U.S. corn (USDA, Feed Situation and Outlook Yearbook. April 2001). **It seems unfortunate that the analysis does not give explicit consideration to this sector over the 25-year study period.** In recent years, the livestock and poultry sectors have been increasing the feeding of U.S. grains and marketing the meat/poultry into international markets (W. Hudson, Global Markets: Opportunities and Strategies for Agriculture. Presentation to the Staff of the Senate Agricultural committee, September 2001). Obviously this trend has implications for future excess supplies of corn in the United States and corn traffic through the Canal. **Further, the formula offers no consideration to grain haulage into or out of the region by other modes, hence the proportion they calculate may be quite inaccurate. The barge mode is the dominant form of transportation used for moving corn and soybeans from the Corn Belt to lower Mississippi River ports, hence to neglect this mode would seem to bias the proportion calculation to be used for the regional consumption estimates.** A USDA publication titled, "Transportation of U.S. Grains: A

Modal Share Analysis, 1978-95 (1998)" shows 38.1 percent of grain in U.S. transported by railroad to export, 50.9 percent by barge with the remaining export grain (11 %) carried by truck. For domestic grain movements, 41 percent is transported by rail, 2.5 percent by barge, and 56.5 percent by truck. **Therefore, to not consider haulage by other modes would seem to represent a problem in the estimation of grain consumption.**

c. For Canada, the researchers assume consumption for each region is that region's share of total production. So, if Alberta grew 30 percent of the wheat it would consume 30 percent of the wheat. **Researchers need to offer an explanation as to the reasonableness of this assumption. It would seem more reasonable to assume domestic consumption of Canadian wheat was proportional to population in each province. Possibly livestock, dairy, and poultry populations by province would have increased appeal as a proxy for the location of barley consumption.**

d. Appendix E offers an explanation of the procedure to estimate world grain/oilseed consumption and production, and presumably U.S. consumption. Data on country yields and harvested acres by crop were obtained from the USDA-ERS's Production, Supply, and Distribution database. Harvested areas are regressed against time (trend), as are yields to obtain a yield and a harvested area equation for each region/country. Estimates of annual crop yield and harvested area to 2025 by region are multiplied to obtain projected annual production to the year 2025. Per capita consumption of each crop in each region was estimated by regressing it against per capita income and time (trend). Per capita consumption estimates for each region are then obtained for each year to 2025 and then multiplied by WEFA population estimates to 2025 to obtain annual consumption projections to 2025. Finally, projections of annual region production and consumption to 2025 are subtracted to determine whether the region has an excess demand or supply and the magnitude of the excess supply/demand.

The procedure to estimate annual production and consumption of grain/oilseeds by region/country to 2025 includes simplifications that may not be acceptable. First, the use of trend lines to estimate future values for a variable over a 25-year time horizon assumes that all forces acting on the value of that variable in the past will continue to act similarly in the future. In general, most believe that is not the case for variables that have an economic dimension. However, when carrying out research we make judgments as to when certain simplifications are appropriate**. Apparently, the researchers believe the above-noted simplifications were acceptable. I am inclined to disagree. Obtaining good estimates of region/country production and consumption of grain/oilseed are critical since it will greatly impact spatial flow patterns. Obviously, if the surpluses/deficits are not correctly estimated for regions that are likely to transit grain via the Canal, the Canal flows could be seriously distorted. Hence, the importance of obtaining good estimates of the production/consumption parameters.**

e. **Interestingly, the researchers did not include any information about the statistical properties of the estimated trend equations.** What portion of the variation in the dependent variable is explained? What variables were statistically significant? What was the DW statistic? How good were the estimated equations in estimating recent region/country production and consumption. **The analysts should have included this information.**

f. The following relates concerns about using trends to estimate future grain production and consumption. It is taken from a recent Transportation Research Board study. Recently, the U.S. Army Corps of Engineers approved a study to estimate grain surpluses near the upper Mississippi and Illinois Rivers that would likely be exported by barge to lower Mississippi River ports. The forecasts were based on projections of acreage along the waterway that could be planted to the selected crops and of yield per acre of these crops that were based on past years and projections. **Estimates of domestic consumption of these crops were derived from historical trends in domestic consumption for various uses. The difference between production and consumption were to give rise to the exported surplus. This procedure was found to seriously overestimate recent exports, hence alternative procedures had to be obtained.** (Inland Navigation System Planning: The Upper Mississippi River and Illinois Waterway. National Research Council, National Academy Press, Washington D.C. 2001, page 35).

