

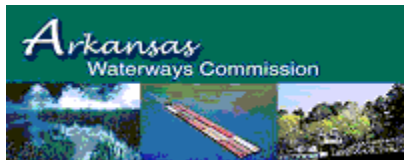


Economic Evaluation of the Impact of Waterways on the State of Arkansas

Heather Nachtmann, Ph.D.
Department of Industrial Engineering
University of Arkansas

July 31, 2002

Project Sponsors



...serving rural America
MACK-BLACKWELL
Transportation Center

Abstract

The objective of this study is to analyze and report the economic impacts of port activities on the state of Arkansas. Arkansas' inland waterways attract industries by offering low-cost transportation in a strategic location. Through the application of an input-output model, the economic impacts of port activities on the state of Arkansas were analyzed. Empirical results indicate that Arkansas ports directly and indirectly contribute to the economic growth of this state, including economic value, earnings, and employment. The findings of the study show that the economic prosperity of this state is affected by utilization of waterways. Investment in port development can increase Arkansas' competitive advantage over neighboring states, while continuing to offer social and environmental benefits.

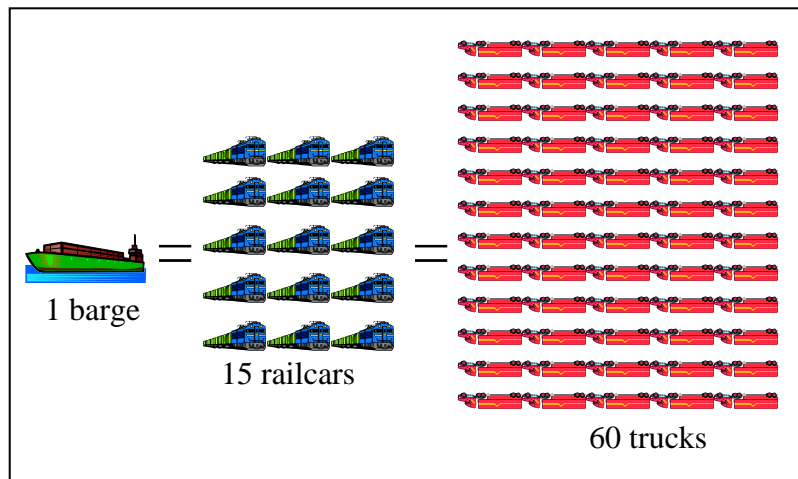
Water Transportation

General

According to the U.S. Department of Transportation, waterways provide the most economical and environmentally sound mode of moving goods and commodities²². Federal, state and local government officials are interested in and supportive of using waterways for transportation in addition to recreation, flood control, and water supply. Inland waterways carry approximately 15% of the total freight transported in the U.S.²¹. The annual value of goods exchanged between states using water transportation exceeds \$100 billion¹¹, and the total impact of waterborne transportation on Arkansas' economy is approximately \$811 million. There are twenty-four river states that are linked by navigable waterways. As one of these centrally located states, Arkansas has a strategic geographic advantage. These twenty-four states account for 54% of the nation's population, 56% of heavy manufacturing, and 61% of agricultural jobs¹⁴. The navigable waterways provide a proficient and economic means for moving 2.2 billion tons of the nation's domestic and foreign trade²². Within these twenty-four river states, nearly 800,000 jobs exist in industries, which ship or receive barge-oriented commodities in counties adjacent to the waterways¹¹.

Benefits

- Barges can carry more cargo than trucks or railcars (see Exhibit 1). Through barge utilization, companies can benefit from economies of scale³.



- Water transportation is less costly than land transportation. Typical cost per ton-mile for a barge is approximately one cent, compared to 2.5 cents for rail, and 5.3 cents for trucking⁴. A pictorial representation of the various shipment costs is provided in Exhibit 2.

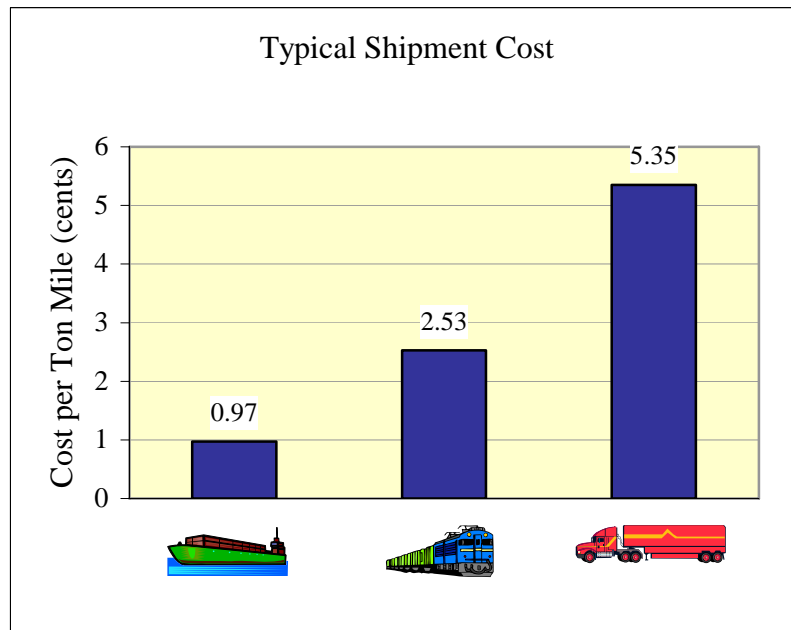


Exhibit 2 Typical Shipment Cost

- Fuel efficiency is another key benefit of water transportation. The number of miles one ton of cargo can be carried per gallon of fuel by a barge is 514 miles, as compared to 202 miles by train, and 59 miles by truck⁴. Fuel efficiency is represented in Exhibit 3 with the number of miles one ton can be carried plotted on the vertical axis.

