ECONOMIC IMPACT OF THE U.S. PORT INDUSTRY

An input output analysis of waterborne transportation

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U.S. Dept. of Commerce / Maritime Administration

VOLUME I

U.S. DEPARTMENT OF COMMERCE
Maritime Administration

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EXECUTIVE SUMMARY

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The objective of this study is to provide policymakers in Government and business with a new tool by which the economic impact of alternative policies relating to the U.S. port industry can be analyzed and assessed.

This was achieved by creating an input-output model showing in quantifiable terms how the port industry is economically linked with every other sector of the economy.

Another important contribution of this study was the determination for the first time of a comprehensive definition of the port industry. The industry was defined as any economic activity that is directly needed in the movement of waterborne cargo.

By applying this definition and using a reliable mathematical framework in the form of the official U.S. Department of Commerce input-output tables, the model can be used as a forecasting and planning tool.

This study is national in scope. It aims to discern the broad impact of the port industry on jobs, income and tax revenues as well as its impact on specific industries on a nationwide basis.

The port industry is analyzed not only as a producer of services upon which many users depend, but also as a consumer of goods and services that account for many jobs in its supplying industries.

Major Findings

Analysis, using the input-output model, showed that port industry operations in the base year of this study were responsible directly and indirectly for:

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* Gross sales (revenues) within the economy of $28 billion.
* A $15 billion contribution to gross national product (GNP).
* 1,046,800 jobs.
* Personal income of $9.6 billion.
* Business income totaling $3.7 billion.
* Federal taxes totaling $5.2 billion.
* State and local taxes amounting to $2 billion.

The analysis also revealed the following:

* The chain reactions initiated by the multiple purchases for port operations gives the Nation's port industry a multiplier effect of 1.6. This means that each dollar of sales by the port industry produces $1.60 in sales throughout the economy.
* The handling of the Nation's waterborne exports and imports was directly and indirectly responsible for $16.2 billion of port revenues. This means that the movement of each ton of waterborne cargo in U.S. foreign trade generated port industry revenues of $34. Applying the above multiplier, the direct and indirect revenues amounted to $55.
* The movement of every 600 long tons in waterborne foreign trade created one job in the national economy.
* Every million dollar increase in the Nation's imports brings about an average increase of $229,400 in demand for port services.

* Every million dollar increase in this Nation's exports requires an average increase of $160,000 in port services.
* Direct purchases of goods and services by the port industry from other industries totaled $8.9 billion.
* Direct and indirect impact of port investments totaled $2.1 billion.

The statistics used in construction of the input-output model in this study were for the year 1970, the latest for which complete and official Government input-output data were available.

Since GNP of $1.9 trillion in 1977 was almost double that of the base year of this study, the above port industry dollar impact figures have approximately doubled from 1970.

The I-O model's property of being able to simulate the impact of a large number of specific policy alternatives permits its use as a forecasting and planning tool. The model can provide answers to key policy questions such as:

* What are the economic implications of a dock strike?
* What new demands are placed on the Nation's port industry and its suppliers when the level of exports rises or declines?
* How are the Nation's ports affected by an increase or a decrease in personal consumption expenditures?

Recommendations

This study demonstrates that the activities stemming from U.S. port operations are indispensable and valuable assets to the Nation's productive output.

It is therefore recommended that:

* MarAd continue to promote and encourage the development of U.S. ports based on its statutory mandates;
* MarAd adopt the definition of the port industry in this report and promote its general use;
* MarAd periodically update the input-ouput model to provide an ongoing tool to assess the impact of alternative policies relating to the U.S. port industry; and
* MarAd proceed to develop further the capability of this national model to be applied on regional levels.

ECONOMIC IMPACT OF THE U.S. PORT INDUSTRY

An input output analysis of waterborne transportation

VOLUME I

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Foreword

The study represents the first application of the input-output techniques to the United States port industry on a national scale. It was conducted for the Maritime Administration by the Port Authority of New York and New Jersey.

This report was prepared by the Port Authority's Planning and Development Department, Edward S. Olcott, Director. The team on this study consisted of Jerome Gilbert, Project Director; Nai-Ching Sun and Amos Ilan, economists, and Walter Hamsar, consulting editor.

The assistance of John Pisani, Manager, Port Planning Programs and of Philip M. Ritz, Chief, Inter-industry Division, Bureau of Economic Analysis, U.S. Department of Commerce, is gratefully acknowledged.

The report consists of two volumes. Volume I contains the study's methodology, analysis and findings. Volume II contains the input-output tables.

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AN INPUT-OUTPUT ANALYSIS OF WATERBORNE TRANSPORTATION

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ECONOMIC IMPACT OF THE U.S. PORT INDUSTRY:

An Input-Output Analysis of Waterborne Transportation

INTRODUCTION

From ancient times ports have been key factors in the advance of civilization. The ships that traded from port to port brought new ideas and cultures as well as commerce. These are the materials with which civilization is fabricated.

Ports have been most essential to the United States' rise to a world economic power. The original thirteen colonies began as ports along the Atlantic Coast. The possession of ports was a strategic necessity to both sides during the American Revolution. They have continued to be strategic necessities in every emergency that has faced the Nation.

As this country expanded so did the development of its ports. Today there are some 170 major deep draft commercial ports serving the fifty states. They exist not only along the Nation's ocean coastlines, but also on its inland navigable rivers and canals.

Purpose

This study was undertaken by the Marine Administration of the U.S. Department of Commerce to determine in dollar values the impact of all U.S. ports on the Nation's economy. It is the first analysis of the Nation's port industry that is comparable in scope with economic analyses that have been made of other major industries in the manufacturing, agriculture, mining and transportation sectors. This was accomplished by the creation of an economic model based on the official U.S. input-output data used in economic planning and policy.

Although the vital importance of individual ports to the economies of the regions or cities surrounding them has long been recognized and demonstrated in various studies, it has never been quantified on a national scale. The development of a new tool for port analysis also makes it possible to address future economic issues in the area of policy and planning of U.S. ports.

Findings

The port industry in the United States is an important part of the national economy not only because of its strategic function in assuring the flow of cargoes, but also because of the chain of economic activity that it generates.

The port industry's services to the economy in terms of sales (outputs), purchases (inputs), income, jobs and taxes are on a par with those of other major industries. The dollars that continuously flow into and out of the industry affect in some way each and every industry in the economy. Analysis, using the input-output model, showed that port industry operations in the base year of this study were responsible directly and indirectly for:

* Gross sales (revenues) within the economy of $28 billion.
* A $15 billion contribution to gross national product (GNP).
* 1,046,800 jobs.
* Personal income of $9.6 billion.
* Business income totaling $3.7 billion.
* Federal taxes totaling $5.2 billion.
* State and local taxes amounting to $2 billion.

The analysis also revealed the following:

* The chain reactions initiated by the multiple purchases for port operations gives the Nation's port industry a multiplier effect of 1.6. This means that each dollar of sales by the port industry produces $1.60 in sales throughout the economy.
* The handling of the Nation's waterborne exports and imports was directly and indirectly responsible for $16.2 billion of port revenues. This means that the movement of each ton of waterborne cargo in U.S. foreign trade generated port industry revenues of $34. Applying the above multiplier, the direct and indirect revenues amounted to $55.
* The movement of every 600 long tons in waterborne foreign trade created one job in the national economy.
* Every million dollar increase in the Nation's imports brings about an average increase of $229,400 in demand for port services.
* Every million dollar increase in this Nation's exports requires an average increase of $160,000 in port services.
* Direct purchases of goods and services by the port industry from other industries totaled $8.9 billion.
* Direct and indirect impact of port investments totaled 2.1 billion.

The statistics used in construction of the input-output model in this study were for the year 1970, the latest for which complete and official Government input-output data were available.

Since GNP of $1.9 trillion in 1977 was almost double that of the base year of this study, the above port industry dollar impact figures have approximately doubled from 1970.

The Nation and its Ports

The vital importance of an adequate port industry to the Nation's international commerce and defense became clear in World War I when the United States was faced with the tremendous task of shipping millions of tons of military and civilian supplies to save and revive a war-torn Europe.

This task was magnified many times in World War II and in the post-war years when shipments of manpower and supplies moved in vast quantities from U.S. ports to every area of the world.

Since its founding, the Federal Government has recognized the value of its ports to the national economy and defense. Traditionally, it has carried forward port development in the United States on the basis of a joint partnership with local public and private interests. The Federal Government's responsibilities, for example, pertaining to the development of the waterside of ports concern the construction and maintenance of ship channels and harbors through the U.S. Army Corps of Engineers and placement in operation of aids to navigation through the U.S. Coast Guard.

The management of landside port development, however, is the responsibility of local interests, such as state and local port authorities,

and private interests. Local interests, therefore, have acted independently in planning the development of shoreside terminal facilities and services to accommodate vessels, cargoes, and inland carriers.

The third major Federal agency influencing U.S. port development is the Maritime Administration. Best known for its promotional and financial activities in support of U.S. Merchant Marine and related elements of the U.S. water transportation system, it is also a key agency in the planning and development of the Nation's ports.

In accordance with the 1920 Merchant Marine Act, MarAd carries out technical, advisory, and promotional programs relating to shoreside port development planning. These activities are aimed at helping local port interests develop adequate capabilities to participate in expanding waterborne commerce and advancing marine and intermodal technology, as well as support national requirements in time of emergency. MarAd's role is explicitly directed at giving national coordination to urban, state, and regional government entities that manage ports within their jurisdictions.

In cooperation with the port industry, MarAd has provided technical planning assistance through an active research and development program. In carrying out its mandate, MarAd has undertaken research projects designed to accomplish those things which are beyond the capability of the industry and can result in benefits for all the Nation's ports. This study of the economic impact of the U.S. port industry is an excellent example of such a MarAd research project.

Scope

This analysis is the first economic evaluation of the port industry that is national in scope. The study determines the impact of the Nation's entire port industry on jobs, income, investment and tax revenues. It depicts the interrelationships of the port industry with other industries to which it sells services and from which it purchases goods and services. It also analyzes investment and government activities that are associated with the handling of waterborne cargo.

The input-output model constructed for this study is a powerful economic tool for assessing and analyzing the economic impact of alternative policies relating to the U.S. port industry.

For example, the model will enable decisionmakers in Government and industry to evaluate the economic impact of dock strikes, budgetary changes, new port construction projects, and changes in the level of exports and imports.

These are only some of the model's applications. A broad spectrum of questions can also be answered on an industry-by-industry basis within the scope of this model.

HOW I-O WORKS

The input-output model used in this analysis followed the procedure developed by Nobel Prize Winner Wassily Leontief. Professor Leontief's method has been accepted by government and industrial economists throughout the world as a reliable tool for measuring and forecasting economic phenomena.

With the assistance of the computer, the model can quantify in terms of dollars the sales and purchases relationships between industries and final consumers. Unlike any other national accounting system, the I-O model's ability is unique in being able to show the interaction between seller and buyer industries before reaching the final consumer.

The I-O model thus shows the impact of the Nation's port industry on the national economy. It also can be used, under certain simulated conditions, to forecast the effects of major changes that may be made in the interrelated industries making up the model.

Data used in creating the port impact I-O model were provided by the Bureau of Economic Analysis of the U.S. Department of Commerce for the base year of 1970, the latest year for which full official data were available.