Forecasted country/region grain demands and supplies throughout the 25-year study period are important components of the spatial model since these forces drive international grain trade and the derived demand for ocean freight transportation and the transit services of the Panama Canal. Obviously this phase of the study is critical and we know international agricultural trade is influenced by a myriad of forces**. It is overly simplistic to rely on trend lines and a patchwork of inconsistent methods to generate insight on the spatial arrangement of future grain production and consumption.** It would probably have been preferable to obtain the services of FAPRI at Iowa State or University of Missouri and their world agricultural models. The WEFA information on macroeconomic variables such as gross domestic product, population and exchange rates could have been incorporated into the FAPRI models as well as various assumptions regarding agricultural policies, etc. In which case, the various assumptions that gave rise to the projections of the world agricultural model would be known and the sensitivity of Canal flows to these assumptions could be evaluated

Grain Land Transportation Costs (Chapter 4, Appendix B)

1. On page 47, the authors indicate the model is constructed so that grain is allowed to enter the upper Mississippi at Minneapolis and St. Louis**. It is unfortunate that grain was not permitted to enter the River at Clinton or Dubuque, Iowa since Iowa/Illinois border is a leading source of grain for the upper Mississippi.**

2. It is noted that rail rates in the U.S. (Appendix B) were based on Waybill data. **Is the Waybill file the source of data for the spatial model?** What years were used? What assumptions were made about the use of unit trains and shuttle trains? Did you average all rail rates from a production region to a port to obtain an average? Was the average

weighted? **No explanation is offered as to how rail rates were adjusted out to the year 2025. What was assumed about railroad rates over time and how they would behave relative to barge rates or motor carrier rates?**

3. Appendix B indicates barge rates were based on the January 2001 to September 2002 period. **Is there reason to assume the observed barge rates are representative of rates in the long run?** What was assumed about barge rates over the next 25 years and their movement relative to rail rates? What was assumed about the lock congestion in the lower reaches of the upper Mississippi and its impact on rates over the 25-year study period?

4. The model description (Appendix H) indicates truck transportation would be included in the model. **Why is there no description of truck rates included in the model or how they were estimated? In addition, the model section indicates logistics costs of importing countries were included into the model, but, there appears no discussion of these parameters.**

5. **This reviewer could find no information on how frozen waterways were treated in the model during the winter season.** What is assumed about the navigability of the upper Mississippi, Great Lakes and St. Lawrence Seaway in the winter period?

6. Ocean shipping rates are apparently discussed in Volume 3, regardless, I'll make several observations regarding the information presented in Volume 2. Table 4-6 includes information on the North American Pacific Northwest ocean ship rate versus the Gulf/Canal Rate to Asian Markets. This indicates the Pacific Northwest rate to Japan is $3.02/metric ton lower than shipments from the U.S. Gulf to Japan rate. **This rate spread is at substantial variance with USDA-AMS data that indicates the average long-run spread is about $9.95/ metric ton.** See figure at end of report. During 2000 through 2001 the monthly spread averaged somewhat less at $7.70/metric ton. From January 1997 through September 2002, I could find only three monthly average rate spreads that are near the $3.02/metric ton value or less. An explanation is required.

7. Tables 4-9, 4-10, etc. include "**export port charges**." **What are included in these charges? Does it include the export grain elevator receiving and load-out charges, stevedoring charges, etc?** How are these charges expected to change out to the year 2025? Clearly, they differ substantially and could have an affect on Canal flows. Ports and harbors in competing world regions have been improving. For example, dredging of lower Parana River ports is estimated to have lowered ship rates up to $5/ton.

Forecast of Canal Potential Market (Chapter 5, Appendix H)

1. **This reviewer does not believe there has been sufficient documentation of the model and associated parameters.** I am unsure exactly what is in the model and how it is structured, i.e., it is somewhat of a black box. Appendix H offers insight but there is

no corresponding discussion of many parameters that are apparently estimated and included in the model.

2. **Authors of study find it necessary to impose a number of constraints on their model to obtain realistic results.** Some seem appropriate in Table 5-1 while others seem doubtful. Interestingly, many constraints are related to wheat. This may result from treating wheat as a homogeneous product. Further**, I'm concerned that a constraint must be placed on U.S. corn exports to the Pacific Northwest ports.** Pacific Northwest ports attract substantial quantities of corn from the western portions of the Corn Belt and accordingly compete with Canal flows. **It is unfortunate that a constraint must be placed on model to obtain correct flows. This may result from excessive spatial aggregation.**

3. **To develop confidence in the model and its projections, a rigorous validation of the model should have been carried out and presented to the ACP.** In particular, actual grain flows through the Pacific Northwest ports and lower Mississippi River ports should have been contrasted with base model flows**. If model-projected flows are not similar to actual flows, questions should be posed about model construction.** Also, do the correct modes transport grain to the various port areas? Most corn and soybeans to lower Mississippi River ports should have been transported by barge? All corn to the Pacific Northwest should have been carried by rail. Further, did the corn and soybeans arriving by barge at lower Mississippi River ports originate in about the correct regions? (Iowa, Illinois, Minnesota, Indiana, etc) Did the corn flows to the Pacific Northwest ports originate in the correct regions? (Nebraska, west Iowa, west Minnesota, east South Dakota) Similarly are the various U.S. port regions shipping to those countries that are known to import through that port area? It is through a rigorous validation of the model that confidence in results and future projections are gained.

4. Interestingly, in this analysis, model-generated flow patterns are partially determined by cost of production. The cost of production is important in determining the location of grain/oilseed production in the world. However, once the grain/oilseed is produced, the cost of production has little to do with the ensuing flow pattern. It is a short–run versus long-run phenomena. Apparently, the researchers contrast their estimated world consumption for a grain in a particular year with world supplies and select those regions/countries that can supply at least cost to the world demanders. Thus, making world supply equal demand in a particular year. They might have obtained better flows if a two-step process were implemented. The initial step would have been analogous to that which is currently carried out. The second phase might have dropped the production costs and used only the transportation and logistics costs in combination with supplies determined in the initial phase to resolve flow patterns.