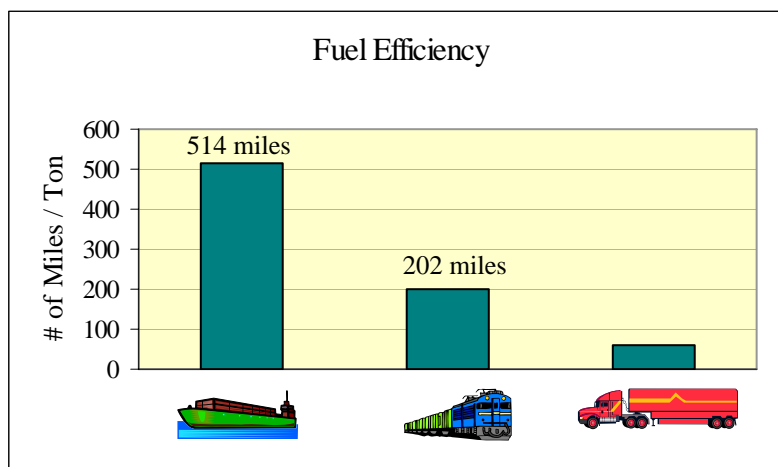


Exhibit 3 Fuel Efficiency

- Water transportation is the safest mode of transportation, with the ability to move large quantities of chemicals and toxic materials with little danger to surrounding cities and towns¹⁴.
- Water transportation is environmentally friendly in that it does not increase noise pollution and creates less air pollution than other modes of transportation⁴.
- Shipping freight by water reduces land congestion⁴.
- Manufacturers benefit from lower raw material costs based on resources made available by inexpensive transportation and less expensive distribution of products⁶.
- Additional benefits are realized by American consumers through lower prices for consumer products, water related recreational opportunities, water supply for cities, farms and industry, flood reduction, and renewable hydropower generation⁶.

Ports

A port includes land and facilities along a segment of navigable waterway in which commercial activity takes place. A river terminal is the location at which barges are loaded or unloaded. River terminals are classified by use (special purpose or general purpose), ownership (public or private), and operation²². A port complex consists of both public and private terminals, industrial sites, railroads, warehousing and other infrastructure. Public port authorities often construct a general-purpose river terminal that can best meet the overall economic development objectives. One concern for new ports is the level of development essential to attract private sector investment, making public financing increasingly significant²².

Arkansas Inland Waterways

General

Arkansas is one of only twenty-four states to have the unique resource of inland waterways. More than 1,000 miles of navigable waterways exist within the state. These inland waterways link Arkansas to domestic markets near cities such as Baton Rouge, Brownsville, Chattanooga, Chicago, Houston, Minneapolis, Mobile, New Orleans, Pittsburgh, and Tulsa²².

Arkansas has five rivers that provide economical waterway access to thirty-five of the state's seventy-five counties, putting every county within sixty-five miles of a navigable waterway²². The five rivers that run through Arkansas are the:

- Arkansas
- Mississippi

- Ouachita
- Red
- White.

Along these five rivers, the state of Arkansas has nine public ports located in:

- Camden
- Crossett
- Fort Smith
- Helena
- Little Rock
- Osceola
- Pine Bluff
- West Memphis
- Yellow Bend near McGehee.

A map of Arkansas' rivers and public ports is displayed in Exhibit 4.



Exhibit 4 Arkansas Rivers and Public Ports⁴

Link to Mexico

The inland waterway system of the U.S. links Arkansas to coastal ports in the Gulf of Mexico including Brownsville, Houston, Mobile, Morgan City, and New Orleans²². This waterway system is presented in Exhibit 5. As trade between the U.S. and Latin America increases, the importance of Arkansas waterways and the strategic location of the state should enhance manufacturing and distribution opportunities. The amount of trade between Latin America and the U.S. is expected to double by the year 2010³.



Exhibit 5 Link to Mexico⁴

Shipments

Exhibits 6 through 9 contain 1999 industry data for waterborne freight shipments originating in and designated for Arkansas²⁰. This data was obtained from the 1999 State to State Public Domain Data Base of the Waterborne Commerce Statistics Center. This database reflects the movement from state to state of commodities by tonnage. The pie chart in Exhibit 6 is a graphical representation of the commodities and corresponding tonnage that are shipped out of Arkansas via water transportation. Exhibit 7 contains this same information in a tabular format.

The top two originating commodities are *Food* (2,765,348 tons) and *Sand and Gravel* (2,566,053 tons). In general, the *Food* commodity classification contains more specific food commodities such as animal feed, corn, cotton, dairy, grain mill products, meat, rice, wheat, etc. It is recognized that economical waterway transportation is extremely important to the farming industry. Specific benefits include²²:

- Moving grain by barge is more economical than by any other mode, and
- Costs are reduced when local distributors receive fertilizer by barge.