The model consists basically of three phases each concerned with constructing a table from which the multipliers used to measure the chain reactions of port industry operations and investments were obtained.

Transaction Table

The first phase, known as the transaction table, shows in terms of dollars the flow of goods and services from producing industries to consuming industries and final buyers. All industries are both producers and consumers of goods and service. The reference to consuming industries is not used in the final sense but rather to describe the purchases that are necessary in order for such industries to produce other products and services.

In this phase the dollar figure in each cell of a transaction table represents the total amount of output sold during the base year by the industry named on the left to the industry named on the top. Where the sales were to final consumers and not for intermediate production, the amount is listed under final demand.

Each vertical column in the table shows the total input purchased by the industry named on the top from all sellers named on the left; each horizontal row of cells shows the total output sold by the industry named on the left to all other industries named on the top. The value added tier represents the dollar value of wages, salaries, profits, interest, depreciation and taxes contributed by the industries named along the top that was generated in producing those industries' goods or services.

All the rows and columns thus represent the total transactions of the national economy in a specific year. The port industry developed within this framework will have one row and one column. The transaction table in this way becomes a picture of how the port industry is a consumer of goods and services produced by other industries in order for it to provide its own services.

Chart I

SIMPLIFIED I-O TRANSACTION MATRIX

(Values in billions of Dollars)

Output / Input	A	B	C	D	Final Demand
A	4	9	15	13	11
B	8	16	14	12	5
C	7	15	6	2	12
D	13	5	4	8	25
Value Added	20	10	3	20	

Chart I is an extremely simplified illustration of a transaction table demonstrating the principles of the first phase of the I-O model technique.

For example, the horizontal tier for industry A in this table shows in dollars the total output of that hypothetical industry to intermediate consumers, including itself, and to final consumers. The vertical column for A shows the inputs purchased and the value added by that industry.

Thus, industry A sold $4 billion in goods and services to itself in producing its goods and services for the base year (e.g., farmers must buy seeds and auto makers must purchase auto parts for their own use). It sold $9 billion worth to industry B, and so on including $11 billion worth to final consumers. To accomplish its production, industry A purchased inputs of $8 billion from industry B, $7 billion from industry C, etc., and paid out $20 billion in wages, salaries, interest, depreciation, taxes and profits.

The table constructed for this port impact study represents a subdivision of economic activity by 90 industries. The dollar figures are in millions. The port industry column in the table shows port purchases (inputs) from a wide variety of industries including the port industry itself. Purchases of services such as insurance, accounting, banking and transportation are some examples of inputs which the port industry purchases from other industries along with its materials' purchases. The sales of port industry services (outputs) shown in the horizontal column were to virtually the entire national economy.*

* The input-output tables developed for this study are contained in Volume II of this report.

Technical Coefficients

The second phase of the I-O model procedure was the derivation of a table of technical coefficients for each cell in the transaction table. Technical coefficients are derived by dividing the inputs of each industry by the total output for that industry.

In the above illustration, the technical coefficients for industry C would be: .38; .33; .14; .09. They were obtained by dividing each of the values in the C column - 15, 14, 6, etc. - by the total output of 42 of Row C.

As can be seen, derivation of the table of technical coefficients for the 90-industry classifications studied in this I-O model required the use of computers.

Each technical coefficient for each industry has a significant meaning. It shows the proportions of each input which must be purchased by the industry named at the top of the table from each industry named on the left to produce each dollar of output. For example, each dollar of output by industry C required about 38 cents of purchases from industry A; 33 cents from B; 14 cents from itself; 9 cents from D.

In effect, the complete table of technical coefficients for this study reflected the technical composition of the entire economy in 1970 in terms of inputs required in the production process.

Total Requirements

The third phase in constructing the I-O model was the derivation of a table of total requirements in the national production process. This

table provides the basis for obtaining multipliers for computing the total impact of any industry on the economy - in this particular study, the port industry.

This process, known as the Leontief inversion, is a complicated mathematical procedure, which could not be performed without the use of a computer.

Each element in the table represents the level of output that must occur in the industry named on the left to satisfy the demand generated throughout the economy by the production or purchase of one final unit of the output of the industry at the top.

The elements of this table thus show not only the initial changes in output of various industries in response to a change of demand, but also the chain reaction throughout the economy.

The sum of the direct and indirect coefficients in each column of the table shows the output levels that must be sustained by each industry supplying goods or services to the producer industry in order for that industry to increase its output by one unit. These are the sectoral multipliers discussed below.

Multipliers

The I-O model's ability to generate multipliers is one of its most important properties. Multipliers are used to measure the direct and indirect effects (chain reactions) of a change in the gross national product (GNP) components* on the economy and also on individual industries.

* GNP components and the sectors listed under the final demand column in the third table are identical. GNP and final demand are used interchangeably in this report.

In fact, the multipliers can be used to measure the ripple effects of a change in the final demand of the port industry not only on the entire economy, but also on each industry served by the ports.

Through the multipliers, the I-O model provides a powerful tool for projecting the potential impact of proposed changes of any policy affecting any industry on income, employment, tax revenues and output. Applications of this property to the port industry are illustrated later in this report.

A sectoral multiplier is a ratio reflecting the requirements on the whole economy placed by a new requirement in a particular industry. It represents the sum of outputs that would have to be produced throughout the economy in response to a change in the final demand of one industry.

For example, the sectoral multiplier would indicate the ripple effect throughout the entire economy if there were an increased requirement on the port industry for transporting the Nation's export and imports or its domestic commerce.

Mathematically the sectoral multipliers are derived by summing up the column coefficients in the table of total requirements for each industry at the top of the table. The computer again is a valuable aid in performing this computation.

The sectoral multipliers differ substantially from one industry to another, depending on the complexity of the chain relationships that are initiated in the production process of each industry. The larger the multiplier, the larger the total outputs required in the economy by a change in an industry's final demand.

The sectoral multiplier not only provides vital information as to how the economy would react to a change in final demand, it can also be used to examine the impact of such a change on individual industries. In this study multiplier analysis was utilized for quantifying and measuring the port industry in terms of outputs, income, employment and tax revenues. See Appendix A and B for further technical discussion of the input-output technique.

The port industry as defined in this report, is an intermodal service industry engaged in cargo handling and cargo movement. It incorporates the services of water carriers on the one hand and the related land transportation on the other. Both represent a natural extension of the total services provided by ports to a consuming public. See Appendices C-G for detailed description of the derivation of the port industry's definition.

PORTS ARE MORE THAN PIERS

Analysis of port impact using an I-O model could not proceed without first having a clearcut understanding of what constitutes the port industry in the United States and how it is defined in precise terms.

Unfortunately, no systematic definition has ever been developed for the industry. Because of this shortcoming, one of the goals of this study was to develop such a useful definition.

Therefore, the following analysis of the economic considerations leading to a new and consistent definition of the U.S. port industry represents one of the major contributions of this study. The use of this new definition in other areas of port analysis could help clarify many conceptual and analytical inconsistencies that have plagued the industry for decades.

The source of the problem has not been the lack of port studies, but rather the overabundance of conflicting approaches, the use of vague terminology, and especially the absence of solid theoretical foundations. What is important is the fact that no official definition of a port industry exists within the government statistical reporting system. Because of this void a superfluity of inaccurate definitions has emerged.

The broad activities of the port industry have never been integrated into a unique classification truely representative of the industry's purpose and scope. What has actually happened in most of the statistical analyses of the U.S. economy by specific industries is a disintegration of the various elements of the port industry and the absorption of the pieces by other industries.

Background

In the past, various port studies have made references to a "port industry" in ways that appear to fall into three broad categories. These conceptual categories are distinguishable by function as well as by breadth.

Under the first approach, which is the narrowest, the port industry is restricted to the purely waterfront activities of loading and unloading of cargo. This concept is confined to the activities of stevedores, and terminal operators including such cargo operations as stuffing and stripping of containers at dockside.

The second approach deals with a broader concept of the port industry by including some production activities that take place within a port area regardless of the output. This has been a common practice in many port studies.

The third and broadest possible concept of the industry includes production activities of all goods that move by waterborne means. This approach, has been utilized in some port studies. In fact it credits most of the value of U.S. export production to the port industry.

None of the above concepts was found to be realistic. Each of the concepts suffers from major theoretical deficiencies which leave the definition of the port industry still highly ambiguous. These deficiencies are discussed at greater length in Appendix C.

Criteria

It was therefore imperative that the port industry be defined in a totally new way that would be descriptive of port functions and measurable in terms of revenue, income, employment, taxes, investment, or all of these.

The following criteria were established:

1. The definition of the port industry had to reflect the industry's unique mission to move waterborne cargo.
2. The definition of the industry had to be consistent with the true contribution and impact of ports within the total economy.
3. The definition had to include only direct activities of the port industry.
4. The definition had to be formulated in terms of the output of the port industry (i.e. services or activities). This minimized the possibility of a double count that could arise from the inclusion of purchases of inputs by the port industry.

Definition

Given these criteria, it was possible to formulate a precise definition of the port industry which would be appropriate for any economic impact analysis. The definition is:

The port industry is any economic activity that is directly needed in the movement of waterborne cargo.

The definition was based on a new system concept which took into account the total function of ports as providers of specific and distinguishable services in the movement of waterborne cargo. In effect, every activity that is generated in conjunction with the direct provision of waterborne services, including activities that take place beyond the

piers, is considered part of the port industry. For example, this includes cargo documentation, cargo insurance, banking, warehousing, land feeder service and water carriage.

In contrast, services and transactions that are farther removed, such as the activities of port suppliers and users, are not counted as part of the port industry's output. Suppliers of ship repair services, fuel, and port machinery, and shippers of export products are examples of these two categories.

However, such activities are assuredly part of the port industry's impact on the economy. The input-output matrix provides a flexible tool by which such related activities are quantified.

Use of Terms

Confusion over the definition of the port industry has posed additional problems in terminology. Due to the lack of conceptual clarity, simple words have become so ambiguous that they have lost their usefulness in port impact studies.

For example, the terms "port-related industry," "port-related activity," "port-dependent industry," "port-dependent activity" and "indirect port impact," have assumed many different meanings in past studies of the ports. The terms have been applied at times in the geographical sense and at other times in the economic sense. They have been used in reference to port suppliers, port users or a combination of both. Frequently, these terms were also used to denote activities of the port industry itself.

This study assigns specific meanings to some of the above terms to avoid the pitfalls that have plagued sub-national studies. This assignment of specific meanings was made possible by the adoption of a definition that clearly distinguishes between the port industry itself and the rest of the economy. The input-output model provides a natural framework for the use of concise terminology because the very structure of the model requires quantifiable definitions. Geographical proximity to a port could not be a consideration in this process.

For example, the term indirect impact is used in a precise technical economic context from its application in input-output analysis. The term refers to economic activities generated by the multiplier effect beyond the first round of purchases by port industry. Thus, the purchase of steel by a manufacturer of heavy lift equipment sold to a port is indirect; in contrast, the sale of the equipment to the port is direct.