5. **In a long-run context, fixed and variable costs seem important in determining where grain production will take place in the world rather than variable costs alone. Is there a return to land included in the variable cost?** In contrast to this study, the USDA indicates grain production costs are generally lower in Brazil and Argentina than the United States. They report, based on 1998 soybean production cost and yield data, per

bushel costs in Mato Grosso and Argentina were 23 to 24 percent lower than in the U.S. heartland, while costs in Parana were 19 percent lower (USDA, Agriculture in Brazil and Argentina: Developments and Prospects for Major Field Crops, ERS, WRSO13, December 2001) U.S. variable cost for corn production is lower than in South America, however, total cost in South America are less because of comparatively low land costs. Possibly one could operate the model in several phases where the initial phase would consider total cost of production while the second phase would have transportation cost, logistics costs and grain supplies determined from the first phase.

6. The conclusions seem to be sensitive to a variety of parameters and decisions relating to model calibration. For example, they conclude the Pacific Northwest ports will play a comparatively minor role as a corn export location because ethanol production will tend to locate in the hinterland of the Pacific Northwest ports. As such, increasingly corn exports will go to the U.S. Gulf and via the Canal to Asia. **Because this is an important happening, it may be valuable to double-check the logic that gave rise to the expectation about the location of ethanol production.** Further, what would be the outcome if the U.S. adopts hydrogen-based fuels and in 2025 ethanol production is one-half of that expected. **Why not carry out sensitivity analysis on those variables that were discovered to be important to Canal grain flows?**

Summary of Review Comments

1. The least-cost methodology employed to project annual grain flows is appropriate.

2. Unfortunately, the constructed least-cost model was not properly specified. In particular,

a. The supply/production regions in the U.S. portion of the model are too large to generate realistic grain flow patterns. Because the research product focuses on grain flows, the model should have been constructed to yield good insight on flows.

b. Wheat is treated in the model as a homogeneous commodity when it should not have been. As such, the generated flow patterns for wheat are misleading and most likely inaccurate.

3. In some cases, there is considerable concern regarding the method/procedure to estimate model parameters.

a. Using trend lines to determine annual level and location of region/country grain production and consumption to the year 2025 is an oversimplification. The spatial distribution of excess supplies and excess demands is central to obtaining accurate flow patterns.

b. The formula to estimate regional consumption of grain in the U.S. and Canadian portion of model is inappropriate. The offered formula fails to consider the major

grain consuming sectors in the U.S. Further, the formula yields incorrect proportional measures since only rail transport is considered in calculating inflows/outflows.

c. Almost no discussion is offered about overland transport modes and associated estimation of rate parameters and how these rates were expected to behave over the 25-year study period. There is little confidence generated regarding overland rates used in the study and rates in a long-run context.

d. The spread between the Pacific Northwest ocean freight rate to Asia and the Gulf rate to Asia differs substantially from reality.

4. After the model was constructed, it should have been rigorously validated by contrasting model-generated flows with actual flow.

a. Because the model was not adequately validated, one has little confidence in its projected flow patterns.

Ways to Improve Study

1. Demand a rigorous validation of the model as outlined above.

2. If the model fails the rigorous validation, reconstruct portions of model and estimate new parameters as necessary.

a. Probably would need to add spatial detail along the boundaries of the Gulf and Pacific Northwest port hinterlands.

b. Reconstruct some portion of wheat model to feature demarcation of production/consumption by wheat class.

c. Improve overland rate estimates as necessary.

Title: Volume 3: Vessel Transit and Fleet Analysis

Objective as Stated in Terms of Reference: Requirements 5.4

Forecast for the two Panama Canal cases described in sub-paragraph 4.1, the contractor shall provide forecasts (see paragraph 6 for base year and time horizon) for the following key variables:

Cargo by commodity and trade route

Transits by vessel characteristics and dimension characteristics and other key variables according to contractor's proposal as accepted by the ACP.

Transits by country/port of origin and destination for each trade route.

Transit revenues by trade route, laden/ballast distribution and direction.

For the performance of this task, the contractor shall take into account growth trends of grain carriers and their deployment over particular routes. The contractor may select the analytical tools to be used in the performance of this task: however, due to the new dimensions of the expanded Canal, if the contractor decides to use an econometric model, the techniques used for these forecasts shall not be limited to this tool.

The contractor shall identify the specific factors that influence each of the key variables' forecasts.

In the Introduction, the contractor indicates Volume 3 presents the vessel transit and fleet analysis for the existing Canal and an expanded Canal. In particular, Volume 3 includes: (1) world fleet analysis and forecast; (2) an estimate of total sea borne transport costs of Canal routes and alternatives; (3) a determination of cost differentials between the existing/expanded Canal and alternatives; and (4) Canal transit analysis and forecast.

Review Comments

In the Introduction, insight on the study approach and methodology are offered. The general description suggests it is appropriate.