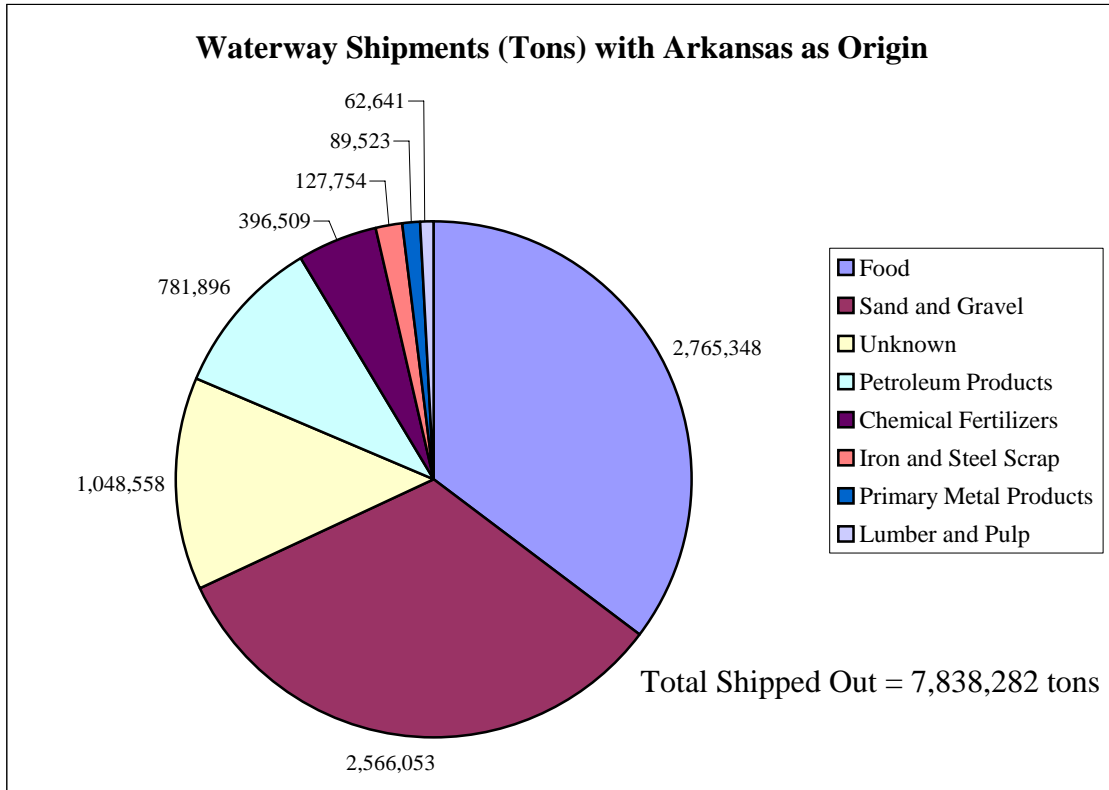


Exhibit 6 1999 Originated Shipments

Commodity	Tonnage
Food	2,765,348
Sand and Gravel	2,566,053
Unknown	1,048,558
Petroleum Products	781,896
Chemical Fertilizers	396,509
Iron and Steel Scrap	127,754
Primary Metal Products	89,523
Lumber and Pulp	62,641
Total	7,838,282

Exhibit 7 1999 Waterway Shipments (Tons) with Arkansas as Origin

Exhibit 8 contains a pie chart of the commodities and corresponding tonnage that are shipped into Arkansas via water transportation. Exhibit 9 contains the same information as Exhibit 8 in a tabular format.

The top two commodities shipped to Arkansas via water are *Sand and Gravel* (2,716,400 tons) and *Iron and Steel Scrap* (1,189,996 tons). An interesting observation is that states outside of Arkansas are only shipping 137,494 tons of *Food* into Arkansas via water transportation, whereas 2,765,348 tons are being shipped out.