The terms "port-related" and "port-dependent" are not used synonomously in this study, nor are they used to denote a differing degree of reliance. They are used to describe the two separate flows of transactions of the port industry. The term "port-related" refers to the activities generated in various industries as a result of port industry purchases of goods and services. In contrast, the term "port-dependent" refers to the activities of port users who must ship through the ports. Here the reliance is on port services, not on port purchases.

Neither term implies that any specific industry is entirely "dependent on" or "related to" the port industry. Moreover, it should be noted that most industries function in the dual role of suppliers as

well as users of the port industry. Therefore, the nature of the port industry's association with any other industry must always be specific. The adoption of the terminology described in this section would be a significant contribution to the port industry.

Port Activities vs. Port Expansion

So far in this discussion of definitions the purpose was to create a unique industry whose on-going activities could be quantified on a national impact scale. The port industry was defined in terms of the activities which it performs; the resulting impact is thus a measure of its current operation.

The impact of the port industry, however, is not limited to current operations. The ports must also gear up for future growth and changing technologies which require heavy investment in new facility construction, machinery and equipment. On a nationwide basis, the port industry invests large sums of dollars each year in such expansion.

Therefore, there are two levels at which impact should be measured. One is the economic impact of port operations; the other is the economic impact of port investment. The latter can be thought of as a single transfusion of capital needed to assure future capacity, while the former represents revenues and expenditures on current operations.

Although there are numerous theoretical arguments as to what precisely constitutes a capital good, this study relies on official U.S. Department of Commerce definitions as provided in the national accounts.

The economic impact of port activities, as opposed to port investment in this study, refers to purchases necessary for current

operation but not to purchases necessary for expansion of port capacity. The exception to this rule is capital consumption (depreciation) reflecting the amount of capital that was used up (worn out) during the year under consideration. As such, depreciation is viewed as a primary input incorporated within the value added of the port industry for the basic year of the study.

The impact of port investment is different from that of port operations. Different kinds of purchases (inputs) are necessary in each case. A special analysis of the investment sector is therefore undertaken in this study to delineate the economic consequences of port investment.

Private vs. Public Sector

Another important breakdown of the economic impact of ports in this study is the division between the private and public sectors of the port industry. The private sector is broken down into current and capital accounts in the manner described above while the government sector is treated as a single (current) entity consistent with national income accounting procedures.

Governmental port activities are basically very different in nature from private port activities. Government services and overhead functions consist primarily of channel and harbor improvements, customs, safety programs, administration, research, promotion, international representation and regulation. As a result of this difference in output, the inputs that must be purchased by Government to perform its port functions are also very different from those purchased by the private sector.

Again, it should be noted that in the government sector of National Income Accounting, no distinction is made between current and capital expenditures. A separate analysis of government port expenditures is presented in this report

HOW THE PORT INDUSTRY INTERACTS WITH THE ECONOMY

The port industry's far-flung interactions with the rest of the Nation's economy are convincingly demonstrated in this study by the sales of port services (outputs) to all other industries and by purchases of products and services (inputs) necessary to provide the broad range of these port services.

Output

The U.S. port industry in 1970 grossed a total of $17.2 billion in revenues from the sales of its services.

This means that the output of the port industry measured by the services it provided directly to all users -- domestic and foreign, private and Government (including the military) -- averaged almost $41 million per day in the base year of this study.

In the input-output model these sales of port services were broken down into two categories -- intermediate and final sales.

Intermediate sales were port services that were purchased by other industries for the movement of goods destined for further processing by the buyer. They represented about 39 percent of the port industry's direct output in 1970.

Final sales of port services - those purchased for movement of cargo to final markets such as consumers - represented 61 percent of the industry's direct output.

In this analysis, port services for imports of products not destined for final consumption were classified as intermediate sales; all other imports and all exports were included in final demand.

Intermediate Port Users

The intermediate sales of the Nation's port industry output in 1970 amounted to $6,689 million. This was the revenue from sales to a large number of users who required the movement of nearly every type of raw material to their factories, processing plants and refineries.

Several key industries relied more heavily than others on port services in the transportation of their inputs. These were mainly heavy industries such as the iron and steel, lumber, rubber and chemical, as well as the oil refining and food processing industries.

The major consumer of port services in the United States was the port industry itself (as defined in this study). A total of $1,220 million was paid during 1970 for such services. These payments included port revenues paid by steamship companies, freight charges paid to inland carriers by stevedore and shipping companies and many other internal transactions among the components of the industry.

The food and kindred products industry was the second major user of the port industry with $749 million worth of services purchased during 1970. The food industry's expenditures mainly were for waterborne transportation and cargo handling services required to bring wheat, corn, rice, sugar, coffee and other agricultural products to plants throughout the United States where processing and packaging took place. Port services for shipments of processed food products to consumers in the Nation and abroad were not included in this category.

The huge volume of ore moved by water between mines and metal mills was also reflected prominently in the revenue data of the port industry.

Primary iron and steel manufacturers paid as much as $705 million and primary non-ferrous metal manufacturers paid $484 million for such services.

Other key industries which purchased large amounts of port services were: the petroleum inudstry which paid $672 million for delivery of crude products by waterborne means to refineries; the lumber and wood products industry's payments of $253 million for the movement and handling of logs and unfinished wood to lumber mills and other plants; the rubber and miscellaneous plastics industry, $237 million; the chemical industry, $223 million; and the construction industry, $205 million.

None of the above expenditures for port services directly entered into gross national product (GNP) accounts because the services were not for final deliveries. To avoid duplicate counting of products and services generated in a given year, intermediate sales are excluded from GNP accounts.

However, they remain traceable as part of the costs incurred in delivering the final product to the actual users. These sales to users in final markets through the various intermediate industries were accounted for in the I-O model through final demand analysis that showed how much of these port services were absorbed in any product or service reaching the final markets.

Table 1 provides a listing of the twenty leading users of the port industry by U.S. industries in 1970.

Final Demand

The sales of port services throughout the Nation in 1970 to final demand consumers came to $10.5 billion.

TABLE 1

Interindustry Sales of the U.S. Port Industry - 1970

($ Millions)

Purchasing Industry	Amount
Port services	$1,220
Food & kindred products	749
Primary iron & steel manufacturing	705
Petroleum refining	672
Primary nonferrous metal mfg.	484
Lumber & wood products	253
Rubber & misc. plastic products	237
Chemicals	223
New construction	205
Fabrics, yarn & thread	199
Paper & allied products	183
Stone & clay mining	181
Radio, television & communication equipment	178
Other agricultural products	170
Misc. manufacturing	127
Federal government enterprises	114
Misc. textile goods	112
Wholesale & retail trade	107
Iron & ferroalloy ores mining	97
Nonferrous metal ores mining	84

These sales were for services provided to final users of all kinds (private and public, domestic and international, investors and consumers) in channeling cargo to its ultimate destination.

Such sales are distinguished from intermediate sales of port industry and are, by definition, GNP components. They were broken down in this study's I-O model into the traditional aggregative categories of consumption, investment, inventory change, exports, and government expenditures.

The largest component of the port industry's final demand category by far was the export sector. A total of $5,706 million accrued to the port industry in 1970 via this sector. This accounted for one-third of the $17.2 billion output of the port industry; the remaining revenues came from domestic trade and from imports.

The export revenues of port industry in 1970 included payments for cargo handling (loading and transfer); payments for carriage of exports on U.S. merchant vessels and on domestic inland carriers that actually handled such cargo; payments for export financing; and cargo insurance.

The second most important sector among the final demand components was the private consumption sector which spent $3,783 million on direct port services in 1970. This amount was mainly for handling, freight, finance and insurance of imported consumer products and the movement of domestically produced goods headed for final consumer markets by waterborne transport. As in exports, the private consumption sector was composed of thousands of

specific commodities which required cargo handling of all kinds such as container, pallet, sling, etc.

The third major source of port industry revenues in final markets was the Federal Government. In 1970, the Government spent a total of $756 million to move materials and inputs of various kinds. Included in this category were expenses for the waterborne shipments of military goods. State and local governments expended an additional $36 million for port services.

The private investment sector was also a significant final user of port services, requiring a total of $155 million for such purposes in 1970. These payments represented the costs of shipping capital goods to their destination and included domestic and foreign made machinery and equipment that moved by water.

Finally, inventory changes in the final demand sector of the port industry amounted to $25 million.

Table 2 shows expenditures for port services by final demand sectors.

Inputs

The total direct purchases of supplies and services (inputs) by the port industry in 1970 came to $8,921 million. Of this amount, $2,174 million in goods and services were imported from other nations and $6,747 million worth of inputs originated in the domestic economy.

In order to provide transportation services to all other industries in the national economy, the port industry must simultaneously be a purchaser of various inputs necessary to make port services available. Such purchases

TABLE 2

Expenditures for Port Services by Final Demand Sectors - 1970

($ Millions)

Final Buyers	Amount
Exports	$5,706
Consumption	3,783
Federal Government	756
Investment	155
State & local government	36
Inventory	25

range from real estate and business services to maintenance, repair, utilities, meals, fuels, and many other goods and services.

Capital investment in plant and equipment by the port industry is not included here. Such port investment is dealt with in a subsequent part of this study.

Domestic business services such as promotion, advertising, consulting, legal and accounting services and dozens of other peripheral business services accounted for the largest block of expenditures by the port industry, amounting to $719 million in the base year of this analysis.

The size of these expenditures for promotional and protective services reflects to a large extent the enormous competitiveness that exists within the industry. Ports and steamship companies both stress these aspects of their port activities.

Purchases from other transportation companies such as domestic truck, rail, air, and freight forwarding formed the second leading category of expenditures by the port industry totaling $537 million. These services were purchased for transporting inputs to the port industry.

Rental of properties at port and off-port locations cost the port industry a total of $493 million. Finance and insurance charges amounted to $401 million.

Purchases of fuels for operating port machinery, vehicles and vessels were also a major expenditure of the industry, costing $323 million. Maintenance and repair construction amounted to $251 million. Other key industries which made more than $200 million in sales to the port industry during 1970 were shipbuilding, business travel, and communication.

Table 3 lists the twenty principal sources of inputs for the Nation's port industry in 1970.

Total Supplier Impact

The direct suppliers of the port industry rely on port purchases in indirect ways as well as the direct purchases analyzed above. Goods they sell to industries other than the port industry are used for the production of other goods and services that in turn are sold to the port industry. This constitutes a considerable impact area of port activities in the United States.

By combining the direct and indirect impact of the port industry a better perspective is obtained of the overall interface of each and every industry with port activities.

This indirect impact can be measured by using the sectoral multiplier of 1.6 that was generated for the port industry by the I-O model.* Application of this multiplier showed that an additional $10,806 million of indirect output was required throughout the economy to sustain the direct level of port industry sales of $17,150 million in 1970.

Thus the total economic impact of the port industry, as measured by its direct and indirect sales impact, came to $27,956 million for the base year of this analysis. This means that the industry's impact on the economy averaged about $77 million per day for that year.

These figures are quite distinct from "value added" to gross national product. Using the value added concept, which omits cumulative resale values the port industry's total annual contribution to the economy was $14,953 million, the daily average was $41 million.

* Adjusted for transferred imports.