Historical Analysis of Panama Canal Traffic (Chapter 2)

On pages 3-44, discussion and tables are offered regarding analysis of laden transits, cargo size distributions by route and DWT range, average DWT by DWT size range and route, DWT utilization by DWT size range and route, conversion factors for PCUMS, Gross Tonnage, Projections of LOA, Beam and Draft from DWT information and an analysis of ballast transits.

1. In general, the analyses is accomplished by merging data sets and then segregating and partitioning the merged data set to yield insight on the relationship of interest. Data sets appear to be satisfactorily rectified when necessary. Page 6 offers an important clarification. Grains that are carried in other than dry bulk carriers (e.g. containers) are not the focus of this particular study. The definition relating to grain vessels and grain transits seems reasonable. Importantly, the data shows there are few grain transits that include ODB commodities not identified for the ACP study. On page 11, a brief discussion is offered regarding grain routes that bypass the Canal because of vessel dimensions and characteristics. They find no marine routes of note and observe only the overland movements of U.S. grain to the Pacific Northwest port as a bypass route of significance. It is important how the researchers view a "bypass" route. For example, soybeans moving from Brazil to Asia via the Cape of Good Hope may not be viewed as a bypass route when it should be. South American soybeans traveling in Cape size vessels via the Indian Ocean to Asia substitute for soybeans from U.S. Gulf that are routed via

the Canal to Asia. Similarly, Australian wheat may substitute for U.S. wheat in selected Asian markets that would travel via the Canal. **It follows the Canal can be bypassed in a number of ways. I'm not sure the researchers understand the broader notion of "bypass."**

2. On pages 20-26, the study reports on efforts to forecast DWT trends for vessels transiting northbound and southbound via the canal. Regressions are estimated for each DWT category, where the dependent variable (%) of transiting vessels within that size category and the independent variable(s) is (are) time or (time in combination with total cargo for the trade). **Theoretically, this approach would seem to violate the assumed conditions associated with OLS since there must be interdependence of the error terms.** Since the sum of percentages for any year equal 100, the larger the percentage for one size category the smaller the percentage for another category. Possibly this could have been overcome by allowing the dependent variable to represent total tonnage moving in that size grouping or number of transiting vessels in that size category. Subsequent to estimation of the regressions, percentages by each size category could be calculated**. Are the independent variables in the estimated equations statistically significant at usual levels? This should be reported.**

3. On pages 26-31, efforts are made to estimate DWT by DWT size range and route. Their analysis showed no trend hence averages were utilized. TABLES 2-3 and 2-4 show DWT projections for the current and expanded Canal scenarios. **Even though these tables are identified as showing DWT by route, they do not.** For the expanded Canal, they assume world fleet size characteristics for vessels above 60,000 DWT. They offer no reasons for this assumption**. For other size categories, characteristics of vessels using Canal do not mirror world fleet. Some explanation of assumptions is required**.

4. They find no statistical evidence that ship utilization by DWT size range varies except by direction of Canal traffic. Hence averages are used. As expected, utilization levels improve with larger vessels when Canal is expanded. **However, no assumptions are forwarded as to how they arrived at these values.** They conclude stowage factor is not an issue.

5. Contractor attempts to estimate conversion factors for PCUMS, gross tonnage, loa, beam and draft from information on DWT. Analysis was based on world fleet information with some necessary modifications except for PCUMS. Approach seems generally appropriate.

6. Why the rapid decline in vessels in ballast over the seven-year period (page 43)? Some explanation would be useful. To gain insight into ballast traffic they attempt to link vessels in ballast with laden transits by the same vessel. Possibly a study into trade routes followed by various bulk carriers and types of commodities hauled on various legs of the trade route would have helped provide insight into factors that give rise to ballast shipments**. Little understanding of the phenomena is offered. However, in Appendix B discussion is offered in this regard. In particular, grain vessels carrying**

grain to Asia often obtain coal and iron ore from Australia for hauling to Europe. Learning more about this market would yield an expanded perspective on vessels in ballast.

Determination and Analysis of Vessel Sailings by Bypass Trades (chapter 3)

1. Definition of bypass trade seems appropriate. **There would seem to be other grain routings that may affect U.S. Gulf shipments to Asia via the Canal other than the two that were investigated (Pacific Northwest and Brazil).** Is it possible that additional wheat shipments would move to Asia from Australia if Canal tolls were substantially increased? Interestingly, the Panama Canal does not generally restrict cargo size on shipments from U.S. Gulf to Asia.

World Fleet Development by Size (chapter 4)

1. Researchers offer no insight on data sources. Where does information on world dry bulk carrier fleet originate (page 80)?

2. **It is important to understand why there is a dearth of tonnage in the 80,000 to 120,000 DWT categories since the expanded Canal will accommodate these vessel sizes. Are these forces likely to change (page 80)?**

3. Researchers estimate dry bulk carrier fleet by size range from 1995 to 2005. This is accomplished by obtaining information on deliveries and scrappings and their associated trends. Method seems legitimate in view of presented information.