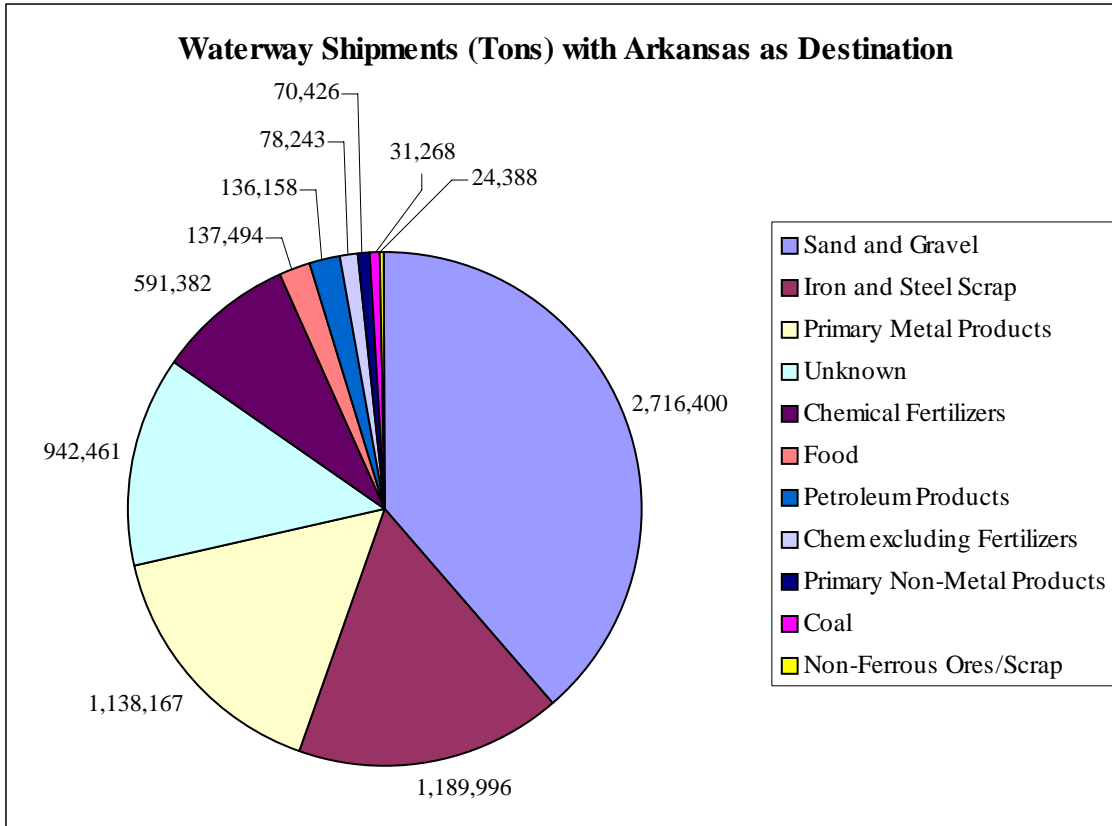


Exhibit 8 1999 Designated Shipments

Commodity	Tonnage
Sand and Gravel	2,716,400
Iron and Steel Scrap	1,189,996
Primary Metal Products	1,138,167
Unknown	942,461
Chemical Fertilizers	591,382
Food	137,494
Petroleum Products	136,158
Chem excluding Fertilizers	78,243
Primary Non-Metal Products	70,426
Coal	31,268
Non-Ferrous Ores/Scrap	24,388
Total	6,978,140

Exhibit 9 1999 Waterway Shipments (Tons) with Arkansas as Destination

Methodology
Literature Review

A thorough literature search and review of relevant documentation was conducted. Pertinent areas of research included:

- Water transportation research
- Arkansas waterways
- Economic impact analysis
- Input-output models.

The information obtained from the literature review provided data and formulated the methodology employed in this study.

Data Collection

In addition to the information obtained from the literature review, transportation and economic data was obtained from several sources. Exhibit 10 contains a listing of data that was used along with their corresponding information sources.

Data	Source
Water shipments by industry (1999)	1999 State to State Public Domain Database ²⁰
Industry dependence (1998)	REEBIE Transearch Database ¹⁵
Industry output values (1977-98)	Regional Economic Information System ¹⁶
Industry earnings (1977-98)	Regional Economic Information System ¹⁶
Industry employment (1997)	1997 Census ¹
RIMS II Multipliers	Bureau of Economic Analysis ⁸

Exhibit 10 Data Sources

Input-Output Models

In order to assess the economic impacts of water transportation on the state of Arkansas, an input-output analysis was conducted^{9,12,13}. Input-output analysis is the most widely used and accepted method for conducting economic impact studies of water transportation¹⁰.

Wassily Leontief⁹, who won the Nobel Prize for Economics in 1973, developed economic input-output analysis. Input-output analysis mathematically models and estimates economic relationships among industries and employees. The basic idea is that the outputs of some industries are the inputs of others. Leontief further explains this as the interdependence of an economy's various productive sectors is observed by viewing the product of each industry both as a commodity demanded for final consumption and as a factor in the production of itself and other goods.

The economic impact of an activity, such as port operations, can be broken into direct and indirect impacts. The direct economic impacts of an activity are measured as the direct economic contributions to the area where the activity is conducted i.e. economic value/output of the activity, earnings of employees employed in the activity, and the number of jobs attributed to this activity. Additional indirect impacts result from the direct economic impacts of an activity, where the direct impacts support additional economic gains indirectly through purchasing and spending. In input-output analysis, multipliers are used to estimate the indirect economic impacts on various industries that result from the direct economic impacts on other industries.

Input-output models use regional multipliers to estimate the indirect economic impacts of an activity within a region. Each multiplier is a numerical quantity that represents the economic impact relationship between two industries for a certain region. Direct economic impacts (which can be obtained through direct data collection or public databases depending on the application) are input into the model and multiplied by the input-output multipliers. The results are the total regional economic impacts of the activity, including both the direct and indirect impacts. This study focuses on three economic indicators: value, earnings of employees, and number of jobs. The regional area is defined as the state of Arkansas.