TABLE 3

Direct Input Requirements of the U.S. Port Industry

by 20 Leading Supplying Industries - 1970

($ Millions)

Supplying Industries	Amount
Business services	$719
Other transportation	537
Real estate and rental	493
Finance and insurance	401
Petroleum refining	323
State and local gov't enterprises	320
Maintenance & repair construction	251
Shipbuilding	251
Business travel & entertainment	228
Communications	203
Automobile repair & services	169
Other fabricated metal products	149
Wholesale & retail trade	117
Food & kindred products	105
Electric, gas, water and sanitary	88
Primary iron & steel manufacturing	81
Federal government enterprises	73
Rubber & misc. plastic products	70
Primary nonferrous metal manufacturing	68
General industrial machinery & equipment	61

The ranking suppliers of the port industry, in terms of both direct and indirect requirements, closely paralleled the port industry's leading direct suppliers in 1970.

Business services amounting to $1,042 million were purchased by port industry directly and by its suppliers indirectly. Other transportation services valued at $909 million were the second leading group.

Payments of $787 million for real estate and rentals formed the third largest category while the finance and insurance industry ranked as the fourth leading supplier of the port industry -- $649 million.

Five other broad industry groups had direct and indirect sales to the port industry that came to more than $300 million and ten additional groups made sales of $200 - $300 million.

Table 4 details the direct and indirect sales of the port industry's twenty leading supplying industries.

The port industry's impact upon the rest of the economy other than the above groups of industries, runs deeply across a broad front of producers of goods and services. The purchasing power of the port industry, with its ripple effect extending to many other industries, is of great importance to many suppliers in the nation.

The Nation's shipbuilding industry, which sold 5.9 percent of its total output in 1970 to the port industry, directly and indirectly, is among those industries which rely upon ports to buy a meaningful share of their outputs. It should be noted that only maintenance and repairs are included here while the purchase of ships is categorized as investment.

Others include the business travel industry which sold 2.3 percent of its 1970 output to the port industry, the transportation industry, which

sold 1.6 percent of its output, the maintenance and repair construction industry, 1.5 percent and the petroleum refining industry, 1.4 percent.

These percentages included the indirect effect, i.e. the impact generated by the sales of each of these industries to various other suppliers of the port industry to enable them to produce such supplies in the first place.

TABLE 4

The Direct & Indirect Requirements of the U.S. Port Industry

by 20 Leading Supplying Industries - 1970

($ Millions)

Supplying Industry	Amount
Business Services	$1,042
Other transportation	909
Real estate	787
Finance & insurance	649
Maintenance & repair construction	477
Petroleum refining	456
Wholesale & retail	402
State & local government enterprises	395
Business travel	311
Primary iron & steel	297
Printing & publishing	288
Communication	287
Electric, gas	280
Food & kindred products	261
Shipbuilding	253
Crude petroleum	229
Primary nonferrous metal	234
Other fabricated metal	218
Automobile repair & service	217
Paper & allied products	195

INCOME, JOBS AND TAXES

The income, jobs and taxes that are generated by each dollar of port industry sales are value added components of the industry. They provide a clear picture of its net contribution to national income, employment and tax collections.

Impact on Personal Income

The total income generated in the United States by the port industry in 1970 was $9,572 million according to the I-O model. This amount was comprised of direct payroll disbursements within the industry itself of $6,695 million, and $2,877 million in wages and salaries of other industries that depend on port purchases directly and indirectly.

Transportation services that were not part of the port industry, were the most strongly affected in 1970 with $359 million in personal income generated directly and indirectly by port purchases.

Direct and indirect wages and salaries earned by the business services industry through port purchases amounted to $303 million while $269 million in personal income were generated in the finance and insurance industry.

Table 5 lists the 10 leading industries ranked by the amount of personal income earned by their employees as a result of port activities. Significantly, 8 of the 10 are service-oriented underscoring the importance of the port industry as a major commercial hub.

TABLE 5

Direct and Indirect Personal Income

Generated by the U.S. Port Industry

by the 10 Leading Supplying Industries - 1970

($ Millions)

Supplying Industry	Amount
Other transportation	$359
Business services	303
Finance & insurance	269
Maintenance & repair construction	252
Wholesale & retail trade	172
Printing & publishing	107
Federal government enterprises	99
Communications	94
Primary iron & steel manufacturing	85
State & local government enterprises	81

Impact on Business Income

Port activities in the United States were important in producing business incomes such as rentals, interest and profits. In 1970, port industry generated a total of $3,741 million in direct and indirect business income.

Gross profits within the port industry itself came to $1,661 million while the total business income generated in other industries was $2,080 million. This impact was based on a business income multiplier of 2.2 derived in the I-O model.

The service industries were the major business income beneficiaries from port activities. Real estate, business services and other transportation services showed the most direct and indirect income impact.

Table 6 lists 10 U.S. industries on which port purchases made the strongest business income impact.

Impact on Employment

The Input-Output model showed that 1,046,800 jobs throughout the United States were directly and indirectly attributable to operations of the port industry in 1970. Of these, 686,800 were employed in port industry operations and 360,000 jobs were generated in various industries supplying the ports.

Table 7 shows the direct and indirect employment impact in the ten supplying industries most affected by port activities. Transportation that was not part of the port industry was most strongly affected with 45,300 port related jobs such as the carriage, transfer and storage of goods. Port activities also generated more than 30,000 jobs each in the

TABLE 6

Direct and Indirect Business Income

Generated by the U.S. Port Industry

by the 10 Leading Supplying Industries - 1970

($ Millions)

Supplying Industry	Amount
Real estate & rental	$433
Business services	239
Other transportation	154
State & local government enterprises	124
Communications	102
Crude petroleum	101
Electric, gas and water	76
Wholesale & retail	63
Automobile repair & services	60
Maintenance & repair services	40

TABLE 7

Direct & Indirect Employment Impact of the U.S.

Port Industry in 10 Leading Supplying Industries - 1970

Supplying Industry	Employment
Other transportation	45,300
Business services	40,600
Wholesale & retail	31,800
Finance & insurance	30,700
Maintenance & repair construction	17,200
State and local government enterprises	13,400
Printing and publishing	12,100
Federal government enterprises	12,100
Shipbuilding	12,000
Communications	11,100

business services, wholesale and retail, and the finance and insurance industries.

The model determined that some 24,800 jobs in federal, state and local government enterprises were directly and indirectly related to port operations in the United States during the study year.

Impact on Tax Revenues

Port activities in the United States are a very important source of revenue to Government at all levels. The U.S. Treasury collected $5,198 million during 1970 that were directly and indirectly generated by port operations.

Personal income taxes amounting to $1,180 million and business income taxes totaling $672 million were collected by the Treasury through port activities that year.

In addition, federal collection of excise taxes on waterborne goods came to $1,258 million.

In 1970, customs collections on waterborne imports totaled $2,088 million. Although such collections at the ports are a direct function of port operations, they are classified as a separate source of Federal income for purposes of fiscal planning since they are better reflected as a function of the value of imports. Such values may be derived independently of the input-output framework.

Aside from the revenues that accrued to the Federal Government, the port industry also contributed meaningfully to state and local tax revenues. In 1970, a total of $1,975 million was received by state and local governments from taxation sources directly and indirectly generated by port operations.

IMPACT OF PRIVATE PORT INVESTMENT

Long term capital investments for port machinery, vessels, construction of wharves and sheds, intermodal containers, computer hardware and many other elements have been of key importance to the port industry. This has been especially true in the last two decades when rapid technological changes and a strong growth in trade have required increased capital expenditures.

This section will focus on the impact of private long term capital investments in ports. Public capital investments by Government will be analyzed in the next section.

Since the input-output model is static, providing only a snapshot of one year's transactions, it is not possible to measure fully the dynamic impact of port investments. A static analysis is limited to the short run output impact per dollar delivered to the gross national product in the same fashion as current expenditures are analyzed.

In contrast, the dynamic impact of long term capital expenditures would take into account the impact of expenditures for new plants and equipment which improve the operating efficiency of an industry. The theory of dynamic input-output modeling has not yet reached practical application.

Therefore, the induced impact that would be generated in future years as a result of the investments in new capacities and technologies in the port industry are not a part of the total impact figures in this study.

Analysis of private port investment within this study's framework showed that in 1970 a total of $1,187 million was spent by the port industry

on purchases of capital goods ranging from ship and communication equipment to facility construction.

Application of the relevant sectoral multipliers from the I-O model for each type of investment showed that the total direct and indirect impact of the port industry actually reached $2,057 million during the study year.

Shipbuilding was the largest single investment category by the industry in 1970, amounting to $664 million. These expenditures covered the costs of new U.S. dry cargo ships and tankers purchased by the port industry. Ship repairs and maintenance were not classified as investment.

The second leading category of private port investment was in communication equipment. The port industry purchased $146 million worth of communication equipment and apparatus for harbor, channel and open sea navigation. Radar systems and other sophisticated electronic system and telecommunication instruments accounted for the bulk of such purchases.

Other important direct and indirect impact areas of long term port investments of the port industry were in the primary iron and steel industry, $93 million, and new construction, $82 million.

It must be emphasized here that the impact of port investment is subject to greater annual fluctuations than the impact of port operations. While the impact of current port activities is primarily a result of a continuous volume of traffic flows from year to year, investment decisions tend to be more sporadic. In some years many more investments are made than in others, depending on the state of the economy.

Table 8 shows the twenty supplying industries which benefitted most from private port capital investment in 1970.

TABLE 8

Direct and Indirect Sales Impact

of Private Port Investment in the 20 Leading Supply Industries - 1970

($ Millions)

Supplying Industry	Amount
Shipbuilding	$664
Communication equipment	146
Primary iron & steel	93
New construction	82
Boat construction	81
Other transportation equipment	68
Nonferrous metal	66
Motor vehicles & equipment	59
Wholesale & retail	58
Heating & plumbing	46
Business services	39
Other transportation	34
Engines & tubes	31
General industrial machinery	31
Lumber & wood products	30
Other fabricated metal products	28
Finance and insurance	25
Real estate and rental	25
Electronic components	21
Electric, gas	19

IMPACT OF GOVERNMENTAL PORT ACTIVITIES

While the private sector of the port industry in the United States is by far the most important element of port operations, the Government sector also plays a very important role in waterborne cargo movements. Government functions essentially in support of private industry, providing a variety of services as well as investments that are an integral part of the port industry.*

Government port activities such as facility construction improvements, equipment, materials and services by its agencies totaled $641 million in 1970.

This figure excluded government expenditures for the shipping services which were previously analyzed in this study as part of the output of port industry. Also excluded were maritime subsidies representing a transfer of funds, and the wages of government employees which are not measurable directly from the I-O model's final demand sectors.

Government expenditures covered such activities as channel dredging, waterway maintenance and the construction of public locks and dams by the Corps of Engineers; the coordination of maritime affairs by the U.S. Department of Commerce; administration of ocean freight rates and other regulations by the Federal Maritime Commission; the collection of tariffs and inspection of merchandise by the U.S. Customs Service; and the

* Although public port authorities are technically agencies of state and local governments, they are treated in this study as part of the private sector of port industry because of the nature of their port activities and the technique of the I-O model.

implementation of vessel traffic control systems and water safety operations such as channel marking, harbor radar systems and the licensing of merchant seamen by the United States Coast Guard.

Application of appropriate industry multipliers to each form of government expenditures on ports increased the total impact throughout the economy to $1,457 million for 1970.