4. Reference is made to a scrapping model, however, almost no explanation is offered except that it was based on historical data that shows the progressive removal of vessels for a given year and vessel size. **Additional explanation and performance of the model should be communicated.**

5. **Methodology to forecast world dry bulk carrier fleet by size range does not appear complete; at least the explanation is inadequate. What was the nature of the data from CRU and what was procedure followed by trade specialist to make trade projections for grain, coal, iron ore and minor bulk trades out to 2025? Was the projected trade in grain based on the research associated with volume 2? What were trade projections based on for coal, iron ore, etc?** Obviously, forecasting world dry bulk carrier fleet size is dependent on a myriad of factors. As such, the researchers are probably required to make a number of assumptions for which there reasonableness is difficult to determine. Thus, the impossibility of obtaining a precise estimate. As such, in the final analysis, I suggest that sensitivity to this estimate be examined. If the final outcome is sensitive to these estimates, then additional time should be spent on the effort. However, if the final outcome is not sensitive to this forecast, then efforts to obtain more precise estimates may not be warranted.

Development of Vessel Size on Canal Routes (Chapter 5)

1. This chapter provides useful and insightful information that must be important to the Canal investment decision. Based on characteristics of exporting/importing ports and grain handling facilities in these ports, expansion of Canal capacity would not yield a dramatic change in vessel sizes utilizing the transiting services of the Canal. Regardless, in a competitive environment in the long run, there is an emphasis on efficiency and cost, hence a tendency for the grain shipping and grain processing industries to adopt more efficient operations. Presumably this would be reflected through the use of larger, more fully utilized vessels.

Analysis of Future Ship Costs and Prices and Determination of Freight Costs (chapter 6)

1. This chapter focuses on estimating ocean freight costs for vessels transiting the Canal, bypass routes, routes that represent alternatives to the existing Canal, and routes where cargo moves in vessels that can transit the existing Canal but are precluded from doing so because of current toll policies. Authors base ocean freight rates on opportunity costs—conceptually an appropriate means to approximate rates. Further, it is correct to assume that rates would go no lower than total variable costs. A study of one-year time charter rates is carried out to gain perspective on market earnings or net daily returns. Historical relationship of one-year time charter rates to fixed operating and capital costs were used to estimate vessel rates. Rates into the future were estimated by projecting costs into future periods.

2. For each cost component, trends are estimated based on historical costs from 1988 to 2001 for a 60,000 DWT vessel. Industry personnel evaluated estimated trends for each cost component. Then, based on trends and industry feedback, expenses for six cost categories were calculated. Projections were made using average historical relationships between total costs and one-year time charter rates. The detail associated with the procedure does not seem to be explained. Freight cost are stated in terms of $/cargo ton. **The value of this approach could easily be resolved by applying it to earlier rates, i.e. an out-of-sample forecast. Unfortunately, great confidence is not possible until one determines how well this methodology might have approximated rates in the past.**

3. Characteristics of vessels and voyages are used to estimate freight rates on various routes. The estimated daily earnings of the vessel are estimated by the above-described approach. The estimated cost of the vessel to the shipper is determined by multiplying total voyage time by estimated daily earnings rate. Bunker fuel costs, port charges and Canal dues are estimated separately and added to daily earnings to estimate rates. **The approach seems reasonable, however, the merits of the approach can only be determined by contrasting estimated rates with actual rates. The figure at the end of this paper relates ocean grain freight rates from the Pacific Northwest and U.S. Gulf ports to Japan from 1985 through 2001. The spread between these rates is important since it can influence grain flows via the Pacific Northwest and U.S. Gulf**

ports. Unfortunately, little confidence is generated by the authors' analyses because no "real-world" rate comparisons are made.

4. The developed voyage-estimating model with cost inputs necessary to estimate rates is presented. Information is presented on operating costs, time charter rates, grain cargo characteristics, bunker prices, mileages port charges, port times, vessel characteristics Canal transit times and Canal tolls (pages 203-209). Then, the developed model and data base are used to estimate freight rates by vessel size and trade route for all grain movements involving transit of the Panama Canal together with the costs of alternative routes via the Suez Canal, Cape of Good Hope and Cape Horn for all years from 2000 through 2025. **Again, confidence with the final outcome of this study would have been greatly enhanced if researchers would compare their rate estimates with historical rates on various important trade routes. Clearly, ship rate estimates over selected routes are important to the outcome of this study.**

Transit Model (Chapter 7)

1. The transit model has been designed to accommodate variations in route definitions, differences evident in vessel sizes and utilization levels, and the necessity to maintain separate outputs for the development of freight costs for grains and other dry bulks for the existing and expanded Canal. In addition, the model examines most probable, best case, and worst-case scenarios. In essence, the model incorporates all previous analyses in volume 3 to develop information that is necessary for rate estimation. For example it relates information on characteristics of grain cargoes, percentage split of cargo allocation to ship sizes, average DWT for bulk carriers in each size range, percent of vessel's capacity that is utilized, etc.

Summary of Review Comments

The vessel transit and fleet analysis offers an in-depth look at factors that impact dry bulk carrier costs/rates on trade routes with the current and expanded Canal out to the year 2025. The section culminates with a methodology to estimate ocean carrier fleet costs/rates. The analysis examines numerous factors that impact shipping cost.