The Regional Economic Modeling System II (RIMS II) was utilized to perform the input-output analysis¹⁹. The RIMS II input-output regional multipliers for the state of Arkansas system were obtained from the Bureau of Economic Analysis of the U.S. Department of Commerce¹⁶. The RIMS II input-output multipliers were used in this analysis because they are the standard by which other input-output multiplier approaches are judged¹⁰ and are based on current data. Utilization of the RIMS multipliers avoided the lengthy data collection and analysis process of developing empirical input-output multipliers.

Direct Impacts

Once input-output analysis was identified as the best approach, the next step was to estimate the direct value, earnings, and employment impacts of port activities on Arkansas. Three assumptions were made during this process:

- All water transportation activities were included as direct impacts
- A proportion of the economic impacts of industries that ship via water transportation can be included as direct impacts of Arkansas ports
- The proportion of direct impact that each industry contributes can be estimated by computing the percentage of goods shipped via water. This was calculated from the REEBIE data¹⁵, which provided all shipment quantities in the state of Arkansas by transportation mode for 1998.

The process used to estimate the direct economic impacts of port activities on the state of Arkansas is as follows:

- 1) The value (Gross State Product), earnings of employees, and employment data for the water transportation industry were obtained. The most recent data that was publicly available was utilized. This data was assumed to be 100 percent dependent on port activities.
- 2) Other industries that are dependent on port activities were determined. This was done by analyzing the REEBIE shipment data to identify which industries transport via water in Arkansas. Once these industries were identified, the corresponding RIMS II multipliers were examined to determine which industries had indirect impacts on the Arkansas economy. Although they provide direct economic impacts, the Stone/Clay/Glass and Primary Metal industries do not have indirect impacts on the Arkansas economy. Therefore, only the direct impacts of these industries were considered in the analysis.
- 3) The direct impact of each dependent industry was estimated by dividing the amount shipped via water by the total amount shipped via all modes of transportation. The resulting percentages shipped by water are presented in Exhibit 11. Each industry percentage was then multiplied by the corresponding value, earnings, and employment data to calculate the direct

economic impacts of each industry due to port activities. The Non-Metallic Mineral Industry was dropped from further analysis due to its low percent dependence of 0.0002.

Industry	% Dependence
Water Transportation	100.00%
Stone/Clay/Glass	66.90%
Chemicals	7.41%
Primary Metals	4.80%
Fabricated Metals	3.25%
Food	2.41%
Farm	2.33%
Lumber	1.91%
Non-metallic Minerals	0.02%

Exhibit 11 Industry Dependence

Input-output Analysis

Once the direct economic impacts for each relevant industry were calculated, the total economic value, earnings, and employment impacts for each industry were calculated using the Final-demand Output, Direct-effect Earnings, and Direct-effect Employment RIMS II multipliers respectively. Effects of inflation were accounted for in the time-series data.

Forecasting

Future growth in output of the water transportation industry was predicted using linear regression. A linear trend line was fit to the 1991-1998 economic value data. This data was believed to be representative of future growth in this industry. The resulting coefficient of variation (R^2) is 0.957. A coefficient of variation close to one indicates a very good fit of the trend line to the data. The predicted future growth of Arkansas water transportation is presented in Exhibit 15 of the Results section.

Results

Economic Impacts

This section contains the results of the input-output analysis, specifically the total economic impacts of port activities on the state of Arkansas. The impacts are broken down by type (output, earnings, and employment) and industry (water transportation and dependent industries). Exhibits 12, 13, and 14 present the economic value, employee earnings, and employment impacts respectively.

Exhibit 12 contains economic value impacts of water transportation on the Arkansas economy. Economic value can be thought of as what others are willing to pay for associated activities. As described in the Methodology section, the 1998 Gross State Product (GSP) is used as the measure of value in this analysis. This graph shows the following:

- Water transportation directly impacts Arkansas by contributing a GSP of \$35 million,
- Water transportation indirectly contributes an additional \$23 million through indirect value impacts on other industries,

- The Arkansas industries that are dependent on water transportation contribute \$484 million to the total 1998 Gross State Product of the state (\$34,597 million), and
- The indirect value impacts affected by the dependent industries total \$270 million.
- Therefore, the total impact on the economic value of the Arkansas economy is \$811 million.