State and local governments also directly participate in various aspects of port planning, construction and operations. These activities are included in the above impact totals.

In addition, state and local governments generally provide for new infrastructure requirements around ports such as highway access, traffic signals and the like. However, indirect expenditures of this type are rarely associated with the handling of waterborne cargo and are not included in this study.

Since government expenditures create a demand in new construction, the ripple effect of such spendings was strongly reflected in demand for construction materials such as metals, lumber, heating and plumbing equipment and other supplies. Business services, wholesalers and retailers were also major beneficiaries.

Table 9 lists the 20 groups of industries which benefit most from government port expenditures.

The impact of governmental port functions on employment is also of great significance. While the I-O model does not provide estimates of the number of government jobs directly involved in port activities, other sources* indicated that roughly 23,000 persons held jobs at the Federal

* Source: Budget of the U.S. - 1970

TABLE 9

Direct & Indirect Output Impact

Of Government Port Expenditures

on the 20 Leading Supplying Industries - 1970

($ Millions)

Supplying Industry	Amount
New construction	$348
Maintenance & repair construction	83
Business services	79
Wholesale & retail	48
Heating & plumbing	36
Stone & clay products	31
Primary iron & steel	31
Primary nonferrous metal	29
Lumber & wood products	28
Other transportation	26
Electric & gas	20
Construction & mining mach.	19
Electric industrial equipment	19
Printing & publishing	19
Hotel & personal services	18
Real estate & rental	16
Service industry machines	14
Finance & insurance	13
Shipbuilding	13
Petroleum refining	12

level alone that were primarily engaged in the facilitation of waterborne cargo in 1970.

Such jobs ranged from top administrators to engineers in the Corps of Engineers and the Maritime Administration to terminal employees. However, the 23,000 figure does not refer to the jobs generated in quasi-government enterprises such as the Export Import Bank and the St. Lawrence Seaway Corporation.

Aside from creating jobs within the Government itself, Government port spending strongly affects civilian employment. Port related purchases of goods and services by Government were responsible for an additional 42,000 jobs in the economy in 1970.

Jobs in the construction field were highest because of government port spending with 11,890 created that year. Wholesalers and retailers maintained 4,190 jobs in 1970 to expedite various materials and supplies for government port functions. Other business services accounted for 4,140 jobs.

Table 10 shows the number of civilian jobs created in 20 leading industries by government port expenditures during 1970.

TABLE 10

Direct & Indirect Jobs Generated

By Direct Government Port Expenditures

in the 20 Leading Supplying Industries - 1970

Supplying Industry	Jobs
New construction	11,890
Wholesale & retail	4,190
Business services	4,140
Maintenance & repair construction	2,910
Hotel & personal services	1,390
Other transportation	1,240
Stone & clay products	1,120
Primary iron & steel	900
Printing & publishing	790
Electric industrial equipment	720
Finance & insurance	530
Construction & mining machinery	520
Primary nonferrous metal	490
Other fabricated metal products	400
Shipbuilding	390
Office & computing machines	350
Federal government enterprises	290
Electric lighting equipment	250
Communication	240
Forestry & fishing products	220

FOREIGN TRADE: THE LIFEBLOOD OF THE PORTS

The input-output model has been used up to this point to analyze the industry's interaction with other industries and to examine the impact of port activities on jobs, income and taxes in the national economy.

The model also can be used to analyze the impact of economic events on the port industry itself. An analysis of the impact of foreign trade upon the port industry is a striking example of the model's usefulness in examining cause and effect relationships from the latter perspective.

In 1970, the handling of the Nation's waterborne exports and imports was responsible for $16,199,300,000 of output in the national economy. This means that the movement of each ton of waterborne cargo by the U.S. port industry in foreign trade generated $34 of port revenues. Applying the port multiplier, the direct and indirect revenues throughout the economy amounted to $55. This does not include the value of the cargo itself. In addition, the movement of every 600 long tons in waterborne foreign trade created one job in the national economy.

The preponderance of the Nation's international trade, measured either by value or weight, moves into or out of the country by waterborne transportation. In fact, exports and imports are the lifeblood of the ports.

International trade that is not carried by ships consists of the growing volume of high value cargo that moves by air transport and the two-way commerce that moves by overland highway and rail transport between the U.S. and Canada to the north and between this Nation and Mexico to the south.

Exports

Cargoes valued at $24.5 billion were carried out of the United States on merchant vessels in 1970. This was 57.8 percent of the Nation's exports which totaled $42.6 billion during that base year. Overland movements to Canada and Mexico and international air cargo accounted for the 42.4 percent remainder.

All of these waterborne exports, regardless of the flag of the ships on which they moved across the oceans, required port services in this country.* During 1970, the Nation's port industry provided direct services valued at $5,706 million for moving exports.

Other port activities resulting from the direct port services added an additional $421 million. This included a variety of waterborne services required by the port industry itself in obtaining its input supplies.

A further $657 million in port services was incorporated in the prices of the exports. These were services needed in moving raw materials and other input cargoes by water to the export producing industries.

Therefore, by adding up the three impact areas, the Nation's total exports of $42.6 billion generated a demand for port services amounting to $6,784 million in 1970, or 16 percent of the total value of U.S. merchandise exports.

Examination of this fact from the perspective of the impact of exports on the ports shows that every million dollar increase in these exports would require an average increase of $160,000 in port services. This assumes proportionate increases in the types of export merchandise.

* Except for the very minor amount of third country trade carried by U.S. flag vessels.

TABLE 11

Leading Waterborne Export Industries

in the United States - 1970

($ Millions)

Industry	Value	Water Penetration
Agricultural products	$3,206	70%
Food & kindred products	2,060	85
Chemicals	1,766	77
Construction, manuf. & oil field mchy	1,372	76
Primary iron & steel	972	77
Motor vehicles & equipment	959	33
Paper & allied products	922	91
Petroleum refining	874	92
Special industry machinery	843	75
Primary nonferrous metal	828	76
Coal mining	646	100
Tobacco manufacturing	645	98
General industrial machy.	539	67
Lumber & wood products	471	77
Service industry machines	425	83
Metal working machy.	419	67
Engines & turbines	373	70
Other fabricated metal products	362	66
Drugs, cleaning & toilet preps	359	57
Ordinance & accessories	342	86

However, changes in the level of shipment for specific export commodities will have a varying impact on port industry in proportion to their transport costs and their relative reliance on vessel shipments. Such characteristics as weight, size, and value of shipments determine their dependence on water transport.

Many industries have no feasible alternative to water transport. For example, bulk shipments of wheat and other commodities to overseas destinations must travel by merchant vessel. In 1970 all the Nation's $646 million of coal exports and 70 percent of the $3,206 million of agricultural exports moved by water. Their true dependence on ports is therefore understated by the above 16 percent impact average.

Table 11 shows the 20 leading export industries, the value of their waterborne exports and the percentage of exports handled by waterborne transport. This table can be used in assessing how changes in the level of total exports of such major industries affect the level of port activities. Appendix D provides additional details on the methodology used for identifying export related waterborne port services.

Imports

Waterborne imports, amounting to $25.4 billion in 1970, accounted for 63.8 percent of the total U.S. merchandise imports of $39.8 billion in that year.

Proportionately, more imports were carried by seagoing vessels than exports, reflecting the abundance of bulk commodities such as agricultural products, petroleum and ores that constitute the Nation's inbound

cargo. Waterborne imports weighed 42 percent more than the total of waterborne exports. Hence, imports required a much larger percentage of the port industry's capacity than exports.

The I-O framework treats imports differently than exports. The reason for this is that imports enter the Nation's economic scene much like any other input in the production and consumption process. They are distinguished only by whether or not they undergo further processing and by the sector purchasing them. This makes it more difficult to estimate the industry by industry impact on ports.

However, it was possible to develop a method of estimating this transportation element and compute an aggregate impact figure for imports.*

Through this method it was determined that the movements of waterborne imports in 1970 accounted, directly and indirectly, for $9,440 million of port services, amounting to slightly less than 23 percent of the total value of $39.8 billion of United States imports that year.

Thus, for each increase of a million dollars of imports, demand for port services would go up an average of $229,400.

This higher increase in port services per dollar of imports compared to exports was due in part to the higher tonnage of imports carried by vessels. Other factors included the U.S. customs duties and excise taxes that are associated only with imports to this country.

Here too, many U.S. industries depend heavily on water transport in their production process since vessels offer the only economical mode of

* Appendix E describes how import related waterborne port services were identified.

transport for the imports of raw materials or partly-finished products they must use. For such industries production could be greatly disturbed if foreign inputs were not available. Consequently, these industries have a great stake in the viability of port services.

Table 12 lists the twenty industries that rely the most on the port industry for their waterborne imports. These 20 industries accounted for 48 percent of U.S. waterborne imports in 1970.

TABLE 12

Ranking of Waterborne Imports by Consuming Industry

in the United States - 1970

($ Millions)

Industry	Value
Food & kindred products	$ 3,111
Primary nonferrous metals	1,097
New construction	1,017
Petroleum refining	1,013
Primary iron & steel	1,003
Radio, television & comm. equipment	729
Motor vehicles	675
Livestock	479
Rubber & misc. plastics products	451
Lumber & wood products	379
Chemicals	375
Paper & allied products	320
Heating & plumbing products	272
Wholesale & retail	255
Other agricultural products	245
Office, computing & accounting machines	234
Electric & gas	220
Misc. manufacturing	219
Business services	182

APPLICATIONS OF THE PORT I-O MODEL

The input-output model's two-way application for determining impact makes it a valuable economic forecasting and planning tool.

The preceding section on foreign trade showed that the I-O model can serve as such a tool. Actually, application of the model within the two-way impact framework - impact of port industry on the national economy and impact of economic events on port industry - can be quite diverse. They can range from dozens of specific simulations of the effects of external changes in the economy on the port industry or, vice versa, the model can be utilized for impact analysis of specific changes in port activities or investments.

However, it is important to remember that the model is not mechanical.

The model does not automatically generate solutions and answers.

Simulations

Extensive sets of assumptions usually must be made whenever the I-O model is used to simulate the conditions of an external development. These assumptions may relate to the current state of the economy, anticipated changes in technology, possible impact of other global developments, and above all, to assumptions that are implicit in all I-O analyses such as the constancy of input proportion, and the transfer of imports and secondary production to primary industries. Furthermore, special adjustments of the model may be necessary for particular applications.

Three examples follow on how the model could be effectively simulated in assessing economic impact:

* An evaluation of the demand for port services generated by increased consumer spending;
* An evaluation of changes in the level of sales of specific industries translated into a need for port services; and
* An analysis of how a major dock strike ripples through the economy.

A discussion of other areas of application will follow these simulations.

Consumer Spending

The most prevalent problem that confronts producers of goods or services is when, where and how to adjust to variations in consumer demands for their products, especially to increased demands. When this occurs, too little expansion of capital facilities can result in bottlenecks, over expansion in economic waste.

Decisionmakers in the port industry are continually concerned with the problem of interpreting various available economic indicators in a way that will be meaningful to their operations.

Personal consumption data which are published routinely as part of the national accounting system, can be put to good use as business indicators via the I-O model's built-in linkage between the private consumption sector of the economy and port industry. Private consumption, in this context, would act as a barometer mainly to demand for port services in handling domestic cargo and imports.