1. One factor that is not explicitly addressed relates to ship queuing at the Canal and the presumed reduction in waiting costs that would result with an expanded Canal. I'm curious why this was not addressed and what type of assumptions were made about ship queuing. Based on the rate cost estimation procedure, cost of waiting time could be easily incorporated.

2. In chapter 4 (World Fleet Development by Size) estimates were made of future world trade in grain, coal, iron ore and minor bulk trade. The analysis appears superficial. Virtually no explanation is offered. Were these estimates based on the other studies, i.e., grain flow analysis in Volume 2?

3. Possibly the most important research product coming from Volume 3 is the estimate of ocean grain freight rates. Unfortunately, the author's make no effort to validate their estimation procedure by comparing their estimated values with actual rates.

4. In general, much of the analysis is based on assumptions that are not well documented. This raises questions about study results and the accuracy of the ultimate findings.

Ways to Improve Study

1. Throughout the study, it was necessary for the researchers to make numerous assumptions for purposes of resolving a particular issue. In many cases, the logic for the assumption was not provided. Confidence in the study would be improved if supporting logic behind these assumptions were forwarded.

2. When assumptions are required to estimate a parameter, it may be helpful to determine the sensitivity of the estimated parameter (e.g., ocean freight costs/rates) to the assumption(s). If the estimated parameter is not sensitive to the assumption(s) necessary to estimate it, then little additional attention would be directed toward the assumption(s). Conversely, if the final output is sensitive to the assumption(s), additional attention to the assumptions would be required.

3. The product of this research is an algorithm to estimate ocean grain freight rates on all routes that may have an impact on the Panama Canal. Confidence in final estimates would be greatly enhanced if researchers had contrasted their estimated rates with actual rates on important routes. Rather, they focus on why the rates cannot be compared. I'm not sure they are correct. In the long run, their rates and actual rates would seem to approximate each other if correctly estimated.

Title: Volume 4: Economic Value of the Panama Canal

Objective as Stated in Terms of Reference: Requirements 5.2

Determine the economic value of the Panama Canal routes versus alternatives for the existing canal and the expanded Canal after 2010.

> For the present Canal, and for the expanded Canal on 2010 and 2025, the contractor shall provide an estimate of the economic value of the Canal's main and potential trade routes as compared to other alternative routes and other transportation means. The economic value shall be expressed in terms of $/metric ton and $/metric ton-mile. In determining the economic value the contractor shall take into accounting, among other factors.

Potential substitution of traditional points of origin and destination due to new production sources, new consumption patterns, technological changes and product substitutes.

Total transportation cost of Canal routes

Differential transportation cost between Canal routes and its alternatives in dollars per measurement unit

For the expanded canal, the contractor shall also consider grain bulk carriers dimensions and characteristics, as well as the value-added from an expanded canal service in terms of decreased delays, greater cargo utilization rates, and cost savings due to larger drafts and shorter routes compared to other alternatives.

The contractor shall determine the relative margin between the economic value of the existing and expanded Canal on 2010 and 2025.

1. In the Introduction, the contractor states the report presents the determination of the economic value of the existing and expanded Canal. The economic value of the Canal refers to the transportation cost differential for specific commodity route pairs through the Panama Canal as compared to the least-cost alternative routing. Specific objectives involve: (1) identification of Canal commodity-route pairs and least-cost alternative; (2) identification of transport constraints; (3) transportation cost of Canal routes and alternative routes including land transport costs when relevant; (4) for the expanded Canal, consideration of grain carrier dimensions and characteristics including utilization rates, and cost savings due to larger drafts and shorter routes as compared to alternatives; (5) for the present Canal, and for the expanded Canal commencing in 2010, the provision of an estimate of the economic value of the Canal's main and potential routes, as compared with alternative routes and transportation means; and (6) determination of the relative margin between the economic value of the existing Canal and the expanded Canal from 2010 and 2025 (pages 1 and 2).

Review Comments

1. In Approach section on pages 2 and 3, the researcher offers an overview of procedure to determine the economic value of the Canal. The Approach appears satisfactory.

Transportation Costs (Chapter 2)

1. The grains spatial equilibrium model presented in Volume 2 is used to identify least-cost alternative routes.

2. A discussion of port constraints is offered on pages 6 and 7; **however, no information is communicated as to the assumed nature of these constraints in the short and long-run when estimating the ocean freight cost. Explicit information about assumptions would be helpful in understanding the final outcome.**

3. When calculating ocean grain freight rates over competing routes (Canal versus least-cost alternative), only the costs of the laden passage are estimated and contrasted by the authors. **It seems the backhaul should be given consideration. If grain shipments from the U.S. Gulf to Asia via the Canal often have a backhaul (e.g., iron ore) while vessels serving a competing supplier typically return in ballast, it seems inappropriate to not give some consideration to the backhaul advantage of the Gulf (page 8).**

4. Table 2-1 shows average shipping costs between U.S. supply regions and ports. It would have been helpful if a similar table had been included for Brazil. **The discussion regarding Brazil does not clearly identify the estimated costs included in the study and the assumed improvements in the Brazilian transport system.** Table 2-2 identifies changing internal shipment costs but the source of the change is not identified.