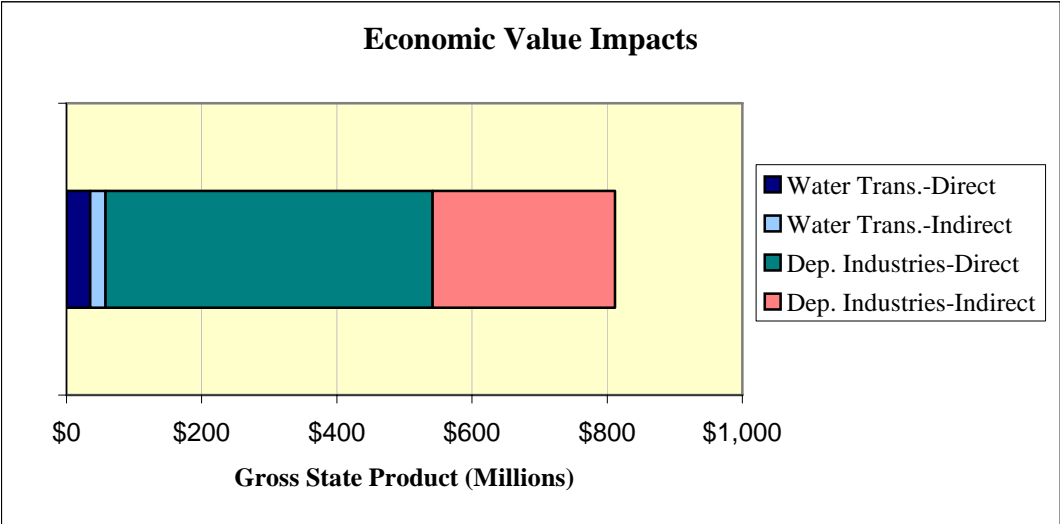


Exhibit 12 Economic Value Impacts

Exhibit 13 presents the economic impacts that the water transportation industry has on earnings of Arkansas employees in this industry. The significant findings are:

- The direct water transportation Employee Earnings in the state of Arkansas are \$23 million,
- These direct earnings indirectly impact an additional \$24 million in employee earnings for the state of Arkansas,
- Arkansas industries that are dependent on water transportation have a direct economic impact of \$241 million in employee earnings, and
- These industries indirectly contribute an additional \$234 million in employee earnings to the state.
- The total impact of water transportation on the state of Arkansas is \$561 million.

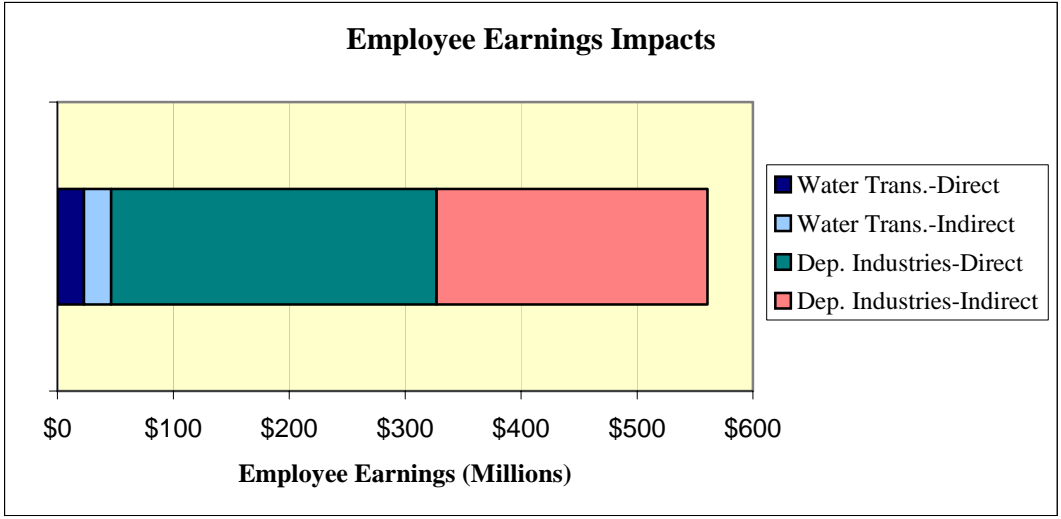


Exhibit 13 Employee Earnings Impacts

The third economic indicator that was analyzed is the number of people employed. Exhibit 14 contains the results of the input-output analysis for employment. The impacts are as follows:

- There are 500 people directly employed in the water transportation industry in Arkansas,
- An additional 603 people are employed as a result of indirect impacts of water transportation employees,
- Dependent industries directly employ 7,910 people in the state of Arkansas, and
- These direct employees indirectly induce an additional 8,405 jobs.
- Therefore, the total number of Arkansas jobs created as a result of its water transportation industry is 17,418.

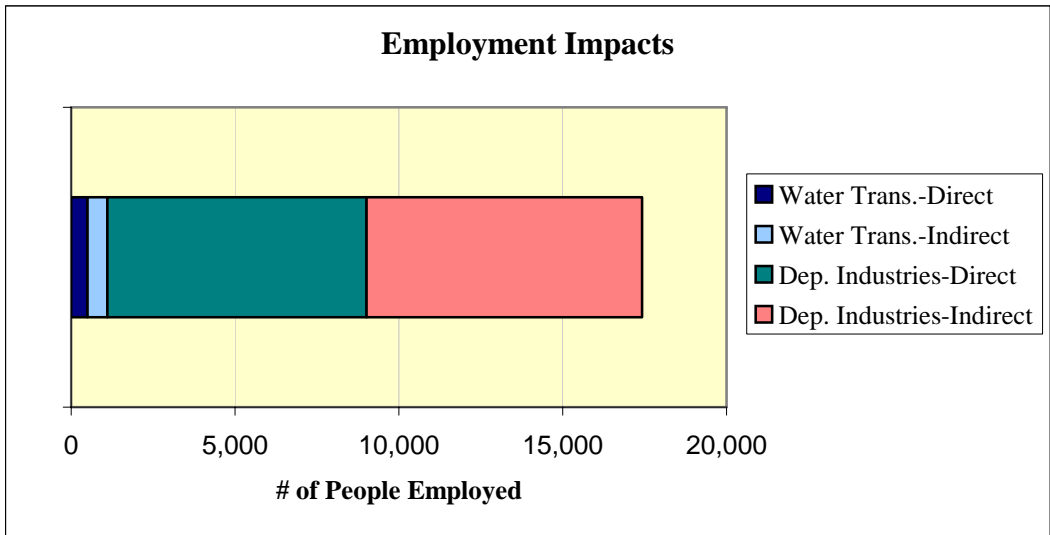


Exhibit 14 Employment Impacts

Taxes

A study conducted by Mercer Management Consulting¹¹ in 1995 indicates the following significant facts:

- Arkansas' inland water transportation industry generates \$2.4 million in payroll taxes for the Federal and State governments, and
- Arkansas-based industries account for over \$165 million in annual payroll taxes.