Consumer expenditures throughout the United States in 1970 totaled $615 billion. This included $8,171 million which represented the costs of waterborne movements of these consumer goods and expenditures for passenger travel by water.

About half of the port services received by private consumers - $4,060 million - was comprised of direct and indirect payments for the transportation of imported products and domestic merchandise for final consumption.

By using the inverse matrix of the I-O model, it was possible to identify and measure the amount of port services absorbed by private consumers through their purchases of all consumer goods and services. This showed that $4,111 million were paid for port services indirectly generated by consumers through purchases of domestically produced goods and services from industries that purchased port services for various inputs in their production processes.

The I-O model was able to determine that the private consumer was responsible for the indirect consumption of $1,109 million of port industry services in 1970 through the purchases of $72 billion of output from the food and kindred products industry. This amount of port services was incorporated into the value (prices) of the output of food and kindred products industry during its production process.

By using these parameters, the I-O model can be used to estimate the impacts of changes in consumer expenditures on demand for port services as follows:

Assuming that proportionality of input-to-output holds, a 10 percent increase in consumer spending would result in an increase in demand for port services of $817 million (10% X $8,171 million). This amounts to 5 percent of the port industry's total output of $17.2 billion.

Changes in Industrial Output

Changes occur from year to year in the output of each and every industry in the economy and as they take place, these changes make new demands (requirements) upon the Nation's port industry.

Forecasts of output changes by most industries are generally available from government and private sources. From these forecasts it is possible to estimate future demand for port services by applying the projections to total requirement coefficients developed in this analysis.

Since each industry requires a different amount of port services in order to increase its output, the impact of output changes upon the port industry is not evenly distributed among all the industries. Those industries that have a strong demand for waterborne transportation services or indirect linkages to other supplying industries that are heavy port users, have a substantially greater economic impact on ports than do industries with little direct or indirect linkages to the port industry.

Furthermore, the total impact of each industry's sales on the port industry, depends not only on the strength of these linkages but also on the size of each industry's output. Naturally, industries with greater absolute sales will tend to have a greater overall impact on the ports.

Two methods can be used to demonstrate how a change in the output of each industry affects demand for port services. One emphasizes the

absolute changes in industries' output; the other underlines the relative changes in industries' output.

The first kind of output simulation by individual industries is to compare the impact of a $1 billion increase in output in each industry on the port industry. The industries with the larger port multiplier effect (direct and indirect demand) will register a larger impact than industries having small multipliers.

The model showed that the industry with the largest impact on the port industry in 1970 was the iron and ferro-alloy industry. Every billion dollars in new sales by this industry required $61 million in new port services.

The second leading impact industry in 1970 was the primary non-ferrous metal manufacturing industry which generated $39 million in new port services for each billion dollars of new output.

Other important impact industries with more than $30 million in new port services demanded for each billion dollars of new sales, were also primarily heavy industries that required wide usage of port services in their production processes. They were the non-ferrous metal ore mining industry, the primary iron and steel industry, the textile goods industry, the petroleum refining industry and the lumber and wood products industry.

The industries that have a major impact on the port industry are ranked in Table 13.

The second method of comparing the impact of changes in industrial output on ports is to simulate an equal percentage increase in output for all industries regardless of their sales levels. By doing so,

TABLE 13

Increase in Port Industry's Output Resulting from

Additional Sales of Other Key Industries - 1970

(Millions of Dollars per $1 Billion Sales by Other Industries)

Industry in Which Output Increased $ 1 Billion	Resulting Port Output (in $ millions)
Iron & ferro-alloy ores mining	$ 61
Primary nonferrous metal manufacturing	39
Nonferrous metal ore mining	38
Primary iron & steel	35
Misc. textile goods	35
Petroleum refining	33
Lumber & wood products	30
Forestry & fishery products	25
Leather tanning and industrial leather products	24
Other transportation equipment	24
Rubber & misc. plastic products	23
Misc. manufacturing	21
Chemicals	20
Paper & allied products	19
Paints & allied products	19
Metal containers	19
Other fabricated metal products	18
Plastic & synthetic materials	18
Heating & plumbing equipments	18
Special industry machinery	17

the stress is put on the overall growth impact of each industry's demand for port services rather than on the strength of the sectoral multipliers.

For example, if a 10 percent increase in output is analyzed separately for each industry, a specific dollar amount of new port services can be determined in every case based on the existing 1970 interindustry relationships and the sales levels existing in that year.

The model showed that a 10 percent increase in the output of the food and kindred product industry would have the greatest impact, generating a $162 million in demand for new port services. The second ranking impact industry was the iron and steel industry with $121 million. New construction was third with $109 million and petroleum refining fourth with $104 million.

Table 14 lists the 20 leading industries in the United States in terms of the impact of a 10 percent growth in their output upon the port industry.

This information can be very useful for the port industry in making long term growth projections. What Table 14 actually demonstrates is that demand for port services is a derived demand and that the logical approach to projecting demand for port services is via those industries that generate the demand in the first place.

Even broad indications about the future growth of each of the key industries could be useful from this perspective. For example, if it is expected that a leading impact industry will have sharp growth rates in the short run but much lower growth rates in the long term, a strong signal should be perceived in the port industry about the scope of demand for its

TABLE 14

Increase in Port Industry's Output Resulting from

10 Percent Additional Sales of Other Key Industries - 1970

($ millions)

Industry in Which Output Increased	Resulting Port Output
Food & kindred products	$162
Primary iron & steel	121
New construction	109
Petroleum refining	104
Primary nonferrous metal	102
Chemicals & selected chemical products	52
Wholesale & retail	49
Lumber & wood products	45
Broad & narrow fabrics	43
Rubber & misc. plastic products	40
Paper & allied products	38
Livestock & livestock products	36
Real estate & rental	34
Other agricultural products	33
Apparel	32
Radio, television & communication equipment	31
Electric & gas	28
Other fabric metal products	26
Other transportation	26
Heating & plumbing equipment	25

services. Capacity expansion should then be moderated despite the short-run boom. However, if such a key impact industry has a steady long term growth potential, the demand for new port capacity may be more soundly based despite short run fluctuations.

Finally, this analytical tool can also help determine whether certain economic developments have only a remote bearing on port traffic. Those industries which need only small amounts of port services directly and indirectly in their production process will not materially affect the port industry even if their output were to double. By recognizing such industries - they include the wooden container industry, chemical fertilizer and mineral mining industry, agricultural forestry, and the fishery services industry - port managements can react much more rationally to future developments in the market place.

Dock Strikes

The economic impact of dock strikes can be assessed by the input-output model. Impact measurement, however, cannot be made with great precision because of the large number of variables that can and do influence the outcome of such strikes. Key variables that must be taken into consideration in assessing the impact of a strike are:

* Duration of the work stoppage.
* Geographical extent of the strike (ports tied up).
* Expectations of the duration and severity of the walkout and the extent of anticipatory inventory build-up by shippers.

* Lead time warning before the strike's onset.
* Amount of cargo divertable to other modes or routes such as air or overland transport to Canadian, Mexican or U.S. ports not affected by a stoppage.
* Extent of post-strike recovery of lost tonnage.

Given basic assumptions about a strike's duration and effectiveness, the I-O model can generate reasonable estimates of losses in output by the port industry. Moreover, by including specific assumptions on the responses of different industries to a dock strike, its impact can be estimated for the economy as a whole.

Experience gained from past dock strikes has shown that the detrimental impact of a strike increases exponentially (by geometrical progression) with time. The daily impact becomes more severe as the strike enters its more advanced stages. For example:

> If a 6 months dock strike were effective on all the Nation's coastlines, waterborne foreign trade and most export production throughout the country would come to a halt. By the end of the 6 months, exports' inventories would have long reached excessive proportions. There would be no space left for storing the build-up of exports awaiting shipment. Alternative short term transportation outlets via Canadian or Mexican ports or air cargo could not possibly absorb this high level of overflow.

Similarly, industries that depend on imported raw materials that have no domestic substitutes would run into major supply problems that would affect production. Many would be forced to shut down, at least for the walkout's duration and for a while afterward, until the flow of imported supplies could be resumed.

As a consequence of the long port industry shutdown, many industries that are unable to withstand the strike's effects could go into bankruptcy with a resulting increase in unemployment and other severe economic disruptions.

In contrast, a strike of only 1 month affecting one coast would have only minor impact consequences for the U.S. economy. Meaningful output losses would occur mainly within the port industry itself. No major impact on production and sales would be noted in such an event, particularly if the duration of the strike was in line with general expectations before it began, or if the delay of seasonal cargo was at a minimum.

The severity of a strike's impact for any work stoppage between the 1 month and 6 months duration would, of course, depend on all the above assumptions. But with each passing day of a shutdown, new industries would begin to be affected.

Some industries that depend only slightly on the Nation's foreign trade in terms of supplies or markets, would not be affected to a great extent by a strike of short duration. However, beyond a certain amount of time, even these industries could be injured if their domestic suppliers or buyers were severely affected by such a strike.

Therefore, production losses resulting from a dock strike should be carefully assessed in each industry by taking into consideration its individual characteristics in terms of export production relative to total production, existing inventories, warehousing space, alternative supplies, potential bottlenecks and seasonality of shipments.

To demonstrate how the input-output model can be used to evaluate the economic impact of a dock strike, a simulation was performed using a hypothetical set of assumptions. Changes in any of the stated assumptions would lead to a different impact figure. The assumptions were for a strike:

* of 2 months duration;
* on the East and Gulf Coasts;
* affecting all waterborne international and all deep sea domestic cargo except petroleum;
* with 20 percent of struck waterborne traffic (based on value) diverted to air and overland transport; and
* with 50 percent recovery of traffic through anticipatory shipments and post-strike inventory adjustments (50 percent based on value).

It was also assumed that the 2 months duration of the strike was expected, allowing ample warning for an anticipatory build-up of exports and imports by shippers.

These assumptions were roughly consistent with the characteristics of most United States dock strikes during the last two decades. The two months duration of the strike probably represents the maximum period in which production in most industries would not be seriously affected.

The joint shutdown of East and Gulf ports has been the rule rather than the exception. These two coasts are responsible for handling approximately 75 percent of the Nation's waterborne foreign trade. Diversions of 20 percent of the struck cargo to other modes and coasts could mean traffic increases of 40 percent to 80 percent for international airlines and (Pacific and Great Lakes) ports that remain open.

The role of expectations is extremely important as the impact of a strike can be greatly cushioned by hedging during the warning period. Industries that depend on exports of their products can rush to get off as many orders as possible before the work stoppage deadline; steamship companies push up sailing times so their ships will not be caught in struck ports; industries that depend on imports stock up before the walkout takes place.

In general, the closer the expectations are to the final outcome of a strike, the less negative impact the walkout is likely to have. Correct expectations allow shippers and carriers alike to react by hedging or accumulating inventory to reduce the potential loss of output.

In contrast, incorrect expectations can be costly in overtime and storage costs. If no strike is expected, hedging usually is at a minimum. When an unexpected strike takes place, losses will then be greater. Similarly, if expectations of a prolonged strike do not materialize, short-run misallocations of resources occur at some costs to the affected industries.