5. **How would results change if Brazil's production costs were found to be lower than U.S. costs? As noted above, many studies report lower production costs in Brazil than in U.S. (page 12) (Tables 2-2 and 2-3).** The following is from a bi-weekly bulletin by Blair Cantafio at Agriculture and Agri-Food Canada:

"For 2002-2003, South American soybean supplies are estimated to rise due to an increase in production, South America has surpassed the United States as the largest soybean supplier in the world. As long as world soybean prices remain relatively strong and the exchange rate continues at about three Brazilian real per U.S. dollar, pasture and new lands will continue to be brought under soybean production. Even if Chicago soybean prices were to fall to$4 per bushel, as long as the Brazilian real does not appreciate more than 10 to 15 percent against the dollar, soybean area will continue to rise."

6. Even though not stated, I'm guessing the researchers assume BR163 will be completed and improved, hence improving the efficiency of the overland routing between Mato Grosso and Santarem. As such, much of the state of Para will increasingly have access to transportation and a market. **What was assumed about additional soybean production in Para as a result of this transportation development?**

Economic Value of the Panama Canal (Chapter 3)

1. Structure of model to measure economic value of Canal and its inputs are presented on pages 20 and 21. Virtually all inputs to the model were discussed in Volume 3.

2. Table 3-6, shows the estimated economic value of the existing Canal in 2001 is about $259.5 million. If the Canal's grain toll were perfectly structured, would the Canal capture this economic value? Would the increased value of the expanded Canal relative to the existing Canal after 2010 be available to service the debt of Canal expansion? The toll would need to be structured so as to capture the complete margin if the debt were to be serviced by the indicated margin.

Summary of Review Comments

1. The section accomplishes most of the requirements outlined in the Terms of Reference. The most notable exception is the failure to examine substitutes for the grains/oilseeds that were included into the analysis. Conceptually, a variety of substitutes are available. Other commodities than soybeans are used to produce oil and protein meal and they could substitute for the observed soybean shipments. If soybeans were increasingly marketed as oil and meal by exporting countries, how would this impact the projected soybean commerce on the Canal?

Ways to Improve Study

1. Include increased detail on flow patterns generated by the spatial grain model that was used to identify least-cost alternatives.

2. Be increasingly explicit about assumed transportation system improvements in South America through 2025.

3. Explain why wheat exports from Australia to Asia were not viewed as competition with U.S. wheat shipments to Asia via the Canal.

Title: Volume 5: Marketing Strategy

Objective as Stated in Terms of Reference: Requirements 5.3

The contractor shall propose and fully justify a marketing strategy that takes into account the existing Canal and the expanded Canal after 2010. This marketing strategy shall determine the optimum price system that best serves the segment, the best unit of measurement to assess such price system, and the proper schedule of events and the cost to implement this system.

The marketing strategy shall pursue the following objectives:

Maximize Canal Earnings

Maximize the Canal's market share for the grain bulk segment

Be non-discriminatory within the grain bulk segment

For the development of the marketing strategy, the contractor shall provide analyses, among other elements, for the supply and demand, prices and logistical costs by commodity involved in the international maritime commercial operation for all components of the logistical chain from the producer to the end user.

The contractor indicated volume 4 presents the analysis and recommendations for a marketing strategy for the existing and expanded Canal. The recommended marketing strategy identifies an optimum pricing strategy for the grains segment including the structure and rates for Canal tolls and its implementation.

Review Comments

1. Approach outlined on pages 1 and 2 seems appropriate.

Toll Policies at Comparable Facilities (Chapter 3)

1. Pages 3 –9 offer good insight on Panama Canal toll policy, Panama Canal treaties of 1977 and toll policy implications while pages 12 –14 provide interesting discussion of Suez and St. Lawrence Seaway toll structures.

Panama Canal Marketing Strategy (Chapter 4)

1. In this section the strategies to be analyzed are identified and the Panama Canal toll Pricing Model is introduced. They assume the toll pricing options include tolls that vary by size of vessel and commodity carried. They note that a toll structure based on tons of cargo carried would be no different than a PCUMS-based pricing option; therefore, all pricing options are based on PCUMS. Table 4-1 includes the PCUMS-based Canal toll-pricing scheme from October 2002 through July 2003. Evaluated pricing options are based on the July, 2003 rate structure and a commodity-based pricing option that offers selected discounts for specific grains.

2. In essence, the model is defined by its data inputs and outputs. The inputs are tabled information in volume 3 that relate to potential canal transits, average cargo sizes, average PCUMS by DWT size range, mileages, commodity prices, vessel speeds, future potential cargo, and ocean freight on Canal and the least cost alternative routes. In addition, the model incorporates information on alternative Canal tolls and the incremental interest on alternative routings.

Initially, the model apparently calculates Canal tolls for each route, commodity and vessel size range combination for the Canal toll under analysis. Then, the per ton savings of the Canal routing is calculated by subtracting the freight cost of the Canal and its toll from the least-cost alternative route and its associated incremental interest cost. If the savings are positive, or there is a cost saving by transiting the Canal, the potential traffic and transits are included in the forecast. Obviously, if the alternative route were less expensive, the Canal route would not be included in the forecast. For those Canal routings that are least cost the corresponding number of potential transits and traffic are included in the forecast.The method is straight-forward and based on a data set that includes substantial detail regarding vessel characteristics on each route along with estimated utilization rates, freight charges, etc.