Water Transportation

The historical direct and total economic impacts of water transportation on the Arkansas economy are shown in Exhibit 15. The direct and total output of water transportation has grown over the last 21 years. Results of the forecasting analysis indicate that this increasing trend will continue. Exhibit 15 shows that it is predicted that the total impact of water transportation on the economic output of Arkansas will grow to \$89 million by the year 2005. This is a 53% increase from 1998 economic output (GSP) of Arkansas water transportation.

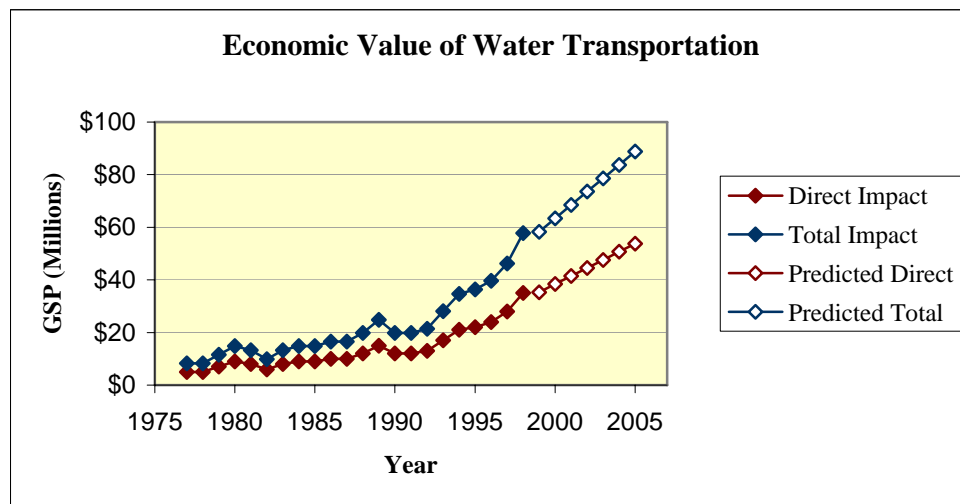


Exhibit 15 Economic Value of Water Transportation

Summary

The results of the study indicate that Arkansas port activities directly and indirectly contribute to the economic growth of this state. It is predicted that these impacts will continue to increase in the future. Increased support and development of ports in Arkansas will increase port activities and can positively affect the economy of this state.

Related Studies

Similar economic impact studies of the waterways have been conducted by other states. Indiana, Louisiana, Mississippi, and Oklahoma are four states that have recently conducted studies to analyze the economic impacts of their waterways. Each of these studies is discussed in this section.

Indiana

A 1997 study¹⁰ was conducted by the Center for Urban Policy and the Environment at Indiana University. Of all the related studies summarized in this section, the methodology utilized in this study is most similar to the methodology employed in the Arkansas study discussed in this report. Their research team utilized an input-output model to estimate impacts of port activities on the Indiana economy.

The following important findings resulted¹⁰:

- Ports contributed over \$600 million income and provided more than 6,000 jobs, along with \$12 million in state and local taxes,
- The agricultural industry strongly benefited from port activities, and
- It is estimated that farmers incurred 10% lower transportation costs shipping via waterways.

On September 28, 2000, Congressman Pete Visclosky (D-Merrillville) announced a total investment of \$17,722,000 for waterway projects in Northwest Indiana. The Congressman stated, “By investing in infrastructure projects such as these, new jobs will be created and the region’s economic viability will be enhanced.” The funds were approved as part of the Conference Report of the 2001 Energy and Water Appropriations Act.

Louisiana

In 1997, the University of New Orleans conducted a survey¹⁷ to calculate the average spending or employment of a port-related firm. In addition, they utilized regional multipliers to estimate the total impact of port users on the state of Louisiana.

The following statistics regarding spending and income generated from port activities resulted¹⁷:

- Port industries spent over \$9 billion
- The total economic impact of port users was approximately \$19 billion, which is 28% of Louisiana’s total gross state product
- Over \$400 million in state taxes was generated
- Water transportation alone accounted for over 17,000 jobs and nearly \$100 million in state and federal payroll taxes

Mississippi

The state of Mississippi conducted a survey¹⁴ in January 2000 to model the economic impact of port development. In addition, forecasting techniques were employed to predict future port traffic.

Major findings of the study are as follows¹⁴:

- Mississippi ports contributed 3% or \$1.4 billion to the total Mississippi economy
- Mississippi ports contributed approximately \$50 Million in state taxes
- They also recognized the need to develop their ports in order to compete with neighboring states, such as Arkansas
- Water transportation alone accounts for over 1,700 jobs and \$13 million in state and federal taxes each year

The state of Mississippi provides state tax relief to shippers that use public ports based on expenditures.