The assumption that petroleum movements would not be affected simplified the analysis by eliminating the possibility of a crisis

stemming from energy shortages. In 1970, petroleum products accounted for 10 percent of the United States' waterborne import value and less than 4 percent of the Nation's export value.

No attempt was made to measure losses in export production and some other repercussions which may result from dock strikes. Such impacts cannot be quantified without extensive surveys. Permanent losses of export markets during a strike because foreign buyers turn to other countries, are examples of such unquantifiable impacts. Domestic bankruptcies resulting directly from dock tie-ups are other examples.

The simulation was therefore based on all the above assumptions and confined to the direct impact on the port industry and the resulting indirect impact throughout the economy as measured by the port industry multiplier in the model.

The input-output model showed that a 2 months dock strike in East and Gulf Coast ports would result in a direct and indirect loss of $1,258 million in output to the United States economy.

The direct impact within the port industry resulting from the idling of ships, machinery, loading and discharge and all the other ports of the industry would amount to $803 million; the rest of the impact would be diffused throughout the economy through a chain of lost sales to the port industry.

The direct impact of such a strike therefore would amount to approximately 5 percent of the port industry's annual output.*

* The strike's impact on port income may be relatively less than on output to the extent that overtime is paid in clearing backlog after the strike is settled or in hedging before the strike is called.

Further Applications

The 1970 input-output model has many other potential applications that can shed light on various economic questions that are national in scope.

Many traditional types of simulations can be made to answer such questions as:

* How many jobs are created as a result of port facility construction of a certain scope?
* What would be the impact on the port industry of changes in tax policy?
* What would be the impact on the port industry of changes in government expenditures?

Again it must be stressed that every such simulation will require a set of assumptions in order for the results to be meaningful.

Special attention must be paid in any further simulations of the model to assure that interpretation of results be made only within the context of the I-O model and its limitations. For example, the model does not account directly for possible supply shortages in the economy or under-utilized labor and capital resources in specific industries.

The model provides estimations based on conditions existing in the survey year, and these must be compared with any new developments in the economy that are not intrinsic to the model.

Updating results into current dollars is another aspect of the analysis that must be handled with great caution. Assumptions of fixed technical coefficients may hold less for certain specific industries than for others.

Moreover, real economic growth and inflation vary by industry. It may be insufficent to merely use trends in real gross national product growth and price deflators to obtain a current dollar impact figure for the port industry. It would be preferrable to use data of a more precise character for such purposes.

The national I-O model also can be applied in analyzing regional economic impact of ports. Obviously, the total impact of the national port industry is made up of the various regional components with each region contributing its share depending on the amount of direct port activities taking place within it and on the direct linkages that it has with the rest of the economy.

Since different regions tend to be more specialized in the handling of different commodity groups, and since regions also tend to have a non-homogeneous productive base, the regional economic impact of ports cannot be achieved by dividing the national impact by any simple weight factor.

For example: It is not appropriate to use regional trade volumes by vessels as proxies for regional impacts. Nor should any other single indicator such as regional population, income or production serve such a purpose.

The national model can be extremely useful however, in drawing some inferences with regard to the linkages of regional ports to specific national industries. The model is able to pinpoint the industries that benefit most from the existence of a port industry; conversely, the model can pinpoint the port industry that benefits most from certain industries.

From this information each region can evaluate its own position relative to the national standard. In addition, by using various adjustments, national impact yardsticks derived by the model can be refined to approximate regional impacts.

For example: Regions that handle bulk items primarily could compensate their impact estimates per ton by lowering them in some proportion to the national norm. On the other hand, regions that specialize in general cargo commodities, or which have a strong international banking sector, could compensate in the other direction above the national average.

Although such methods are crude and do not provide precise regional measures, they could serve a useful purpose in gauging overall impact trends in various regions.

Actually, all of the factors that make a region unique economically must be taken into consideration when making inferences from the national model. Not only must ratios of bulk to general cargo be analyzed, but also the proportions of export, import and domestic trade as well as regional production and consumption patterns.

All of which indicates that while the national I-O model does provide a valuable blueprint for the derivation of a regional I-O study of individual ports, the national study in itself is not a substitute for a more refined regional analysis.

RECOMMENDATIONS

This study demonstrates that the activities stemming from U.S. port operations are indispensable and valuable assets to the Nation's productive output. It is therefore recommended that:

* MarAd continue to promote and encourage the development of U.S. ports based on its statutory mandates;
* MarAd adopt the definition of the port industry in this report and promote its general use;
* MarAd periodically update the input-output model to provide an ongoing tool to assess the impact of alternative policies relating to the U.S. port industry; and
* MarAd proceed to develop further the capability of this national model to be applied on regional levels.

APPENDICES

APPENDICES

A. Input-Output Technique

The conventional input-output matrix displays the transactions taking place among all industries in the economy in a specified year. A row in the matrix shows the distribution of output to all other industries and to final demand sectors. A column shows the purchases of inputs made by each industry from all others, including payments to factors of production.

By definition, the sum of each industry's output is equal to the sum of its inputs; moreover, the sum of the final demand for all industries is equal to the sum of the value-added by factors of production in all industries. This provides a double accounting determination of GNP from both the product and the income sides.

The dollar transaction table conveys additional information when converted into a table of technical coefficients. The table shows the direct input requirements per dollar output of each industry. The proportionality is assumed to hold for all levels of output. Technical coefficients are also assumed to be relatively constant over a period of several years, primarily because of the gradual nature at which technological change takes place. (Technological change includes such elements as changes in capital-labor requirements, development of new production techniques, the introduction of new products, etc.) Other factors may influence the proportion of input requirements. Among these are relative price changes, substitution of one raw material for another, nonproportionality of certain

inputs as reflected in the relative rigidity of overhead costs over the business cycle, and a variety of statistical factors relating to definition of industries and techniques of transferring secondary outputs.

Based on the table of technical coefficients, the inverse matrix can also be derived showing the direct and the indirect production requirements per unit of final demand. The inverse coefficient matrix provides a measure of the total chain impact (multiplier) throughout the economy.

Imports of goods and services in the transaction table are treated in two distinct ways. Imports that have no domestic counterparts are directly allocated to consuming industries. Imports that are competitive with domestic goods or services are treated as transfers and distributed along with domestic outputs of corresponding sectors. In deriving the amount of output of the domestic industries, these imports are subtracted.

In the case of the U.S. Port Industry, output consists of revenues of port operators; earnings of U.S. vessels generated through the carriage of U.S. exports, imports and passengers; domestic waterborne transportation; freight insurance and financing and rail and truck revenues dedicated strictly to ports, revenues of export-import agents; and customs collections.

Foreign flag services for carrying U.S. imports and passengers are treated as transferred imports, and integrated into the total output of the industry. To obtain total output of the port industry the amount of transferred imports is subtracted from the intermediate sectors to which transferred imports are allocated.

B. General Analytical Methodology

The primary source of data utilized in this study is the 1970 input-output table of the United States, prepared by the Interindustry Division of the Bureau of Economic Analysis, U.S. Department of Commerce. The table is an update of the 1967 survey, using new control totals at the 2-digit I-O sector level.

The port industry is defined at the more disaggregative level, and therefore, special estimates were necessary in order to update the data for the industry. The underlying assumption in the updating procedures was that the proportionality within the components of I-O industry 65 remained constant between 1967 and 1970. The Port Industry contained elements of industries 65, 69, and 70.

To obtain direct and indirect employment figures related to the Port Industry, an employment row for the year 1970 was developed based on several sources of data:

Employment and Earnings

1) Bulletin 1312-9, U.S. Dept. of Labor, Bureau of Labor Statistics.
2) Occupation by Industry, U.S. Department of Commerce, Bureau of the Census, Oct. 1972.
3) Economic Report of the President, 1975.

In developing the employment data, SIC based classifications were converted to I-O classifications utilizing the published bridge. To ascertain the validity of the estimates a further test was taken comparing

the average wage per employee using I-O classifications against statistics on average earnings developed by BLS.

Several measures are utilized to convey how the port industry interacts with the rest of the economy beyond the employment impact. These are analysis of the distribution of the industry's output and inputs; analysis of gross product originating (or value-added) by their components; analysis of final demand; and multiplier analysis of both the output and the input sides, as they relate to total sales, income, and taxes.

In estimating the total impact of the port industry, given the static nature of the input-output table and the assumption of a homogeneous production function, the measures obtained describe how the port industry fits within an existing economic framework. In order to answer questions on what the economy might be like in the absence of the industry, additional information about the response of the economic system and of policymakers would be required, particularly in the areas of import substitution.

The application of the sectoral multiplier in this report should also be amplified. Sectoral multipliers were derived in the traditional fashion by summing up the column coefficients of the inverse matrix for the relevant industries. The domestic multiplier is obtained by subtracting the import element of the inverse columns. These multipliers quantify the total (direct and indirect) requirements placed on the economy as a result of change in the level of output of any specified industry's final demand.

In an advanced economy that is roundabout in terms of the production process (i.e., in which intermediate sales are large relative to final demand), it is also of interest to measure the amount of sales transactions that are attributable to the activities of a given sector indirectly. The sectoral multiplier when applied to the total output of an industry provides an estimate of such sales in the economy. When applied to gross output, the sectoral multiplier is adjusted slightly downward (by the weight of the diagonal element of the inverse matrix of the particular industry.

Multipliers that are applied to the value-added elements of the relevant industries describe the total change in value-added throughout the economy relative to a unit change in the value-added of a single industry. The same concept is applied to the job multiplier.

It should be noted that some of the economic definitions in the study are used primarily to modify technical input-output terminology and they are not to be confused with more formal definitions of national income accounting. For example, personal income and business income in this study actually stand for the conventional input-output definitions of Employee Compensations and Property Type Income, respectively.

Finally, in computing the tax impact of the port industry, the average 1970 tax rate on personal incomes was utilized to obtain the amount of personal income taxes paid. A weighted average tax rate (adjusted for non-wage incomes by individuals) was utilized in determining corporate income taxes. Indirect business taxes were obtained directly from the input-output transaction table.

Appendix C. Derivation of Port Industry Definition

Since this study's definition of the port industry was based on stated economic criteria, it is hoped it will become widely accepted as the standardized format of the port industry. Such a format is needed to facilitate future port impact analyses, at both the national and regional levels, as well as to make the findings of various port studies comparable to one another.

Several existing concepts of the port industry were considered and rejected for this study. The narrowest concept restricted the port industry to the actual waterfront activities of loading and discharging cargo. While such a definition would encompass the activities of stevedores and include various cargo operations such as stuffing and stripping containers at dockside, it would exclude many other port operations.

Critical examination showed this extremely limited concept to be unsuitable for an indepth economic impact analysis. Such a narrow definition would necessarily produce results that consistently underestimate the true impact of actions affecting the ports.

The very nature of the port industry connotes port intermodal activities that include railroad, truck and ocean carrier operations, insurers, agents, warehouse operators as well as stevedores. Their activities are an integral part of port industry in providing basic services. The key is the direct linkage to the movement of every ton of cargo through the total system.

Therefore a narrow definition that excludes such activities does not permit a full accounting of the economic impact of such events as dock

strikes, trade expansion, or even technological change. To illustrate, a narrow definition of the port industry would underestimate the economic impact of a modern bulk handling facility because much of the activity is remote to the terminal (e.g. management, data processing, financing, insurance and documentation).