Unfortunately, the outlined toll pricing procedure has shortcomings that may allow it to generate a misleading or naive solution. In particular, the model lacks the qualities of a spatial equilibrium model, hence its inability to evaluate certain happenings. A superior decision tool would result if a spatial equilibrium framework were linked to the information in the Canal toll pricing model. As the Canal increases its toll, greater quantities of grain would shift to the Pacific Northwest ports, thus reducing the quantities available to the Canal. Eventually, however, the cost of assembling additional grain to the Pacific Northwest would become too costly because of the eastward movement of the ports hinterland and associated increase in assembly costs. At some point, there would be a tendency to switch trading partners. The U.S. would then commence exporting more to Europe and less to Asia, while South America would shift away from Europe and route more to Asia. I do not believe the Canal pricing model has ocean freight rates linking the U.S. Gulf with European markets, thus its inability to accurately know when that switch might occur. **Further, a complete spatial equilibrium model would feature Australia and the potential competition it may offer to U.S. wheat shipments via the Canal as toll rates increase. In addition, the developed toll-pricing model does not allow one to evaluate the effect of changing overland transportation charges.** Regardless, the developed tool is useful.

Summary of Review Comments

The Canal toll-pricing model is not featured in a spatial equilibrium framework, therefore, it may generate naive recommendations. As such, it may not meet requirements outlined in the Terms of Reference. In particular, that portion stating, "the contractor shall provide analyses, among other elements for the supply and demand, price and logistical costs by commodity involved in the international maritime commercial operation for all components of the logistical chain from the producer to the end user." Further, the contractor does not evaluate the cost of implementing the proposed system that was requested in the first paragraph of Requirements 5.3.

Ways to Improve Study

1. After improving the spatial equilibrium model presented in volume 2, it could be coupled with the grains toll-pricing model for purposes of meeting the Terms of Reference outlined in Requirement 5.3.

Title: Volume 6: Forecast of Panama Canal Transits, Cargo and Toll Revenue

Objective as Stated in Terms of Reference: Requirements 5.4

See pages 12 and 13 of this report for statement of Requirements 5.4.

The contractor indicates volume 6 includes the forecast of Panama Canal transits, Cargo and Toll Revenue through 2025 for the existing canal and the Expanded Canal.

Review Comments

Forecast of Panama Canal Transits, Toll Revenue, Cargo and PCUMS (Chapter 2)

1. Volume 6 is virtually all tables. **The presentation would be improved if discussion were offered at various points to orient reader.**

2. Tables 2-7 through 2-12 **show Canal toll revenues are lower with the expanded Canal than the existing Canal. Clearly, this requires explanation and the logic behind this outcome requires discussion.** Tables 2-13 through 2-18 show greater cargo carried with the expanded Canal, however, tables 2-19 through 2-24 show fewer PCUMS. Since revenues are based on PCUMS, it follows that total revenues are lower with the expanded Canal.

On page 15 of volume 5, authors indicate toll options were analyzed with tolls assessed by PCUMS and by tons of cargo carried. **They state, "it was determined that no pricing benefit was obtained from the assessment of tolls by ton of cargo carried that was not already captured by one of the PCUMS-based pricing options." Clearly, this statement must be in error in view of the outcome noted in the preceding paragraph. This suggests an incomplete analysis regarding toll-pricing strategies.**

Summary of Review Comments

1. This section is comprised of numerous tables that examine alternative dimensions of scenarios that focus on the existing Canal and the expanded Canal under the most probable, best case, and worst case macroeconomic conditions. **Unfortunately, the presented outcome suggests that researchers developed an unimaginative toll-pricing scheme. In particular, even though increased tonnage was projected to transit the expanded Canal, toll revenues were less than with the current Canal.**

Ways to Improve Study

1. Reevaluate toll-pricing scheme outlined in Volume 5. Outcomes presented in Volume 6 indicate toll revenues for the expanded Canal are less than for the existing Canal even though transiting tonnage is increased with an expanded Canal.

Summarizing Thoughts

1. The adopted methodology to determine grain flows via the Panama Canal is appropriate (Volume 2). Unfortunately, the developed model is incorrectly specified and model parameters (region grain surpluses/deficits and transport costs) estimated without adequate detail to generate reliable grain flow forecasts. Because the output of this model is central to subsequent analyses, study results are compromised.

2. The vessel and fleet analysis is largely dependent on data that were obtained through merger of data sets that included substantial detail (Volume 3). In general the analyses seems appropriate, however, at various points the analysis seems superficial and documentation of assumptions inadequate. The most important output of this effort is a reliable estimate of ship rates: unfortunately, no effort is made to validate the rate estimates by comparing them with actual rates.

3. The developed marketing strategy (toll rate structure) shows the ACP generating greater revenue with the current Canal than an expanded Canal even though greater tonnage transits the expanded Canal. The research has obviously not developed the optimal pricing strategy.

4. In general, the rigor of the analysis is modest and the research is not carefully executed. It seems unlikely that a discerning financial analyst would have high regard for the effort.

Average Ocean Freight Rates U.S. To Japan
1985 -2002