Oklahoma

Oklahoma’s recent study focused on the economic impacts associated with continued development of the McClellan-Kerr River. The goals of the study were to assess the existing condition of waterway development and highlight potential improvements.

The study concluded that¹⁸:

- The state's total domestic waterborne commerce each year amounts to nearly 4 million tons, worth over \$1.3 billion
- Oklahoma ports generate \$2 billion in sales annually
- Oklahoma ports have contributed \$35 billion over the last 35 years
- Nearly all of this waterborne commerce travels through Arkansas on the Arkansas River

Summary

This section discusses four other states that have analyzed the economic impacts of port activities on their states. The purpose of these studies was to assess the benefits of developing ports, waterways, and multi-modal sites. Each of these states has recognized the impact of port activities on local economies. These states' governments are participating by providing support, services, and funding²².

Conclusions and Future Work

The results of this study indicate that port activities directly and indirectly contribute to the Arkansas economy. With its abundance of navigable waterways and strategic location, it is imperative that Arkansas continues to develop its ports and waterways to remain competitive. There is regional competition for federal funds allocated for waterways; those states that are active proponents receive more attention and more funding²². In addition to federal funding, local ports in Arkansas need state assistance in planning, development and marketing²². Arkansas legislature recently passed Act 1546, which allows for establishment of "rules and regulations for eligibility for awarding funds to any public port authority to aid in the development of port infrastructure⁶." At this time, no financial appropriations have been made to support this program.

Potential areas for further analysis include:

- Arkansas industries could be surveyed to verify the estimated percent dependence on port activities
- The economic impacts of each port or potential ports could be assessed individually
- Port tenants are tenant firms that operate on leased land surrounding ports. Multiple ports of Arkansas contain industrial parks where port tenants can operate. The economic impacts of Arkansas port tenants could be determined and included in the total impact on the economy¹⁰.

References

- [1] 1997 Economic Census Comparative Statistics for United States (1987 SIC Basis) website, <http://www.census.gov/epcd/ec97sic/RANKUSE.HTM>.
- [2] Arkansas Department of Economic Development, "Arkansas Waterways Cruising Through America's Heartland."
- [3] Arkansas Governor's Conference on Waterborne Transportation, "Waterways: A Value-Added Transportation System," August 2000.
- [4] Arkansas Waterways Commission official website, <http://waterways.dina.org>.

- [5] Arkansas Waterways Commission, "Our Navigable Rivers: Nature's Freeways Biennium Report," February 1998.
- [6] Arkansas Waterways Commission, "The Flow of Arkansas Waterways," Vol. 3, No. 2, Spring 2001.
- [7] Arkansas Waterways Commission, "The Flow of Opportunities in Arkansas."
- [8] Bureau of Economic Analysis Regional Multiplier Product website, http://www.bea.doc.gov/bea/uguide.htm#_1_32.
- [9] Leontief, W., Input-Output Economics (New York: Oxford University Press, 1986).
- [10] Littlepage, L., D. Klacik, M. Przybylski, and S. Payton, "The Ports of the Indiana Port Commission: Economic Impacts and Economic Development, January 1997.
- [11] Mercer Management Consulting, "The Importance of Inland and Intracoastal Waterways to State Economies," August 1995.
- [12] Miernyk, W. H., The Elements of Input-Output Analysis (New York: Random House, 1965).
- [13] O'Connor, R., Input-Output Analysis and its Applications (London: Griffin, 1975).
- [14] Parsons Brinckerhoff Quade & Douglas, Inc, "Comprehensive Assessment of the Ports of Mississippi," January 2000.
- [15] REEBIE Associates, "Arkansas Highway Department Transearch Database," 1998.
- [16] Regional Economic Information System website, <http://fisher.lib.virginia.edu/reis/>
- [17] Ryan, T. P., "The Economic Impacts of the Ports of Louisiana and the Maritime Industry, March 1998.
- [18] Tulsa District, Corps of Engineers, "Continuing Development of the McClellan-Kerr Arkansas River Navigation System, August 2000.
- [19] U.S. Department of Commerce, "Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System," March 1997.
- [20] Waterborne Commerce Statistics Center, "1999 State to State Public Domain Data Base."
- [21] Waterways Branch of OKDOT, AR Dept. of Economic Development, and AR Waterways Commission, "Directory of River Ports and Terminals on the McClellan-Kerr Arkansas River Navigation System in Arkansas and Oklahoma."

[22] W.R. Coles and Associates, "General Assessment of Ports and Waterways in Arkansas," August 1998.

Contact Information

Heather Nachtmann, Ph.D.
Department of Industrial Engineering
University of Arkansas
4177 Bell Engineering Center
Fayetteville, AR 72701
(479)575-5857 (phone)
(479)575-8431 (fax)
hln@uark.edu (email)

Arkansas Waterways Commission
101 East Capitol Ave. Suite 370
Little Rock, AR 72201
501-682-1173 (phone)

Mack Blackwell Transportation Center
4190 Bell Engineering Center
University of Arkansas
Fayetteville, AR 72701
479-575-6026 (phone)
479-575-7168 (fax)