Equally important in this discussion if the relevance of various production activities in the definition of port industry. Three forms of production activities have been used in past regional studies as segments of a port industry:

1. The production of inputs that are consumed by the port themselves.
2. The production of goods near the waterfront.
3. The production of any goods that move by water.

Clearly these three types of activities are closely related to the day-by-day operations of the nation's port system. Changes in the levels of such production activities could affect port cargo handling, and vice versa.

But the critical task here was not to assess the interrelationship of such activities but rather to determine whether the nature of the production activities merited their inclusion in the definition of port industry. If they are included in the definition, then the output produced by such activities becomes internal to port industry; if excluded, their output becomes external to port industry.

Most regional port studies have included some of the above mentioned as part of the industry. Great confusion was created due to the

lack of systematic methodology and proper guidelines for the exclusion of these activities. Indeed all such studies have found it extremely difficult to draw a line that would meaningfully separate production activities that may be included directly in a port industry from those that may not.

This difficulty becomes apparent when each of the three different types of production activities mentioned above are analyzed separately:

1. Production of Inputs Consumed by the Port Industry

The port industry is a producer as well as a consumer of goods and services. A common error in impact studies is the failure to distinguish properly between the impact of output from that of input. Often, double counting of economic activities takes place when output and input values are added together when, in fact, they should be counted only as two sides of the same coin.

For example, the port industry buys a large number of products and services (inputs) in the process of providing port services (output). The cost of all the inputs, ranging from basic material to sophisticated computer services, are also represented in the revenues the port industry obtains when it sells its own services. Therefore, one can not add the value of all port revenues to those of its suppliers without seriously overstating the true impact of the industry.

The Input-Output model provides a systematic method of handling this kind of breakdown for the industry. Double counting is avoided by keeping separate tabs for the port industry's sales and purchases.

To summarize, port purchases represent diverse production activities of other industries, and they are fully accounted for in this study in

their proper perspective as inputs consumed by the ports. It should be noted that the multiplier analysis in this study also evaluates the additional indirect import on these suppliers of the port industry and on the rest of the economy.

2. Production Near the Waterfront

Another group of production activities that has often been mistaken for the output of the port industry itself is production that takes place near the waterfront. In this category fall a host of activities including manufacturing in waterside plants. The inclusion of such production activities was based primarily on location.

Conceptually, the inclusion of these activities within the port industry totally misrepresents the mission of the port industry, which is to provide transportation services. Location alone is not a sufficient reason.

While it may be factually correct to state that ports could provide the original magnet for drawing such production activities to particular areas, many of these activities would go on even if the port stopped functioning because they have developed into base industries capable of supporting themselves.

Thus, these activities were not included within the definition of the port industry. However, waterborne transportation services waterside plants at their own docks are considered part of the port industry.

3. Production of Any Goods that Move by Water

Production activities of various port users (shippers) that must rely on waterborne transportation to market their products have often been

used erroneously as part of the port industry. These were mainly production for exports and, to a lesser extent, production for domestic markets that are served by vessel.

Such activities are clearly beyond the scope of the port industry because the users are merely the customers of the port industry who pay for services rendered. For example, the value of production of exported automobiles, machinery or farm products cannot be considered a contribution of the port industry. This does not deny the strategic importance of ports to the movement of export production in the same way as highways and rails are strategically important for the movement of domestic products.

There is admittedly some overlap between this concept of production and the previous concept of production based on location. The overlap relates to production that takes place near the waterfront where the finished product must also be shipped by waterborne means. The lack of clearcut separation between these two concepts has been one of the major sources of confusion in the analyses of ports over the years.

D. Identifying Export-Related Waterborne Services

All exports and their corresponding transportation costs were treated as final demand within the I-O framework. A special computer analysis of exports was conducted at the detailed 4-digit level including domestic transportation costs by mode, insurance costs, and wholesale margin. International transportation costs of exports and their related banking expenses were recorded as exports.

All export values in the I-O table represent the total exports moved out of the country by all modes of transport including vessel, air and overland movements. No information on the amount of waterborne exports by industry can be derived directly from the I-O data. Since only waterborne exports and their related ports costs are considered in this study, it was necessary to separate the value of waterborne exports from the value of total exports for each I-O sector.

The identification and measurement of U.S. waterborne exports by industry was accomplished using a computer study on foreign trade that was based on Census data. One of the major tasks here was to reconcile the commodity classification differences between the I-O table and the official Schedule B of U.S. exports. Once the waterborne export values were determined for each I-O sector, their corresponding port costs could also be simultaneously measured.

E. Identifying Import-Related Port Services

1. Directly Allocated Import (DAI), I-O industry 80.01.

Imports used in production which have no domestic counterparts are classified as DAI. They are treated as purchased directly by the consuming industry as any other intermediate inputs. The major difference between DAI and all other inputs in the model is that each DAI element is composed of all kinds of imported goods that are consumed by each specific consuming industry.

To illustrate, DAI of industry 14 consist of bananas, coffee, copra, cocoa beans, sesame seeds and other agricultural commodities not produced in the United States. Based on I-O information alone there is no direct method of identifying the mode of transportation by which these imports were brought into the country. Therefore, to extract the waterborne elements from DAI a special methodology was devised of two major steps. The first step was to identify the commodity composition of DAI for each consuming industry. The second was to identify the waterborne share of each of the imported commodities.

The only way to identify the commodity composition of DAI was to use the Bureau of Economic Analysis (BEA) detailed DAI work sheets for each of the consuming industries. In these work sheets, commodity details at the six digit I-O and the four-digit SIC levels were given. With the knowledge of these import commodity details for each DAI, and modal distribution information for U.S. imports at the seven-digit commodity level based on Census foreign trade data, the portion of waterborne imports could be identified for each consuming industry.

2. Transferred Imports, I-O industry 80.02.

Imports used for production, which are interchangeable with domestically produced goods and services, were defined as transferred imports. The dollar amounts of transferred imports shown for each consuming industry do not represent the amount of imports consumed by that particular industry. In fact, these imports were transferred to the industry by assuming that the consuming industry makes fictitious purchases from the import row. They were essentially the same products as the outputs of the consuming industry. Therefore, there is no problem of commodity identification.

The process of identifying port services associated with waterborne transferred imports that were actually consumed by the consuming industry was complex. It requires a brief discussion of the methods used by the Bureau of Economic Analysis (BEA) to distribute transportation margins.

The technique used by BEA to distribute transportation margins associates freight revenues with each commodity carried. They are then classified according to the I-O industry producing the commodity. These margins, separately identified by transportation mode, were then distributed to the industries using the commodity, usually in proportion to the amount of the commodity used.

BEA's method of treating domestic transfer and transferred imports automatically distributes domestic transport costs of transfers to each consuming industry. When transportation costs were allocated to each I-O industry, the origins of the producers -- primary, secondary or foreign --

were not identified. Thus, the domestic inland transportation costs for moving waterborne transferred imports (WTM) were buried in each of the transportation margins for each consuming sector. The portion of rail, truck and other transportation costs directly linked to the movements of WTM had to be identified and separated in each of the transportation margins for every consuming industry.

To achieve this, the amount of waterborne transferred imports actually consumed by each consuming industry had to be determined. This task was accomplished by a computerized study, that distributed all waterborne transferred imports to all of the consuming industries proportionately to their consumption of the same imports. The basic procedures were as follows:

1. Compute the total value of each industry's output.
2. Compute individual transportation margins at two-digit I-O levels.
3. Compute waterborne transferred imports (WTM).
4. Compute the ratios of WTM to total value of the producing industry's output.
5. Compute the value of WTM-related transportation margins for each producing industry.
6. Sum up the related transportation margins for each of the consuming industries by mode of transport.
7. Adjust for each consuming industry the direct allocation and domestic transfers of waterborne transportation costs.

8. Compute for each consuming industry a ratio of total transportation margins associated with allocated waterborne transferred imports and direct allocation of waterborne transportation to total transportation costs.

F. Domestic Waterborne Trade

Waterborne transportation costs account for most of the port costs for moving domestic waterborne cargoes. Other inland transportation costs are relatively minor as compared to internationally traded waterborne exports and imports. This is due largely to the preponderance of low-value liquid and dry bulk commodities such as crude petroleum, grains, ore, and sand and stones in domestic waterborne movements. Normally they require only dock to dock or terminal to terminal movements by water and no further interface with other modes are necessary.

In 1970, the base year for this study, only 0.3 percent of all domestic waterborne traffic in terms of tonnage was jointly carried by rail and water.* It was assumed that other port services rendered to domestic waterborne cargoes would include only inland rail movements. All other elements due to their trivial significance were not estimated. It should be noted that all domestic inland movements and other related port services associated with exports and imports were included in the port services element for foreign waterborne trade.

The information for joint rail and water movements by commodity was derived from Transportation Statistics in the U.S. Since there were differences in commodity classifications between ICC code and I-O code, reconciliations had to be made.

* Transportation Statistics in the U.S., ICC; and Domestic Waterborne Trade of the U.S. 1960-1975, U.S. Department of Commerce, Maritime Administration.

G. Estimation of Port-Related Banking Activities

Letters of credit, acceptance financing and loan financing are the three major banking activities related to waterborne foreign trade movements. These are the essential services provided by international banking communities to facilitate the flow of exports and imports.

Letters of credit are the instruments mostly used by importers and exporters in international trade. The issuing and handling of letters of credit does not involve any financing; it is strictly a non-financial service offered by the bank. The service charge for issuing or handling letters of credit is usually one-eighth of 1 percent of the dollar amount stated in the letter of credit.

For short-term financing, acceptances are usually favored by importers and exporters. Bankers' acceptances arise from international trade transactions where there is an underlying obligation of a buyer (importer) of goods to make payment to a seller (exporter) at some future time. Bankers' acceptances may also be created when payment takes place on a collection basis. Financing acceptances consists of three components: the bank's acceptance fee, the discount charges and any supporting balance requirements. The fee is usually 1-½ percent per annum and the discount charges are mainly based on Treasury rates.

Loan financing for international trade is another popular bank service where the issuing of letters of credit and the creation of bankers' acceptance do not involve any of the bank's own funds, loan financing does require the use of bank funds. The financial charges for loan financing are basically the same as any short-term loans.

Based on interviews with the international departments of major banks in the United States, the average cost of banking service charges to importers and exporters for handling of letters of credit and acceptances of loan financing was determined to be about one-fourth of 1 percent of the value of the traded goods. This is due largely to a rapid increase in acceptance financing in recent years.

With this general guide of banking service charges, the port-related banking service inputs could be estimated. Banking inputs were treated within the I-O framework in the same way as other regular inputs. This differed from the treatment of transferred imports and their related transportation and insurance costs. Since banking activities consumed by each industry are in direct proportion to the total amount of waterborne foreign imports actually purchased by the industry, the transferred imports have to be reallocated to all consuming industries as similar domestic products. The reallocation of transferred imports was done by computer.

Banking activities associated with total waterborne foreign imports consumed by the consuming industry were estimated by applying the average rate of one-fourth of 1 percent to the total amount of waterborne imports actually consumed by each consuming industry.

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